Hamersley HMS

Hope Downs 4 Iron Ore Project

Response to Submissions

Prepared for
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By Strategen

strategen

August 2010

Hope Downs 4 Iron Ore Project

Response to submissions

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Client: Hamersley HMS Pty Ltd

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Preliminary Draft Report	V1	TS/MB	AP	1 electronic	29/04/2010
Draft Report	V1a	TS/MB	AP	1 electronic	10/05/2010
	V1b	TS/MB	AP	1 electronic	
Final Report	FINAL	TS	AP/WM	1 electronic	21/05/2010
Final Report 2	FINAL2	JN	JN	-	14/07/2010
Final Report 3	FINAL3	JN	JN	-	29/07/2010
Final Report 4	FINAL4	JN	JN	-	17/08/2010

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1. INTRODUCTION

The following document is a summary of, and responses to, submissions made on the Public Environmental Review (PER) for the Hope Downs 4 Iron Ore Project proposed by Hamersley HMS Pty Ltd. It also describes changes made to the proposal since the release of the PER for public review in January 2010.

1.1 HOPE DOWNS 4 IRON ORE PROJECT

The Proponent[1], Hamersley HMS Pty Ltd, on behalf of the Hope Downs Joint Venture Participants is evaluating the development of the Hope Downs 4 Iron Ore Project (the Proposal), an above and below the water table greenfields iron ore mine and associated infrastructure located in the east Pilbara region of Western Australia. The Hope Downs 4 iron ore deposit includes four potential mining zones with a known high grade resource of approximately 347 million tonnes (Mt) and a low grade resource of approximately 141 Mt. The Proposal involves the development and operation of an iron ore mine with a potential throughput of up to 30 million tonnes per annum (Mtpa) dry ore. An infrastructure corridor containing rail, communications and power infrastructure, approximately 52 to 65 km in length (depending on the route option selected) will also be constructed to extend services that connect the existing Hope Downs 1 Iron Ore Mine (HD 1) to the Pilbara Coast.

The Proponent will undertake mining within a designated mining area at Hope Downs 4 in four main pit zones. The designated mining area will include mineral waste rock dumps and operational infrastructure. Site preparation at the mining area also involves the realignment of a 2.5 km section of Coondiner Creek.

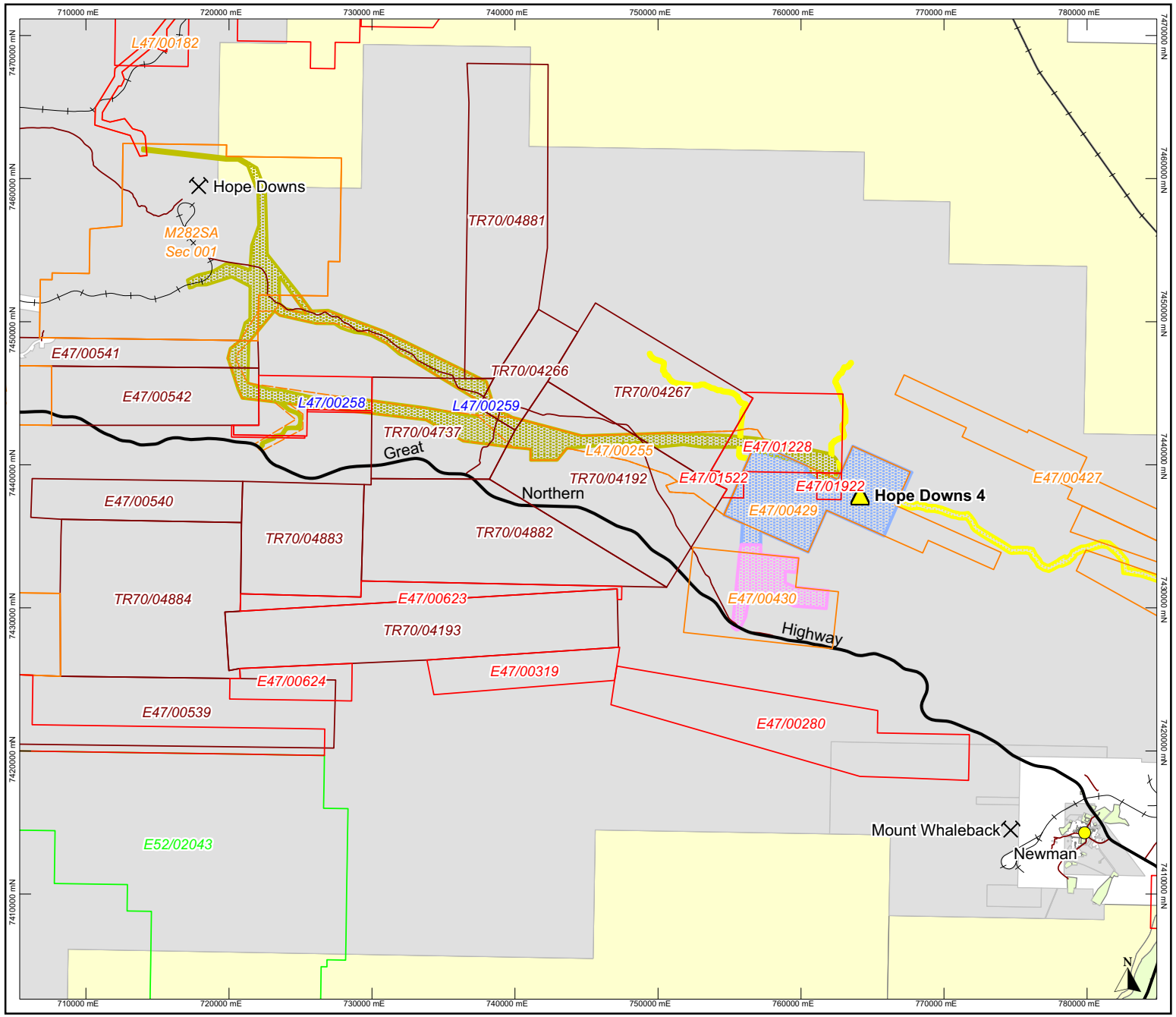
Approximately 80% of the ore resource to be mined occurs below the water table and thus access to this resource will require dewatering of the ore body aquifer. Initially abstracted water from dewatering will be used to supply on-site operational demand, however once excess water exceeds this demand it will be transferred or discharged off-site. The management of possible excess water is currently subject to a detailed feasibility study. Environmental baseline studies undertaken for the PER have taken into account potential environmental and social impacts, engineering, cost and tenure considerations. As indicated in Section 7.1 of the PER, the construction of and abstraction from groundwater bores for construction and potable water is subject to separate environmental approvals and not considered as part of this Proposal.

1.2 CHANGES TO PROPOSAL SINCE RELEASE OF PER

1.2.1 Amended tenure figure

Figure 10 (Land use and tenure) in the PER has been amended following responses from surrounding landholders identifying that land tenure was not correctly described. This amended tenure figure is included here as Figure 1. The changes to this figure do not have any implications for the environmental impact assessment presented in the PER.

[1] The Proponent for the Hope Downs 4 Iron Ore Project is a member of the Rio Tinto Group.



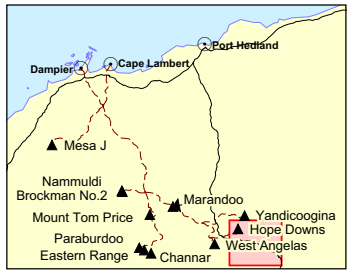
LEGEND

Area Within Which Distubance Will Occur

- Infrastructure Corridor
- Mining Area
- Excess Water Pipeline Options
- Accommodation Area and Access

- Hope Downs 4
- Town
- Railway
- Road
- Highway
- Hamersley Iron (HI)
- ROBE
- Hope Downs Joint Venture (HDJV)
- Rhodes Ridge Joint Venture (RRJV)
- Rio Tinto Exploration (RTX)
- Pending HDJV Tenure
- Crown Land
- Pastoral Lease
- Reserve

LOCATION MAP



SCALE

10 0 10km

1:400 000 @ A4

Hamersley HMS

Figure 1 Updated land use and tenure figure

Drawn: H Priest
Date: Jan 2010

Plan No. PDE0057294v6
Proj: MGA94 Zone 50

1.2.2 Minor changes to Proposal footprint

Since the release of the PER, minor changes have been made to the Proposal component polygons that indicate the area in which impacts may occur. These were originally presented in Figure 2 of the PER. These minor changes outlined below and summarised in Table 1, only increase the area of the Proposal component polygons and do not increase the previously nominated total clearing indicated in Table 5 and Table 12 of the PER. These minor changes increase the total area of Proposal component polygons from 18 910 ha to 20 135 ha while the total proposed clearing is unchanged at approximately 5470 ha (i.e. less than 30% of the total Proposal area).

The revised polygon areas are a result of the evolution and optimisation of the proposed project areas, including the optimisation of environmental opportunities, which include but are not limited to minimising clearing and avoidance of locally conservation significant vegetation communities and conservation significant flora species.

The implications of the modifications to the component polygons on the flora and vegetation impact assessment presented in Section 15.3.1 of the PER is discussed in Section 2.1.2 of this document.

Table 1 Environmental footprint of the Proposal (key characteristics) revised

Environmental impact/aspect	Proposal component	Area of Proposal component polygon within which disturbance will occur indicated in PER	Revised area of Proposal component polygon within which disturbance will occur	Extent of impact indicated in PER
Vegetation/fauna habitat disturbance changes	Mining area	5780 ha	5805 ha	Up to 4000 ha of ground disturbance No change
	Infrastructure corridor	8890 ha	9960 ha	Up to 1100 ha of ground disturbance (depending on route selected) No change
	Excess water discharge infrastructure	2520 ha	2520 ha No change	Up to 180 ha of ground disturbance (depending on option and route selected) No change
	Accommodation area	1720 ha	1850 ha	Up to 190 ha of ground disturbance No change

Mine area

The proposed mine area component polygon has been slightly modified to accommodate two small additions to the mine area without increasing the requirement for total clearing. These changes include:

- the relocation of the switch yard/substation to avoid a proposed waste dump location
- realignment of the main access road and associated services corridor at the southern edge of the mine area boundary.

The amended area is illustrated in Figure 2.

Accommodation and access area

Changes to the proposed accommodation and access area component polygon comprise of an expanded area to the west of the camp/village without increasing the requirement for total clearing. The changes to this area are required to cover relocation and optimisation of the spray field associated with the waste water treatment plant. The relocation of the spray field has optimised avoidance of the M1 mulga community.

The amended area is illustrated on Figure 2.

Infrastructure corridor

Changes to the proposed infrastructure corridor component polygon have been made to accommodate refinements to the rail and power related requirements for the Proposal without increasing the requirement for total clearing. These changes include:

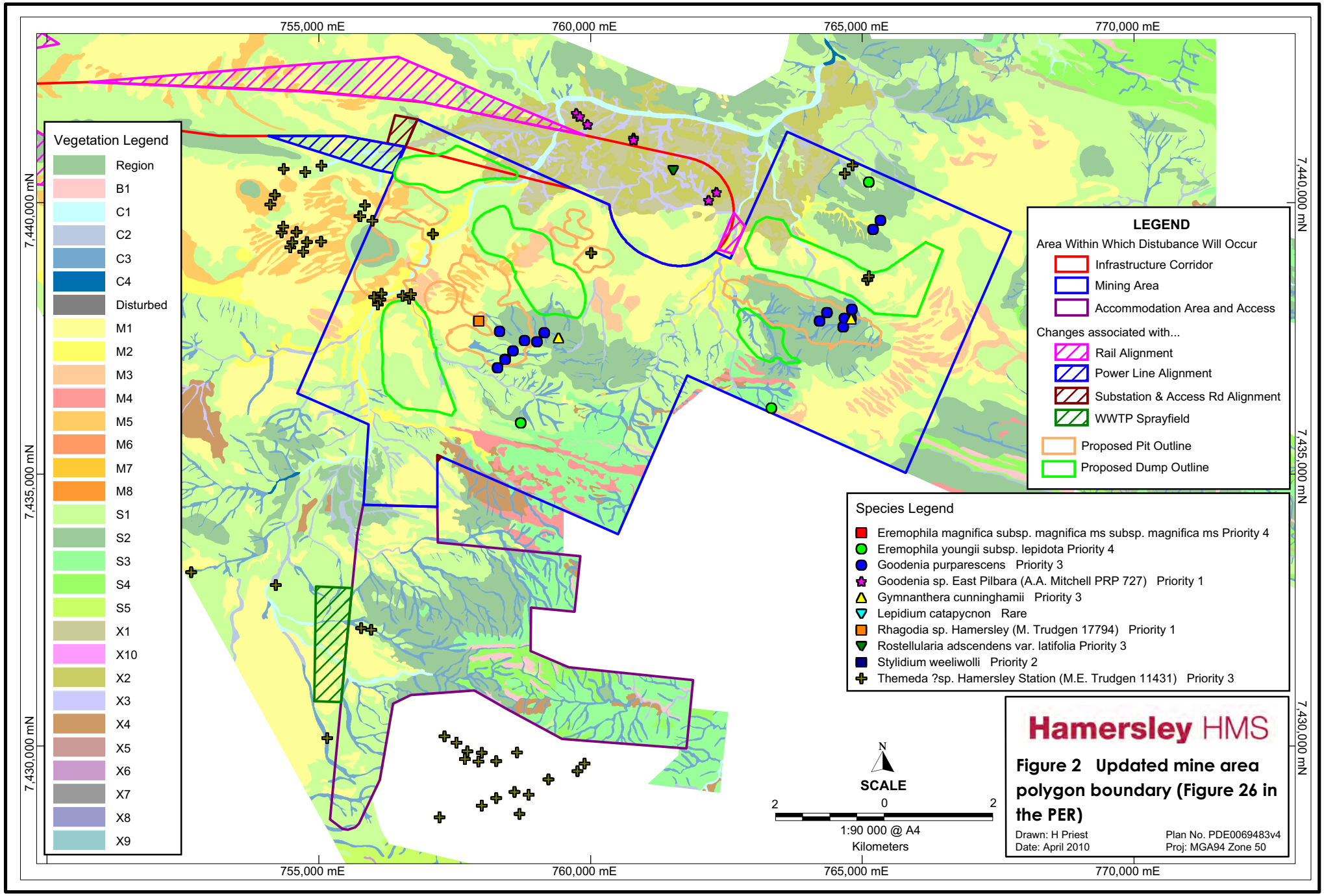
Power

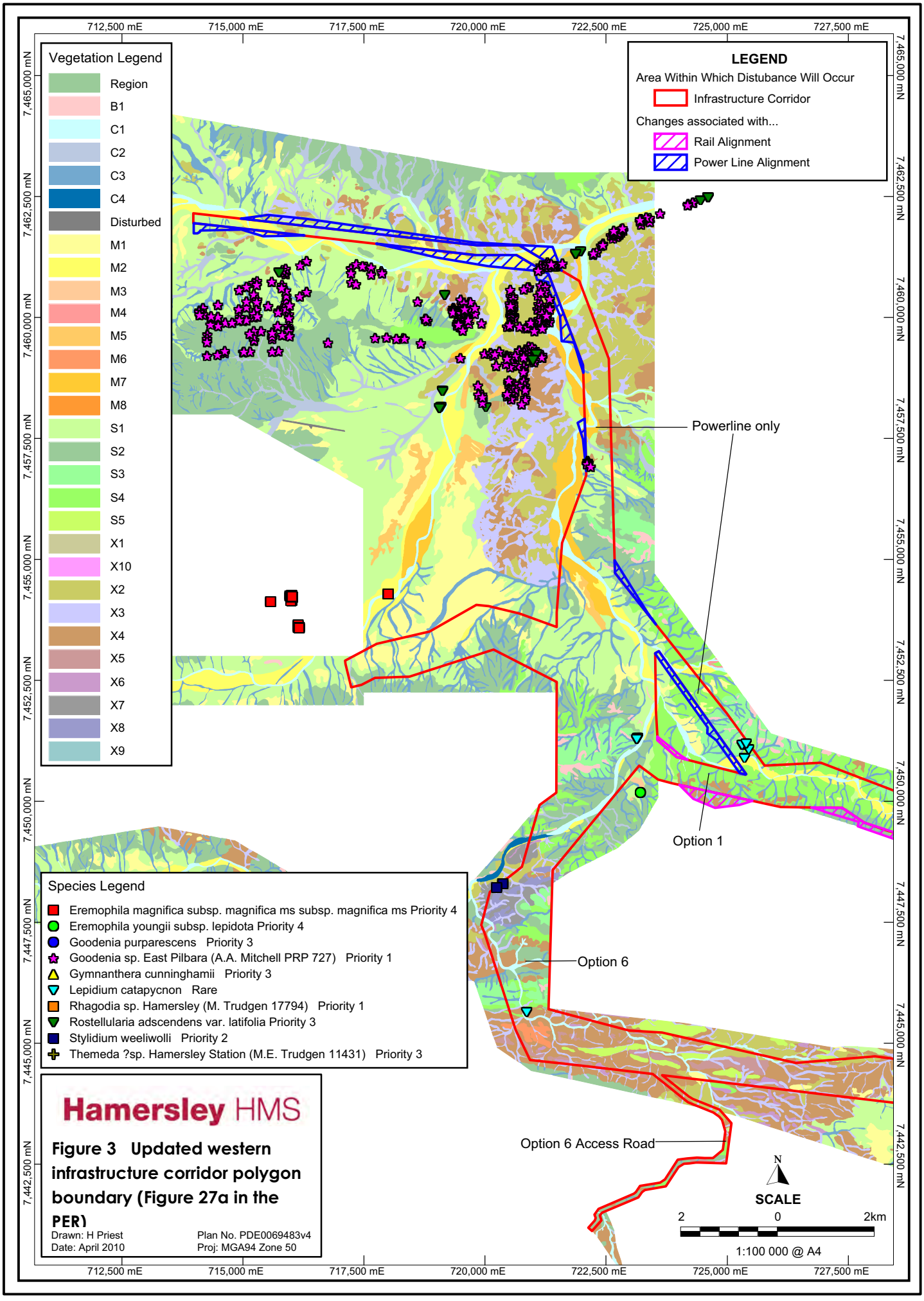
- an area at eastern end of the power corridor to optimise the construction laydown and support areas so as to avoid heritage sites identified during surveys
- areas at the north western end of the power corridor on the HD1 mining lease. Due to the occurrence of Priority Flora in this area of the corridor a larger area is required to provide the opportunity to optimise the detailed design of the area to allow for the avoidance of Priority Flora
- along the north south segment on the HD1 mining lease, the additional polygon areas allow optimisation of the construction and maintenance access needs from existing access points (i.e. reduce clearing requirements)
- along the east west segment between HD1 and in the vicinity of Rhodes Ridge, the additional polygon areas are required to allow for the optimisation of the rail alignment through this sector.

Rail

- several areas along the western end of the rail corridor to facilitate the realignment of the existing public road and installation of appropriate signalling equipment
- one area to the west of the corridor to optimise the avoidance of several significant heritage sites identified during surveys
- an area to the west of the corridor to reduce the impact to a creek system and improve the underpass crossing of the existing BHPB power line
- several areas to the east of the corridor to obtain good quality borrow material
- an area associated with the Coondiner Creek area to facilitate a lower impact creek crossing; the new location avoids the need for two crossings of Coondiner Creek and results in a shorter bridge length
- an area to the east of the rail loop to facilitate construction access between the rail corridor and the mine area.

The amended areas are illustrated on Figure 3 and Figure 4.


755,000 mE
760,000 mE
765,000 mE
770,000 mE
7,440,000 mN
7,435,000 mN
7,430,000 mN
Vegetation Legend
Region
B1
C1
C2
C3
C4
Disturbed
M1
M2
M3
M4
M5
M6
M7
M8
S1
S2
S3
S4
S5
X1
X10
X2
X3
X4
X5
X6
X7
X8
X9
LEGEND
Area Within Which Distubance Will Occur
Infrastructure Corridor
Mining Area
Accommodation Area and Access
Changes associated with...
Rail Alignment
Power Line Alignment
Substation & Access Rd Alignment
WWTP Sprayfield
Proposed Pit Outline
Proposed Dump Outline
Species Legend
Eremophila magnifica subsp. magnifica ms subsp. magnifica ms Priority 4
Eremophila youngii subsp. lepidota Priority 4
Goodenia purparescens Priority 3
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727) Priority 1
Gymnanthera cunninghamii Priority 3
Lepidium catapycnon Rare
Rhagodia sp. Hamersley (M. Trudgen 17794) Priority 1
Rostellularia adscendens var. latifolia Priority 3
Stylidium weeliwolli Priority 2
Themeda ?sp. Hamersley Station (M.E. Trudgen 11431) Priority 3
N
SCALE
2 0 2
1:90 000 @ A4
Kilometers
Hamersley HMS
Figure 2 Updated mine area polygon boundary (Figure 26 in the PER)
Drawn: H Priest
Date: April 2010
Plan No. PDE0069483v4
Proj: MGA94 Zone 50

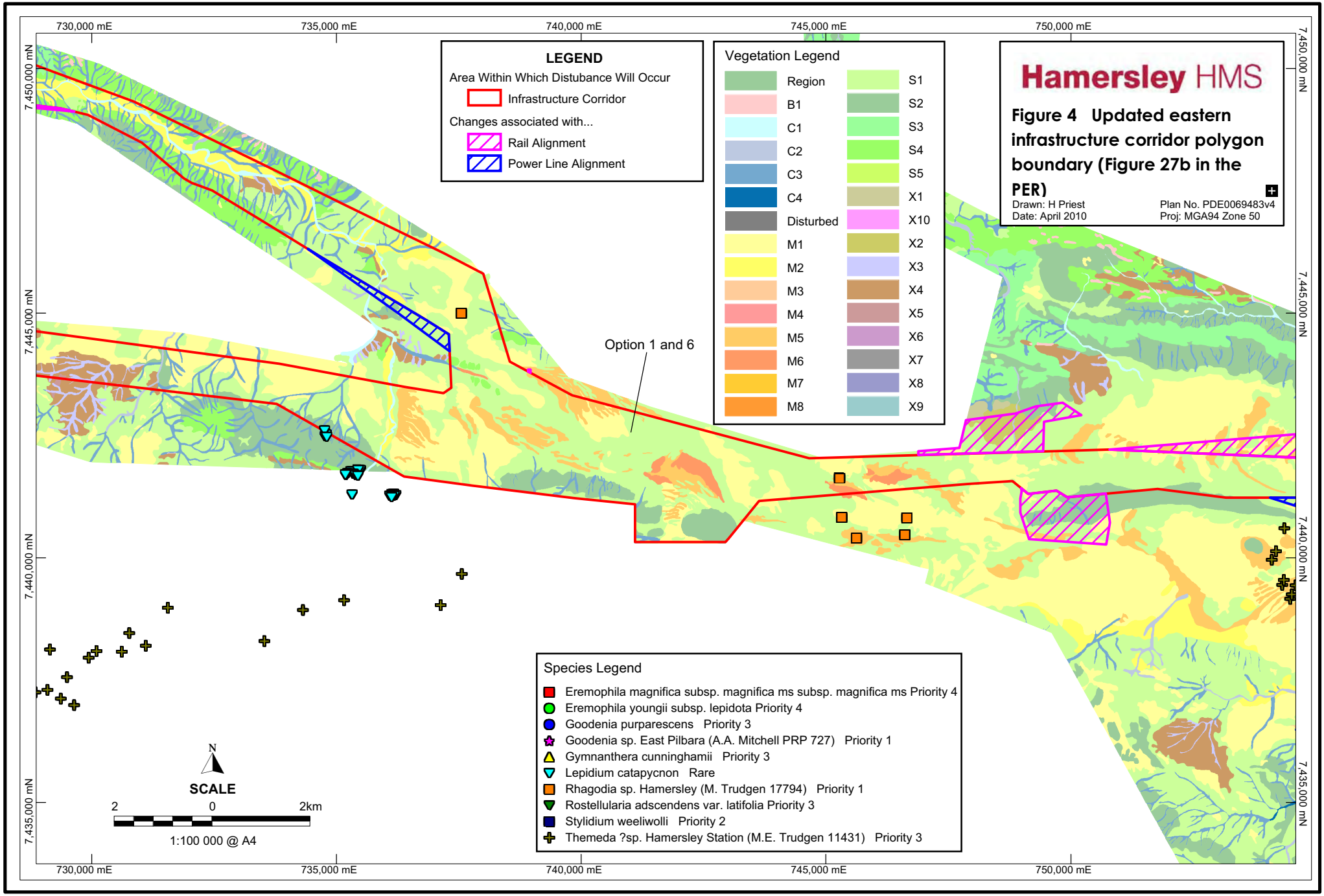


Hamersley HMS

Figure 3 Updated western infrastructure corridor polygon boundary (Figure 27a in the PER)

Drawn: H Priest
Date: April 2010

Plan No. PDE0069483v4
Proj: MGA94 Zone 50


730,000 mE
735,000 mE
740,000 mE
745,000 mE
750,000 mE
7,450,000 mN
7,445,000 mN
7,440,000 mN
7,435,000 mN
LEGEND
Area Within Which Distubance Will Occur
Infrastructure Corridor
Changes associated with...
Rail Alignment
Power Line Alignment
Vegetation Legend
Region
B1
C1
C2
C3
C4
Disturbed
M1
M2
M3
M4
M5
M6
M7
M8
S1
S2
S3
S4
S5
X1
X10
X2
X3
X4
X5
X6
X7
X8
X9
Option 1 and 6
Hamersley HMS
Figure 4 Updated eastern infrastructure corridor polygon boundary (Figure 27b in the PER)
Drawn: H Priest
Date: April 2010
Plan No. PDE0069483v4
Proj: MGA94 Zone 50
Species Legend
Eremophila magnifica subsp. magnifica ms subsp. magnifica ms Priority 4
Eremophila youngii subsp. lepidota Priority 4
Goodenia purparescens Priority 3
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727) Priority 1
Gymnanthera cunninghamii Priority 3
Lepidium catapycnon Rare
Rhagodia sp. Hamersley (M. Trudgen 17794) Priority 1
Rostellularia adscendens var. latifolia Priority 3
Stylidium weeliwolli Priority 2
Themeda ?sp. Hamersley Station (M.E. Trudgen 11431) Priority 3
N
SCALE
2
0
2km
1:100 000 @ A4

1.2.3 Clarification of excess water management options

As described in the PER, investigations are ongoing to determine the feasibility of the various excess water (dewatering/abstracted) management options for the Hope Downs 4 Iron Ore Project. These investigations will determine the most feasible option/s available.

The Proponent can advise the Office of the Environmental Protection Authority (OEPA) that discharge of excess water to Ophthalmia Dam will not be pursued further as an excess water management option for the Hope Downs 4 Iron Ore Project. As stated in the PER (page 41), the Ophthalmia Dam structure is owned and operated by BHPBIO and pursuing this option would require the construction of a pipeline in excess of 40 km (from the proposed discharge location on Kalgan Creek). A meeting was held with BHPBIO on 16 March 2010 to discuss the Hope Downs 4 Iron Ore Project and the Ophthalmia Dam option in particular. At this meeting BHPBIO indicated that Ophthalmia Dam is at capacity and is unlikely to be able to accommodate additional inflow from the Hope Downs 4 Iron Ore Project. This, combined with the economic implications of constructing a pipeline to the Dam, has resulted in a decision not to pursue this option further.

The option to transfer of excess water to the Hope Downs 1 operation to meet onsite water requirements and post-closure environmental obligations at that operation will continue to be investigated by the Proponent. Ministerial Statement 584, which applies to Hope Downs 1, requires the Weeli Wolli Spring to be maintained post closure until the natural groundwater system has been re-established. Sourcing water from Hope Downs 4 exists as an opportunity to either speed up the aquifer recovery or to directly maintain spring flow at the Weeli Wolli Spring. Should reinjection be undertaken post-closure at Hope Downs 1, it will be undertaken in accordance with the relevant Conditions and Proponent Commitments contained in Ministerial Statement 584 and other appropriate approvals will be obtained (e.g. licence from the DEC). The Proponent can confirm that no other Rio Tinto Iron Ore (RTIO) mines, including the RTIO Yandicoogina operation and proposed expansions (e.g. Oxbow), propose to discharge excess water via the existing gabion discharge outlet on Weeli Wolli Creek that is associated with the Hope Downs 1 mine.

However, it should be noted that this option is contingent on alignment of scheduling (i.e. coincidence of water surplus and water deficit) at both the Hope Downs 1 and 4 operations. The Proponent recognises that it is the preference of the various State agencies for excess water to be transferred to offsite users; however, this option will continue to be problematic and cost-prohibitive in most instances (especially given the remoteness of the Hope Downs 4 Iron Ore Project). Therefore, discharge to creeklines will continue to play an important role in the management of excess water for remote operations.

The Proponent can advise the OEPA that discharge of excess water to Mindy Mindy Creek will not be pursued further. This is due to a number of reasons, including the possible need to construct a dam-like structure at the discharge location, the steep terrain required to be crossed by the pipeline and the relatively undisturbed nature of the creek system. The Proponent can advise the OEPA that discharge to Kalgan Creek (downstream of Kalgan Pool) will be pursued in preference to discharge to Coondiner Creek (downstream of Eagle Rock Falls). Therefore, the design of the discharge infrastructure to Kalgan Creek will be taken forward in the next stages of engineering design for the Proposal. At this stage, the Proponent does not intend to pursue multiple-creek discharge (alternating or shared-continuous) as part of the excess water management strategy; however, the Proponent would like to keep Coondiner Creek in the scope of the Proposal under assessment as a contingency discharge option. That is, should the discharge of excess water to Kalgan Creek approach or exceed the triggers

developed as part of the Adaptive Surface Water Management Plan (PER, Appendix 2) consideration will be given to discharge to an alternate creek (i.e. Coondiner Creek).

1.3 ASSESSMENT PROCESS

The Proposal was referred to the Environmental Protection Authority (EPA) under section 38 of the *Environmental Protection Act 1986* (WA) (EP Act) on 2 May 2008. In June 2008, the EPA determined the Proposal would be assessed at the level of PER with an eight week public review period. In accordance with the EP Act, a PER document was prepared which described the proposal and its likely effects on the environment (Hamersley HMS 2010). The PER was released for public comment on 11 January 2010, with the public submission period closing on 8 March 2010.

1.4 PURPOSE AND STRUCTURE OF DOCUMENT

The Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002 state that the Proponent is required to prepare a summary of the pertinent issues raised in public and government agency submissions. The Proponent is then required to respond in writing to the summary of issues and any other issues the OEPA considers need to be addressed and, where appropriate, amend the proposal and environmental commitments.

The purpose of this document is to provide a summary of submissions on the Hope Downs 4 PER and respond to the matters raised in the submissions. Submissions and responses have been grouped according to the environmental factor they addressed (e.g. flora, fauna, surface water).

This document comprises five sections as follows:

1. **Introduction:** outlines the Proposal and changes made to the proposal since the release of the PER the environmental impact assessment process and the purpose and structure of the document.
2. **Supporting information:** describes additional supporting information and studies undertaken/collated since the release of the PER and investigations proposed to be undertaken.
3. **Ongoing consultation:** describes further consultation proposed to be undertaken.
4. **Summary of submissions received:** summarises the submissions received from government agencies.
5. **Detailed responses to submissions:** provides detailed Proponent responses to each individual comment raised in the submissions.

Outline of Procedure for PER Assessment

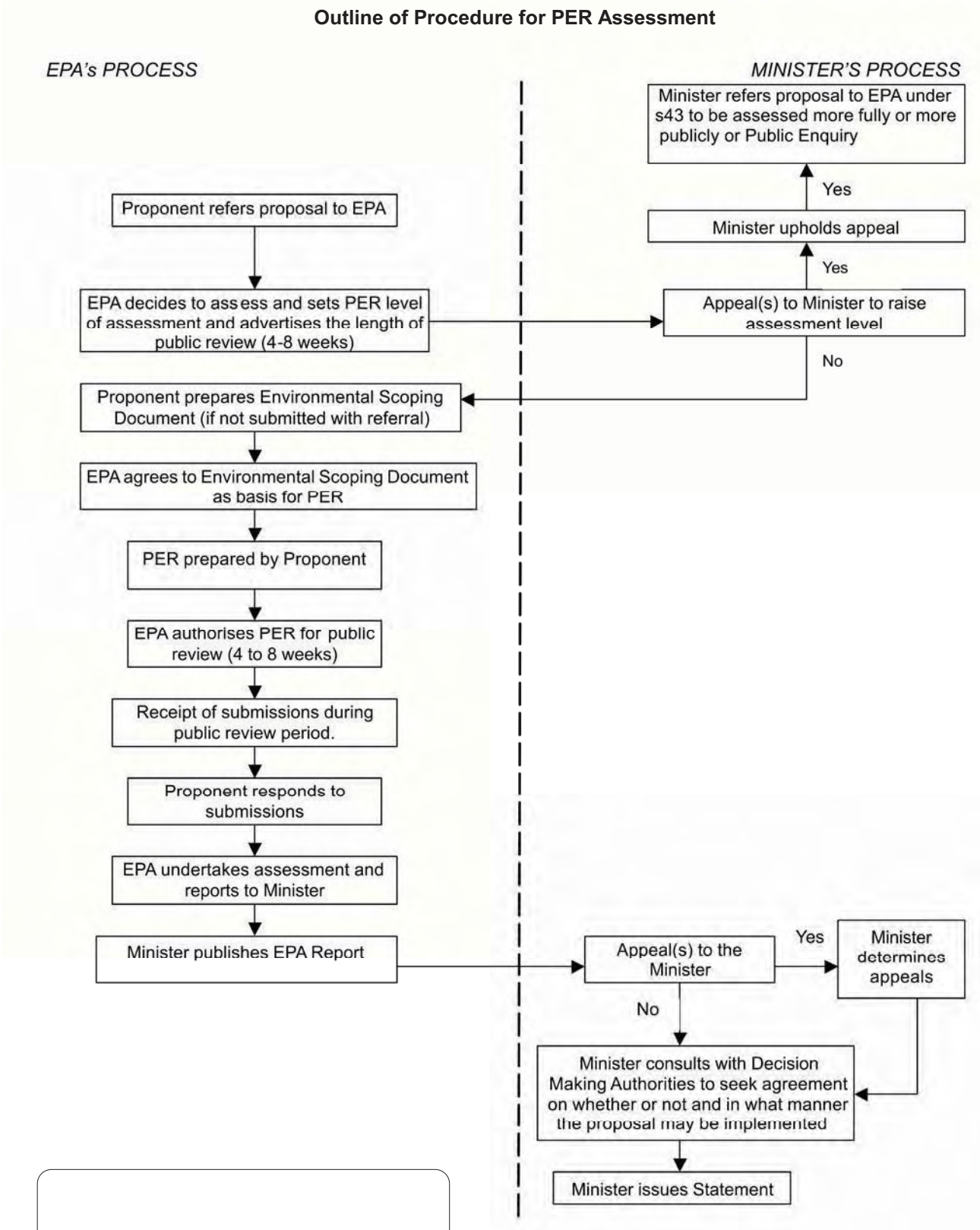


Figure 5 Public Environmental Review (PER) process

Date: August 2008 Plan No: PDE0049509v1

2. SUPPORTING INFORMATION

2.1 OVERVIEW

Since the release of the Hope Downs 4 Iron Ore Project PER for public review in January 2010 the Proponent has:

- collated additional information in relation to the bat survey methodology utilised for the terrestrial fauna surveys
- assessed the effects of the changes to the Proposal component polygons (described in Section 1.1.2) on the flora and vegetation impact assessment presented in the PER
- undertaken additional water chemistry and isotopic tracer studies
- received results from the April 2009 short range endemic survey from the Western Australian Museum.

Results from these works are summarised below in Section 2.2 and full reports have been appended where appropriate.

The PER indicated several surface water, groundwater and ecological related monitoring programs/investigations were either ongoing or due to be implemented as part of the proposed management strategy. Additional information on these ongoing and proposed programs/investigations is summarised below in Section 2.3.

2.2 ADDITIONAL INFORMATION AND STUDIES UNDERTAKEN

2.2.1 Bat survey methodology

It its submission on the PER, the Department of Environment and Conservation (DEC) requested further information regarding the survey methodology and analysis of results used for sampling bats in the Proposal area (refer to Item 2 and 3 of Table 5 for full details). The analysis was undertaken by Specialised Zoological of the acoustic calls recorded by two Anabat SD1 detectors deployed by Ninox Wildlife Consulting. Specialised Zoological outlined the results of analysis undertaken in reports on bat species identifications that were included as appendices to the three Ninox fauna reports (Ninox 2009a, 2009b, 2009c) provided as supporting information to the PER.

Specifically, DEC commented that the works of McKenzie and Bullen (2009) on recording bats in the Pilbara suggested that Anabat system used for the bat analysis for the Hope Downs 4 Iron Ore Project "may miss 50 – 70 per cent of Pilbara Leaf-nosed Bat calls due to software limitations". The DEC therefore considered this method to be inadequate and recommended the use of the Anabat ll ultrasound detectors connected to minidisc recorders in "mono, long-play mode".

The following is a summary of a response to the DEC submission regarding the methodology for recording and analysing bat calls from Dr Kyle Armstrong of Specialised Zoological, and includes technical advice from the manufacturer and designer of Anabat recording device. Dr Armstrong considers it incorrect of the DEC to base their comments on the works of McKenzie and Bullen (2009) as he believes that they have misunderstood how the Anabat system works. Dr Armstrong is considered to be suitably qualified and experienced in analysing bat calls, particularly *Rhinonicteris*

aurantia (Orange Leaf-nosed Bats), as he specialises specifically in bat acoustics and Pilbara bats. In addition, he undertook his PhD degree at the University of Western Australia on the Orange Leaf-nosed Bats and has published extensively on this species and the ghost bat.

The response from Specialised Zoological has been included in full in Appendix 1.

Comparison of methods for recording and analysing bat calls

The number of bat calls recorded would not influenced by whether they are recorded via the Anabat ll detectors connected to Minidisc recorders on long-play mode via an 8-pin DIN jack (as recommended by the DEC in their comment) or the Anabat detector routed internally to the Compact Flash card as happens in an SD1 (as used for the Hope Downs 4 Iron Ore Project) does not affect. Both recording devices receive an output that has already been digitised and converted to a square wave based on zero crossings, subject to a sensitivity threshold, and filtered so that only a proportion of waves are retained (i.e. frequency divided). Therefore, there is no additional information contained on the Minidisc and there can be no extra noise.

While single echolocation pulses will not be saved into a separate Anabat sequence file when the Anabat DAT file is parsed by Anabat/CFC Read software, they can still be viewed in the ZCA and MAP files in AnalookW software. Thus, the Anabat system does not lose information relative to the MiniDisc recording.

AnalookW software (used for analysing the output of the Anabat device) allows the same measurements to be made from a square wave signal as in Cool Edit/Adobe Audition, or any other software that can calculate a power curve (used for the analysing the Minidisc recording).

As a result of this comparison, Dr Armstrong concluded that the method of McKenzie and Bullen (2009) for conducting acoustic surveys for Orange Leaf-nosed Bats is inferior to the standard Anabat system utilised for the Hope Downs 4 Iron Ore Project bat surveys.

2.2.2 Floristic data evaluation

Effect of the modification of Proposal component polygons

The changes to the Proposal component polygons described in Section 1.1.2 increase the area within which the Proposal will be developed; however, the changes do not represent a change to the effective footprint of the Proposal and do not result in an increase in the total clearing indicated in Table 5 and Table 12 of the PER. The changes will increase the total area of the Proposal component polygons from 18 910 ha to 20 135 ha while the total proposed clearing remains unchanged at approximately 5470 ha (i.e. less than 30% of the total Proposal area).

Vegetation communities

The effect of the changes on vegetation communities is an increase in the representation of vegetation communities within the Proposal component polygons (but not necessarily an increase in the area of disturbance to those vegetation communities). No new vegetation communities (not previously represented in the Proposal component polygons) are intercepted. The following vegetation communities are represented in the areas associated with the changes to the Proposal component polygons: B1, C1, C2, C3, M1, M2, M3, M5, M7, S1, S2, S3, S4, X1, X2, X3 and X4.

Of the vegetation communities that are within the changes to the Proposal component polygons, their representation will generally increase by less than 10% of their previous extent within the polygons. The exception is vegetation community X2, which will increase in representation by 17%, however this community is well represented outside the Proposal component polygon. There will be no increase in vegetation community M6 represented in the Proposal component polygons and an increase of only 0.1 ha to vegetation community M3 (refer below for discussion relating to these vegetation communities – Brockman iron cracking clays communities).

As stated in the PER, all vegetation communities recorded within the Proposal area are considered to be widespread and well represented locally and regionally. Some vegetation communities are considered to be of local conservation significance due to their high range/diversity of taxa and the fact that they are known to support taxa of conservation significance including riparian, Mulga and grassland/Spinifex vegetation communities (B1, C1, C3, C4, S1, S2, S3, S4, M1, M2, X2, X4 and X5). The Proposal is likely to require some clearing of these vegetation communities, although they will be preferentially avoided where practicable. These conclusions remain valid when also considering the additional areas associated with the changes to the Proposal component polygons.

The assessment undertaken in the PER (PER, Section 15.3.1, page 121) to understand the regional context of the extent of the proposed vegetation clearing also remains valid. This assessment was undertaken using the total area of the Proposal component polygons (i.e. approximately 18 910 ha); the actual extent of clearing will only be approximately 30% of this (i.e. 5470 ha).

Therefore, the Proponent believes the conclusions made from the vegetation communities' impact assessment in the PER are still valid and are as follows (PER, Section 15.3.1, page 121):

> *Given the representation of vegetation communities outside of the Proposal area, and the management and mitigation measure to be implemented, vegetation clearing is unlikely to significantly affect regional vegetation values.*

Flora species

The only changes made to the Proposal component polygon that have the potential to affect flora species of conservation significance are those made to allow construction of the power line (Figure 3). The changes to the power line corridor will result in the inclusion of 12 new occurrences of *Goodenia* sp. East Pilbara (A. A. Mitchell PRP727) (Priority 1) being located in the polygon. All these new occurrences are in association with the Weeli Wolli Creek crossing area. As stated in the PER, surveys by Mattiske (2008a, 2008b) recorded approximately 400 occurrences of this species outside the Proposal component polygon and over 500 occurrences of this species have been recorded in the Proponent's conservation flora database. Therefore the increase in the number of occurrences of this species in the polygon from 25 to 37 is not considered significant. Further, the occurrence of this species within the changed footprint for the power line alignment does not mean that they will be disturbed. The location of infrastructure will be such that as a preference, disturbance to conservation significant flora will be avoided.

In addition, as the area between the individual power line pylons is not usually cleared, it is expected that the power line will be able to be strung without disturbing Priority Flora locations during construction.

The Proponent believes the conclusions made from the flora impact assessment in the PER are still valid and are as follows (PER, Section 15.3.1, page 125):

> *In regard to significance of impact, most Priority Flora species recorded from the Proposal area are known to occur relatively broadly throughout the Pilbara and are not restricted to the locality of the Proposal area. The location of infrastructure will be such that as a preference, disturbance to conservation significant flora will be avoided. Given the representation of recorded flora species (and the vegetation communities which they are found in association with) outside of the Proposal area, and the management and mitigation measures to be put in place, vegetation clearing is unlikely to significantly affect floral values or the conservation status of any flora species. Following decommissioning, infrastructure will be removed and disturbed areas will be rehabilitated in accordance with the Closure Management Plan (Section 19).*

Additional analysis – Brockman iron cracking clay communities

It its submission on the PER, the DEC commented that the conservation status of vegetation communities M3 and M6 was unclear and could be similar to the Priority Ecological Community (PEC) 'Brockman Iron cracking clay communities of the Hamersley Range' (Priority 1). DEC also commented that the communities needed to be more clearly defined on figures included in the PER (refer to Item 6 of Table 4 for full submission).

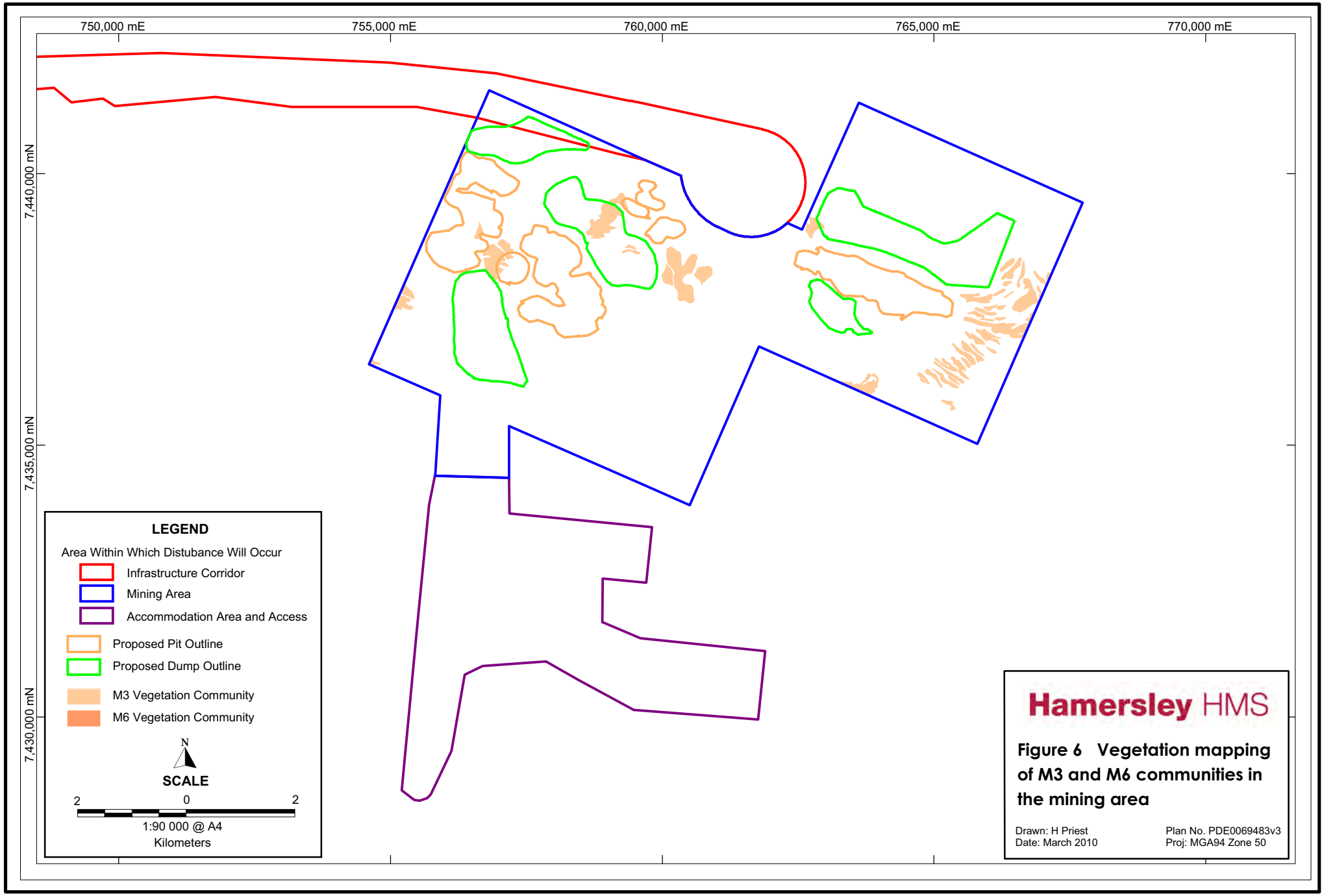
Clarification from DEC in regard to their comments, and detailed floristic data of the PEC, was sought from Stephen van Leeuwen, DEC Principal Research Scientist, in order that a floristic analysis could be undertaken by Mattiske (Appendix 4). In a reply by email (22 March 2010), Stephen van Leeuwen stated that the DEC was unable to provide floristic data on the PEC and rephrased the DEC request. Specifically, the DEC requested:

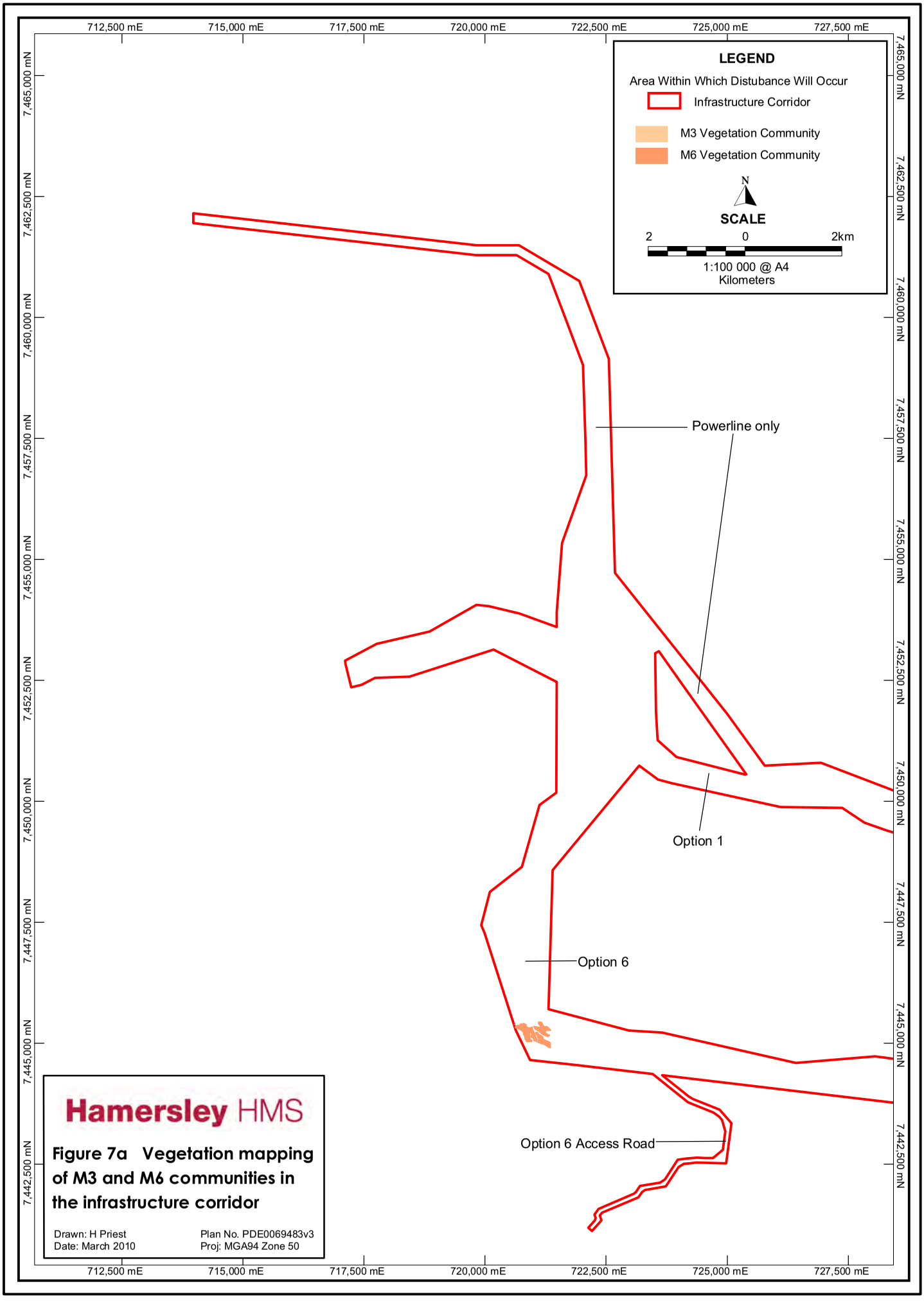
- the species list from quadrats in each of the M3 and M6 vegetation structural types
- better vegetation maps at an appropriate scale and resolution.

To satisfy the DEC request the following tables have been provided:

- species by M3 and M6 communities: Table 1 in Appendix 4 describes the species present in vegetation communities M3 and M6 and reflects the degree of abundance in the respective sites
- species within the M3 and M6 communities by site: Table 2 in Appendix 4 includes the species present at each survey location located within vegetation communities M3 and M6
- vegetation maps: A0 size copies of the vegetation maps have been provided to OEPA with submission of this Response to Submissions document for provision to the DEC.

The mapped extent of these vegetation communities has been presented in Figure 6 to Figure 7b. Both vegetation communities are well represented outside the Proposal component polygons. Less than 25% of the mapped extent of both communities is within the Proposal component polygons (93 ha of 282 ha for the M6 community and 270 ha of 1084 ha for the M3 community).


750,000 mE
755,000 mE
760,000 mE
765,000 mE
770,000 mE
7,440,000 mN
7,435,000 mN
7,430,000 mN
LEGEND
Area Within Which Distubance Will Occur
Infrastructure Corridor
Mining Area
Accommodation Area and Access
Proposed Pit Outline
Proposed Dump Outline
M3 Vegetation Community
M6 Vegetation Community
N
SCALE
2
0
2
1:90 000 @ A4
Kilometers
Hamersley HMS
Figure 6 Vegetation mapping of M3 and M6 communities in the mining area
Drawn: H Priest
Date: March 2010
Plan No. PDE0069483v3
Proj: MGA94 Zone 50

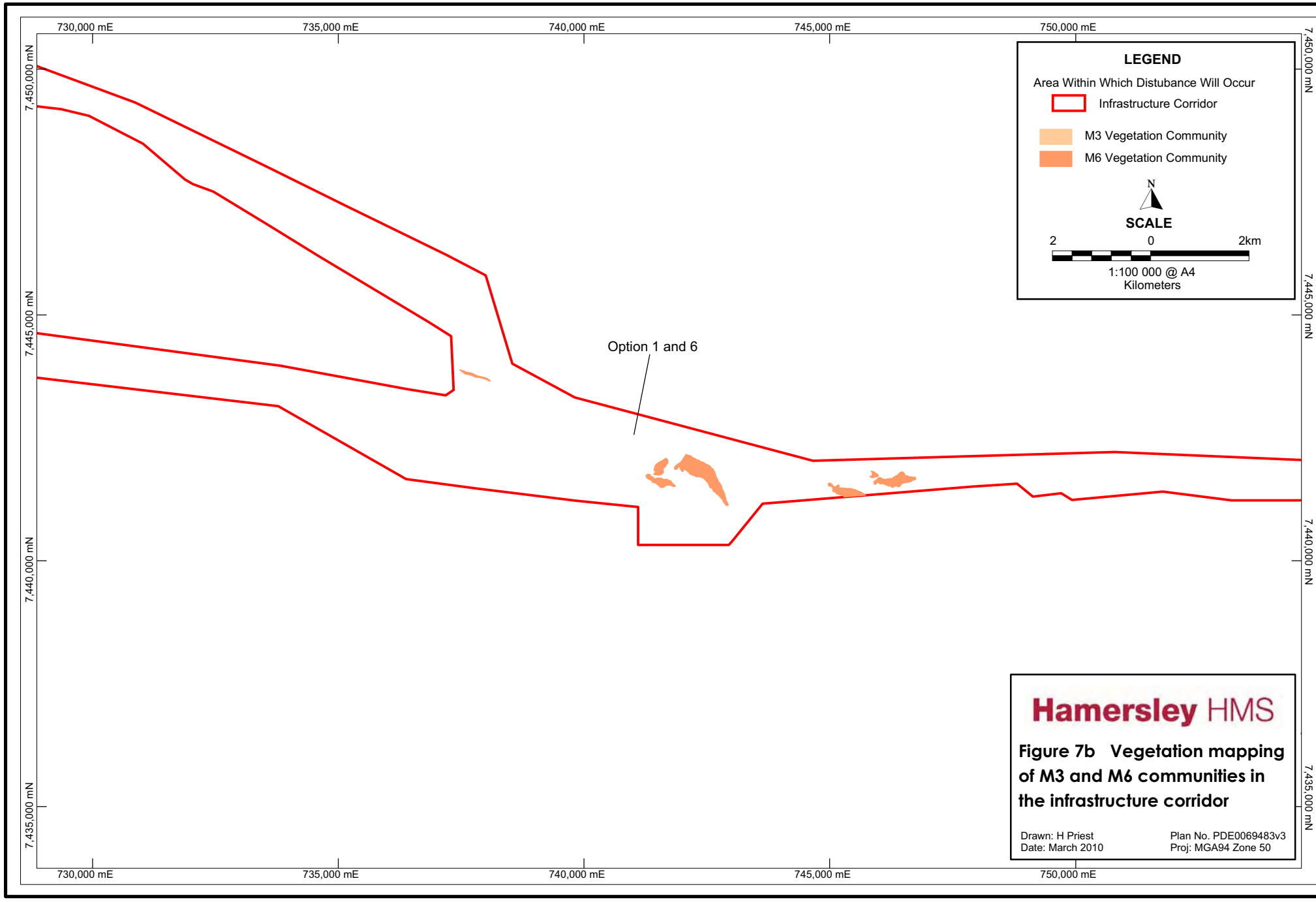


Hamersley HMS

Figure 7a Vegetation mapping of M3 and M6 communities in the infrastructure corridor

Drawn: H Priest
Date: March 2010

Plan No. PDE0069483v3
Proj: MGA94 Zone 50


730,000 mE
735,000 mE
740,000 mE
745,000 mE
750,000 mE
7,450,000 mN
7,445,000 mN
7,440,000 mN
7,435,000 mN
LEGEND
Area Within Which Distubance Will Occur
Infrastructure Corridor
M3 Vegetation Community
M6 Vegetation Community
N
SCALE
2
0
2km
1:100 000 @ A4
Kilometers
Option 1 and 6
Hamersley HMS
Figure 7b Vegetation mapping of M3 and M6 communities in the infrastructure corridor
Drawn: H Priest
Date: March 2010
Plan No. PDE0069483v3
Proj: MGA94 Zone 50

2.2.3 Water chemistry and isotopic tracer investigations

An investigation into the connectivity of surface water pools and groundwater systems has been undertaken by the Proponent using Hope Downs 4 as the case study area. The paper developed by Dogramaci and Dodson (2010), *Deuterium and O-18 data to estimate the relative contribution of summer and winter season precipitation to surface water pools; A case study from Hamersley Basin, Western Australia*, investigates the potential impact of dewatering the Hope Downs 4 ore body on nearby surface pools.

The study focuses on the use of chemical and isotopic tracers as a tool to supplement data gathered from monitoring bores to obtain subsurface hydrogeological data. Chloride (Cl) and naturally occurring stable isotope concentrations (δ^2H and $\delta^{18}O$) have been used to understand the origins of water in the permanent pools of Coondiner Creek and Stuart Pool located on the Kalgan Creek (refer to Figure 9 in the PER).

The evolution of the surface water chemistry and isotope composition was modelled using a combination of the binary mixing and the Rayleigh distillation model (Dogramaci & Dodson 2010). By 'working backward' in a manner not dissimilar to a 'forensic approach' it was possible to synthesise all existing data and knowledge to determine the processes that have resulted in specific groundwater and surface water composition signatures, and in doing so, gain an insight into the provenance of the particular water at precise locations.

The distinct isotopic signature of summer and winter rainfall in the area was reflected in the isotopic signature of surface water and groundwater (Dogramaci & Dodson 2010). The results of the study concluded that while the isotopic composition in permanent surface water pools reflects that of the most recent rain fall events irrespective of seasons; the isotopic signature of groundwater reflects the long term mean signature of wet season (more intense) rainfall (Dogramaci & Dodson 2010). Quite simply, larger wet season rainfall, and by inference greater recharge, is associated with the wet season stable isotope signature, which tends to be more depleted in the heavier isotope fraction. The study also further concludes that the dominant source of water in most permanent pools around Hope Downs 4 mining area is recent precipitation. Therefore, as creek flow (including baseflow) in locations that are outside of the specific proposed Hope Downs 4 mine area and downstream from it appears to be supported by "recent" rainfall (and to be largely disconnected from the deeper orebody aquifer), it is expected that dewatering will have little or no impact on creek levels and flows in these downstream locations.

This paper has been included within Appendix 2. This study will be presented as a paper to the XXXVIII International Association of Hydrogeologists Congress in Krakow Poland in September 2010.

2.2.4 Short range endemics survey results

Ninox Wildlife Consulting conducted two surveys of the Option 6 infrastructure corridor during September 2008 and April 2009 to sample for short range endemic (SRE) invertebrate species. Results from the September 2008 survey were presented in the PER and it was noted that analysis by the WA Museum was still to be completed for the second survey. On page 135 of the PER, it was indicated that the first survey recorded a species of paraoxosomatid millipede that could potentially be a SRE. The second survey did not find any additional specimens of the paraoxosomatid millipede that was considered to potentially be a SRE in the first survey.

The results of the April 2009 survey of the Option 6 infrastructure corridor are presented in full in this document in Appendix 3 and a summary is provided below.

Analysis by the WA Museum was undertaken for 47 specimens, including 24 snails, 8 pseudoscorpions, 7 scorpions, 5 millipedes and 3 spiders. The specimens included mygalomorph spiders from two different families (Barychelidae: *Idiommata*; Idiopidae: *Aganippe*), olpiid pseudoscorpions (?*Austrohorus*, *Beierolpium*, *Euryolpium*), two different scorpion species in the genus *Lychas* (Buthidae) and a pachybolid millipede (*Austrostrophus*).

The analysis by the WA Museum determined that one species of pseudoscorpion of the genus *Beierolpium* may represent a SRE species; however, the WA Museum noted that a full taxonomic revision of the genus is necessary to confirm their status. While not recorded during the September 2008 survey of the of the Option 6 infrastructure corridor (Ninox 2009c) this genus was collected from five sites during the April 2009 survey. One specimen was also collected in site HD08[2] (an open Mulga woodland) along the Option 1 infrastructure corridor, which was surveyed in May 2008 (Ninox 2009b). Another specimen was collected from a small gully within site HD03 (the top of a small rocky range) during the survey of the proposed Hope Downs 4 mining area (Ninox 2009a).

The WA Museum stated that the absence of data on the spatial relationship between the collecting sites at which the undescribed *Bothriembryon* snail species has been found precluded any comments upon the possible effect of any disturbance on the population(s) of this species in the Hope Downs 4 Option 6 infrastructure corridor. However, this undescribed snail has been collected at site HD08 along the Option 1 infrastructure corridor (Ninox 2009b) approximately 5 km east north east of site HD14a (the site in Option 6 infrastructure corridor that the snail was recorded at) and site HD03 within the mining area (Ninox 2009a) approximately 40 km east of site HD14a. These sites represent a wide range of habitats and geographical distribution within the total Hope Downs 4 proposal area.

Given that only one of the two proposed infrastructure corridors will be developed, and that the potential SRE species of pseudoscorpion and snail occur in a range of habitats within both corridor options, it is unlikely that there will be any significant impact on the status of these species when one of the infrastructure corridors is developed.

2.3 ONGOING AND PROPOSED INVESTIGATIONS AND MONITORING

2.3.1 Groundwater and surface water monitoring

Water level data associated with the Hope Downs 4 area has been collected since 2005. Additional data has been collected as part of a continuous water monitoring program which has been ongoing since 2008 and is specific to the Hope Downs 4 Proposal. The monitoring program captures baseline information on the existing groundwater resources and surface pools and includes:

- a number of monitoring boreholes that have been completed and screened against different horizons including alluvium, calcrete and various units of the Hamersley Group. These borehole locations are associated with the monitoring of groundwater levels and the collection of groundwater quality data

[2] See Figure 29 of the PER for survey sampling site locations.

- three sites along Coondiner Creek where shallow water levels in the alluvium associated with the creek bed are monitoring with automated data loggers in an attempt to identify and characterise/quantify flow events
- seven pool locations (which include Stuarts Pool, Kalgan Pool, Three Pools, Eagle Rock Pool and Eagle Rock Falls), which are sampled regularly for water quality determination (including environmental isotopes) and are also photographed.

The Proponent has given consideration to the installation of depth gauges at surface water locations within the Proposal area. The Proponent is of the opinion that:

- there are a number of constraints associated with such installations, including the potential for the gauges to be destroyed during flood events and potential environmental impact associated with establishing these gauges
- the continuation of the existing surface water photographic program should provide an enduring record that is sufficient for the purposes of determining water level changes. This photography will be assessed in conjunction with the ongoing monitoring of groundwater within the Proposal area.

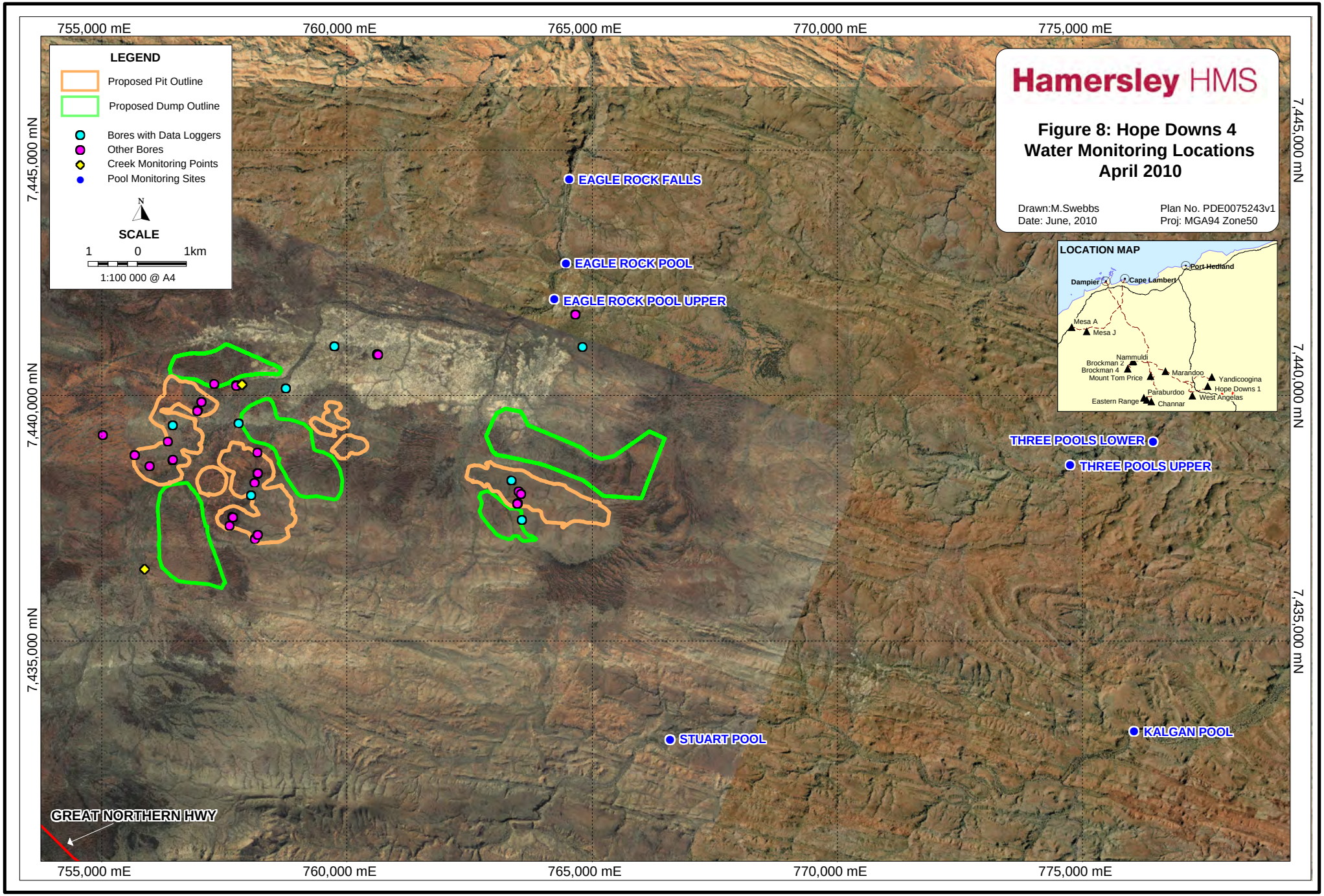
However, the Proponent can confirm that graduated water level indicator posts and/or electronic water level data loggers will be established and surveyed at key larger pools as practicable; other means of water level measurement will be considered if these two means are not feasible. As such, it will be possible to quantitatively approximate the natural seasonal variation of pool water levels. Installation of this equipment will be subject to receiving the appropriate approvals.

Groundwater and surface water data collection points cover the area in and around the proposed mine site, in addition to the pool locations listed above, which are located to the north, east and southeast of the proposed mining area. The collection points will contribute to: the collation of groundwater level data (time series – automated data loggers); the determination of water quality of both surface water and groundwater; measurement of actual versus predicted impacts to groundwater resources and pools; and isotopic studies of surface water and groundwater. In addition to the monitoring of groundwater and surface water levels and quality, the Proponent is also undertaking the photographic monitoring of various pools and the recording of local rainfall events which are captured by an instrumented automatic rain gauge.

The monitoring program at Hope Downs 4 is designed to be flexible, adaptive and dynamic, with additional points added over time as dictated by the continuous flow of data generated by the existing network. The monitoring program is able to be modified in response to trends observed in the data, and the spatial coverage of automated borehole water level data loggers can be enhanced where deemed necessary.

An expansion to the network outlined above will be undertaken during 2010. Additional boreholes will be drilled and completed as part of an investigation aimed at better understanding the hydrogeology in and adjacent to the Proposal area, with additional surface water pools to be included in the program as required. As a result, a comprehensive baseline data set will be available before commencement of any mining or dewatering activities associated with the Proposal. This water monitoring network will also form a solid basis from which to identify any effects dewatering may have on the dynamics of both surface and groundwater in the area as the monitoring program continues into the future.

Figure 8 indicates the monitoring locations within and surrounding the Hope Downs 4 mining area.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775,000 mE
7,445,000 mN
7,440,000 mN
7,435,000 mN
LEGEND
Proposed Pit Outline
Proposed Dump Outline
Bores with Data Loggers
Other Bores
Creek Monitoring Points
Pool Monitoring Sites
N
SCALE
1 0 1km
1:100 000 @ A4
EAGLE ROCK FALLS
EAGLE ROCK POOL
EAGLE ROCK POOL UPPER
THREE POOLS LOWER
THREE POOLS UPPER
STUART POOL
KALGAN POOL
GREAT NORTHERN HWY
Hamersley HMS
Figure 8: Hope Downs 4
Water Monitoring Locations
April 2010
Drawn:M.Swebbs
Date: June, 2010
Plan No. PDE0075243v1
Proj: MGA94 Zone50
LOCATION MAP
Port Hedland
Dampier
Cape Lambert
Mesa A
Mesa J
Nammuldi
Brockman 2
Brockman 4
Mount Tom Price
Marandoo
Yandicoogina
Hope Downs 1
West Angelas
Paraburdoo
Eastern Range
Channar

The potential for connectivity between groundwater (specifically that groundwater associated with the ore body) and surface water pool systems (including Kalgan Pool and Mindy Mindy Creek) is also assessed using this data as part of the Hope Downs 4 monitoring program. Recent chemistry and environmental isotope studies undertaken in the Hope Downs 4 area have focussed on determining the provenance of water contained in the numerous surface water pools and other features found in the area (Section 2.2.3). The studies have been based on known principles associated with the processes determining the chemical and isotopic composition of naturally occurring surface and groundwater bodies. Published results of the analyses of chemical and isotopic data of water samples taken from surface water pools, groundwater and rainfall collected over a recent approximate twelve month period, within and surrounding the Hope Downs 4 Proposal area, suggest that the source of water in these pools is recent rainfall (Dogramici & Dodson 2009 2010). The contribution of groundwater to Coondiner Creek and Kalgan Creek pools is thought to be insignificant compared to rainfall and surface flow. The hydrochemical models presented for the Hope Downs 4 area are corroborated by conventional hydrogeological drilling data and the surface flow monitoring data of the discharge from Eagle Rock Falls. The intended monitoring program for the Proposal will continue to ensure dewatering activities have no or minimal impact to surface water systems within and surrounding the Hope Downs 4 proposal area.

2.3.2 Creek systems aquatic fauna monitoring program

The Proponent is currently implementing an aquatic ecosystems monitoring program for the creek systems of the Proposal area. The Proponent has commissioned Wetland Research and Management (WRM) to undertake the monitoring program. The monitoring program commenced in September 2008, and involves sampling water quality and aquatic fauna along creek lines in and around the Proposal area.

The sampling program has been designed to link-in with other targeted and regional studies already being conducted for the Proponent's Hope Downs 1 (Weeli Wolli Creek), Yandicoogina (Marillana Creek) and Marandoo developments (Southern Fortescue River System), whereby water quality, fish and aquatic invertebrates are routinely sampled to establish baseline conditions and to assess potential impacts.

The sampling design to establish fauna composition, conservation significance and baseline conditions for the creek systems includes sampling:

- replicate sites upstream and downstream of the proposed excess water discharge point on each of the creek lines
- replicate sites on adjacent, unaffected control/reference headwater creek lines of surrounding creek lines.

2.3.3 Riparian ecological monitoring program

As outlined in the PER, a riparian ecological monitoring program is currently underway for the Hope Downs 4 Iron Ore Project. This monitoring program is similar to the programs implemented at the Rio Tinto Yandicoogina and Hope Downs 1 iron ore operations and includes creek vegetation, tree health and aquatic ecosystems monitoring. The monitoring programs undertaken at Yandicoogina and Hope Downs 1 to date have been successful in the detection of ecosystem changes and the determination of whether those changes were a result of mining activities and therefore, whether remediation measures were required to be implemented. This riparian ecological monitoring program is incorporated into the Hope Downs 4 Adaptive Surface Water Management Plan and the Vegetation

and Flora Management Plan (refer to the Environmental Management Plan contained in Appendix 2 of the PER) and includes:

- riparian condition monitoring at proposed discharge creeks and reference sites using:
  - remote sensing of vegetation
  - annual survey of vegetation transects during proposed discharge periods
  - observations of erosion and sedimentation
- aquatic ecosystems monitoring at:
  - permanent/semi permanent pools within 20 km of the proposed excess water discharge points
  - representative pools upstream of the proposed excess water discharge points
  - adjacent creek lines, if present.

2.3.4 Closure planning studies

As outlined within the PER, closure management studies are proposed throughout the operational mine life. At the time of submission of this document the Proponent is proposing acid rock drainage (ARD) studies, pit lake water quality modelling studies and a land form design/erodiblity investigations. These further studies will inform the closure management requirements of the Proposal, to ensure that disturbed areas are safe and are suitably rehabilitated for the long term end land use as determined in consultation with relevant stakeholders. However, closure planning for the Proposal is not limited to these mentioned studies, it is envisaged that additional studies are likely to occur in the future to aid the closure planning process.

ARD Studies

The Proponent proposes to commence column leach testing investigations in Q4 2010 to better quantify the potential for ARD from sulfidic material expected to be mine at Hope Downs 4. The investigation will aim to:

- determine the rate of sulfide oxidation (including lag time)
- determine the acidity and contaminant release rate.

Leachate from the column leach experiments is collected monthly for full metal and major element analysis. A comprehensive review of the laboratory results will be undertaken after six months of the study to determine the ongoing relevance of the data and to realign the monitoring objectives. Results from the column leach experiments will be used to assess closure risks and modifications will be made to the Rio Tinto Iron Ore (RTIO)[3] operations SCARD Management Plan if necessary. Currently proposed ARD management at the site is based on the outcomes of column leach experiments undertaken on black shale material from the Tom Price mine site, acid base accounting data collected specifically from Hope Downs 4, and the extensive database that RTIO has for materials across all its mine sites.

[3] The Proponent for the Hope Downs 4 Iron Ore Project is a member of the Rio Tinto Group.

Pit lake water quality modelling

Groundwater modelling has found that the final pit lake in mining zone 4 at Hope Downs 4 will be a 'sink' and not a 'flow through' system. Black shale will be less than 1% of the material on the final pit wall (0.3% cold black shale and 0.4% hot black shale, Figure 9). Most material (other than a small patch to the north west) will be above the post mining water table (Figure 10). The risk of an acidic pit lake developing will be reduced due to the:

- buffering capacity within groundwater: the average alkalinity in production bores at Hope Downs 4 is 300 mg/L and the average pH is 8
- end tipping inert material over the black shale exposures on the pit wall, thereby limiting surface water runoff contact with the black shale and also reducing oxygen penetration.

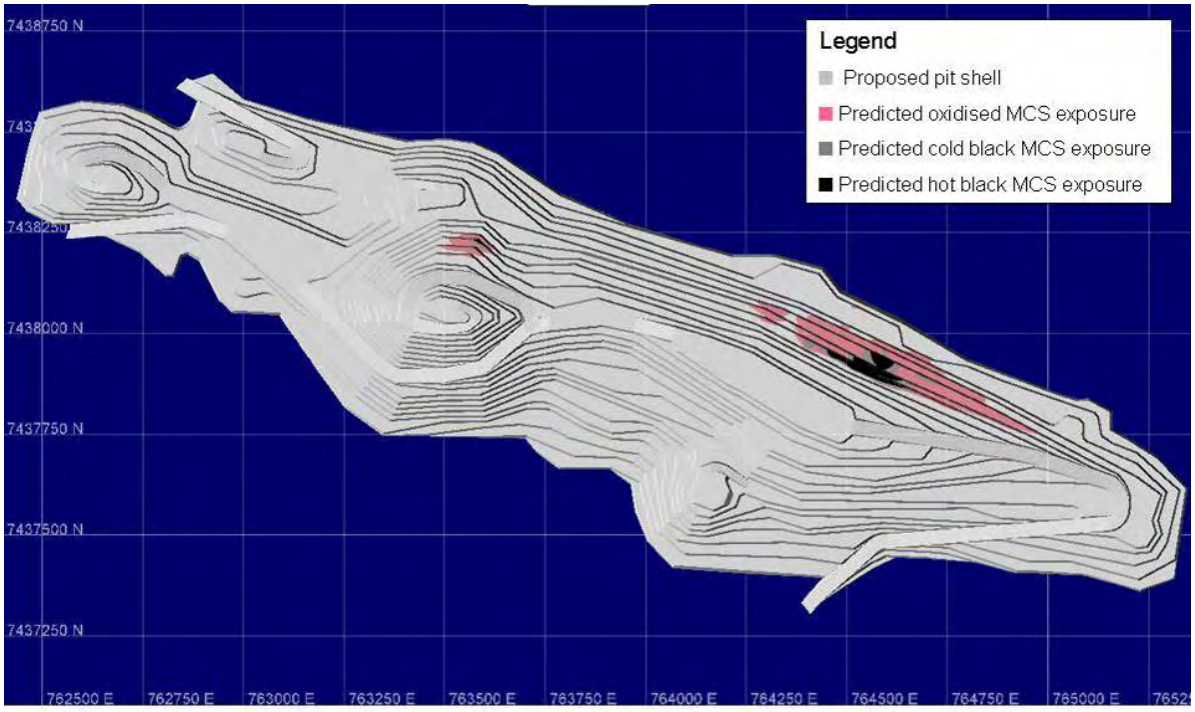

Figure 9 Predicted Mount McRae Shale surface exposures on proposed final pit shell

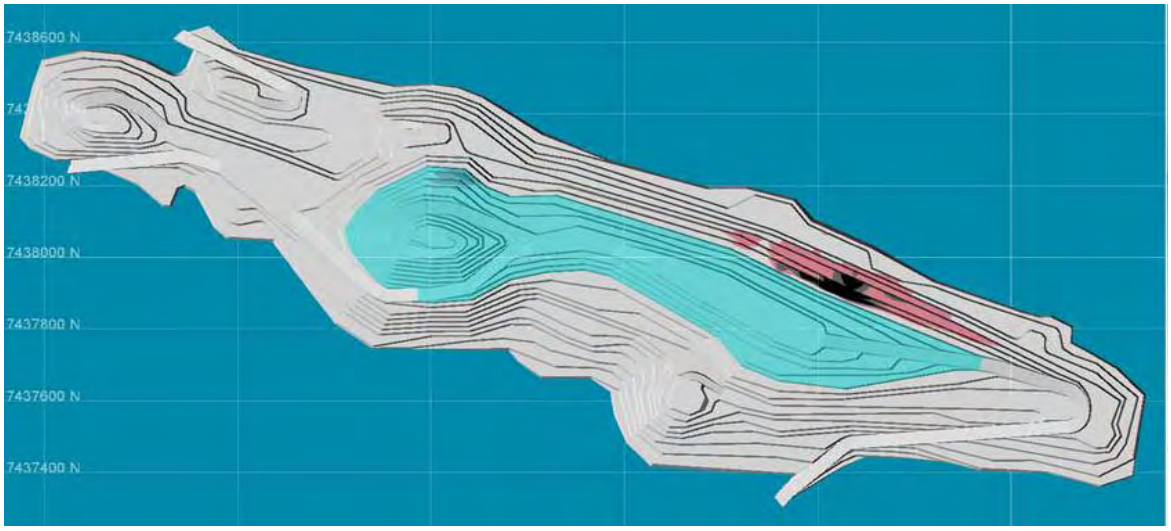

Figure 10 Mount McRae Shale exposures and the predicted post mining water table

A similar analysis of pit wall exposures will also be undertaken by the Proponent for mining zones 1 and 2. If a large amount of black shale exposure is found then more detailed geochemical modelling will be undertaken to determine the long term acidity and contaminant trends. RTIO have undertaken substantial research into final pit void modelling techniques during the past year and a half. This has included a post doctoral researcher from the University of Western Australia (UWA) working full time on this study (specifically at Tom Price mine site), however learnings from this study can be applied across RTIO operations. Final pit void water quality modelling is an emerging science and RTIO are investing in the development of appropriate and practical tools to predict water quality into the future. In addition, RTIO have also been working with Edith Cowan University (ECU) to research bioremediation options at the Tom Price mine site. Learning from this study can be applied to other RTIO mine sites. RTIO have also initiated another significant research project investigating the implementation of constructed wetlands in final pit voids.

Landform design/erodibility investigations

The Proponent has commenced a landform design/erodibility investigation to define the erodibility characteristics of identified mineral wastes across its Pilbara operations. The outputs from the investigation will be used to develop practicable final landform design criteria that will address safety stability requirements. The project is spilt into two phases. Phase 1 will involve:

- completing a literature search and review of relevant technical literature
- undertaking a technical workshop that brings together experts in the subject to discuss and finalise the project scope
- conducting a gap analysis to identify matters requiring further incestigation
- developing a scope of work for Phase 2 of the investigation.

It is envisaged that Phase 1 works will be completed by the end of the second quarter of 2010 with Phase 2 works to commence in Q3 of 2010. This study will inform the final closure management plan and decommission specifications required for the Proposal.

3. ONGOING CONSULTATION

The Proponent is committed to continuing to consult regularly with stakeholders throughout the remainder of the PER assessment process and during the ongoing operations of the Hope Downs 4 Iron Ore Project as required and requested. This consultation process will include ongoing discussions with the Nyiyaparli people to address potential impacts from excess water discharge into creeks nearby, onsite consultation regarding the realignment of part of Coondiner Creek, a Rio Tinto – Nyiyaparli workshop to evaluate mine closure options and ongoing local implementation committee meetings to cooperatively manage heritage and environmental concerns (refer to Item 1 of Table 8 for full details).

The Proponent will continue to consult with the DEC and the OEPA on environmental matters associated with the Proposal. The Proponent will also continue to consult with the DoW on the management of water resources and other matters related to the *Rights in Water and Irrigation Act 1914* licensing requirements for the operations at Hope Downs 4.

4. SUMMARY OF SUBMISSIONS RECEIVED

In total, five submissions were received in response to the Hope Downs 4 Iron Ore Project PER. All responses were from the following government agencies/branches:

- Department of Environment and Conservation (DEC)
- Department of Water (DoW)
- Department of Mines and Petroleum (DMP)
- Department of Indigenous Affairs (DIA)
- Office of the Environmental Protection Authority (OEPA) Terrestrial Ecosystems Branch (TEB).

4.1 GROUNDWATER

Two respondents commented on groundwater aspects of the PER. The majority of the comments related to the management of dewatering and monitoring the impacts of groundwater drawdown on the surrounding environment.

Groundwater management

- DoW supported the development of a management plan to augment groundwater in the calcrete and Eagle Rock Pool if they are impacted by dewatering.
- DoW requested to review the suggested groundwater augmentation plan and recommended the formulation of an associated outcome based condition, with triggers to be reviewed annually.
- DoW recommended that the assessment of actual versus predicted impacts be ongoing to determine whether the effects on the creeks/pools are related to drawdown.

Monitoring

- DoW recommended continued monitoring of groundwater levels in the calcrete and towards Eagle Rock Pool as well as the surrounding pools to collect baseline data prior to dewatering/mining.
- DEC recommended that further investigation of the feasibility of contingency measures be undertaken in the event that unacceptable impacts are observed in permanent pools as a result of dewatering.
- DEC recommended that water levels at permanent/semi-permanent pools be monitored using depth gauges as well as photography in order to determine whether changes to pool levels could be linked to dewatering activities.
- DEC recommend that trigger levels in the Adaptive Surface Water Management Plan related to pools be revised so that they are specific and measurable, and can be monitored and used as triggers for contingency actions in the event that an unacceptable impact is detected.
- DEC recommended that the Proponent provides a map detailing the locations of all the monitoring bores and collects baseline data from both the existing and proposed additional monitoring bores prior to the commencement of mining and dewatering.

- DEC recommended that the Proponent provides the monitoring methodology, baseline data and monitoring results for Weeli Wolli Creek to support the view that there has been no significant impact on tree health due to dewatering at Hope Downs 1 and to substantiate how lessons learnt from monitoring and management of discharge dewatering at Hope Downs 1 will be used to avoid impacts at Hope Downs 4.

4.2 SURFACE WATER

Two respondents provided comments related to surface water aspects, in particular, comments were provided on excess water management, disposal of excess dewatering water to the environment and the realignment of Coondiner Creek.

Excess water management

- DoW considered discharge to Opthalmia Dam as the preferred option for excess water management, but recognised that there were limitations to this option. The DoW's next preferred option, if the Opthalmia Dam option was not feasible, was the transfer of water to the Hope Downs 1 operation. However, the DoW noted that as the operations evolve the project timelines could change and make water sharing opportunities unviable.
- DoW indicated that they understood that while the options of controlled discharge to creeks would have local impacts, they were of the opinion that these impacts were manageable through appropriate conditions.
- DoW indicated that they would like the Proponent to clarify parameters by which the proposed environmental conditions for discharge to the creeks would be measured.
- DoW requested the refinement of the proposed discharge conditions to specify response actions and include an action to cease discharge if required to allow any identified impacts to be managed.
- DoW recommended that a Ministerial condition be included requiring the implementation of a water management plan covering excess water management issues, and that it be annually reviewed and updated during the life of the operation.
- DEC recommended that the Proponent provide a timeline for the cessation of the discharge of excess water to nearby surface drainage systems and for the implementation of a more environmentally acceptable strategy for managing excess water, such as piping water to Opthalmia Dam.
- DEC recommended that the assessment of the water management strategy proposed at Hope Downs 4 should take into consideration the hydrological modelling and contingencies built into the approval of Hope Downs 1. DEC further stated that the Hope Downs 4 hydrological modelling and water balance provided in this assessment should be confirmed as adequately allowing for the upper limits of potential dewatering and possible discharge plans.

Disposal of excess water to the environment

- DEC recommended that the Proponent define its intentions and the intended approvals processes for the intended transfer and disposal of excess water from Hope Downs 4 offsite and the potential environmental impacts or benefits associated with the transfer.
- DEC recommended that the Proponent clarifies the proposed volume, rate and duration of discharge of excess water and the anticipated number of discharge events, as well as the potential

impacts on Kalgan Creek and other creeks, of the initial excess water management strategy. As part of this clarification, the DEC recommended that the criteria that constitute "exceptional circumstances" be defined along with an explanation of the proposed discharge characteristics and the monitoring and management measures to be applied to maintain impacts below the specified limits of acceptable change.

- DEC recommended that the Proponent further develop the environmental triggers and contingency measured for discharge of excess water to creeks (including a rehabilitation and ongoing management plan for impacts to creek ecosystems in the event of significant plant deaths), in consultation with the OEPA and if required the DEC. The DEC further recommended that the triggers and contingencies should have particular regard to significant flora, fauna and communities within the discharge footprint, in particular the C4 vegetation community.
- DEC is particularly concerned that regulatory authorities would only be informed of degradation of riparian values when there is 40 per cent loss of foliage cover (Trigger Level 2). At that late stage, recovery of the affected systems may not be possible.
- DEC recommended that the proponent should make a commitment to maintaining the ecological value of rehabilitated creeks after discharge is complete, potentially involving ongoing monitoring, supplementation of water levels and/or rehabilitation, is recommended.
- DEC recommended that the environmental impacts and technical and economic feasibility of all excess water management strategies discussed in the PER be considered as part this Proposal.
- DEC consider that a commitment should be made by the proponent to pursue lower impact options for excess water management.
- DEC consider the provision of water to other mine sites or projects appears not to have been fully considered, and appears to warrant more detailed investigation, in particular with Hancock Prospecting's Roy Hill Stage 1 project which has a significant water requirement. Based on the available information, it is DEC's preference that the proponent pipes the excess water to the Ophthalmia Dam or Hancock Prospecting's Roy Hill borefield (for reinjection).
- DEC recommended that the outcome based conditions and management criteria for discharge to creeks be reviewed in consultation with the DEC on the basis of the advice that they have provided in their PER submission.
- DEC recommended that the Proponent consult the OEPA and DEC with respect to appropriate management criteria for addressing the impacts and risks associated with discharge to creeks, as the range of triggers proposed may not be adequate to determine impacts on creeks in a timely fashion. The DEC further recommends, in retrospect of the above comment, that proposed Condition 7-1 be reviewed and to consider reviewing the creek monitoring data on a quarterly basis to ensure that any observed impacts can be detected and managed as early as possible.

Realignment of Coondiner Creek

- DEC recommended that a gauging station be put in place on Coondiner Creek to obtain accurate flood depths and velocity and that the design for the realignment of Coondiner Creek takes into account the information collected from this station.
- DEC recommended that the Proponent's commitment to establish vegetation along the Coondiner Creek realignment as 'soon as practicable' following construction be further defined and made a condition of the project.

- DEC recommended that if the proposed condition (Condition No. 6-1) is approved, the condition should:
    - ensure the realignment be made operational prior to disturbance of the existing channel and in adequate time to accommodate seasonal flows in the creek system
    - include a requirement for monitoring of water quality and quantity upstream of the pool prior to, during and after the realignment in order to collect baseline data for comparison purposes.

4.3 VEGETATION AND FLORA

Two respondents provided comments related to vegetation and flora aspects, these being:

- DEC recommended that the Proponent identify C1 and C4 community types in good or better condition within the drawdown footprint and monitor vegetation health in these communities.
- DEC recommended that the Proponent avoid impacts on species, communities and habitats of local and regional conservation significance (in particular the C4 community) in the management of dewatering and discharge.
- DEC recommended that the Proponent confirms whether or not a C4 community occurs within the option1 and/or option 6 infrastructure corridors.
- DEC recommended that the Proponent avoids direct and indirect impacts on species, communities and habitats of local and regional conservation significance (in particular the C4 community) in the selection of the infrastructure corridor alignment.
- DEC recommended that the Proponent consults with the DEC regarding the final alignment of the infrastructure corridor, including the suitable location of borrow pits and culverts in areas where the corridor intersects mulga communities.
- DEC recommended that the Proponent provide further information on the M6 and M3 vegetation communities to allow DEC to confirm whether or not the 'Brockman Iron cracking clay communities of the Hamersley Range' (Priority 1) occur within these vegetation communities within the project footprint.
- DEC recommended that the Proponent incorporate hygiene measures into the Operation Environmental Management Plan (EMP) and that these measures be implemented to ensure that Natal Red Top (*Melinis repens*) is not spread from Hope Downs 1, along the infrastructure corridor, to Hope Downs 4.
- TEB stated that the flora and vegetation assessment appeared to be sufficient to assess the impacts of the proposal, however, the TEB believed that there were a number of statements within the PER that had no justification or were lacking references, which include statements relating to changes in groundwater dependent vegetation, and representation of vegetation communities outside the proposal area.
- TEB commented that the impacts of groundwater drawdown on native vegetation were not adequately clarified in the PER.
- TEB commented on a statement within the PER, which noted variations in the range of species in vegetation communities, some of which was thought to be due to sampling variation. TEB asked for clarification on why the sampling methods had changed to a degree where comparisons

between surveys were difficult, and suggested that this outcome would negate the benefits of the multiple surveys.

- TEB stated that more current TEC identification lists are available on the DEC website and should be utilised instead of the English and Blythe (1997, 1999) lists.

4.4 FAUNA AND HABITAT

Two respondents provided submissions on fauna and habitat factors of the PER. DEC and TEB provided comments in relation to the cumulative impacts of the disposal of excess water to surrounding habitats, the monitoring of the Pilbara Leaf-nosed Bat habitat, surveys of short range endemics (SREs) and the impacts of clearing.

Cumulative impacts on riparian ecosystems

- DEC recommended that the Proponent determined whether discharge from Hope Downs 4 had the potential to impact cumulatively (either directly or indirectly) on the Fortescue Marsh and significant riparian ecosystems.

Fauna

- DEC suggested that the Proponent confirm that the bat monitoring undertaken was appropriate for the detection of the Pilbara Leaf-nosed Bat and recommended that the Proponent undertake further bat monitoring, if this was not the case.
- DEC recommended that if possible, further work to be undertaken to confirm whether maternity roosts/suitable habitat for Pilbara Leaf-nosed Bat occur within the impact area.

Short range endemics

- DEC recommended that the results of the most recent SRE survey be completed and that the Proponent avoids or minimises any potential impacts on any known SREs.

Terrestrial fauna

- TEB stated that the scope of work on terrestrial fauna was generally adequate and that the conclusions on impacts and proposed management measures for terrestrial fauna appear to be adequately addressed. However, the TEB identified two examples of statements in the PER that the TEB believed lacked certainty and requested that these examples be addressed:
    - Page 137 “The majority of the clearing is comprised of vegetation communities of low conservation significance that are likely to be widely distributed and relatively well-represented in the locality, suggesting that fauna habitats are likewise probably more widely distributed.” This statement needs to give justification for the opinions expressed. A clear basis and scientific certainty for the statement needs to be provided.
    - Page 138 The basis for the comment in relation to clearing being undertaken in a progressive manner “that allows fauna the opportunity to move beyond the disturbance footprint” needs to be provided together with substantiation of which fauna will be able to respond in this way, and which fauna may not.

4.5 SUBTERRANEAN FAUNA

One respondent provided comments on the impacts to subterranean fauna. The key comments were in regards to the distribution and representation of subterranean communities within and outside the boundaries of the Proposal mining area. Other comments were only minor and related to spelling of species.

The comments provided were as follows:

- TEB commented on the content of the executive summary of the PER in regards to stygofauna and stated that they felt that the summary misrepresented information presented in Section 17.2.2 of the PER in relation to the findings of the stygofauna sampling surveys. As a result, the TEB believed that that no conclusion was provided on the distribution of subterranean fauna within the PER.
- TEB suggested that data regarding both stygofauna and troglofauna taxa needs to be re-examined to demonstrate with scientific certainty whether they occur outside the project area with particular attention required to be given to considering the status and impact on any fauna that are not demonstrated to occur outside the project area thereby providing the regional significance of the impacts.
- TEB highlighted a number of minor technical errors (e.g. spelling errors) and inconsistencies in the PER on pages x, xi, 131, 134, 135 and 139.

4.6 POTENTIAL ACID FORMING MATERIAL (PAF)

Comments were received from two respondents in relation to potential acid forming (PAF) material. The majority of the comments received were in relation to the extent which PAF/acid mine drainage (AMD) was addressed within the PER. The comments were as follows:

- DMP stated that it was unclear why the risk of AMD was not considered as one of the key environmental factors raised in the PER or raised as a potential impact in the Key Environmental Factors Table in the PER.
- DMP stated that if AMD occurred at this site it would be likely to impact on most of the other identified key environmental factors for the project with the key environmental factors to be impacted to be groundwater, surface water, subterranean fauna and closure.
- DMP stated that if the risk of ARD processes producing acid water have been considered significant enough to warrant an Acid Treatment Plant (PER, Section 8.4.3), it is likely the risk of this acid water (if not appropriately treated) will impact on other environmental factors and should therefore be considered as a key environmental issue in the assessment of the PER.
- DMP stated that the risk of ARD creating a situation where the pit void had elevated levels of potentially harmful elements (such as metals), as well as salts, does not appear to have been adequately addressed in the PER.
- DMP noted that in order to conduct a full assessment of the potential risks and management of ARD at Hope Downs 4 the 'risk assessment of the potential for acid rock drainage and detrimental geochemical material' and the SCARD management plan will need to be included within the PER appendices. It is noted that leachate testing for other elements that may become elevated in pit water has not been completed (page 179) and that studies are still being undertaken

in relation to the post closure development of pit lakes and the associated impacts on groundwater (page 170).

- DMP recommended that an environmental condition for the management of PAF material exposed in pit walls be included as part of the Hope Downs 4 Ministerial Statement and also recommended that the condition include commitments to ensure all PAF material exposed in pit walls is adequately covered (or otherwise managed as appropriate) at closure.
- DoW recommended that the Proponent continue investigations to determine appropriate methods to manage the PAF in waste rock with regards to storage and exposure at closure.
- DMP commented that the PER indicated that DMP raised no issues in relation to stakeholder consultation, however the DMP noted that it did provide advice to the Environmental Impact Assessment Division in relation to the Hope Downs 4 scoping document. The DMP further states that this advice highlighted ARD and other adverse geochemical and geophysical material as potential environmental issues.

4.7 ABORIGINAL HERITAGE

One submission was received relating to Aboriginal Heritage. The comments within the submission were related to compliance, consultation processes and impacts to cultural and heritage values.

Consultation

- DIA recommended that further consultation be conducted with relevant Aboriginal people over the process of and potential effects on Aboriginal heritage caused by dewatering at Hope Downs 4, in light complaints raised by Aboriginal people in relation to the effects on Weeli Wolli Creek of dewatering associated with the Hope Downs 1 project.
- DIA noted that page iv of Day's *2008 Report of an ethnographic survey for a Bankable Feasibility Study at Hope Downs 4* recommends that the Nyiyaparli community be provided with more information concerning the possible effects on the Coondiner Creek system by dewatering at Hope Downs 4.
- DIA recommended that representatives of Nyiyaparli should be provided with more detail regarding proposed dewatering at Hope Downs 4, in particular, explanation should be provided on the number of possible options for the disposal of excess water from Hope Downs 4 with comment to be sought from the Aboriginal people on the preferred method of excess water disposal.
- DIA suggested that if it is deemed necessary to dewater directly into existing creek bodies, comment should be sought as to which creek the Nyiyaparli people would prefer the water to be disposed into.
- DIA suggested that consultation be undertaken with the Aboriginal people in order to determine the possible impact of the realignment of Coondiner Creek on the overall cultural landscape and to identify specific ethnographic values associated with the Creek.
- DIA suggested that comments be sought from local Aboriginal people regarding the design of any realignment of Coondiner Creek, with particular emphasis on replicating the existing physical environment of the Creek.

Cultural and heritage values

- DIA suggested that the Proponent may wish to further investigate the cultural values of whichever creek will have excess water discharged into it in order to be more aware of possible effects to Aboriginal heritage located in riparian environments located in the area, and notes that there is a possibility that ethnographic and archaeological heritage values downstream of Hope Downs 4 may be impacted by increased flow through a creek body.

Compliance

- DIA noted that if there was a requirement to impact an Aboriginal heritage site as part of the project, consent from the Minister for Indigenous Affairs under Section 18 of the *Aboriginal Heritage Act 1972* would be required in order to avoid breaching Section 17 of the *Aboriginal Heritage Act 1972*.

4.8 CLOSURE AND REHABILITATION

Two respondents commented on closure and rehabilitation. The majority of the comments related to mine closure and management; however, a number of rehabilitation comments were received.

Closure management

- DEC requested information on why it will not be possible to backfill pits to above the watertable. In addition, the DEC requested further information on an option outlined in the PER of partially backfilling 50% of the pit. The DEC noted a preference for all pits to be backfilled to at least 2 m above the level of the pre-mining ware table. The DEC noted that it does not support the establishment of mine pit lakes that will become toxic to wildlife over time.
- DEC recommended that the Proponent develop mining strategies to allow for the progressive backfilling of pits, which will prevent the formation of pit lakes, and reduce the area needed for waste stockpiles.
- DEC stated that greater characterisation of the likely areas of exposed PAF in pits and specific remediation methodologies is required and that advice should be sought from the DMP and DEC on this issue.
- DEC noted that the 'spontaneous combustion and acid rock drainage' (SCARD) management plan referred to within the PER document and previously requested by the DEC was not included within the PER and recommended that it be provided for review by DMP and DEC.

Mine closure

- DMP suggested that the Hope Downs 4 closure criteria should state that post closure landforms are to be non-polluting.
- DMP suggested that proposed Condition 9-1, should reference the DMP as well as the DEC and that the Closure Management Plan (Decommissioning and Closure Plan) should be developed at least five years prior to closure.
- DMP stated a belief that the terminology in proposed Condition 9.1 is ambiguous and should be refined further to allow clarification between the 'Closure Management Plan' and the end of mine life 'Decommissioning and Closure Plan' in order to avoid confusion in relation to when the two Plans are required to be developed.

Rehabilitation

- DMP stated that the design of the waste dumps within the PER seemed specific, however the DMP identified that within the document it stated that the 'final design of landforms will be determined by the results of waste material characterisation' but the link between the waste dump specifics and waste characterisation have not been provided in the document. DMP recommended that a commitment in the PER be included for rehabilitation trials to be conducted in order to determine the best final landform design.
- DMP noted that that within proposed Condition 8.1, regarding the progressive rehabilitation schedule, there should be a reference made to the DMP.
- DEC recommended that the Progressive Rehabilitation Schedule be developed in consultation with the DEC to the satisfaction of the OEPA and that the Schedule should also specifically address the revegetation of Coondiner Creek, if this matter is not already incorporated into other management plans.

4.9 AIR QUALITY AND DUST

One respondent provided comments on air quality and dust, as outlined below:

- DEC requested that more detailed information about the proposed dust monitoring program and technique should be provided.
- DEC recommended that the Proponent should provide any dust model validation results to the EPA.
- DEC noted that assessments undertaken by the DEC of air quality modelling associated with this project will need to comply with the DEC's air quality modelling guidelines, and that the guidelines recommend that a "worst case scenario screening" approach be adopted. The DEC noted SKM's conservative approach to the screening of air emissions was consistent with the guidelines and that the configuration of the air dispersion model appeared reasonable.
- DEC noted that modelling undertaken for the site indicated that predicted concentrations of PM_{10} for potential receptors (includes a background concentration of 25 g/m^3) will exceed NEPM standard at several locations close to mining operations (e.g. construction camp, permanent village, Eagle Rock Falls and Pool). As a consequence, the DEC requested that particulate concentrations be confirmed as being below national air quality guidelines levels for human receptors, and noted that it is the responsibility of the Proponent to demonstrate that air quality impacts are low and to provide evidence that verifies the Proponents claims of emissions being insignificant.
- DEC noted that NEPM standards are based on human health criteria and may not be protective of native flora and fauna. The DEC suggested that additional performance measures may be required, such as the monitoring of local species population health to investigate whether native species are being impact by air emissions and to demonstrate if NEPM is sufficiently protective.
- DEC stated the belief that that modelling results and predicted impacts on air quality presented in SKM report (2008a) have not been adequately addressed in the PER.
- DEC commented that the predicted concentrations of TSP for potential receptors were significant. DEC recommended that the Proponent develop a comprehensive dust management system that involves validation of dust emissions rates as well as the installation of an appropriate dust monitoring and dust control systems.

- DEC queried whether the proponent had investigated the potential for moving the mining camp to a slightly different location in order to mitigate dust impacts and reduce exposure of individuals residing at the mining camp.

4.10 MISCELLANEOUS COMMENTS

The following general comments were received from two respondents:

Water supply requirements

- DOW commented that the PER specifically excludes estimates for construction and potable water supply and presumes this can be covered by a groundwater licence under the *Rights in Water and Irrigation Act 1914*. The DoW further states that this information was previously requested during the draft PER process as it is essential to the context of the life-of-mine-water balance. The DoW noted that the provision of this information would ensure that there were minimal outlays in the project start-up as the licensing assessment needed to take into account impacts from the water management activities.

Reporting

- DoW requested clarification on the reporting and notification requirements for the project, and suggested that the OEPA should be the primary contact as they are best able to disseminate project information to the appropriate Decision Making Authority.

Infrastructure

- DMP identified discrepancies in the area allocated for mine camps within the PER document and the 'Hope Downs 4 Conceptual Closure Management Study'. The DMP requested that the differences in areas allocated for mine camps/accommodation between the two documents be justified.
- DMP recommended that a condition be placed in the Ministerial Statement, or on the State Agreement to ensure that an acceptable geotechnical design report is provided to DMP or the Department of State Development (DSD), prior to the tailing storage facility being constructed to ensure the safety and environmental risks of the facility are assessed.

Tenure

- DMP commented on the tenure status of the proposal. DMP stated that if State Agreement tenure is granted over this area, a Project Proposal must be submitted to DSD. However, DMP noted that if tenure under the Mining Act is granted then a mining proposal must be submitted in accordance with tenement conditions. Further, DMP stated that the Proponent must ensure that the appropriate tenure has been granted for all proposed disturbance areas, including bores and water discharge points.
- DMP stated that if the project was assessed under the Mining Act it would also have tenement conditions that would need to be complied with.

Terminology

- DMP commented on the use of 'if required' in relation to an environmental action and stated that it has the potential to create confusion in the future as it was not clear if the action would be undertaken when monitoring conducted by the Proponent suggests it was required or if the action would have to be requested by the EPA.

Environmental Factors

- The DMP stated that Table ES2 on pages xvii and xxii should also list salinisation as a potential groundwater and subterranean fauna impact.

5. DETAILED RESPONSE TO SUBMISSIONS

5.1 OVERVIEW

The following sections provide detailed Proponent responses to individual comments raised in the submissions. The comments and corresponding responses have been tabulated and grouped according to the environmental factor they address as follows:

- Groundwater (Section 5.2)
- Surface water (Section 5.3)
- Vegetation and flora (Section 5.4)
- Fauna and habitat (Section 5.5)
- Subterranean fauna (Section 5.6)
- Potential acid forming material (Section 5.7)
- Aboriginal heritage (Section 5.8)
- Closure and rehabilitation (Section 5.9)
- Air quality and dust (Section 5.10)
- Miscellaneous (Section 5.11).

5.2 GROUNDWATER

Several submissions commented on groundwater aspects of the Hope Downs 4 Iron Ore Project. Most comments related to the monitoring and management of groundwater abstraction during the life of the proposal.

Table 2 Response to submissions relating to groundwater

Item	Submitter	Submission	Proponent response
Groundwater management			
1.	DoW	The DoW supports the development of a management plan to augment groundwater in the calcrete and Eagle Rock Pool if they are impacted by dewatering.	The Proponent notes this comment. The Adaptive Surface Water Management Plan (contained in the EMP appended to the PER) already contains a provision for monitoring surface water pools (including Eagle Rock Pool). The Proponent will also include the calcrete area in the proposed groundwater monitoring program (see Section 2.3.1 of this document for more detail). Based on current hydrological, hydrogeological, geological, hydrochemistry and isotopic data, it is considered unlikely that the proposed dewatering will have a significant detrimental effect on the calcrete and Eagle Rock Pool. However, the Proponent will consult with relevant stakeholders in the unlikely event that it is necessary to implement an augmentation plan for the calcrete and Eagle Rock Pool.
2.	DoW	The DoW would like to review the groundwater augmentation plan and believes an outcome based condition would be suitable in this instance, with triggers to be reviewed annually.	The Proponent notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine. Triggers have been developed for the Groundwater Management Plan and the Adaptive Surface Water Management Plan (contained in the EMP appended to the PER). These triggers will continue to be reviewed and revised in consultation with relevant stakeholders.
3.	DoW	Assessment of actual versus predicted impacts should be ongoing to determine whether effects on the creeks/pools are related to drawdown.	The Proponent will continue to monitor the predicted versus actual impacts of dewatering and the potential effects on the creeks/pools from drawdown as per the monitoring program stated in Item 1 above (see also Section 2.3.1 of this document).

Item	Submitter	Submission	Proponent response
Monitoring			
4.	DoW	The PER asserts water levels in nearby pools are not expected to change as a result of dewatering. However, the model suggests that there may be an effect on water levels at Eagle Rock Pool four years after commencement of mining. The proponent should continue to monitor groundwater levels in the calcrete and towards Eagle Rock Pool as well as the surrounding pools to collect baseline data prior to dewatering/mining.	The Proponent has undertaken further hydrochemistry and isotopic investigations that further validate the predicted surface water impacts presented in the PER. Refer to Section 2.2.3 and Appendix 2 of this document. The Proponent has initiated a continuous groundwater and surface water monitoring program to collect baseline data in the Hope Downs 4 area. Groundwater levels and the visual assessments of water level changes in various surface pools are included in the monitoring program. The monitoring program aims to capture data that will identify impacts to the groundwater resources and pools. Monitoring infrastructure includes: • a number of monitoring boreholes that have been completed and screened against different horizons including alluvium, calcrete and various units of the Hamersley Group. These boreholes are associated with monitoring groundwater level and groundwater quality. Some of these boreholes are equipped with automated down hole water level data loggers • three sites along Coondiner Creek where shallow water levels in the alluvium associated with the creek bed are monitoring with automated data loggers in an attempt to identify and characterise /quantify flow events • seven pool locations (which include Stuarts Pool, Kalgan Pool, Three Pools, Eagle Rock Pool and Eagle Rock Falls) which are sampled regularly for water quality determination (including environmental isotopes) and are also photographed.
5.	DEC	The DEC supports the proponent commitment to monitoring the impact of dewatering on these systems using monitoring bores between the permanent pools and the ore body. There is, however, a need to further investigate the feasibility of contingency measures in the event that unacceptable impacts are observed, which is not discussed.	The Proponent notes that based on current hydrological, hydrogeological, geological, hydrochemistry and isotopic data, it is considered unlikely that the proposed dewatering will have a significant detrimental effect on surrounding permanent surface water bodies (refer also to Section 2.2.3 and Appendix 2 of this document). The Groundwater Management Plan and the Adaptive Surface Water Management Plan (contained in the EMP appended to the PER) provide details of the management, monitoring and contingency measures. These measures will continue to be reviewed and revised in consultation with relevant stakeholders.

Item	Submitter	Submission	Proponent response
6.	DEC	The PER includes advice that there is limited connectivity between the orebody aquifer and Kalgan Pool. However, it also indicates that Kalgan Pool has a mix of surface and ground water (section 14.2.2, page 82), and has the richest abundance of macroinvertebrate species (section 14.2.3 "Species Occurrence", page 84), which may be due to its unique water chemistry. Potentially stygobitic amphipods were recorded from Mindy Mindy Creek and permanent pools along Mindy Mindy Creek are likely to be associated with groundwater springs (para. 7, page 71). It is also stated that Eagle Rock Pool and Eagle Rock Falls, which are located along Coondiner Creek (5km and 8km away respectively), are unlikely to be impacted as a result of dewatering (para. 1, page 70). However, it is recognised on page 75 (para. 3) that the alluvials associated with Coondiner Creek within the mining area are likely to experience some degree of groundwater loss due to dewatering. The PER states that dewatering will have a negligible impact on these surface water pools (section 13.5, page 77), but, from the discussion referred to above, at least some pools could potentially be impacted by dewatering, with the extent of impact currently undefined. DEC supports the proponent commitment to monitoring the impact of dewatering on these systems using monitoring bores between the permanent pools and the ore body. There is, however, a need to further investigate the feasibility of contingency measures in the event that unacceptable impacts are observed, which is not discussed. Recommendation 5: That water levels at permanent/semi-permanent pools be monitored using depth gauges as well as photography in order to determine whether changes to these levels could be linked to dewatering activities.	The Proponent notes that based on current hydrological, hydrogeological, geological, hydrochemistry and isotopic data, it is considered unlikely that the proposed dewatering will have a significant detrimental effect on surrounding permanent surface water bodies (refer also to Section 2.2.3 and Appendix 2 of this document). The Proponent has given consideration to the installation of depth gauges at surface water locations within the Proposal area. The Proponent is of the opinion that: • there are a number of constraints associated with such installations, including the potential for the gauges to be destroyed during flood events and potential environmental impact associated with establishing these gauges • the continuation of the existing surface water photographic program should provide an enduring record that is sufficient for the purposes of determining water level changes. This photography will be assessed in conjunction with the ongoing monitoring of groundwater within the Proposal area. However, the Proponent can confirm that graduated water level indicator posts and/or electronic water level data loggers will be established and surveyed at key larger pools as practicable; other means of water level measurement will be considered if these two means are not feasible. As such, it will be possible to quantitatively approximate the natural seasonal variation of pool water levels. Installation of this equipment will be subject to receiving the appropriate approvals. If unacceptable impacts are observed, any necessary contingency measures will be reviewed as part of the Adaptive Surface Water Management Plan. The refinement of relevant contingency measures will continue to be reviewed and revised in consultation with relevant stakeholders. Outcomes from ongoing monitoring following on from the work described in Dogramaci and Dodson (2010) (Section 2.2.3) will also inform the feasibility of these contingency measures over the life of the mine.
7.	DEC	It is DEC's view that there is excessive subjectivity in the trigger levels specified in the Adaptive Surface Water Management Plan relating to pools in the area (Appendix 2, page 23) (i.e. "Change in the status of the quality and quantity of water"). It is recommended that the trigger levels be upgraded so that they are unambiguous and measurable. Recommendation 6: That trigger levels in the Adaptive Surface Water Management Plan that relate to pools be revised to ensure that they are specific and measurable, and can be monitored and used as triggers for contingency actions in the event that an unacceptable impact is detected.	The Proponent will continue to review and revise the trigger prescribed in the Adaptive Surface Water Management Plan (in consultation with relevant stakeholders) relating to pools in the area to ensure that the triggers are measurable and can be monitored.

Item	Submitter	Submission	Proponent response
8.	DEC	The PER does not appear to identify where the monitoring bores will be located. It is recommended that the location of the monitoring bores be identified, and it is important that the locations include the calcrete area north of the pit to further investigate the relationship between the alluvials/calcrete groundwater, the bedrock groundwater and the discharges at Eagle Rock pool. DEC anticipates that the bores between Eagle Rock and Kalgan Pools will be north of the pit but this needs to be confirmed. While dewatering is not anticipated to significantly affect the calcrete area north of the mining area, the possibility of leakage of water through this boundary area leading to impacts on pools should be recognised and managed to minimise unacceptable impacts. Recommendation 7: That the proponent provides a map detailing the locations of all the monitoring bores and collects baseline data from both the existing and proposed additional monitoring bores prior to the commencement of mining and dewatering.	The Proponent notes that a brief description of the current baseline monitoring program is provided in the response to Item 1 (refer also to Section 2.3.1 of this document) and the locations of all monitoring bores are indicated in Figure 8.
9.	DEC	The reliability of the information included on page 75 of the PER on monitoring of tree health along Weeli Wolli Creek (as part of Hope Downs 1) needs to be clarified as does its applicability to management of this new proposal. The PER states (para. 4, page 75) that there has been "no significant decline in tree health along Weeli Wolli Creek where the water table has been drawn down by up to 19m", and attributes decline in foliage cover to a bushfire event. DEC concurs that decline in foliage cover at Weeli Wolli Spring was in part due to bushfire impacts, but is also concerned that there may be a more sustained decline associated with the groundwater drawdown. DEC has not yet had the opportunity to comment on the design and methodology of the monitoring program at Weeli Wolli (commenced over 12 months ago) and is yet to review the results obtained. Therefore DEC cannot verify the proponent's statement that there have been no impacts from drawdown. It is recommended that the proponent clarify this information, with particular regard to how monitoring and management of discharge dewatering at Hope Downs 1 may be able to be used to avoid impacts at Hope Downs 4. Recommendation 8: That the proponent provides the monitoring methodology, baseline data and monitoring results for Weeli Wolli Creek to support the view that there has been no significant impact on tree health along Weeli Wolli Creek due to dewatering at Hope Downs I and to substantiate how lessons learnt from monitoring and management of discharge dewatering at Hope Downs 1 will be used to avoid impacts at Hope Downs 4.	The Proponent notes that the provision of monitoring methods used at Hope Downs 1 will be via different process which is outside of the environmental impact assessment for the Hope Downs 4 Iron Ore Project. There are already established processes in place specific to the Hope Downs 1 project and the Weeli Wolli Creek monitoring. However, the Proponent believes that the summary of the Hope Downs 1 information included on page 75 of the PER is: a) applicable to the Hope Downs 4 area as: • the Proponent is intending to monitor the same species (*Eucalyptus victrix* and *E. camaldulensis*) at Hope Downs 4 that are currently monitored at Hope Downs 1 • the Proponent is intending to monitoring vegetation in areas that may be subject to groundwater drawdown at Hope Downs 4 as is currently monitored at Hope Downs 1 b) reliable as: • the information provided in the PER is reliable as it is based on monitoring methods that are quantitative and repeatable. Lessons learned from the Hope Downs 1 Project will be applied to the following aspects to the Hope Downs 4 Proposal: • development of suitable monitoring methods to capture the potential impacts of excess water discharge • regional approach to monitoring to capture the overall impacts of the Proposal • engage relevant stakeholders early to ensure that all environmental outcomes are considered • agree on monitoring methods with relevant stakeholders • collect baseline data. The Proponent will continue to review and revise the management and monitoring prescribed in the component management plans contained in the EMP. This review process will include consultation with relevant stakeholders.

5.3 SURFACE WATER

Several submissions commented on surface water aspects of the Hope Downs 4 Iron Ore Project. Most comments related to the impacts of excess water discharge to the surrounding environment and the realignment of Coondiner Creek.

Table 3 Response to submissions relating to surface water

Item	Submitter	Submission	Proponent response
Excess water management			
1.	DoW	The DoW considers discharge to Ophthalmia Dam the preferred option for excess water management, but recognises that there are limitations to this. The next preferred option would be for the transfer of water to the Hope Downs operation but the DoW has concerns that as the operations evolve the project timelines may change, which could make water sharing unviable.	The Proponent notes this comment. The Proponent understands the risks associated with each excess water management option and is aware of the DoW's hierarchy of preferred options. Refer also to Section 1.1.3 of this document for more detail.
2.	DoW	While the option of controlled discharge to creeks will have some local impacts, the DoW believes these are manageable through appropriate conditions.	The Proponent notes this comment. The Proponent will manage the option of controlled discharge through regular monitoring of excess water discharge as described in the Adaptive Surface Water management Plan (appended to the PER) and is committed to complying with all conditions that may be required the OEPA.
3.	DoW	The DoW has reviewed the proposed environmental conditions for discharge to the creeks and would like to see some clarification on how the parameters are measured.	The Proponent provides the following clarification (as described in the Adaptive Surface Water Management Plan appended to the PER): • extent of surface water flow: monthly visual observations of flow extent at defined locations along discharge creekline • water quality parameters/ANZECC water quality criteria: quarterly water quality sampling at designated locations along discharge creekline • erosion along banks: annual visual inspection of channel along length of discharge footprint • flows exceed bank full capacity: continuous flow rate monitoring at discharge outlet and water level monitoring • loss of foliage cover: riparian vegetation monitoring as described in Section 2.3.3 of this document.
4.	DoW	Refinement of the proposed conditions to specify response actions and include ceasing of discharge if required, should enable impacts to be identified and managed.	The Proponent notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine.
5.	DoW	The DoW recommends a ministerial condition be included requiring implementation of a water management plan covering these issues, and it be annually reviewed and updated during the life of operation.	The Proponent notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine. The Proponent intends to manage these issues through the Adaptive Surface Water Management Plan included in the Hope Downs 4 Operations EMP. All Plans in the Hope Downs 4 Operations EMP will be regularly reviewed and updated where required over the life of the Proposal in consultation with relevant stakeholders. The Proponent will comply with any conditions applied to the Proposal.

Item	Submitter	Submission	Proponent response
6.	DEC	Approval of the proposal as set out in the PER does not appear to commit the proponent to pursuing lower impact options for excess water management. Such a requirement should be included in any approved development. Provision of water to other mine sites or projects appears not to have been fully considered, and appears to warrant more detailed investigation, in particular with Hancock Prospecting's Roy Hill Stage 1 project which has a significant water requirement. Based on the available information, it is DEC's preference that the proponent pipes the excess water to the Ophthalmia Darn or Hancock Prospecting's Roy Hill borefield (for reinjection), if technically and environmentally feasible. Recommendation 3: That the proponent provides a timeline for cessation of discharge of excess water to nearby surface drainage systems and for implementing a more environmentally acceptable strategy for managing excess water, such as piping water to Ophthalmia Dam.	Refer to Section 1.2.3 of this document for clarification of the Proponent's excess water management strategy, and the response to Item 9 below for a discussion on discharge timelines. The Proponent has not considered the provision of water to Hancock's Roy Hill Stage 1 project due to the fact that the option presents no economic, social or environmental benefit to the State or the Proponent. Dewatering is not designed to provide a reliable sustainable water supply, rather it is designed to remove the groundwater from storage as rapidly as possible and then continue to remove water from an area faster than it can be naturally recharged. Therefore, the recipient of any transfer of water between locations has to recognise the inherent risks associated with relying on a dewatering source, one which in this instance Hancock Prospecting would have to accept. In addition to these operational risks, transferring water from Hope Downs 4 to Roy Hill raises a number of environmental, social and economic concerns. The Proponent's and Rio Tinto's discussions with the Nyayaparli traditional owner group have resulted in a commitment not to disturb the Fortescue Marsh. Similarly, previous attempts by other organisations to traverse the Marsh with roads and pipelines have been rejected by the DEC on environmental impact grounds. In order to avoid the Marsh the resultant pipeline route would be of the order of 100+ km resulting in an increased clearing footprint over and above the direct route across the Marsh and a higher emissions profile during construction and operation than any other option being considered. Economically, the investment in a pipeline that could deliver an average maximum of 4 GL for approximately eight years is not appropriate as the investment could be better spent elsewhere.
7.	DEC	In addition, it is recommended that the assessment of the water management strategy proposed at Hope Downs 4 should take into consideration the hydrological modelling and contingencies built into the approval of Hope Downs 1. The Hope Downs 4 hydrological modelling and water balance provided in this assessment should be confirmed as adequately' allowing for the upper limits of potential dewatering and possible discharge plans.	Refer to Section 1.2.3 of this document for clarification of the Proponent's excess water management strategy. Investigation into the feasibility of transferring excess water to Hope Downs 1 mine site will continue to take into account the hydrological modelling and relevant parameters built into the approval of Hope Downs 1 as appropriate for this Proposal. Based on current mine and dewatering planning (including hydrological modelling) for both Hope Downs 1 and the proposed Hope Downs 4 mining operations, transfer of excess water to Hope Downs 1 could commence when Hope Downs 4 moves into surplus. The transferred water would be used to supplement operational and environmental water requirements as Hope Downs 1 nears completion of its operation and beyond. The period which Hope Downs 1 could receive excess water is dependent on recovery of the groundwater cone of depression at Hope Downs 1. This is included as Section 8.3.3 of the PER (page 41). The modelling undertaken to date has taken into account the worst case scenario or 'upper limits of potential dewatering and possible discharge' as outlined on page 93 of the PER, with the discharge footprint for each creek system modelled with the assumption that the entire volume of excess water will be discharge to a single creek. A study to better understand how much water would be required and for how long at Hope Downs 1 (in relation to meeting post-closure environmental water requirements) is currently underway.

Item	Submitter	Submission	Proponent response
Disposal of excess water to the environment			
8.	DEC	The Proponent also needs to define its intentions and the intended approvals processes for the intended transfer and disposal of excess water from this proposal offsite and the potential environmental impacts or benefits associated with this.	Refer to Section 1.2.3 of this document for clarification of the Proponent's excess water management strategy. In summary, the option of transfer to Ophthalmia Dam is no longer being pursued by the Proponent. The Proponent is continuing to investigate the feasibility of transferring excess water to the Hope Downs 1 mine site, however, this option is contingent on alignment of scheduling (i.e. coincidence of water surplus and water deficit) at both the Hope Downs 1 and 4 operations. For remote operations such as Hope Downs 4, the transfer of excess water will continue to be problematic and cost-prohibitive. Therefore, discharge to creeklines will continue to play an important role in the management of excess water for remote operations. Should transfer to Hope Downs 1 mine site be pursued the Proponent will consult with relevant agencies as to the necessary licensing and permit requirements for any proposed works. As stated in the PER (page 91): "Transferring excess water to Ophthalmia Dam and/or Hope Downs 1 is contingent on agreement from third parties, outcomes of ongoing studies and scheduling considerations. If this option is chosen, the management of this water will become the responsibility of the Proponent of Hope Downs 1 or Ophthalmia Dam. Therefore the environmental considerations for excess water following physical transfer to HD1 and Ophthalmia Dam would be considered under separate approval process (if required) to this Proposal and are not discussed further in this PER".
9.	DEC	The discharge of excess water into creeks and associated impacts on affected ecosystems are considered to be an important environmental issue that needs to be properly assessed and addressed for this proposal. A very large volume of water is proposed for dewatering (possibly up to 20 GL/yr). Downstream riparian ecosystems are adapted to highly seasonal rather than year-round flow regimes and the proposed change in water flows is likely to have significant impacts on their conservation. If surface discharge to creeks is found to be the only feasible option, then impacts need to be avoided or mitigated to an acceptable level. The PER contains limited information on the initial excess water management, stating that any initial excess water from dewatering will be discharged to Kalgan Creek under "exceptional circumstances" or to other (single or multiple) creeks if required (section 8.3.1, page 39, section 14.3.2, page 91). There is limited specific information in the PER or the Environmental Management Plan (Appendix 2) on the daily or weekly volumes of water that are likely to be discharged, the rate, duration and timing of discharge or the number of discharge events required, making it difficult to understand the potential impacts of discharge or the likely effectiveness of intended management. It is recommended that the criteria that constitute "exceptional circumstances" and the limit of acceptable change to affected ecosystems (degree and areas affected) be defined along with an explanation of the proposed discharge characteristics and the monitoring and management measures to be applied to maintain impacts below the specified limits of acceptable change.	At this planning stage of the Proposal, numerical groundwater modelling has estimated that a volume in the order of 100 GL of groundwater will require abstraction at the mine site over the planned life-of-mine to meet the proposed mine plan. There is always some uncertainty associated with a model's prediction and as a result predictions will be continually refined over the life of the operation as further data becomes available. The total abstraction volume however will not be evenly distributed over the period over which dewatering is undertaken. The current preferred dewatering scenario estimates that relatively lower annual abstraction volumes in the earlier years, increasing to peak abstraction years during the mid-life of the mine followed by decreasing annual volumes in subsequent years, will be sufficient to achieve water level targets (see Figure 23 in the PER). As water demand at site is expected to closely match these early-period abstraction volumes the result will be no net discharge of abstracted water 'off-lease' during this first three year period. Demand for water for the mine operation is not continuous and during periods of low demand water can be discharged to a proposed exchange dam which will act as a buffer for periods when demand falls below abstraction capacity. Should the dam reach its limit during the mine's early years of operation, the abstraction system can be adjusted to match the demand such that no discharge to the environment will be required. In doing so some portion of the total abstraction volume for the life of mine will be deferred to later during the mining period. It is understood that although some flexibility is possible with regard to avoiding the discharge of abstracted groundwater to the environment during the mine's early operation there will come a point when the rate of continued groundwater abstraction must increase to reduce groundwater levels sufficiently for mining. At this time the discharge of excess water to the environmental will be unavoidable. Should it be necessary for periodic off-site discharge in the early years of the mine, it would be undertaken in accordance with the long-term discharge strategy (i.e. discharge to Kalgan Creek). The potential impacts to Kalgan Creek (changes to ecosystem) from discharge of excess water were described in the PER (Section 14.3.2). Should excess water be

Item	Submitter	Submission	Proponent response
		Recommendation 1: That the proponent clarifies the proposed volume, rate and duration of discharge of excess water and the anticipated number of discharge events, as well as the potential impacts on Kalgan Creek and other creeks, of the initial excess water management strategy.	discharged to Kalgan Creek under exceptional circumstances during the initial period of mining this will be managed in accordance with the management measures developed for the long-term discharge strategy (see PER, Section 14.3.2, page 101 and OEMP contained in the PER, Appendix 2). Current predictions indicate that water level targets can be achieved by following a dewatering plan that does not distribute the total groundwater abstraction volume evenly over the life-of-mine and allows lower annual cumulative abstraction rates during the earlier years. Rates of abstraction are therefore more likely to align more closely with water demands at site during the early period - reducing the need to discharge 'off-lease' excess abstracted groundwater during this time. The total number of years when excess water is discharged 'off-lease' is therefore effectively reduced. In attaining this flexibility to modulate water release in the initial stages of the operation, a trade-off is required such that in later years a greater volume of water per year may require discharge to the environment. In this case, increasing the discharge footprint due to higher annual discharge rates is probable, but the period of discharge is reduced. Monitoring and management measures to be applied to control impacts Owing to existing uncertainties embedded in the planning process, particularly those introduced by the groundwater numerical model, a pipeline to deliver discharge water to the discharge point(s) may require construction earlier than anticipated. In such a case, a minimum 18 month pipeline design and planning period would be required prior to the planned date of pipeline commissioning. Although it may be possible that the early years of the operation may be run as a 'demand' system with no planned discharge to the environment of abstracted groundwater, 'excess' water generated from storm events during that period will be discharged off-site according to approved regulatory frameworks. As outlined on page 93 of the PER, discharge of excess water to creek line(s) will be subject to management measures in accordance with the Adaptive Surface Water Management Plan (appended to the PER). This plan includes a number of environmental triggers that if met will prompt the implementation of contingency actions including reviewing and changing discharge strategies as appropriate. In accordance with the contingencies, changing the discharge strategy may involve discharging to an alternative point along the creek line or discharging to a separate creek line.

Item	Submitter	Submission	Proponent response
10.	DEC	The environmental triggers and contingency measures for discharge of excess water to creek line(s) (Table 9, p. 102) need to be further developed in consultation with the Office of the EPA (OPEA) and, if required, DEC. In particular DEC is concerned that regulatory authorities (the PER refers to DEC but this should be OEPA in the first instance) would only be informed of degradation of riparian values when there is 40 per cent loss of foliage cover (Trigger Level 2). At that late stage, recovery of the affected systems may not be possible. The proponent should develop a strategy for rehabilitating creeks to EPA requirements in the event that discharge results in unacceptable levels of deaths of riparian vegetation. A commitment to maintaining the ecological value of rehabilitated creeks after discharge is complete, potentially involving ongoing monitoring, supplementation of water levels and/or rehabilitation, is recommended. It is recommended that the environmental impacts of this excess water discharge be confined to the least significant or sensitive systems. Information presented in the appendix on flora and vegetation on the creek lines (Coondiner, Kalgan, Mindy Mindy and Unnamed) associated with Hope Downs 4 (Mattiske 2009c) indicates that the C4 community, which has similarities to the Weeli Wolli Spring community (Priority 1), occurs along the major flow lines which have been identified as areas for discharge of excess water. Impacts on this significant ' vegetation community from discharging of excess water should also be considered in the assessment. Recommendation 2: That the proponent further develops the environmental triggers and contingency measures for discharge of excess water to creeks (Table 9, p. 102) (including a rehabilitation and ongoing management plan for impacted creek ecosystems in the event of significant plant deaths), in consultation with DEC. Triggers and contingencies should have particular regard to significant flora, fauna and communities within the discharge footprint, in particular the C4 vegetation community.	The C4 vegetation community was recorded along Weeli Wolli, Mindy Mindy and Coondiner Creeks. As stated in Section 1.2.3, *Clarification of excess water management options* (page 8), the Proponent will not be pursing discharge of excess water to Mindy Mindy or Coondiner Creeks; the design of the discharge infrastructure to Kalgan Creek will be taken forward in the next stages of engineering design for the Proposal. There are no occurrences of the C4 vegetation community along the mapped extent of Kalgan Creek. The Proposal does not include discharge to Weeli Wolli Creek. The triggers proposed as part of the adaptive management approach for the discharge of excess water to ephemeral creeklines (see PER, Table 9, page 102 and OEMP Appendix 2, Table 10, page 24) are in-line with the management triggers the Proponent and the DEC have previously agreed to regarding foliage loss in riparian trees both at the Yandicoogina and Hope Downs 1 mine sites. The 25% and 40% foliage loss trigger levels are considered conservative due to the natural losses/gains in foliage cover between monitoring events in regional reference sites (Adams, 2005, 2006, 2007). However, as part of the adaptive management approach, the Proponent has committed to develop and implement measures to mitigate impact as required should monitoring indicate a trigger has been met (see Table 10 in the OEMP contained in Appendix 2 of the PER). The Proponent considers there to be adequate time prior to discharging excess water to consult with relevant stakeholders to review and revise the triggers proposed and to further develop mitigation responses. The Proponent would consider it appropriate if the OEPA were to apply a condition of project approval requiring triggers and mitigation responses to be developed prior to commencement of excess water discharge.

Item	Submitter	Submission	Proponent response
11.	DEC	With respect to alternatives to on-site discharge to the environment, the PER does not demonstrate a clear commitment to the most environmentally beneficial management of excess water and also does not indicate whether new environmental impacts and approvals (or environmental benefits) may result from transfer and disposal of water off-site. The PER indicates that the environmental considerations for excess water following physical transfer to Hope Downs 1 and Ophthalmia Dam would be considered under separate approval processes. The environmental impacts and/or benefits associated with these 'longer term' options are therefore not discussed in any detail in the PER. It is-recommended that these options be considered in this assessment, given the likelihood of significant impacts from local discharge to creek ecosystems if these options are not technically or economically feasible. Ideally water should only be transferred where it is to be used on other mine sites or where it can be disposed of in a manner that achieves no net environmental loss. For example, this project should not increase ongoing environmental impacts at Hope Downs 1 by adding to or continuing the impacts of discharge of that operation into Weeli Wolli Creek. Recommendation 4: That the environmental impacts and technical and economic feasibility of all excess water management strategies discussed in the PER be considered as part of this proposal.	Refer to Section 1.1.3 of this document for clarification of the Proponent's excess water management strategy. In summary, the options of transfer to Ophthalmia Dam and discharge to Mindy Mindy Creek are no longer being pursued by the Proponent. The Proponent is continuing to investigate the feasibility of transferring excess water to Hope Downs 1 mine site, however, this option is contingent on alignment of scheduling (i.e. coincidence of water surplus and water deficit) at both the Hope Downs 1 and 4 operations. If transfer of excess water to Hope Downs 1 was pursued the water would be used to meet the operational (e.g. dust suppression) and environmental water requirements at Hope Downs 1; the Hope Downs 1 operation has environmental obligations to maintain the integrity of the Weeli Wolli Spring beyond closure until natural groundwater conditions can be restored. Sourcing water from Hope Downs 4 exists as an opportunity to either speed up the aquifer recovery or to directly maintain spring flow at the Weeli Wolli Spring. For remote operations such as Hope Downs 4, transfer of excess water will continue to be problematic and cost-prohibitive. Therefore, discharge to creek lines will continue to play an important role in the management of excess water for remote operations. Investigations are ongoing to further define the technical and economic feasibility for the remaining excess water management options. The option(s) chosen for excess water management will consider environmental short and long term impacts and benefits; discharge to creeklines has already been fully assessed in the PER (PER Section 14.3.2, page 91).
12.	DEC	Recommendation 23: That the outcome based conditions and the management criteria for discharge to creeks (Table 24, p. 199) be reviewed in consultation with DEC on the basis of the advice provided in this submission.	The Proponent notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine. Refer to the response to Item 13.
13.	DEC	The PER includes proposed environmental conditions (pp. 197-201). These proposed conditions (and the accompanying management documentation provided with the PER) do not appear likely to fully and adequately address management and mitigation of the potential environmental impacts of the proposal, in particular the Coondiner Creek realignment and dewater discharge to creeks. It is recommended that DEC be consulted with respect to the triggers in Table 24 (page 199) and monitoring and management actions relating to these. Below are some specific recommendations in relation to the proposed outcome based conditions. Conditions No. 7-1 and 7-2 Condition 7-1 relates to the discharge of excess water to watercourses. It is recommended that the proponent consult the OEPA and DEC with respect to appropriate management criteria for addressing the impacts and risks associated with discharge to creeks, as the range of triggers proposed may not be adequate to determine impacts on creeks in a timely fashion. Additionally, the trigger levels require revision in consultation with the OEPA and DEC. The proponent needs to review the creek monitoring data on a quarterly basis to ensure that any observed impacts can be detected and managed as early as possible.	The Proponent notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine. The Proponent will continue to review and revise the triggers prescribed in the component management plans contained in the EMP. This review process will include consultation with relevant stakeholders. The development of these triggers and contingency measures will also include a provision for regular review and adaptation of measures to achieve the long term environmental objectives for the Proposal.

Item	Submitter	Submission	Proponent response
Realignment of Coondiner Creek			
14.	DEC	The objective of the preliminary assessment of the hydrology of Coondiner Creek was to establish the existing flood extent, depth and velocity of the creek for 10, 20, 50 and 100 year Annual Recurrence Interval (ARI) events, however this was done without the benefit of any site specific monitoring data and .assumptions had to be made with respect to the estimated peak flows and conditions of the creek and its catchment (page 6-1 of the appendix to the PER by Kellog, Brown and Root, 2009). It is recommended that the proponent attempts to validate these predictions using rainfall and flow data via the use of a gauging station in order to improve the proposed creek realignment design, prior to construction. Recommendation 20: That a gauging station is put in place on Coondiner Creek to obtain accurate flood depths and velocity, and that the realignment of Coondiner Creek is designed taking into account the information from this station.	There are currently three pressure gauges in place at Coondiner Creek to capture flow depth data within the Creek. The Proponent's intent is to refine the flood model with flows data from the gauges during definitive design of the realignment. The Proponent intends use these gauges to collect additional data between now and construction of the realignment. However, the suitability of the data for refining the model will depend on the number of large flood events occurring between now and the next design phase. It is noted that to accurately calibrate a flood model for the Creek, the rainfall and flow records would ideally be long (in decades and centuries terms). The Proponent believes that the existing pressure gauges will be sufficient to collect data for design purposes and therefore does not intend to install a gauging station. Information collected by the pressure gauges together with creek cross sections post rainfall events, slope measurements and estimate of creek bed roughness will be sufficient to design the realignment of Coondiner Creek. The Proponent will use collected rainfall and flow data to refine the Creek model.
15.	DEC	The realignment of Coondiner Creek may impact on flows to Eagle Rock Pool and Falls, and the timing, construction and revegetation of the new creek alignment are also relevant to the maintenance of the conservation values of the creek and the downstream pools. It is important that not only the hydrological regime be maintained and monitored, but also that, as far as possible, habitat connectivity be maintained. The PER has identified that riparian habitat, in particular C1 and C4, is considered to be significant vertebrate fauna habitat not found in other areas. Coondiner Creek is mostly of the C1 vegetation community. The proponent indicates that vegetation will be established within the realigned channel as soon as practicable following construction and that the realignment will be made operational prior to disturbance of the existing channel and in time to accommodate seasonal flows in the creek system (para. 3, page 87). It is recommended that this commitment is further explained, clearly defined and subject to a condition if the proposal is approved. Recommendation 21: That the proponent's commitment to establish vegetation along the Coondiner Creek realignment as soon as practicable (para. 3, page 87) be further defined and made a condition of the project, should it be approved.	The Proponent notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine. In the initial stages of the realignment of Coondiner Creek the Proponent intends to revegetate the realigned area with grass and very low lying shrubs in order to stabilise the banks and beds of the creek. It would be impractical to establish sophisticated vegetation communities successfully due to complex structure of such systems and in the short term simple grasses and low lying shrubs would be more successful. However, over time, natural vegetation establishment (typical of the area) can be expected as the functionality the realigned creek section will not differ from the existing channel. As part of the Proposal rehabilitation strategy/plan, a program to propagate the disturbed areas with local native flora species will be implemented in accordance with the Construction Environmental Management Plan (in preparation). This program will include work to propagate species of relevance to the C1 community and of relevance to the Coondiner Creek realignment environment, for re-establishment by direct planting of advanced specimens if practicable.

Item	Submitter	Submission	Proponent response
16.	DEC	The PER includes proposed environmental conditions (pp. 197-201). These proposed conditions (and the accompanying management documentation provided with the PER) do not appear likely to fully and adequately address management and mitigation of the potential environmental impacts of the proposal, in particular the Coondiner Creek realignment and dewater discharge to creeks. It is recommended that DEC be consulted with respect to the triggers in Table 24 (page 199) and monitoring and management actions relating to these. Below are some specific recommendations in relation to the proposed outcome based conditions. Condition No. 6-1 It is recommended that this condition, regarding the Coondiner Creek realignment, incorporate a requirement to revegetate the realigned creek line as soon as practicable following construction. The realignment should also be made operational prior to disturbance of the existing channel and in adequate time to accommodate seasonal flows in the creek system. The realignment of Coondiner Creek may impact on flows to, and quality of water at, Eagle Rock Pool and Falls, and the timing, construction and revegetation of the new creek alignment are relevant to the maintenance of the habitat values of the creek and the downstream pools. The condition should also include a requirement for monitoring of water quality and quantity upstream of the pool prior to, during and after the realignment. It is important that baseline data are collected for comparison.	The Proponent notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine. A revegetation plan for the rehabilitation of Coondiner Creek will be developed in further consultation with relevant stakeholders as part of the Construction Environmental Management Plan, with appropriate additions included within the Adaptive Surface Water Management Plan. It should be noted that the realignment of Coondiner Creek is not required until approximately year five of mining.

5.4 VEGETATION AND FLORA

There were several submissions received on vegetation and flora aspects of the PER. Most of the comments received were in relation to the management of potential impacts to conservation significant species.

Table 4 Response to submissions relating to vegetation and flora

Item	Submitter	Submission	Proponent response
1.	DEC	The PER indicates that the C4 community and some species of flora in the C1 and C2 communities are thought to access groundwater at different times of the year (para. 7, page 116; para. 1, page 117). By comparing the vegetation mapping with the groundwater drawdown contours, it is apparent that there are occurrences of these communities within the drawdown zone. The vegetation in the vicinity of the mine is not subject to grazing and is considered to be in 'good' condition, using the Keighery condition scale (page 19 in Mattiske 2009a). Other areas have been impacted significantly by grazing, increasing the habitat value of those remaining areas of vegetation in good condition. The vegetation health of these communities accessing groundwater within the drawdown zone should be monitored, with a focus on protection of occurrences of the C4 community that are in good condition or better. Recommendation 9: That the proponent identifies C1 and C4 community types in good or better condition within the drawdown footprint and monitor vegetation health in these communities.	As noted in the PER (Section 13.3.1, page 74) vegetation communities that occur on the creek line systems (i.e. the C4 vegetation community) may access the creek alluvial aquifer; not the orebody aquifer which has an average depth to the water table within the mining area of approximately 30 m bgl. It is also noted in the PER on page 75, the availability of alluvial groundwater within the area of drawdown is not expected to be significantly affected by dewatering the orebody aquifer given: • the expected limited connectivity between the alluvial and orebody aquifers (refer Section 2.2.3 of this document) • recharge of the alluvial aquifer from seasonal surface flow is expected to be far greater than any loss from vertical leakage to the dewatered bedrock. However, the alluvials associated with Coondiner Creek within the mining area are likely to experience some degree of groundwater loss due to dewatering. As described in the PER on page 75, the Proponent will implement a tree health monitoring program on undisturbed sections of Coondiner Creek upstream and downstream of the mining area as outlined in the Vegetation and Flora Management Plan (PER Appendix 2). The Proponent intends to monitor riparian vegetation foliage cover, condition, composition and indicator tree species health, in accordance with standard Rio Tinto procedures, to monitor trends of vegetation health in comparison to selected reference sites.
2.	DEC	The C1 and C4 communities are considered to support significant vertebrate fauna habitat (section 16.3.1, page 137) and the C4 community has similarities to the Weeli Wolli Spring community (Priority 1), so it is reasonable to suggest that the impacts of drawdown on these communities should be considered and be avoided, where possible. Recommendation 10: That the proponent avoid impacts on species, communities and habitats of local and regional conservation significance (in particular the C4 community) in the management of dewatering and discharge.	As noted in the response to Item 1, the drawdown zone will not extend to the C4 vegetation community. In addition, discharge of excess dewatering water to Weeli Wolli Creek is not proposed; therefore, creek discharge from the Hope Downs 4 Iron Ore Project has no implications for the C4 community. As noted in Item 1 above, the availability of alluvial groundwater within the area of drawdown is not expected to be significantly affected by dewatering the orebody aquifer. Where vegetation community C1 occurs within the drawdown zone its occurrence is restricted to along Coondiner Creek and other creek lines. The occurrence of this vegetation community along the watercourse indicates that although some species present within the community may access groundwater at different times of the year they are also reliant on seasonal surface flow. In addition the vegetation community C1 is considered to be relatively widespread in the local area and as stated on page 120 of the PER, it extends for approximately 25 km downstream and 4 km upstream of the Proposal area along Coondiner Creek. This vegetation community also occurs in long tracts along other creeks in the area, including Kalgan, Mindy Mindy and Weeli Wolli Creeks and several unnamed creeks (refer to PER page 120).

Item	Submitter	Submission	Proponent response
3.	DEC	The PER states that "the restricted C4 community only occurs along a small section of Welli [sic] Wolli Creek within the option 1 infrastructure corridor" (para. 1, page 117), but Figure 27a (page 114) shows the C4 community within the option 6 corridor. This information needs to be checked to determine where the error is in the PER. Recommendation 11: That the proponent confirms that the C4 community occurs within the option 6 infrastructure corridor.	The Proponent notes that this comment was a typographic error. The sentence in the PER on page 117 should have stated “the restricted C4 community only occurs along a small section of Weeli Wolli Creek within the option 6 infrastructure corridor”.

Item	Submitter	Submission	Proponent response
4.	DEC	Weeli Wolli Spring is an ecosystem that is unusual in the region, having a large diversity of vegetation and high floristic richness due to the varied geology and landscape. The site is considered by DEC to be a relictual/refugial habitat. The flora, microbat assemblage and stygofauna are the main groups of biota that are considered most significant at Weeli Wolli Spring and Creek. The PER indicates there is some similarity between the C4 vegetation community within the Hope Downs 4 project area and the (Priority 1) Weeli Wolli Spring Priority Ecological Community (PEC) (para. 1, page 117). The PER then goes on to state that the C4 community is of conservation and scientific interest for comparative research needs (para. 1, page 117). The implication from this statement is that the area of the C4 community on Weeli Wolli Creek within the option 6 corridor may provide a suitable reference site for consideration of the impacts from Hope Downs 1 on the Weeli Wolli Spring PEC. In addition to direct impacts from clearing, impacts such as noise and dust from the infrastructure corridor may impact on the habitat values of this site, reducing the value of the habitat for birds, bats and other native fauna (and for comparative research purposes). Recommendation 12: That the proponent avoids primary and secondary impacts on species, communities and habitats of local and regional conservation significance (in particular the C4 community) in the selection of the infrastructure corridor alignment.	As indicated on page 121 of the PER, if infrastructure Option 6 is selected the disturbance to vegetation community C4 is expected to be limited to approximately 0.2 ha or 1% of the 17.4 ha occurrence of this vegetation community mapped. In addition, advice from RTIO botanists indicates that the north-eastern extent of the C4 community may have been over-mapped. Detailed ground-truthing of the community is proposed (should Option 6 be pursued) and may result in the north-eastern extent of the community being reduced such that there may no longer be a coincidence between the C4 community and the proposed rail infrastructure. In the PER (Section 14.3.3, page 104) it was stated that construction of railway bridges will result in some localised short-term disturbance to channel morphology and riparian vegetation. Long-term stability of the creek banks at the bridges will be maintained through the use of stone-pitching on the riverbanks alongside the bridges to prevent scouring. The bridges will also be designed to maintain natural surface water flow regimes. Dust deposition on vegetation is more likely to occur during the construction phase of the bridges, however, as stated in the PER (Section 20.4, page 184) periodic rainfall events would remove dust build-up on leaves mitigating any physical effects this may have on plants. As stated in the PER (Section 16.3, page 137), other minor sources of potential impact to terrestrial fauna include noise emissions. It should be noted that: • noise emissions from rail movements will be intermittent (not continuous) at the Weeli Wolli Creek crossing • it is only the option 6 (southern) corridor that may potentially disturb the C4 vegetation community • there are occurrences of the C4 vegetation community along Mindy Mindy and Coondiner Creeks which are not proposed to be disturbed and are at distance from noise sources associated with the Proposal. The Proponent is also of the opinion that fauna species utilising the C4 vegetation community (habitation or foraging) would not be restricted to this community as delineated by the vegetation mapping (PER, Figure 28, page 122) – it is likely that the same species would also occur in the adjacent downstream and upstream vegetation communities. Noise emissions from the rail at the creek crossing location may deter species from foraging and general habitation close to the noise source; however, this will not detrimentally affect the persistence of the fauna populations in the vicinity (i.e. fauna will migrate [if anything] rather than cease to persist). Disturbance to the C4 community will be completely avoided if Option 1 is selected. In the event that Option 6 is selected and disturbance takes place in vegetation community C4, disturbance will be limited to the vegetation community in accordance with management actions described in the Flora and Vegetation Management Plan contained in the Hope Downs 4 Operational EMP.

Item	Submitter	Submission	Proponent response
5.	DEC	It is recommended that DEC be consulted regarding the final alignment of the infrastructure corridor. Additional to the matter of impacts on the C4 community, the corridors intersect sheet flow-dependent mulga communities. Consultation in regard to the location of borrow pits, environmental culverts and other drainage designs, as well as rehabilitation strategies to ensure that sheet flow is maintained during and after construction, is also recommended. The option 6 corridor would also involve the removal of Lepidium catapycnon (Declared Rare Flora), while the PER indicates that populations within the option 1 infrastructure corridor can be avoided (para. 2, page 123). Additionally, one potential short range endemic species (Antichiropus sp.) was collected within the option 6 corridor. Assuming that Figure 27a is correct regarding the location of the C4 community on Weeli Wolli Creek and on the basis of the above points, it is DEC's preference that the proponent avoids the option 6 corridor and consults with DEC regarding the specific alignment of the proposed option 1 infrastructure corridor. Recommendation 13: That the proponent consults with DEC regarding the final alignment of the infrastructure corridor, including the suitable location of borrow pits and culverts in areas where the corridor intersects mulga communities.	The Proponent notes this comment and recommendation. It is the intention of the Proponent to consult with the DEC in relation to drainage surrounding the infrastructure corridor. This consultation will also involve discussion on proposed borrow pit locations. In the event that Option 6 is selected and disturbance takes place in vegetation community C4 and surrounding the *Lepidium catapycnon* and potential SRE (Antichiropus sp.), disturbance will be limited in these areas in accordance with management actions described in the Flora and Vegetation Management Plan contained in the Hope Downs 4 Operational EMP (contained in Appendix 2 of the PER).
6.	DEC	It is recommended that the proponent review the flora survey data to confirm whether or not this Priority listed community occurs within the project footprint. DEC has not been able to determine the extent of the M6 and M3 vegetation types in relation to landforms and consequently determine the likelihood of presence of this PEC within the project area from the data supplied. The maps supplied in the PER are of low resolution and have poor colour separation between community types. As the maps appear to depict structurally-based community mapping, they would be improved through reconciliation with floristic community analysis. DEC would appreciate access to the floristic analysis and associated site data to confirm the potential for an occurrence of the PEC. Recommendation 14: That further information be provided on the M6 and M3 vegetation communities to allow DEC to confirm whether or not the 'Brockman Iron cracking clay communities of the Hamersley Range' (Priority 1) occur within these vegetation communities within the project footprint.	The Proponent notes that a detailed description of the 'Brockman Iron cracking clay communities of the Hamersley Range' (Priority 1) was sought from the DEC in order to undertake a floristic comparison between the M3 and M6 vegetation communities (refer to Section 2.2.2). In an email response to the request by the Proponent, Stephen van Leeuwen (refer to Appendix 4) stated that the DEC were unable to provide the detailed floristic data needed to undertake floristic analyses and clarified that the DEC request was for access to the data (from quadrats) that was used to describe the M3 and M6 communities. The Proponent notes that Appendix 4 includes a table of species presence within the vegetation units and a detailed breakdown of survey data by quadrat. Simplified maps included as Figure 6, Figure 7a and Figure 7b have been provided in this document and show only the extent of vegetation communities M3 and M6. The vegetation mapping for this Proposal was undertaken by a highly experienced botanist using internationally accepted techniques on the basis of structural and floristic information from detailed recording sites and from the interpretation and extrapolation of aerial photographs.
7.	DEC	The weed Natal Red Top (Melinis repens) is known to occur along the power line at Hope Downs 1. It is not currently recorded from the infrastructure corridor at Hope Downs 4 (Mattiske 2009b). Recommendation 15: That hygiene measures be incorporated into the Operation Environmental Management Plan (EMP) and implemented to ensure that Natal Red Top (Melinis repens) is not spread from Hope Downs 1, along the infrastructure Corridor, to Hope Downs 4.	The Proponent notes this comment. The weed Natal Red Top will be added to the list of target weed species identified in the Hope Downs 4 Operational EMP.

Item	Submitter	Submission	Proponent response
8.	TEB	The flora and vegetation assessment appears to be sufficient to assess impacts of the proposal however a number of statements have no justification or are lacking references. For example, page 75 states that "Riparian vegetation in the Pilbara region that access alluvial groundwater is generally able to adapt to changes in water table depth as a result of natural fluctuations". What studies have been undertaken in the region to support this? Similar sweeping comments are related to clearing of locally significant vegetation communities - "these communities are well represented outside of the Proposal area and regional biodiversity will not be significantly affected". The studies undertaken for the environmental impact assessment of the proposal do not sufficiently support this comment.	The Proponent believes that sufficient justification has been provided relating to the comments raised in the submission. As described in Section 4.1 of the PER, rainfall in the Pilbara is generally unreliable and highly variable and can occur as a result of tropical lows or cyclones, which often result in widespread flooding. Riparian vegetation in the Pilbara is therefore considered to be able to withstand significant variations in water availability. In addition, as noted in the PER on page 75, monitoring data from Hope Downs 1 has indicated that there has been no significant decline in tree health along Weeli Wolli Creek where the water table has been drawn down by up to 19 m (over a 2.5 year period). All vegetation communities mapped with the Proposal component polygons were also mapped outside of the polygons. It is the opinion of the consultant botanist (Dr L Mattiske) that all vegetation communities are considered to be widespread and well represented locally and regionally. As mapping of vegetation to the community level does not extend regionally, an analysis of vegetation community representation in relation to land systems was undertaken and presented in the PER (page 121). All land systems that intersected the Proposal component polygons are well represented regionally.
9.	TEB	Impacts of groundwater draw down on native vegetation is not adequately clarified. Page 98 states that "historical declines in tree health were associated with areas experiencing groundwater drawdown and drought". Previous statements on page 75 states that "Monitoring data from Hope Downs 1 has indicated that there has been no significant decline in tree health along Weeli Wolli Creek where the water table has been drawn down..."	The Proponent does not consider that these comments contradict each other. The statement on page 98 of the PER indicates that there has been historic declines in tree health at other RTIO operational sites due to the combination of groundwater drawdown and other factors such as drought or fire. The comment on page 75 of the PER relates specifically to Weeli Wolli Creek where no significant decline in tree health from draw down of the watertable has been observed, suggesting that the drawdown has not had a significant effect on the health of riparian vegetation.
10.	TEB	Page 116 states that "...some of this variation could be attributed to variations in sampling..." Why has the sampling method changed to a degree that it would make comparison between survey difficult? This action negates the benefits of multiple surveys.	Prior to the Level 2 surveys undertaken to support the Hope Downs 4 PER, Mattiske had undertaken surveys for the purpose of clearing tracks and drill sites for exploration drilling. The historical flora and vegetation data from these initial surveys, which were completed to satisfy the requirements of Level 1 survey, augmented the Level 2 surveys that were conducted to support the Hope Downs 4 PER. It should be noted that a consistent methodology was used during the Level 2 surveys conducted in the Proposal area.
11.	TEB	Page 116 states that TECs are assessed by English and Blyth (1997, 1999). These documents provide a basis for identifying TECs however the more current lists are available on the DEC website and should be utilised instead.	The Proponent notes this comment. The comparison was undertaken by Mattiske (2008b) between the TEC and vegetation communities recorded using a list defined by the DEC (2008), however, this was incorrectly cited in text of the PER.

5.5 FAUNA AND HABITAT

Several submissions were received regarding fauna and habitat aspects of the PER. These comments were varied with specific comments on survey methodologies and provision of further information.

Table 5 Response to submissions relating to fauna and habitat

Item	Submitter	Submission	Proponent response
Cumulative impacts on riparian ecosystems			
1.	DEC	There are a number of mines operating in the Upper Fortescue River catchment, including Hope Downs 1, BHPB Yandi and Mining Area C and the Whaleback mine. There are also new mines proposed within the catchment which are currently being assessed by the EPA. DEC has concerns regarding the potential for unacceptable cumulative impacts on the wetland values of the Fortescue Marsh and the Weeli Wolli Creek system from dewatering and discharge, from mines within the Upper Fortescue Catchment. The Fortescue Marsh is well known as a wetland of high conservation significance. The samphire shrubland on the Fortescue Marsh is the largest ephemeral wetland in the Pilbara and the only feature of this type in the Pilbara bioregion. The fringing mulga woodlands of the Fortescue Marsh are at the limits of their distributional range. The PER states that modelling indicates that the discharge footprint will not extend to the Fortescue Marsh (para. 1, page 94). It is apparent that this prediction does not take into account the cumulative impacts of dewatering discharge from other projects in the region, including Hope Downs 1 and Yandicoogina. As an example it is understood that water discharged from Hope Downs- 1 into Weeli Creek is contributing to excess groundwater flow in the CID (channel iron deposit) aquifer at Rio Tinto's Yandi operation (in a separate surface water sub-catchment). In this regard, it is important for the EPA to consider the cumulative impacts of all dewatering proposals on the significant environmental values of the Fortescue Marsh. Recommendation 16: That the proponent determines whether discharge from this proposal has the potential to impact cumulatively (either directly or indirectly) on the Fortescue Marsh and significant riparian ecosystems.	As stated on page 94 of the PER, the modelled discharge footprint using the worst case discharge scenario (e.g. 17.5 GL/a) will not reach the Fortescue Marsh therefore there is no risk of excess water affecting the ecological values of the Fortescue Marsh. Under the worst case scenario, creek bed saturation will extend no closer than within 20 km of the 5 km buffer applied to the Marsh boundary when discharged to Mindy Mindy Creek (surface expression of water will not extend as far as creek bed saturation). In addition, it is not proposed to discharge water to any creeks in the region that currently receive discharges from other mining operations. Therefore, it is not necessary to consider the cumulative impacts of the discharge. Please note, the Proposal does not include Weeli Wolli Creek as a possible creek discharge option.

Item	Submitter	Submission	Proponent response
Fauna			
2.	DEC	The Specialised Zoological report (2009), provided as an appendix to "A Vertebrate Fauna Survey of the Proposed Hope Downs 4 Option 6 Infrastructure Corridor" (Ninox 2009c), indicates that "signals as recorded with an Anabat SDI unit were downloaded and examined in AnalookW' (p. 62, Ninox 2009c). Recent DEC experience from bat monitoring and survey work in the Pilbara has shown that standard Anabat echolocation surveys using the supplied software for post processing may miss 50 - 70 per cent of Pilbara Leaf-nosed Bat calls due to software limitations. Standard Anabat ZCAIM or SDI based surveys are therefore now considered by DEC to be inadequate for Pilbara Leaf-nosed Bat studies. Recommendation 17: That the proponent confirms that bat monitoring undertaken was appropriate for detection of Pilbara Leaf-nosed Bat and undertakes further bat monitoring, if this was not the case.	The Proponent considers that the survey methods and analysis that were undertaken for the Hope Downs 4 Iron Ore Project were entirely appropriate for detection of Orange Leaf-nosed Bats. Monitoring and analysis of recorded bats calls were undertaken by Dr Kyle Armstrong, who is suitably qualified and experienced in analysing bat calls, particularly Rhinonicteris aurantia Orange Leaf-nosed Bats. Dr Armstrong specialises specifically on bat acoustics and Pilbara bats. The DEC has based their comments on the works of McKenzie and Bullen (2009) who, in the opinion of Dr Armstrong, have misunderstood how the Anabat system works. The method of recording and processing bat calls does not affect the number of bat calls recorded, such that a 'continuous recording' (i.e. a recording made from the 8 pin DIN jack of an Anabat II detector onto a MiniDisc) does not contain any more bat calls or ultrasonic signals than the same signal processed by a CF-ZCAIM, or indeed if the signal was routed internally to the Compact Flash card as happens in an SD1. They both receive an output that has already been digitised and converted to a square wave based on zero crossings, subject to a sensitivity threshold, and filtered so that only a proportion of waves are retained (i.e. frequency divided). Once the recording has been made (on either the Mini-disc recorder or a Compact Flash card of the SD1) no extra information that can be recovered or extrapolated from a bat signal by using an FFT (fast-Fourier Transform) analysis of the MiniDisc-recorded output from an Anabat II. In fact, there are always extra noise and analysis artifacts that are added to the bat signals during the MiniDisc–CoolEdit recording and analysis process, and the recording process diminishes the quality of the signal. A summary of Dr Armstrong's response has been included in Section 2.1.1 of this document with the complete response included in Appendix 1
3.	DEC	Recent success in locating new Pilbara Leaf-nosed Bat roosts has been achieved using bat detectors, including Anabat ll ultrasound detectors connected to minidisc recorders in 'mono, long-play mode. Further details on this methodology are available in "The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats" (McKenzie and Bullen 2009). These recordings capture all ultrasonic echolocation and thereby all Pilbara Leaf-nosed Bat calls, no matter how short. If possible, areas of potential Pilbara Leaf-nosed Bat habitat should be resurveyed using the above technique. Recommendation 18: That, if possible, further work be undertaken to confirm whether maternity roosts/suitable habitat for Pilbara Leaf-nosed Bat occur within the impact area.	Refer to the response to Item 2.

Item	Submitter	Submission	Proponent response
Short range endemics			
4.	DEC	The final targeted SRE survey was conducted in April 2009 and is yet to be completed by the WA Museum. The proponent should finalise SRE surveys, consider the results and avoid or minimise impacts, where possible. Based on available information, one potential SRE (a millipede of the genus Antichiropus), was collected within the option 6 corridor, but the species cannot be confirmed as the specimen was juvenile (p. 135). As noted above, the option 6 rail corridor impacts on significant habitat for flora and fauna, and it is therefore DEC's preference that the alternative option 1 infrastructure corridor be used. Recommendation 19: That the results of the most recent SRE survey are completed and impacts on any known SREs avoided or minimised.	The analysis by the WA Museum for the final targeted SRE survey of the Option 6 Infrastructure corridor has now been completed and has been appended to this document (Appendix 3). Additionally a summary of the report has been included in Section 2.2.4. The report determined that one species of pseudoscorpion of the genus Beierolpium and one species of snail (undescribed Bothriembryon species) collected during the survey could potentially be SREs. Both species have been recorded from numerous sites within the Proposal area (refer to the summary provided in Section 2.2.4 of this document). Given that only one of the two proposed infrastructure corridors will be developed, and that the potential SRE species of pseudoscorpion and snail occur in a range of habitats within both corridor options, it is unlikely that there will be any significant impact on the status of these species when one of the infrastructure corridors is developed. The second survey did not record any more specimens of the paraoxosomatid millipede that was considered to potentially be a SRE in the first survey (infrastructure corridor Option 6). As stated in Table 15 of the PER, this species was located on the upper slopes of the ranges south of the infrastructure corridor and infrastructure will be concentrated on the low levels of the landscape so it is unlikely that there will be any impact on this species.
Terrestrial fauna			
5.	EPA TEB	Scope of work is generally adequate and conclusions on impacts and proposed management measures for terrestrial fauna appear to be adequately addressed. However there are a few examples where statements lack certainty. This needs to be addressed (see below). The statement in relation to clearing of habitat on page 137 that "The majority of the clearing is comprised of vegetation communities of low conservation significance that are likely to be widely distributed and relatively well-represented in the locality, suggesting that fauna habitats are likewise probably more widely distributed." needs to give justification for the opinions expressed. A clear basis and scientific certainty for this statement needs to be provided. Similarly, the basis for the comment in relation to clearing being undertaken in a progressive manner on page 138 "that allows fauna the opportunity to move beyond the disturbance footprint" needs to be provided together with substantiation of which fauna will be able to respond in this way, and which fauna may not.	The Proponent believes that sufficient justification has been provided relating to the comments raised in the submission. As stated in Section 15.3.1 on page 120 of the PER, all vegetation communities recorded within the Proposal area are considered to be widespread and well represented locally and in the region. Refer also to the response to Item 8 in Table 4. Where it is not reasonably practicable to survey extensively beyond the Proposal area, the Proponent considers is reasonable to draw on other sources of information, such as expert opinion, State databases, aerial photography and vegetation and land systems mapping, to draw conclusions on habitat representation. Therefore, in consultation with the fauna consultant (Ninox) the Proponent considers it reasonable to conclude that fauna habitats would also be widespread on the basis of the representation of the mapped vegetation communities and land systems. The Proponent considers that conducting clearing in progressively outward manner would allow more mobile fauna species (i.e. mammals and birds) the opportunity to move out of the clearing area. Less mobile species (such as reptiles) may not be able to readily move out of the clearing area. The noise associated with the operation of clearing machinery is considered a significant factor in fauna moving away from the clearing area, although the there are additional provisions in the Hope Downs 4 Operational EMP that include giving all native animals encountered the opportunity to move on and ensuring a dedicated snake handler is on available at all times to relocate snakes. It should also be noted that the majority of species of conservation significance are bird species and that of the other species only the Pilbara Olive Python and a species of millipede are not considered mobile.

5.6 SUBTERRANEAN FAUNA

A few comments were received from one submitter in relation to subterranean fauna. These comments related to examination of data and minor comments relating to spelling.

Table 6 Response to submissions relating to subterranean fauna

Item	Submitter	Submission	Proponent response
1	OEPA TEB	The Executive Summary (page xi) significantly misrepresents information presented in section 17.2.2 of the PER. The statement (page xi) that "All stygofauna species were found to be well represented in the subterranean fauna throughout the Pilbara and Yilgarn regions of Western Australia and therefore local impacts to stygofauna habitat are unlikely to be of regional significance or represent a risk to the preservation of these taxa." is not a true reflection of the findings of the stygofauna sampling surveys. The findings (summarised in section 17.2.2) indicate that many of the specimens could not be identified to species or morphospecies level. Accordingly no conclusion was presented on their distribution outside the project area. Simply because the families or higher classification categories are known to be widely distributed is not a justification to state that unidentified species have a similarly wide distribution.	The Proponent notes this comment. As the PER will not be re-published/released, there is not an opportunity to amend the text in the Executive Summary. However, the Proponent believes that Section 17 of the PER, which accurately describes the survey results, and provision of the stygofauna report in Appendix 1 of the PER are more than sufficient.
2	OEPA TEB	Data regarding both stygofauna and troglofauna taxa need to be re-examined to demonstrate with scientific certainty whether they occur outside the project area. Particular attention needs to be given to considering the status of and impacts on any fauna that are not demonstrated to occur outside the project area. In the absence of this certainty it is not possible to determine whether impacts are likely to be of regional significance.	The Proponent considers that the information provided in the PER was sufficient to demonstrate the likelihood of species occurrence outside the Proposal area and considers that the conclusion presented in the PER that the Proposal is unlikely to have a significant impact on subterranean biodiversity values is valid. The Proponent does note that demonstrating scientific certainty in the environmental impact assessment of subterranean fauna is difficult. Unfortunately, this level of conclusion is unlikely especially for those species which: • are not submitted for genetic analysis on a regular basis and as such there is not a regional species dataset (as is developing for Schizomids, for example) • are morphologically unidentifiable predominantly due to present lack of supporting taxonomic framework. The Proponent also notes that the subterranean fauna assessment was conducted in accordance with EPA Guidance Statement No. 54 to demonstrate that the development poses no threats to subterranean fauna present. As stated in the assessment of stygofauna in Section 17.2.2, page 144 and Table 16 of the PER, only one taxa of Oligochaetes (Phreodrilidae) was collected from a bore within the predicted zone of dewatering (i.e. not collected from a reference site). As stated on page 144 of the PER, this family has been recorded at nearby Hope Downs 1 and the family is common throughout the Pilbara. Another taxa of the same family was recorded widely throughout the Hope Downs 4 area and members of this family have been collected from groundwater in the in the Pilbara and Yilgarn areas and the family is distributed throughout Australia. As the subterranean fauna studies indicated that it is unlikely that the habitat is of particular significance, it is therefore considered that this taxa is likely to occur outside the impact area.

Item	Submitter	Submission	Proponent response
			As stated in the assessment of troglofauna in Section 17.2.3, page 149, Section 7.3.1, page 153 and Table 17, page 151 of the PER, all SRE or troglobitic species except the collected Dipluran (Family Japygidae) were located outside the impact areas. An occurrence of low abundances is typical of all Japygidae, and Diplurans are considered to be among the more vagile subterranean fauna species. Considering that the other troglobitic fauna recorded have a demonstrated range of over ~10 to 30km^2 it is therefore considered that this taxa is likely to occur outside the impact area.
3	OEPA TEB	There are a number of relatively minor technical errors and inconsistencies in the PER that detract from its technical professionalism. Some of these are noted below: • Page x and page 131. Statement that "litter layer is expansive providing potential habitat for some species, particularly short range endemic invertebrates" is unexpected considering that short range endemic invertebrates in arid environments are generally concentrated in relictual environments where evolution has occurred subsequent to fragmentation and isolation. Current short term processes such as the lack of fire in mulga stands are unlikely to be significant factors giving rise to short range endemic invertebrates. • Page xi and subsequently throughout PER. Name hallucatus is misspelt • Page 134 rosamondae is misspelt and subsequently in PER (sometimes it is correctly spelt) • Page 135 Typhlopidae and savage! are misspelt and some species names wrongly begin with a capital. • Page 139 peregrinus is misspelt	The Proponent notes that this statement simply refers to field observations that SRE species may be found in these environments. The Proponent notes that the minor, typographical errors were unintentional.

5.7 POTENTIAL ACID FORMING MATERIAL

Several comments were received regarding the potential acid forming (PAF) material aspects of the Proposal. Most of these comments were related to the level of detail that was provided on the subject of PAF materials within the PER.

Table 7 Response to submissions relating to potential acid forming material

Item	Submitter	Submission	Proponent response
1.	DMP	It is unclear why the risk of Acid Mine Drainage (AMD) was not considered one of the key environmental factors addressed in the PER, or raised as a potential impact to the identified Key Environmental Factors in Table ES2. A number of reasons for ARD to be considered a major environmental factor are listed below:	The Proponent undertook a number of risk assessments during the development of the PER document as additional information on PAF/AMD monitoring and management options became available. This process resulted in the potential risk of AMD impacting on the environment being decreased to a lower level of impact for the Proposal, to a point where AMD was no longer considered to be a key environmental factor. However, although PAF/AMD was addressed as a minor environmental factor in the PER, the level of detail included on this factor in the PER would have been the same for if it was addressed as a key environmental factor. The management measures to be applied remain unchanged and are as described in the RTIO SCARD and Mineral Waste Management Plans.

2.	DMP	If Acid Mine Drainage (AMD) occurred at this site it would be likely to impact on most of the other identified key environmental factors for the project. The main key environmental factors to be impacted by AMD processes would be Groundwater, Surface water, Subterranean Fauna and Closure.	There is a potential for AMD to affect the environmental factors indicated, however the Proponent believes that this potential is low given the Proponent's intention to implement stringent monitoring and management procedures (as detailed in the RTIO SCARD and Mineral Waste Management Plans) to ensure that any potential AMD does not affect these factors. These commitments include:
			• identification of PAF material distribution and characteristics, specifically:
			  • collection of representative samples from each mineral waste type (including process wastes), for solid and liquid extract geochemical analysis every two years. The samples are required to represent the spatial and volumetric variability of the lithology in the deposit and not just be collected from a single location in one batch
			  • annual acid base accounting for PAF material to confirm adequate management strategies have been adopted if acidity load should change as the pit deepens
			• minimising the exposure and mining of PAF material as far as practicable
			• identification and special handling of PAF material that must be mined
			• encapsulation of PAF material inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated. Place store and release covers over PAF waste dumps to limit water infiltration
			• monitoring groundwater and surface water quality and interpreting trends to determine if there are early signs for ARD (i.e. monitoring sulphate concentration trends)
			• regular meetings by the mineral waste team on site to ensure ongoing improvement and implementation of the SCARD plan
			• audit compliance and investigate necessary improvements to the management plan every two years.

Item	Submitter	Submission	Proponent response
3.	DMP	It is indicated in Section 8.4.3 that an Acid Water Treatment plant will be constructed at Hope Downs 4. If the risk of ARD processes producing acid water have been considered significant enough to warrant a treatment plant, it is likely the risk of this acid water (if not appropriately treated) will impact on other environmental factors and should therefore should be considered as a key environmental issue in the assessment of the PER.	As indicated in Item 1, risk assessments undertaken during the development of the PER document resulted in the risk of AMD being decreased to a lower level of impact for the Proposal. However, in order to allow a detailed engineering cost estimate to be made for the Proposal, the Proponent made an allowance for the inclusion of an acid water treatment plant or other suitable treatment options (PER, page 176) to treat any acidic water generated on site. The Proponent is of the opinion that it is more than likely than an acid water treatment plant would be excessive for the Proposal given the intention to implement stringent monitoring and management procedures as detailed in the RTIO SCARD and Mineral Waste Management Plans. Prior to the development of remediation measures an acidity flux rate (i.e. likely water volumes and likely acidity) for the site will be estimated to ensure the correct method of treatment is applied. For example, for a low acidity flux the use of multiple portable treatment systems to treat water in pit are likely to be more appropriate than a fixed acid water treatment plant.
4.	DMP	The risk of ARD creating a situation where the pit void had elevated levels of other potentially harmful elements (such as heavy metals) as well as salts does not appear to have been adequately addressed in the PER. It is noted that leacate testing for other elements that may become elevated in pit water has not been completed (page 179) and that studies are still being undertaken in relation to the post closure development of pit lakes and the associated impact on groundwater (page 170).	The RTIO Mineral Waste Management Plan requires the geochemical characterisation of waste every two years and during exploration. At Hope Downs 4, 92 samples from all lithologies have undergone geochemical characterisation. The waste can be enriched in tin, antimony, boron and sulfur. None of the elements that were enriched were found to be present in significant concentrations in the liquid extract (1 part solid: 2 part liquid). However, the concentration of fluoride, nickel, iron and manganese in the liquid extracts could be occasionally elevated and the Proponent will monitor these elements in routine water quality monitoring programs at the site. In addition to this assessment, a detailed geochemical risk assessment has also been undertaken using all available data within the drill hole data base. This assessment found elevated concentrations of iron, arsenic and tin in most lithologies. Mobilisation of arsenic into the groundwater is thought to be unlikely based on groundwater assessments and experience at similar deposits in the Pilbara. Hydrated iron hydroxides are often used throughout the world to remediate water enriched in arsenic (via adsorption to the hydrated iron hydroxide surface). Therefore, the risk of mobilisation is considered low. Tin is unlikely to mobilise into the groundwater and cause any environmental concern. Final void water quality modelling has been undertaken for the below water table pit at Tom Price. This research is still ongoing and has included a 1.5 year full time study by a post doctoral researcher from UWA. Currently the modelling is being undertaken by a consultant. The learning from this study will be applied across all RTIO operations and can be used at Hope Downs 4 to predict final void chemistry. Final pit void water quality modelling is an emerging science and RTIO are investing in developing appropriate and practical tools to predict water quality into the future. Acid base accounting has been undertaken for PAF material at Hope Downs 4 and kinetic column leach experiments will be undertaken after the 2010 drilling program. The column leach experiments will provide an improved prediction of likely contaminants that could be present in water quality from the site. RTIO are currently running column leach experiments for material from the Brockman Syncline 2 mine site and have previously run these experiments for black shale from Tom Price mine site and this data is likely to be similar to that expected at Hope Downs 4.
5.	DMP	ARD issues were raised by stakeholders during the consultation process (including by the Department of Mines and Petroleum (DMP)).	ARD issues raised during the consultation have been considered and addressed throughout the development of the PER and internal revisions of the RTIO SCARD and Mineral Waste Management Plans.

Item	Submitter	Submission	Proponent response
6.	DMP	It is noted that the 'risk assessment of the potential for acid rock drainage and detrimental geochemical material' (RTIO 2009b) and the SCARD Management Plan have not been included in the PER appendices. In order to conduct a full assessment of the potential risks and management of ARD at Hope Downs 4, these documents should have been included in the PER.	The Proponent manages Potentially Acid Forming (PAF) waste using two management plans. The RTIO Mineral Waste Management Plan (MWMP) is used to identify geochemical risks and the RTIO Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan is used to manage the PAF risks identified in the MWMP. Both management plans outline the actions that need to be completed to manage or identify geochemical risks and assign these actions to the appropriate superintendant or manager. The MWMP is relevant to every RTIO operation in the Pilbara and the SCARD plan is relevant for every operation that needs to manage PAF material. These management plans are detailed documents that are regularly updated and improved. Improvements are made based on discussions with relevant groups at the sites, current best management practices, auditing of the plans (every two years) or any new material characterisation information. The Proponent considers that the material within these documents represents leading practices that have been the result of significant research and financial investment. The Proponent would not like this information released or used by other mining companies.
7.	DMP	It is indicated in the PER that it is not feasible to fully backfill all the mine pits and therefore a number of other closure options to manage PAF (exposed in pit walls) have been provided (page 176-177). It is recommended that an environmental condition for the management of PAF material exposed in pit walls is placed as part of the Hope Downs 4 Ministerial Statement. This condition should include commitments to ensure all PAF exposed in pit walls is adequately covered (or otherwise managed as appropriate) at closure.	As outlined on page 176 of the PER, mine voids that may have exposed PAF material will be prioritised for backfilling at completion of mining to ensure that PAF material is encapsulated. As extensive backfilling will not be practicable (due to available material) at the mine pit voids, other measures will be considered at closure to manage PAF. Given that the Proponent has made a commitment to the management of PAF materials through the implementation of the RTIO SCARD and Mineral Waste Management Plans, the Proponent does not believe that it is necessary to include an environmental condition for the management of PAF material exposed in any Ministerial Statement that may be issued by the OEPA for the Hope Downs 4 Iron Ore Project.

Item	Submitter	Submission	Proponent response
8.	DoW	PAF has been identified within the mine planning zones. The proponent should continue investigations to determine appropriate methods to manage the PAF in waste rock with regards to storage and exposure at closure.	PAF material has been successfully managed for at least 10 years across RTIO's Pilbara mine operations. Significant research and investment have been undertaken to develop appropriate management techniques to minimise the risk of ARD and spontaneous combustion. The Proponent has undertaken, or plans to undertake, the following investigations aimed at enhancing management techniques for ARD: • validation measurements on two complete waste dumps to check design and functionality – drilling into completed PAF dumps to validate PAF material placement, oxygen consumption and temperature. This was undertaken at Tom Price operations to ensure design parameters for PAF dumps were appropriate • store and release cover research including: literature investigations into appropriate covers, material characterisation, scenario modelling, and field trials with continual monitoring and performance modelling • material characterisation using standard acid base accounting and kinetic experiments to enhance the Proponent's existing extensive database of mineral characterisation work across the Pilbara. Black shale specifically from Hope Downs 4 has been characterised by acid base accounting. Column leach experiments with black shale from Hope Downs 4 will be initiated once samples have been collected from the 2010 drilling program • final void water quality modelling has been undertaken for a below water table pit at Tom Price mine site. This research work is still ongoing and has included a 1.5 year full time study by a post doctoral researcher from UWA. The learning from this study will be applied across the Proponent's Pilbara operations and can be used at Hope Downs 4 to predict final void chemistry • groundwater monitoring surrounding PAF waste dumps and annual reporting of water quality including interpretation of early ARD signals i.e. increasing sulfate concentrations. RTIO currently holds regular meetings across it's Pilbara operations to review and discuss compliance with the SCARD Management Plan and to ensure that improvements to the plan are implemented where necessary. In addition, the Proponent audits the SCARD Management Plan every two years.
9.	DMP	The PER indicates that DMP raised no issues in relation to stakeholder consultation (page 57), however DMP provided advice to the Environmental Impact Assessment Division on 29 July 2008 in relation to the Hope Downs 4 scoping document. This advice highlighted ARD and other adverse geochemical (non ARID) and Geophysical material as potential environmental issues. The advice also raised the issue of appropriate tenure.	The Proponent notes this comment. ARD and other geotechnical factors have been considered in detail throughout the scoping and PER stages of the Proposal. The Proponent will implement the RTIO SCARD, Mineral Waste and Closure Management Plans for the Proposal in order to ensure adequate management of ARD. Tenure issues are discussed in the Miscellaneous Section of this document (see Item 5 in Table 11.

5.8 ABORIGINAL HERITAGE

Submissions were received regarding the cultural heritage aspects of the PER. Most comments were regarding the ongoing consultation commitments of the Proponent to the relevant Traditional Owners potentially impacted by the Proposal.

Table 8 Response to submissions relating to Aboriginal heritage

Item	Submitter	Submission	Proponent response
Consultation			
1.	DIA	In light of complaints raised by Aboriginal people in relation to the effects on Weeli Wolli Creek by dewatering that has occurred in relation to the Hope Downs 1 Project, and in line with recommendations made in the anthropological reports forwarded along with the PER, it is suggested that further consultation be conducted with relevant Aboriginal people over the process of and potential effects on Aboriginal heritage caused by dewatering at Hope Downs 4.	The Proponent is committed to continue to liaise with indigenous stakeholders in relation to potential cultural heritage impacts associated with the Proposal. In late 2009 the proponent commissioned an ethnographic survey with the Nyiyaparli traditional owners to discuss the proposed rail crossing over Weeli Wolli Creek and Coondiner Creek, excess mining water disposal options, and the partial realignment of Coondiner Creek for mining operations. In 2010 the Proponent plans to further engage with the Nyiyaparli traditional owners regarding water management, including excess water disposal and creek realignment, during follow up ethnographic consultation. In addition, the Proponent will continue with scheduled meetings with the Nyiyaparli Local Implementation Committee.
2.	DIA	Page iv of Day's 2008 Report of an ethnographic survey for a Bankable Feasibility Study at Hope Downs 4 recommends that the Nyiyaparli community be provided with more information concerning the possible effects on the Coondiner Creek system by dewatering at Hope Downs 4.	Refer to the response to Item 1.
3.	DIA	Representatives of the Nyiyaparli should be provided with more detail regarding proposed dewatering at Hope Downs 4. In particular, it should be explained that there are a number of possible options regarding the disposal of excess water from Hope Downs 4 and comment should be sought on which is the preferred method of excess water disposal by Aboriginal people.	Refer to the response to Item 1.
4.	DIA	Should it be deemed necessary to dewater directly into existing creek bodies, comment also sought upon which creek the Nyiyaparli people would prefer the water to be disposed into.	Refer to the response to Item 1.
5.	DIA	It is also noted that the Proposal will entail a necessary realignment of Coondiner Creek. It is suggested that consultation occurs with Aboriginal people in order to determine the possible impact this will have on the overall cultural landscape of Coondiner Creek as well as identifying any possible impacts to specific ethnographic values associated with the Creek.	Refer to the response to Item 7.
6.	DIA	It is also suggested that comments are sought from local Aboriginal people regarding the design of any realignment of Coondiner Creek, with particular emphasis on replicating the existing physical environment of the Creek.	Refer to the response to Item 1.

Item	Submitter	Submission	Proponent response
Cultural and heritage values			
7.	DIA	The proponents may also wish to further investigate the cultural values of whichever creek will have excess water discharged into it in order to be more aware of possible effects to Aboriginal heritage located in riparian environments located in the area. While it is appreciated that the dewatering operation would be significantly less than that which has occurred at Hope Downs 1, there is the possibility that ethnographic and archaeological heritage values downstream from Hope Downs 4 will be impacted by increased flow through a creek body.	The Proponent is committed to ongoing Aboriginal heritage surveys in the Proposal area prior to ground disturbance to ensure that heritage sites are avoided and protected where practicable. As noted above in Item 1, the Proponent is also committed to liaise with indigenous stakeholders in relation to potential cultural heritage impacts associated with the Proposal. The PER noted that there may be the potential for direct disturbance of some archaeological sites, mostly of low archaeological significance, but it is not expected that any specific ethnographic sites will be affected. The Proponent will manage Aboriginal heritage issues through the implementation of an Aboriginal Heritage Management Plan (refer to the EMP contained in Appendix 2 of the PER) and a Cultural Heritage Management Plan yet to be developed.
Compliance			
8.	DIA	If there is a requirement to impact an Aboriginal heritage site consent from the Minister for Indigenous Affairs under section 18 of the Aboriginal Heritage Act 1972 (AHA) will be required in order to avoid breaching section 17 of the AHA.	The Proponent notes the comment and is cognisant of the need to obtain prior consent from the Minister under Section 18 of the *Aboriginal Heritage Act 1972* (WA) if an Aboriginal heritage site is to be disturbed during the course of the project (refer to Section 18.1.3 of the PER).

5.9 CLOSURE AND REHABILITATION

Several comments were received regarding the closure and rehabilitation aspects of the Hope Downs 4 Iron Ore Project. The comments received addressed various aspects of closure and the Coodiner Creek realignment.

Table 9 Response to submissions relating to closure and rehabilitation

Item	Submitter	Submission	Proponent response
Closure management			
1.	DEC	The PER indicates that backfilling to above the water table will not be possible, however it is recommended that information be provided to justify this. DEC prefers that all pits are backfilled to at least 2m above the level of the pre-mining water table to avoid potential long-term impacts on water quality and conservation of native fauna. The establishment of pit lakes that will become toxic to wildlife over time is not supported. Given the number and size of the proposed waste stockpiles, it is unclear why the PER indicates that there is not enough waste material to backfill pits. The PER mentions the option of partially backfilling 50 per cent of the pit (para. 1, page 170), but gives no reasons why this option is not adopted.	Calculations undertaken by the Proponent on the total amount of material available for backfilling pits indicate that the backfilling of all pits to the level of the pre-mining water table is not physically possible, as there is not adequate excavated waste material to back fill these pits. A summary of the calculations is provided below: Total volume of pits: ~165 Mm3 Total waste tonnes available: ~285 Mt Total tonnes required for back fill: ~330 Mt Total material short fall: ~44 Mt Additional backfill material would also be required to encapsulate any PAF materials exposed in final pit walls, as per the PER document (PER page 176), increasing the tonnage shortfall. Additional information regarding the preferential backfilling of PAF exposures is outlined in Item 8 of Table 7. The PER (Section 19.3.2, page 170) reported on the model predictions for pit lake formation and water quality based on partially backfilling 50% of the pit. This scenario predicted pit lakes would form and salinity would progressively increase. This outcome is similar to the modelling predictions for the no backfill scenario (PER Section 19.3.2, page 169). This example (50% backfill) was presented in the PER to demonstrate that there was little benefit in partially backfilling pits as pit lakes would still form and salinity progressively increase. In addition, there are significant greenhouse gas emissions associated with the re-handling of the waste material to backfill the pits.

Item	Submitter	Submission	Proponent response
2.	DEC	Recommendation 22: That the proponent develops mining strategies to allow for the progressive backfilling of pits, which will prevent the formation of pit lakes, and reduce the area needed for waste stockpiles.	As highlighted in Item 1 there is inadequate material to backfill final mine pits at Hope Downs 4. As a result, the Proponent does not intend to develop mining strategies for progressive backfilling, except where backfilling is required to manage PAF material exposures (refer to page 176 of the PER and Item 8 in Table 7 above). Pit lakes will exist at the end of the project, however modeling suggests that these pits are likely to become local groundwater sinks and that groundwater through-flow will not be reinstated making the risk of groundwater contamination low. The proponent intends to implement management actions to ensure that the potential for environmental impact from the pits is low. In particular, implementation of the RTIO SCARD and Mineral Waste Management Plans will limit any potential impact from PAF materials (refer to detail provided in the PER [Section 20.1] and in Section 5.7 of this document). As indicated in the PER (Section 20.1, page 176), mine voids that may have exposed PAF material will be prioritised for backfilling at completion of mining to ensure that PAF material is encapsulated. The final landform for the Proposal will be in accordance with the Decommissioning and Closure Plan (to be developed prior to closure), the concepts of which are already detailed in the Conceptual Closure Study (appended to the PER and key elements discussed in Section 19 of the PER). Design of the final landform will be in accordance with relevant regulatory requirements where applicable. The final closure state will satisfy the pre-determined post-closure criteria developed in consultation with relevant stakeholders. Groundwater quality will be consistent with the predetermined post-closure water quality criteria developed in consultation with relevant stakeholders. The Proponent intends to manage waste stockpiles to avoid ARD and other potential impacts in accordance with the RTIO SCARD and Mineral Waste Management Plans. Detail from these Plans has been provided in the PER and in other responses relating to ARD (refer to Section 5.7 of this document and Section 20.1 in the PER).
3.	DEC	The PER states that the salinity of the pit lakes is expected to increase indefinitely, increasing from 400mg/L to 1300mg/L in 40 years (para. 4, page 169). Furthermore, it is likely that metals which have the potential to accumulate in the food chain will be leached and further concentrated by evaporation. Although some remediation measures are provided, there is limited confidence in the ability of these mechanisms to manage environmental pollutants in the pit lakes. Greater characterisation of the likely area of exposed potentially acid forming (PAF) material in pits and specific remediation methodologies is required. Advice should be sought from the Department of Mines and Petroleum (DMP) and DEC on this issue.	The Proponent intends to undertake additional modelling and monitoring to better qualify the water quality of the pit lakes on closure of the mine (refer to Section 2.4.3 for discussion on proposed investigations and future monitoring program). The Proponent will consult further with the relevant stakeholders on this matter as additional information becomes available.
4.	DEC	The SCARD (Spontaneous Combustion and Acid Rock Drainage) Management Plan referred to in the document and requested previously is not included in the PER and should have been provided for review by DMP and DEC.	The RTIO SCARD Management Plan has been developed as a result of significant research and investment undertaken by Rio Tinto Iron Ore (RTIO) and contains information that RTIO considers to be commercial in-confidence information. The relevant information from this Plan and relevant to the Proposal have been included in Section 20.1 (Potentially Acid Forming Material) of the PER. Additional information from the RTIO SCARD Management Plan relating to waste rock stockpiles has also been included in the PER (PER, page 175).

Item	Submitter	Submission	Proponent response
Mine closure			
5.	DMP	The Hope Downs 4 closure criteria should state that post closure landforms are to be non-polluting (areas requiring this commitment detailed below): • Table ES 2 (on page xxiii) should also list 'non-polluting' as a closure requirement/end state. • Section 19.1.1 —the closure objective of 'non-polluting' to be an essential characteristic of post closure landforms. • Section 19.2.1 should also include non-polluting in the closure vision.	The Proponent does not support the change of closure criteria to 'non-polluting' and believes that it would be more appropriate to update the closure criteria to include a commitment to 'no off-site pollution' as per the *Environmental Protection Act 1986* requirements. The Proponent notes that closure criteria for post closure land forms cannot be 'non-polluting' as some landforms, such as the pit lakes, are likely to show elevated levels of some contaminants. The Proponent is committed to achieving beneficial outcomes for the environment through post closure and rehabilitation management within the tenement boundary. The Proponent also notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine.
6.	DMP	Condition 9-1 should reference DMP (as well as DEC) and the 'final Closure Management Plan' should be developed at least 5 years prior to closure. The 5 years timeframe is considered more appropriate as Hope Downs 4 has a long mine life and the Hope Downs 4 conceptual closure management study (RTIO 2009a - Appendix 1) indicates the RTIO standard is for a Decommissioning Closure Plan to be developed 5 years prior to planned closure.	The Proponent notes this comment and notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine. The Proponent considers DMP (rather than the DEC as stated in the PER) to be the more relevant advising agency to apply to a closure-based condition. The Proponent also considers two years prior to closure to be an adequate and appropriate time frame for submitting a Final Decommissioning and Closure Plan to DMP.
7.	DMP	The terminology in Condition 9-1 is ambiguous and should be refined further. A 'Closure Management Plan' is a document that Hamersley should be continuously revising throughout the life of the mine (Section 19.2.2 and 21.6). The document that is required at the end of mine life is a 'Decommissioning and Closure Plan', which addresses in detail how the site will finally be closed and all infrastructure removed. It appears that throughout the PER these documents are given the same title, which could create confusion in relation to when they are required to be developed.	The Closure Management Plan referred to within the PER is the Closure Management Plan that will address in detail how the site will finally be closed and all infrastructure removed. As indicated in the PER, the Closure Management Plan is intended to be developed two years prior to closure of the mine. This Closure Management Plan will include the decommissioning, decontamination, rehabilitation and other components related to the closure of the mine. As noted by the submitter, the Closure Management Plan referred to in the PER corresponds to the Decommissioning and Closure Plan referred to by the submitter. The Conceptual Closure Management Study (referred to on page 163 of the PER and contained in Appendix 1 of the PER) is the ongoing study that is continuously revised throughout the life of mine to ensure closure objectives and obligations are understood ahead of mining and are known to be able to be met; and that adequate financial provisions are made for closure in accordance with accounting standards. The Conceptual Closure Management Study identifies the key aspects of closure that will require further investigation throughout the life of the Proposal and the high risk considerations associated with the eventual closure of the proposed operation.
Rehabilitation			
8.	DMP	Section 19.3.3 appears to be very specific about the design of the waste dumps (berms of 5-10m, benchs of 10m). It is acknowledged that Section 19.3.3 states that the 'final design of landforms will be determined by the results of waste material characterisation', but the link between the waste dump specifics given in the PER and the waste characterisation has not been provided. It is advised that there should be a commitment in the PER for rehabilitation trials to be conducted to determine the best landform design.	The Proponent has already commissioned a 'Landform Design Study'; with detail being provided in Section 2.3.4 of this document. The aim of this study is to define the erodibility characteristics of identified mineral wastes across RTIO's Pilbara operations and to use this information to develop practicable final landform design criteria that will satisfy stability requirements. The first phase of this study has commenced and is anticipated that it will be completed by mid-2010, with Phase 2 being commissioned shortly thereafter.
9.	DMP	Condition 8.1, regarding the Progressive Rehabilitation Schedule should also reference DMP (Page 201).	The Proponent notes this comment and notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine.

Item	Submitter	Submission	Proponent response
10.	DEC	The PER includes proposed environmental conditions (pp. 197-201). These proposed conditions (and the accompanying management documentation provided with the PER) do not appear likely to fully and adequately address management and mitigation of the potential environmental impacts of the proposal, in particular the Coondiner Creek realignment and dewater discharge to creeks. It is recommended that DEC be consulted with respect to the triggers in Table 24 (page 199) and monitoring and management actions relating to these. Below are some specific recommendations in relation to the proposed outcome based conditions. Condition No. 8-1 Condition 8-1 requires the development of a Progressive Rehabilitation Schedule in consultation with DEC. It is recommended that this plan be developed to the satisfaction of the OEPA on advice of DEC. This rehabilitation schedule should also specifically address the revegetation of Coondiner Creek, if this matter is not incorporated into other management plans.	The Proponent will consult with the DEC to further define the triggers, monitoring and management actions to address the potential environmental impacts of the proposal, in particular the Coondiner Creek realignment and dewater discharge to creeks. The relevant plans and rehabilitation schedules in the Hope Downs 4 Operations EMP will be regularly reviewed and updated where required over the life of the Project. The Proponent will respond to any conditions recommended by the OEPA. It should be noted that realignment of Coondiner Creek is not required until approximately year five of mining and that discharge of excess water is not anticipated in the initial stages of mining.

5.10 AIR QUALITY AND DUST

Submissions were received in relation to the air quality and dust aspects of the Hope Downs 4 Iron Ore Project. Most of the comments received were regarding the adequacy in which the potential air quality and dust aspects were addressed.

Table 10 Response to submissions relating to air quality and dust

Item	Submitter	Submission	Proponent response
1	DEC	In the response from the proponent provided to address AQMB comments on the proposed dust monitoring procedure (Response to DMA comments on the Hope Downs 4 Iron Ore Mine Draft PER), proponent stated "Rio Tinto intends to install dust monitors for the purpose of preliminary dust model validation during operations" This matter is not reflected in the PER. More detailed information about dust monitoring program and technique needs to be provided in the report.	The modelling undertaken as part of the PER indicates that whilst mining and related activities may cause short term 'dust' events, they will not significantly contribute to dust deposition rates in the region, making the potential for significantly impacting on native flora and fauna low. As such, additional monitoring detail on an aspect that is considered to be of low risk to the environment (as per the modelling results presented within the PER) is not deemed to be warranted. However, as an internal measure, the Proponent intends to install dust monitors for the purpose of preliminary dust model validation during operations. It is not intended to install monitoring equipment for the purpose of strict dust management and control as dust generation from the project is not considered to have a regionally deleterious impact. Dust model validation will comprise the placement of monitoring units at selected points around the operational area, in alignment with the air quality modelling report undertaken as part of the PER (SKM 2008). The placement of the monitors will take into account the predominant wind direction and sensitive receptors as discussed in the PER and the air quality assessment. The Proponent will advise the OEPA if the outcomes of the air quality modelling undertaken as to support the PER will alter significantly as a result of the dust model validation monitoring program.
2	DEC	In addition, proponent should be required to provide any dust model validation results to EPA.	The Proponent will advise the OEPA if the outcomes of the air quality modelling undertaken as part of the PER will alter significantly as a result of the dust model validation monitoring program.
3	DEC	Please note that any assessment by AQMB of air quality modelling associated with this project needs to comply with the department's air quality modelling guidelines. AQMB -recommends "worst case scenario screening" approach. SKM's conservative approach to the screening of air emissions (i.e. conservatively simulated blasting emissions over an hour) is consistent with the "DEC's Air Quality Modelling Guidance Notes" and the configuration of air dispersion modelling appears reasonable	As noted in Section 20.4 of the PER, the air quality study was undertaken by SKM (2008) in accordance with the DoE (2006) 'Air Quality and Air Pollution Modelling Guidance Notes'. An extremely conservative approach was taken as the model developed simulated blasting over an hour period, when in reality dust emissions associated with this activity are more likely to impact a receptor for 10 minutes or less.
4	DEC	However, results from dust modelling (SKM 2008a, Table 9-3) show that the. maximum predicted concentrations of PM10 for potential receptors (includes a background concentration of 25 g/m3) will exceed NEPM standard at several locations close to mining operations such as: Construction Camp (with maximum of 141.g/m3 and 17 exceedances), Permanent Village (with maximum of 97 .g/m3 and 7 exceedances), Eagle Rock Pool (with maximum of 125.g/m3 and 6 exceedances) and Eagle Rock Falls (with maximum of 81.g/m3 and 5 exceedances). NEPM air quality standards mention an allowance of 5 days per year in excess of 50 µg/m3. Please note that 5 exceedances consideration is	As noted in Item 2 above, an extremely conservative approach was taken by SKM (2008) as the model developed simulated blasting over an hour period, when in reality dust emissions associated with this activity are more likely to impact a receptor for 10 minutes or less. Whilst the model did predict a number of occasions where maximum PM_{10} ground level concentrations exceeded the NEPM standard at several locations, it is noted that there is a significant difference between the predicted maximum and 99th percentile concentrations which indicates that the high concentrations result from only a few days. An analysis of the model results indicates that these high concentrations were caused by blasting activities during stable meteorological conditions.

Item	Submitter	Submission	Proponent response
		provided to allow for extreme periods of background concentrations, including bushfires/controlled burning. It is required to be confirmed that particulate concentrations are below national air quality guideline levels for human receptors. It is the responsibility of the proponent to demonstrate that air quality impacts are low and provide evidence that verifies their claims of emissions being insignificant.	The Proponent is of the opinion that such high concentrations are unlikely to occur during normal operating conditions. The SKM (2008) report outlined that activities such as blasting would be the most likely contributors to the generation of dust for this project. The Proponent believes that blasting (specifically) will be more sporadic than the model infers, with an estimated 'real-time' duration of airborne dust being ten minutes or less, as opposed to the one hour duration as discussed/modelled in the SKM (2008) report (see page 48). It is recognised by the Proponent that the duration of airborne dust from a blasting event is significantly less than that which has been modelled (the model simulates the blasting emissions over an hour when in reality dust emissions associated with this activity are most likely to impact a receptor for 10 minutes or less). As such, it is here where the Proponent considers the model to be conservative. Also, over time, the deeper the pit, the lower the propensity for lateral movement of airborne dust as it will be contained within the pit confines. It is because of this increase in pit depth over the life of the project, combined with the modelled projections from 2014 activities and the above-mentioned management measures that the Proponent believes that the information provided to date is sufficient to conclude assessment on dust propagation for the project. This does not exclude its previous comments on validation of the dust model (see Proponent response to Section 5.10, Item No. 1 above). As such, the Proponent will advise the OEPA if the outcomes of the air quality modelling undertaken as part of the PER will alter significantly as a result of the dust model validation monitoring program. The Proponent notes that the NEPM standards are designed to protect human health and as such apply primarily to sensitive receptors such as residences, hospitals, schools and other places where people may congregate including sporting and recreational venues, and as a result, are not necessarily applicable to the remote location where this mine is proposed to be situated.
5	DEC	It should be also noted that NEPM standards are based on human health criteria and may not be protective of native flora and fauna. Therefore additional performance measures may be required. It is recommended that, in addition to monitoring air quality and using NEPM as an interim standard, local species population health be monitored to investigate whether native species are being impacted by air emissions and if NEPM is sufficiently protective.	The Proponent does not believe that additional performance measures are required for the protection of native flora and fauna. The modelling undertaken as part of the PER indicates that whilst mining and related activities may cause short term 'dust' events, they will not significantly contribute to dust deposition rates in the region, making the potential for significant impact on native flora and fauna low . In addition, the Proponent engaged Biota Environmental Services to carry out a risk assessment of the impacts of dust deposition on Declared Rare Flora (DRF) and Priority flora at the proposed Hope Downs 4 Iron Ore Project. The results found that the majority of the recorded species of conservation significance have a low dust loading potential and would not be at risk of physiological impacts. One species, *Eremophila forrestii* (P3), is considered to be at high risk of potential dust loading, however, recent research has found that the dust loading does not have significant impact on the physiological function of this species (Butler 2009).
6	DEC	Modelling results and predicted impacts on air quality presented in SKM report (2008a) have not been adequately addressed in the PER.	The Proponent believes that Section 20.4 of the PER adequately summarises the air quality modelling undertaken by SKM (2008) given that dust is not considered to be a significant environmental factor and the remoteness of this proposal. However, the Proponent notes that more detail could have been provided in the PER on the 99th Percentile concentration results for PM_{10} and TSP to demonstrate that ground level particulate concentrations are likely to be below relevant standards under normal conditions It is noted that this information was provided in the air quality assessment report prepared by SKM (2008) that was appended to the PER.

Item	Submitter	Submission	Proponent response
7	DEC	The predicted concentrations of TSP for potential receptors are significant. The TSP modelling indicates that there is potential for the mine to contribute to exceedances of the Kwinana EPP 24 hour average .TSP criteria of 90 50 µg/m3, especially in the Construction Camp and Eagle Rock Pool. It is important to emphasise that the proponent needs to develop a comprehensive dust management system which involves validation of dust emission rates as well as the installation of an appropriate dust monitoring and dust control systems.	The Proponent does not believe that the predicted concentrations of TSP are significant given the extremely conservative approach taken by SKM (2008) towards the modelling. Maximum predicted TSP concentrations and 99th Percentile TSP concentrations were modelled to be below the Kwinana EPP Area C limit (for residential areas) of 150 µg/m^3, with most predicted results at nominated receptors being below 90 µg/m^3. In addition, the maximum predicted monthly deposition rate was modelled to be within the NSW EPA guideline of 2 g/m^2/month. As noted in Section 20.4 of the PER, the Proponent will implement a comprehensive Dust Management Plan, which includes dust control systems, as part of the Proposal's EMP. The Proponent does not intend to install a dedicated dust monitoring system as part of the management proposed in the EMP due to the low predicted impact from dust emissions from the Proposal.
8	DEC	Has the proponent investigated the potential for moving the mining camp to a slightly different location to mitigate dust impacts and reduce exposure of individuals residing at the mining camp?	The Proponent has investigated various locations for the camp within the larger polygon area indicated in the PER. Key factors considered when making a decision on the location of the camp included the optimisation of the distance from the mining operations in order to minimise potential noise and dust impacts as well as other factors such as avoiding significant flora populations, reducing disturbance to significant vegetation communities, topography, and distance from the North West Highway. The Proponent considers the proposed location for the camp to be the most appropriate one after careful consideration of all the relevant factors.

5.11 MISCELLANEOUS

Table 11 includes comments received from submitters which were not able to be categorised within the aforementioned table themes.

Table 11 Responses relating to miscellaneous submissions

Item	Submitter	Submission	Proponent response
Water supply requirements			
1.	DoW	The PER specifically excludes estimates for construction and potable water supply and presumes this can be covered by a groundwater license under the Rights in Water and Irrigation Act 1914. The DoW has previously requested this information during the Draft PER process as it is essential to the context of the life-of-mine water balance. This will ensure that there are minimal outlays in project start-up as the licensing assessment need to take into account impacts from the water management activities.	As noted in Section 8.5.3 of the PER, the Proponent intends to establish a separate potable water borefield to supply water to the proposed accommodation village in order to avoid the potential for contamination of the water and to ensure a reliable supply. The Proponent considers that it is not feasible to source potable water from the orebody aquifer given the additional costs and environmental footprint associated with the construction of the temporary pipeline that would be required. In addition, the Proponent proposes to establish separate groundwater bores to supply water for construction accommodation and construction activities, including those along the rail line. The total volume of water required for the construction and permanent villages may be up to 80 ML/year (assuming a conservatively high 220 L/day/person and a peak population of 1000). Additionally, it is estimated that 2374 ML of water will be required for the Hope Downs 4 Iron Ore Project construction phase (excluding the rail construction component). For rail construction it is estimated that a further 2000 ML of water will be required. Drilling to prove supply for each of these identified applications is expected to be undertaken later in 2010. The Proponent will liaise further with DoW in regards to the proposed drilling activities and will obtain the appropriate abstraction licences in accordance with the *Rights in Water and Irrigation Act 1914.*
Reporting			
2.	DoW	The DoW requests clarification on the proponents reporting and notification requirements. The proposed environmental conditions identify the Chief Executive Officer of the Department of Environment and Conservation as the proponent nominee and contact person. The DoW believes the Office of the Environmental Protection Authority should be the primary contact as they are better able to disseminate the information to the appropriate Decision Making Authority.	The Proponent notes the request and notes that prescribing conditions to apply to the Proposal is a matter for the OEPA to determine.
Infrastructure			
3.	DMP	190 ha for a mine camp appears to be beyond the normal area for mine camps. It is noted that in Appendix 1 — Hope Downs 4 Conceptual Closure Management Study (RTIO 2009a) only 100ha has been identified for accommodation. The discrepancy between these documents accounts for nearly 50% of the applied area for accommodation and the difference/size of this area should be justified.	The Proponent notes that the area of up to 190 ha of ground disturbance in Table 5 of the PER includes allowances for clearing and earthworks for accommodation facilities, a mine access road and associated facilities. Of this 190 ha, approximately 100 ha is required for the accommodation facilities (as noted in the Hope Downs 4 Conceptual Closure Management Study [RTIO 2008]), with the remainder being utilised for the mine access road and facilities such as a radio base, potable water borefield, power corridor, waste water treatment facilities, laydown areas and borrow pits.

Item	Submitter	Submission	Proponent response
4.	DMP	Very little detail has been provided in relation to the Tailing Storage Facility (residue storage facility) and the potential safety and environmental risks of this facility. Under the Mining Act 1978 (Mining Act), a geotechnical design report must be provided when applying for a Tailing Storage Facility. These geotechnical reports are assessed by the Resources Safety Division of DMP to ensure that the design is suitable. As the Hope Downs 4 project is likely to be constructed on State Agreement tenure, it is not clear if a geotechnical report will be provided and assessed for this facility, which is a concern to DMP. The potential safety and environmental risks of a Tailings Storage Facility have not been adequately addressed in the PER and it is therefore recommended that a condition be placed in the Ministerial Statement, or on the State Agreement to ensure that an acceptable Geotechnical Design Report is provided to DMP or the Department of State Development (DSD), prior to the Tailing Storage Facility being constructed.	The Proponent will be seeking approval for the residue storage facility (RSF) as part of the Proposal under the *Iron Ore (Hope Downs) Agreement Act 1992*. The Proponent understands that the Minister will seek advice from the Department of State Development as appropriate prior to giving approval for the construction of the RSF. The Department of State Development will then seek advice and guidance from the relevant government agencies including the DMP as it sees fit. The Proponent is of the opinion that this is the appropriate time when these issues can be addressed/discussed.
Tenure			
5.	DMP	The tenure for this mine has not yet been granted (currently the area is covered by Exploration Licences under the Mining Act). If State Agreement tenure is granted over this area, a Project Proposal must be submitted to DSD (with comment to be provided by DMP). If tenure under the Mining Act is granted over this area then a Mining Proposal must be submitted in accordance with tenement conditions. Hamersley must ensure that appropriate tenure has been granted for all proposed disturbance areas (including dewatering bores and water discharge points).	The Proponent notes that the Hope Downs 4 deposit is covered by Exploration Licences 47/429 and 47/430 held jointly by Hope Downs Iron Ore Pty Ltd and Hamersley WA Pty Ltd (both of whom form the Hope Downs Joint Venture). Hamersley HMS Pty Ltd is the Manager of the Hope Downs Joint Venture. The Hope Downs 4 deposit will be brought under the *Iron Ore (Hope Downs) Agreement Act 1992* (HD State Agreement) and the exploration licences will be converted to mining leases under the HD State Agreement. Proposals for the development of the Hope Downs 4 deposit will be submitted to the Minister for State Development for approval under the HD State Agreement. Hamersley HMS will ensure that appropriate tenure is in place for all aspects of the Hope Downs 4 development.
6.	DMP	If the project is assessed under the Mining Act, it will also have tenement conditions to be complied with (page xiv).	Refer to the response to Item 5.
Terminology			
7.	DMP	In some places throughout the document the terminology 'if required' is used in relation to an environmental action. This terminology has the potential to create confusion in the future as it is not clear if the action will be conducted when Hamersley's own monitoring suggests it is required or if the action has to be requested by EPA.	The Proponent notes the comment, but feels that the use of the term ‘if required’ is appropriate at this early stage of the Proposal to indicated where a decision may need to be made at a future point in relation to the best means of addressing a matter as further information becomes available during the construction, operation and closure phases of the Proposal. At the appropriate time and on consideration of the information available, the Proponent will take necessary actions ‘if required’ to address an environmental matter without the need for the action to be requested by the OEPA.

Item	Submitter	Submission	Proponent response
Environmental factors			
8.	DMP	Table ES2 on page (on page xvii and xxii) should also list salinisation as a potential groundwater and subterranean fauna impact.	The Proponent does not consider that there is a need to list salinisation in Table ES2 of the PER as a potential groundwater and subterranean fauna impact. Although the predicted salinity levels in pit lakes (with no backfill) is modelled to gradually increase from 400 mg/L to 1300 mg/L over a 40 year period, the rapid evaporation and low elevation of the pit bases means that the surface water levels will generally be at elevations lower than the surrounding groundwater, therefore, the pit lakes will act as local groundwater sinks and groundwater through-flow will not be reinstated. As a result, the potential to impact on groundwater or subterranean fauna should be limited. The presence of the Mount McRae Shale will also limit groundwater through-flows to and from the pit lakes.

6. REFERENCES

Adams M 2005, *Monitoring Plan for the Impacts on Tree Health in Riparian Ecosystems surrounding Pilbara Iron's Yandicoogina Operations*, University of Western Australia.

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Dogramaci. S and Dodson. W, 2010 *Deuterium and O-18 data to estimate the relative contribution of summer and winter season precipitation to surface water pools; A case study from Hamersley Basin, Western Australia*, Rio Tinto Iron Ore.

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Mattiske Consulting Pty Ltd 2008a, *Flora and Vegetation on the Hope Downs 4 Mine and Village Camp Area*, Prepared for Pilbara Iron, Perth Western Australia, August 2008.

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Rio Tinto Iron Ore (RTIO) 2009, *Conceptual Closure Management Study*, Perth, Western Australia, Rio Tinto Iron Ore , October 2009

Sinclair Knight Merz (SKM) 2008, *Pilbara Iron – Air quality assessment for Hope Downs 4*, Prepared for Hamersley Iron, Perth, Western Australia, November 2008.

Appendix 1

Bat survey methodology: additional information from Dr Kyle Armstrong

Specialised Zoological
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15 April 2010

Formal response to DEC comment on submission for the Hope Downs 4 project: bat surveys

This letter is a formal response to a comment by the Department of Environment and Conservation on the public submission by Rio Tinto Iron Ore for the Hope Downs 4 project. The comment involved the adequacy of methodology used for the bat surveys.

Under my business name of Specialised Zoological, I undertook the acoustic analysis of calls recorded with two Anabat SD1 detectors owned and deployed by Ninox Wildlife Consulting, and provided a report on bat species identifications that were included as appendices to the Ninox fauna report. Given that the DEC comment was specifically on acoustic analysis, I am assisting Rio Tinto Iron Ore and Ninox Wildlife Consulting by responding as a specialist in this area. The views expressed in this letter are my own, and I hope that they will be sufficient to address the comment favourably on behalf of my clients.

My specialist opinion of the comment by the DEC is that it does not contain correct information, and that the view is based on a fundamental misunderstanding of how Anabat works. I think it is particularly important to address the DEC comment in detail because a similar comment could be directed at any Pilbara development submission, and therefore has wide implications. I have sought technical advice from the manufacturer and designer of Anabat in support of my opinion, as well as other technical literature as cited.

Please contact me if further information is required.

Yours sincerely,

Via email

Kyle Armstrong, PhD
Zoologist

Qualifications and experience

As background, I would like to outline my zoological experience, specifically on bat acoustics, and also on Pilbara bats. I am a research Zoologist, with an active commercial interest in bat surveys, mainly in Western Australia, but I also have consultative and research experience in East Asia, Timor-Leste and Papua New Guinea. I undertook my PhD degree at The University of Western Australia on the orange leaf-nosed bat *Rhinonicteris aurantia*, and have published extensively on this species and the ghost bat. In addition I have several manuscripts in various stages of preparation and review that deal with subjects on *Rhinonicteris*, bat acoustics and other topics on bats. Selected references are given at the end of this letter, and a capability statement of my business Specialised Zoological is available at the following web address:
http://www.gaiaresources.com.au/sz

DEC comment

FAUNA

Issue: Bat monitoring may have been undertaken using a methodology that does not adequately detect Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*).

Recommendation 17: *That the proponent confirms that bat monitoring undertaken was appropriate for detection of Pilbara Leaf-nosed Bat and undertakes further bat monitoring, if this was not the case.*

Recommendation 18: *That, if possible, further work be undertaken to confirm whether maternity roosts/suitable habitat for Pilbara Leaf-nosed Bat occur within the impact area.*

Discussion:
The Specialised Zoological report (2009), provided as an appendix to "*A Vertebrate Fauna Survey of the Proposed Hope Downs 4 Option 6 Infrastructure Corridor*" (Ninox 2009c), indicates that "*signals as recorded with an Anabat SD1 unit were downloaded and examined in AnalookW*" (p. 62, Ninox 2009c). Recent DEC experience from bat monitoring and survey work in the Pilbara has shown that standard Anabat echolocation surveys using the supplied software for post processing may miss 50 - 70 per cent of Pilbara Leaf-nosed Bat calls due to software limitations. Standard Anabat ZCAIM or SD1 based surveys are therefore now considered by DEC to be inadequate for Pilbara Leaf-nosed Bat studies. Recent success in locating new Pilbara Leaf-nosed Bat roosts has been achieved using bat detectors, including Anabat II ultrasound detectors connected to minidisc recorders in 'mono, long-play' mode. Further details on this methodology are available in "*The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats*" (McKenzie and Bullen 2009). These recordings capture all ultrasonic echolocation and thereby all Pilbara Leaf-nosed Bat calls, no matter how short. If possible, areas of potential Pilbara Leaf-nosed Bat habitat should be resurveyed using the above technique.

Response

In order to justify my comment that the method of McKenzie and Bullen is based on a fundamental misunderstanding of how the Anabat system works, I have provided a schematic diagram (Figures 1 and 2) and several statements that explain the system, which underpin all of the following comments made in this response letter.

- The same information is available to both a MiniDisc recorder and an Anabat ZCAIM (Zero Crossings Analysis Interface Module) attached to an Anabat II bat detector via the 8 pin DIN jack. It is impossible for the MiniDisc to see anything (in the way of bat calls) not seen by a ZCAIM. They both receive an output that has already been digitised and converted to a square wave based on zero crossings, subject to a sensitivity threshold, and filtered so that only a proportion of waves are retained (i.e. frequency divided).

- A 'continuous recording', i.e. a recording made from of an Anabat II detector onto a MiniDisc, does not contain any more bat calls or ultrasonic signals than the same signal processed by an older model ZCAIM, CF-ZCAIM, or the 'internal' CF-ZCAIM within the SD1. The signal has already been subject to a sensitivity threshold in both cases.

- There is no extra information that can be recovered or extrapolated from a bat signal by using an FFT (fast-Fourier Transform) analysis of the MiniDisc-recorded output from an Anabat II.

- In fact, there are always extra noise and analysis artefacts that are added to the bat signals during the MiniDisc–recording and FFT analysis process, and the recording process diminishes the quality of the signal.

- While single echolocation pulses will not be saved into a separate Anabat sequence file when the Anabat DAT file is parsed by Anabat / CFC Read software, they can still be viewed in the ZCA and MAP files in AnalookW software. Thus, the Anabat system does not lose information relative to the MiniDisc recording.

- AnalookW software allows the same measurements to be made from a square wave signal as in Cool Edit / Adobe Audition, or any software that can calculate a power curve. This includes an estimate of 'peak frequency', which is essentially the frequency band that contains the greatest number of cycles (F_{pz}). It is directly equivalent to the value calculated by McKenzie and Bullen (2003, 2009) they call F_{peakC}, because both use the square wave output. The only difference is that McKenzie and Bullen recover this using FFT. Also available in the AnalookW flatness display is a measure of the width of this estimation of peak frequency (quality factor, Q-factor or Q6dB) at 50% of the cycle-count, which is equivalent to that calculated by McKenzie and Bullen. Because the same variable is calculated in a different way by the two methods, they might give slightly different values for the same emitted pulse, but as long as Q-factors are compared using the same method of calculation, then it would not matter which is used. Further information on F_{pz} is available at URL:

http://users.lmi.net/corben/antislope.htm In summary then, the AnalookW software is not inferior, and in fact can calculate many more variables more reliably.

- There are many practical advantages for using the standard Anabat system over the Anabat II – MiniDisc system, but the greatest consideration is that both Anabat II and MiniDisc are now dated technology. Anabat II is now no longer manufactured by Titley Electronics, and MiniDisc recorders are likely to become increasingly difficult to purchase in the future.

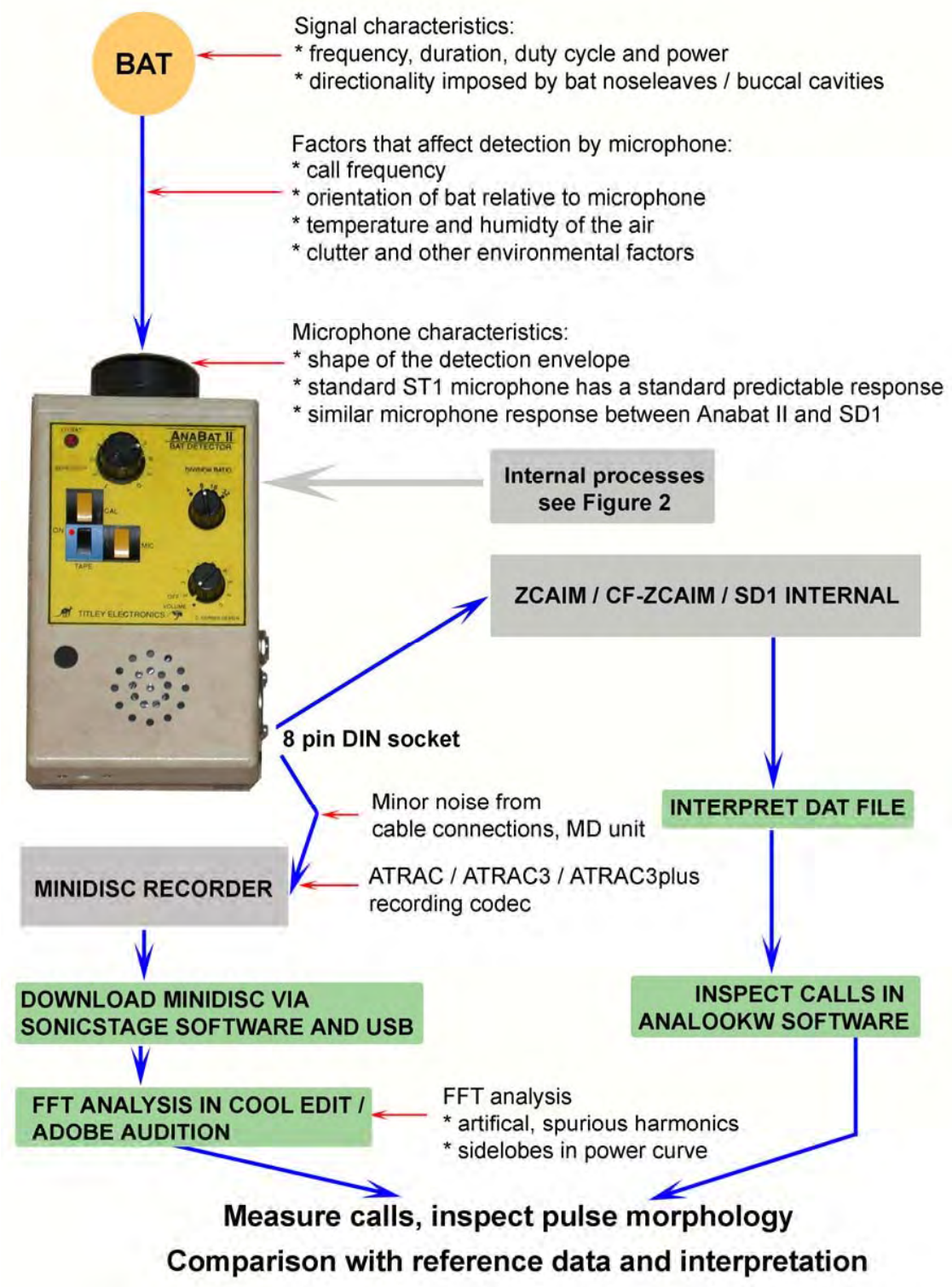

Figure 1. The two pathways of signal recording (blue arrows), with influences or modifications indicated (red arrows).

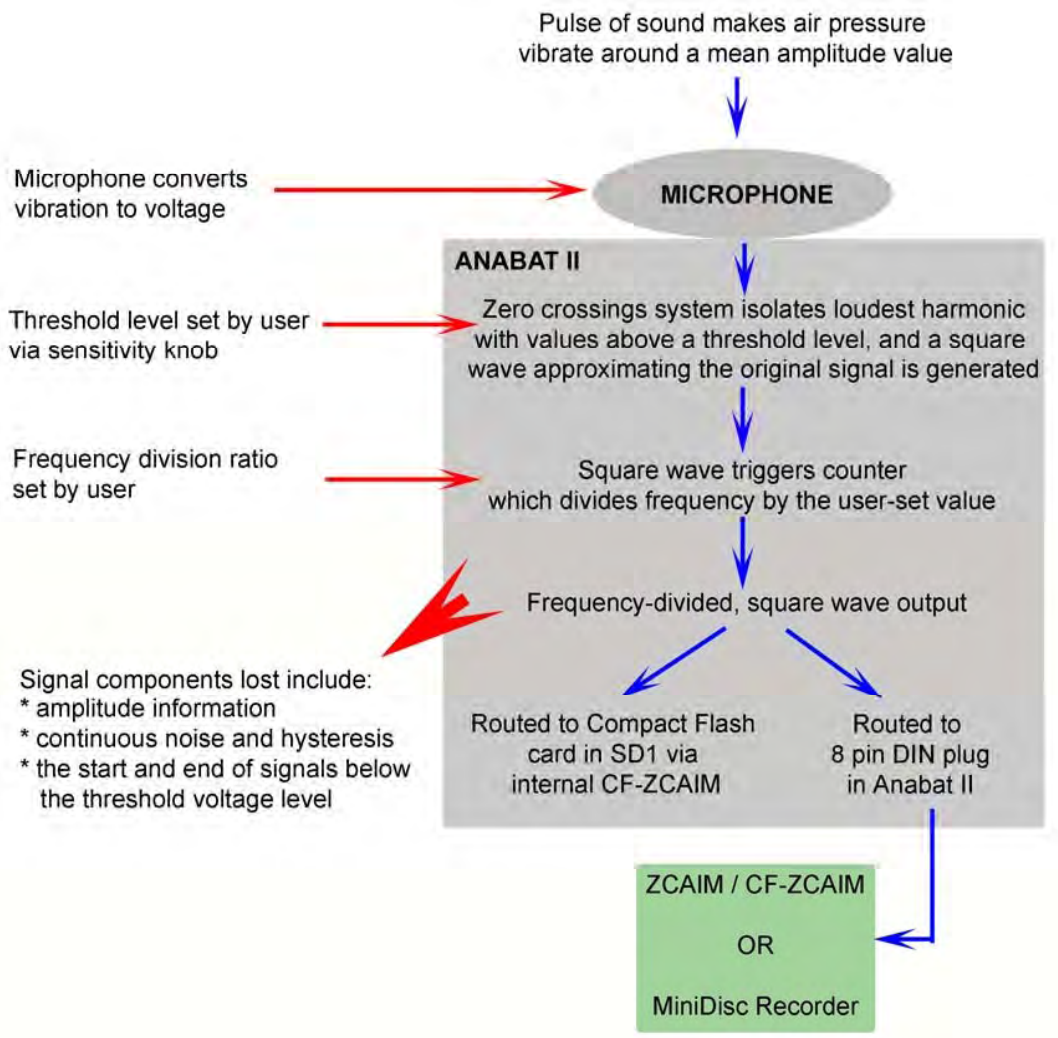

Figure 2. The MiniDisc recorder receives signals AFTER they have been subject to capture based on the sensitivity threshold (set by the user), converted to a square wave based on zero-crossings of the raw signal, and then frequency divided. Critically here, the MiniDisc recorder cannot access signals BEFORE they have been subject to capture based on the sensitivity threshold, because only the frequency divided square wave output is available at the 8-pin DIN plug at the side of the Anabat II. This simple fact completely negates any claim that MiniDisc recordings are superior and contain more information because they are continuous and not subject to the 'trigger' or 'threshold'. After this, the ZCAIM measures the time intervals between the zero-crossings in the square wave output by the bat detector. It then stores (in a CF card in a DAT file) or transmits (via serial or parallel port, depending on the model) the time interval values to a computer. The computer software (older 'Anabat' software, 'CFC Read' software) takes these values and computes the frequencies from them. There is no difference between ZCAIM models or types except for the nature of the interface. Further information is available in Corben and O'Farrell (1999), Parsons et al. (2000), Corben (2004) and Parsons and Obrist (2004).

Recent DEC experience from bat monitoring and survey work in the Pilbara has shown that standard Anabat echolocation surveys using the supplied software for post processing may miss 50 – 70 per cent of Pilbara Leaf-nosed Bat calls due to software limitations.

This figure of 50 – 70 % of Pilbara Leaf-nosed bat calls has not been demonstrated in a publication. To support this statement, McKenzie and Bullen would need to have performed a side-by-side comparison of their hardware setup and either an Anabat II – CF-ZCAIM or SD1. Generally, if an alternative to a widely held view is to be convincing, it is incumbent upon the proponents of that view to demonstrate this. I know of no such technical and comprehensive comparison, and this information is certainly not contained in the recent publication of McKenzie and Bullen (2009). Given what I have explained in the remainder of this letter, I doubt that it is accurate.

There is only one situation where this claim could have some validity. When the DAT file is interpreted in the Anabat download software CFC Read, there are a number of 'interpretation options'. The default values are normally used by most people (including myself). During the interpretation process, the raw signal is parsed according to the interpretation options and many Anabat sequence files are produced that can span up to 15 seconds worth of data. An ultrasonic signal must meet certain criteria before it is recognised as a bat call by the Anabat. A single bat call will never be saved to a file unless it is accompanied by other noise which passes the interpretation parameters. However, you can view the original data in a ZCA file, which shows everything. In this case, I checked the raw, unparsed ZCA file outputs and the MAP files that can be generated from these to determine if there were any remaining single-pulse signals above 100 kHz that could have been left out. There were none, so the Anabat recordings saved to CF card did not contain 'extra' Pilbara leaf-nosed bat calls that were not parsed into sequence files.

Standard Anabat ZCAIM or SD1 surveys are therefore now considered by DEC to be inadequate for Pilbara Leaf-nosed Bat studies.

It would be a major backward step to expect Western Australian biological consultants to adopt the method of McKenzie and Bullen when conducting acoustic surveys for this bat species because the method is actually inferior to the standard Anabat system, as I have demonstrated throughout this letter. Of relevance here also is that the DEC has not yet released a final guidelines document, and neither the EPA nor the public have commented upon it. Furthermore, I have read a draft of the guidelines, and it does not recommend (much less enforce) one acoustic method over another, nor does it mention specifically the Pilbara leaf-nosed bat. The DEC statement does not seem reasonable in light of this.

Recent success in locating new Pilbara Leaf-nosed Bat roosts has been achieved using bat detectors, including Anabat II ultrasound detectors connected to minidisc recorders in 'mono, long-play' mode.

I have read McKenzie and Bullen (2009) in detail. Nowhere does it state that roosts of the Pilbara Leaf-nosed Bat were discovered. Nor does it state in the methods whether searches were made for roosts other than through placing an Anabat detector in the vicinity of caves. Anabats were placed as stationery passive recording stations at rocky outcrop with cave development, or a variety of other habitats. This approach does not confirm roosting. Furthermore, the paper did not even suggest the existence of roosts at any of the cave sites it surveyed. I have consistently provided advice since 2006 that roosts of Pilbara Leaf-nosed bats need to be determined unambiguously with a method that distinguishes bats that fly out from the cave after sunset (having used the cave as a diurnal roost) from those that fly in from elsewhere. This advice is available in detail on the DEWHA SPRAT profile for the species (DEWHA 2010), and has been written into the draft survey standards for Threatened Australian bats (Reardon 2003). Unless such an activity is undertaken at caves where calls of the Pilbara leaf-nosed bat are detected, roosting cannot be confirmed.

By "mono long-play mode" I assume the writer means Hi-MD LP4 format, which would allow recordings to be made over a full night (an '80 minute' Hi-MD formatted MiniDisc would then give 590 minutes or 9 hours and 50 minutes of recording). The disadvantage of using this mode is that it is of lower quality than other available modes in recent models of the Sony MiniDisc recorder. Thus, by extending recording time, the quality of the recorded signal is reduced and therefore a potential compromise that might affect how well ultra-high frequencies are recorded. As an example, signals recorded in Hi-MD LP4 mode are encoded using the ATRAC3 codec, and are recorded at a bitrate of 66 kilobits per second, whereas in Hi-MD Hi-SP mode they are encoded using the ATRAC3plus codec and recorded at a better resolution of 256 kilobits per second. The point I make here is that DEC is recommending recording at a lower quality than is possible. When this effect is added to the many other considerations that make MiniDisc recordings appear of relatively low quality (*see next paragraph for a justification of this*), it does not inspire confidence in the second sentence of the DEC comment that the MiniDisc method can detect 50 – 70% more Pilbara leaf-nosed bats. It also needs to be added that McKenzie and Bullen (2009) saved their calls in MP3 format, which is a lossy format containing less information than WAV, and not something generally recommended in bioacoustic studies.

The relatively low quality recording of MiniDisc can be demonstrated easily using components of Anabat hardware. If an ultrasonic signal is fed into an Anabat II detector connected to a ZCAIM 5 or ZCAIM 6, a Zero Crossings Analysis display will be clearer than if the same signal is fed into an Anabat II detector, recorded to MiniDisc, and then replayed into the ZCAIM. In this case, the difference between the two displays is the sum of the various influences (summarised in Figure 1)

that are introduced by placing a MiniDisc in the middle of the Anabat system. The point I make is that MiniDiscs add noise and remove signal quality, and it follows that it would be less likely for the MiniDisc-based recordings to record more Pilbara Leaf-nosed bats.

Further details on this methodology are available in "*The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats*" (McKenzie and Bullen 2009).

I have read this document, as well as Bullen and McKenzie (2002) and McKenzie and Bullen (2003) where it is also described. I have used this method, and consider it not only inferior, but extremely time consuming (thus expensive), tedious and inconvenient compared with the standard Anabat system. It is beyond the scope of this response letter to give my opinion of this paper, but there are two relevant points here that demonstrate the inferiority of the McKenzie and Bullen system, and the superiority of making identifications of the Pilbara leaf-nosed bat from the ZCA display in AnalookW software.

Firstly, an excellent demonstration of the spurious artefacts introduced by the MiniDisc system can be found in the paper by McKenzie and Bullen (2009). In their figure 2, they show a spectrographic representation of a single pulse next to a power spectrum of the same signal (from an FM bat). The example of the spectrogram shows multiple 'harmonics', which are in fact spurious artefacts introduced by the FFT analysis. The authors do acknowledge this, but do not emphasise well that these components need to be ignored during analysis. They do not show a spectrographic representation of a Pilbara leaf-nosed bat call , but the relatively poor quality images of the species they do provide as examples suggests that not much information can be gleaned from this display. In the example power spectrum shown, the lobed nature of the envelope is not particularly obvious, but in my experience it is typically greater, which limits the ability to make measurements such as minimum and maximum frequency from these displays. The limits of the signal relative to the 'sound floor' or background noise level are difficult to distinguish accurately in a power spectrum resulting from a MiniDisc recording of less than high quality calls. In comparison, many measurements are possible in the ZCA display of AnalookW, some of which can describe diagnostic pulse shape characteristics for some species. I notice also that the paper of Mckenzie and Bullen (2009) also states that calls were recorded at a division ratio of 16, which gives less information and therefore a coarser representation of the calls than a ratio of 8, which is generally used on SD1 based surveys in WA, including by Ninox on the Hope Downs surveys.

Making an identification of the Pilbara leaf-nosed bat based on pulse structure is of paramount importance. The shape of the pulse is absolutely diagnostic (in combination with F_{pz}), and allows calls of this species to be distinguished from non-search phase calls of other species, or potential ultrasonic noise. Even some Pilbara leaf-nosed bat pulses of relatively poor quality can be identified with confidence, because the 'degradation' of the signal by ZCA occurs in a predictable

way. I have observed literally hundreds of pulses of the Pilbara leaf-nosed bat as part of monitoring surveys that deploy Anabat detectors at cave entrances. Using the Anabat ZCA display, recognition of the difference between pulses from the Pilbara leaf-nosed bat and other sources is straightforward.

> These recordings capture all ultrasonic echolocation and thereby all Pilbara Leaf-nosed Bat calls, no matter how short.

It is inaccurate to state that Anabat II – MiniDisc recordings "capture all ultrasonic echolocation". The signal available to the MiniDisc recorder has been modified by several processes (Figure 1), and will only convert ultrasonic bat calls that are above the threshold determined by the sensitivity setting (Figure 2). As has been explained, the Anabat II output that is available to the ZCAIM and the MiniDisc recorder is exactly the same.

The words "thereby [capture] all Pilbara leaf-nosed bat calls, no matter how short" is also somewhat inaccurate. If signals produced by the Pilbara leaf-nosed bat are of sufficient amplitude, i.e. above the sensitivity threshold, then the calls will be available at the 8 pin DIN plug to any recording system, including MiniDisc, digital recorders, earlier model ZCAIM, CF-CAIM (saved to the DAT file), or the internal CF-ZCAIM in the case of the SD1 (also saved to the DAT file). If the duration of a pulse is shorter than would be allowed via the settings in the interpretation options when parsing the DAT file, then it is indeed true that this pulse would not end up being displayed in an Anabat sequence file. But as I have mentioned, such short duration calls can still be observed in the ZCA and MAP files, which were examined in both analysis sessions that I undertook.

A point needs to be made here on the reliability of identifications. If there are relatively few calls detected of the Pilbara leaf-nosed bat, and all consist of sequences containing only one pulse, and/or pulses of minimal duration, the identifications are obviously being made on extremely low quality signals. If one pulse happens to pass through the interpretation process in Anabat, and can be distinguished from other signals based on characteristic frequency and pulse shape, then this is obviously superior and provides a better basis for recommending further investigative work. It is more logical to set a quality standard so that identifications can be regarded as unambiguous. The default parameters of the interpretation options provide an adequate benchmark for allocating an unambiguous identification. Anything less is more difficult to justify because there is no lower benchmark, and it would be more appropriate to suggest increasing the likelihood of detection through different ways of deploying Anabat units than relying on an analysis method. Active acoustic monitoring on prolonged night traverses is one such activity that I always recommend for bringing Pilbara leaf-nosed bats within range of the detector, but unfortunately most mining companies limit night driving and walks away from the vehicle for safety reasons.

To further reinforce the point about the unreliability of including call fragments of short duration, there is a very great danger of misidentifying the Pilbara leaf-nosed bat if these are used. Finlayson's cave bat *Vespadelus finlaysoni* normally emits curvilinear hook-shaped echolocation calls with a peak frequency around 53 kHz. When they are in clutter, especially within caves or close to cave entrances, they often produce sequences of short duration pulses that rise in frequency to the band where Pilbara leaf-nosed bats operate. I imagine that an ultra-high pulse of Finlayson's cave bat would be very difficult to distinguish from a poor quality short duration fragment of the Pilbara leaf-nosed bat in the spectrographic display, and also the power curve when analysis is conducted in Cool Edit. In an Anabat ZCA display, the difference is extremely clear (Figure 3), especially the difference between the typically hook-shaped ultra-high frequency calls of *V. finlaysoni* and situations where only the terminal frequency sweep of a call from *R. aurantia is recorded*. While I am not sure how McKenzie and Bullen distinguish these two call types, especially when they are of poor quality, it does not inspire confidence in their identifications, and might have implications for their most recent paper. In the absence of any other information (i.e. good quality calls from other sites in a project area), determining identifications from single, short duration signals is unreliable.

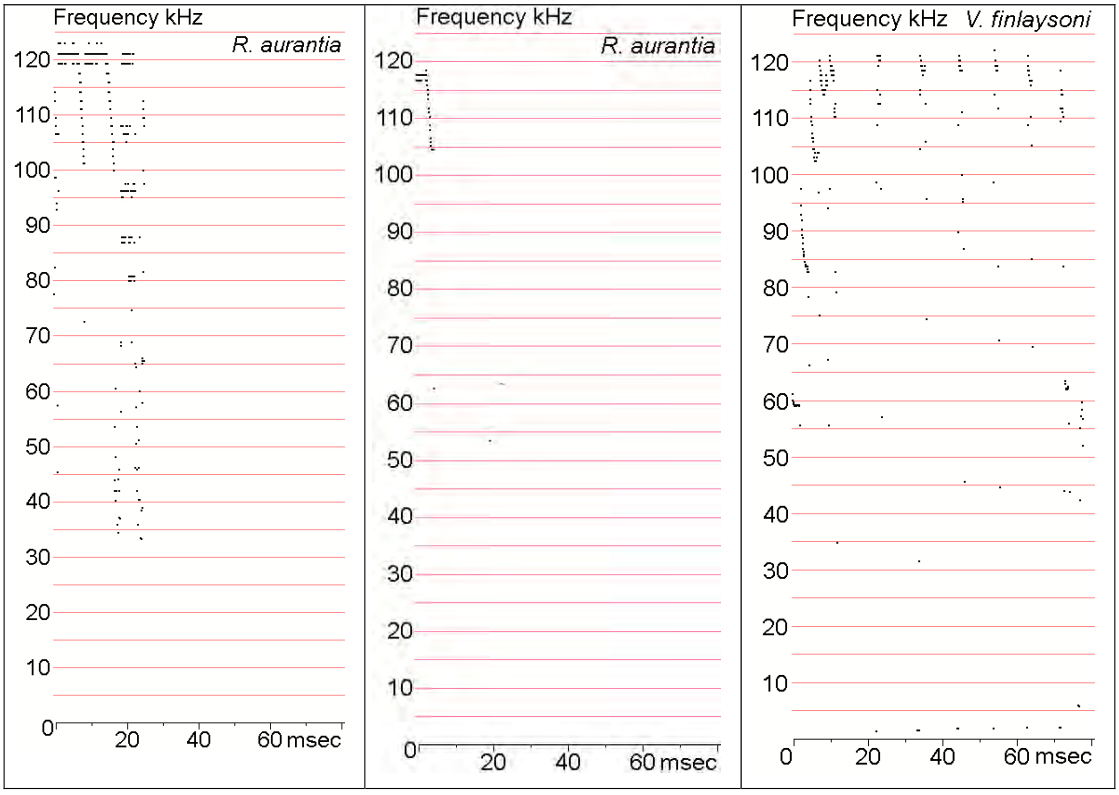

Figure 3. Time-frequency representations following Zero Crossings Analysis of Anabat recorded signals that illustrate the clear difference in echolocation pulse structure between Finlayson's cave bat and the Pilbara leaf-nosed bat (Specialised Zoological 2009).

If possible, areas of potential Pilbara Leaf-nosed Bat habitat should be resurveyed using the above technique."

Given all of the above, I would have to flatly disagree that there is a sound basis on acoustic methodological grounds for expecting Rio Tinto Iron Ore to commission further survey work using the technique of McKenzie and Bullen. If there was some evidence that the species was present, I could see that a request for further work to identify possible roosts or regular foraging habitats would be valid, and I would certainly make the same recommendation. Also, if there was some suggestion that Ninox Wildlife Consulting had not surveyed rocky areas adequately for deep caves, then such a request would also be valid. From reading the report of Ninox, it was clear that bats were one of several groups assessed during a general fauna survey, thus the survey could not devote all its effort to bats. Also, it appears from the description of the survey sites, and the map of the project area, that rocky habitats did not represent a large proportion of the Hope Downs 4 Option 6 Infrastructure Corridor. Ninox determined that the most likely site to detect the Pilbara leaf-nosed bat was at site OP6, a pool in Weeli Wolli creek (a potential foraging habitat). Despite 3 nights of Anabat recording at OP6, no Pilbara leaf-nosed bats were recorded. It is not unreasonable to conclude that if Pilbara leaf-nosed bats were apparently absent from this permanent pool, then roost sites may not be close by. I have previously noted that this species seems to prefer gullies and gorges with pools as foraging areas (Armstrong 2001). Ninox will be able to provide further details on cave occurrence in the project area if required. The issue of the thoroughness of cave surveys is separate to that of the acoustic analysis methods discussed here.

Recommendation 17: That the proponent confirms that bat monitoring undertaken was appropriate for detection of Pilbara leaf-nosed bat and undertakes further bat monitoring, if this was not the case.

As described in this letter, my opinion is that the equipment was indeed appropriate for detection of the Pilbara leaf-nosed bat. To be clear, I see no reason why the survey should be repeated if the only issue is whether an Anabat II – MiniDisc system should have been used instead of the Anabat SD1 units. If the DEC felt that the Anabats were not deployed or used adequately, or there was an insufficient level of Anabat deployment per site or per night, then this would be a different issue. Ninox will be able to provide further comment on this if required.

Recommendation 18: That, if possible, further work be undertaken to confirm whether maternity roosts/suitable habitat for the Pilbara leaf-nosed Bat occur within the impact area.

There was no indication that the Pilbara leaf-nosed bat was present in foraging habitats, even when the most likely preferred habitat was targeted and subject to greater Anabat survey effort than other sites. If DEC felt that there was insufficient survey effort directed towards locating and then assessing larger caves, then Recommendation 18 would have a better basis. In this case, Ninox will be able to provide further comment on the field activities undertaken if required.

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Appendix 2

Water chemistry and isotopic tracer investigations: additional information from Dogramaci & Dodson (2010)

Mixing and evaporation processes of surface pools using stable isotope and chloride concentrations in Hamersley Basin, Western Australia

Shawan Dogramaci and Wade Dodson

1. Introduction

The chemical and isotopic composition of waters have been used for identifying inter-aquifer mixing and groundwater surface water interactions for the past three decades (Cook and Herczeg 1999; Barbieri et al., 1993; Mazor et al., 1993). One of the most powerful tracers for this purpose is dissolved Chloride (Cl). Chloride is considered to be a conservative ion with no mechanism to remove it from waters within the range of TDS up to 300,000 mg/l. In the absence of Cl bearing minerals such as halite, the variation in Cl concentration from that of rainfall can only occur via evaporation-evapotranspiration of rainfall or mixing with water that has different Cl concentration.

Furthermore, understanding groundwater dynamics in areas where there is a restriction on obtaining subsurface hydrogeologic information by conventional drilling methods due to rugged terrain, the chemical and isotopic tracers may be useful as a non-evasive low cost investigation method to supplement conventional hydrogeological investigations (Demlie, 2007; Barbieri, 2005). In this study major ion concentrations and stable isotopes (δ^2H and $\delta^{18}O$) have been used as a tool to determine the relationship between the mineralised ore body aquifer at the proposed Hope Downs 4 pits and the surrounding Tertiary aquifer (TR), unmineralised Brockman Iron (BIF) and Woongarra Volcanics (WV) Formations.

Furthermore, the stable isotope composition of water can provide important clues into processes that dominate during evapo-concentration processes. Water uptake of infiltrating rainwater (or soil moisture) by plants increases Cl concentration in the remaining water. However, the original δ^2H and $\delta^{18}O$ composition (derived from rainfall) is maintained. This occurs because fractionation associated with plant transpirational processes is small relative to the much greater fractionation that can occur with evaporation (Farquha et al., 2007).

The Hope Downs Joint Venture participants are assessing the development of a proposed iron ore mine located approximately 30 km northwest of Newman in the Coondiner Creek catchment in the East Pilbara Region. Eighty percent of the ore body occurs below the water table and would require dewatering for safe mining conditions and ore processing. Understanding the potential impact of dewatering the ore body on the surrounding water bodies, particularly environmentally sensitive surface pools, is a prerequisite for regulatory approvals. This study presents the results of hydrogeological and hydrochemical analysis of surface pools and groundwater to determine the likely origin of water in the nearby Coondiner and Kalgan Creeks.

2. Physiography

The proposed mine occurs near a catchment divide between the Coondiner and Kalgan Creeks (Figure 1). The topography of the catchments mimics the underlying geology and is controlled by geological structure. The Coondiner Creek catchment covers an area of 460km^2 and drains in an east north-easterly direction through the ephemeral Coondiner Creek. The terrain is characterised by gently rolling hills in the upper catchment pene-plain to the south and southwest to steep gorges incised up to ~60m in the downstream catchment to the north. The main gorge starts downstream

of Eagle Rock Falls, approximately 5km north of the proposed mine site. The gorge then gives way before the broad, low lying Fortescue valley a further 11 kilometres downstream. Numerous tributaries from surrounding hills flow into the Coondiner Creek from the east and west downstream of Eagle Rock Falls due to the relatively dissected and more pronounced morphology.

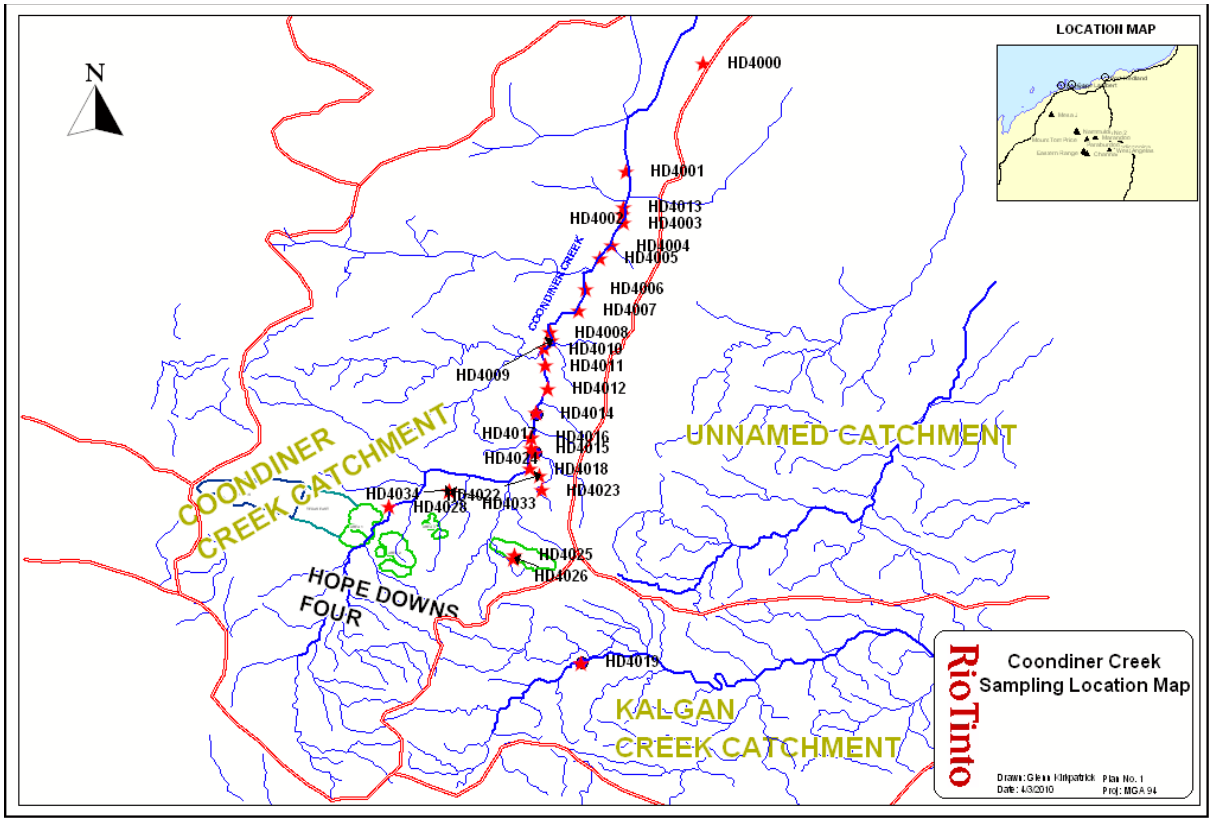

Figure 1 Coondiner Creek Sampling location map and the catchment boundaries in the Hope Downs 4 mining area

Kalgan Creek Catchment located to the southeast of Coondiner Creek Catchment is drained by the ephemeral Kalgan Creek from west to east. The upper catchment is comprised of etched pene-plain and a lower catchment of steep gorges, ultimately draining to the Fortescue valley. The Coondiner and Kalgan Creeks flow briefly in the wet season in direct response to rainfall events. Once rainfall recedes, several pools remain in the creek bed particularly in the lower parts of the catchments.

3. Climate

The climate of the area is classified a semi-arid and is characterised by hydrologic extremes with long periods of drought and occasional high intensity storm events from sub-tropical summer rainfalls. Meteorological data available from the Newman Bureau of Meteorology station and Rhodes Ridge located 60 km to the south east and 25 Km to the east respectively, show average annual rainfall of approximately 300mm.

Rainfall is highly variable, falling mainly in the summer months from January to March. Most of the summer rain comes from scattered thunderstorms producing

heavy localised falls in short periods. Tropical lows originating off the Pilbara coast can also bring widespread rain to the area. Rainfall in May and June may be produced as a result of tropical cloud band movement. Temperatures range from a minimum of 8 ^{o}C in winter to maximum temperatures of 35 to 40 ^{o}C in summer. The average annual evaporation rate for the region is 2,500 mm, exceeding average rainfall.

The frequent tropical storms produce large volumes of surface flow in a relatively small period with little evaporative effect. This results in groundwater recharge to the aquifers particularly to the surficial alluvium aquifer along the creek lines (Dogramaci and Dodson 2009).

4. Hydrogeological setting

The East Pilbara comprises metasediments and basement rock of the Lower Proterozoic Hamersley Basin. The orebody at Hope Down 4 mine site occurs in the mineralised sections of the Dales Gorge and Joffre Members of the Brockman Iron Formation (BIF). The mineralised Brockman Iron Formation is considered the primary aquifer with hydraulic conductivities up to 10 m/d. The aquifer is bound in a eastward plunging syncline lined to the east, north and west by the impermeable Mt. McRae Shale. Groundwater flow through the southern boundary of the aquifer is also restricted by impermeable unmineralised BIF. A series of north-south trending faults cut the orebody in the vicinity of Coondiner Creek. A north south conceptual hydrogeological cross section in Figure 2 depicts the ore body aquifer in relation to the surrounding formations.

In the north and south of the orebody aquifer, the impermeable Mt. McRae Shale is underlain by Wittenoom Formation and overlain by BIF, Weeli Wolli Formation and the Wongarra Volcanics. The Wittenoom Formation is recognised as an aquifer with high yield restricted to where karsts are developed. To the north of the orebody is also a veneer of Tertiary calcrete between 20 and 40m in thickness overlying the Mt. McRae Shale.

In addition to the two primary aquifers within the Ore body and Wittenoom Formation, the 20 to 40 m thick veneer of calcrete to the north of the orebody is considered an aquifer. The Mt. McRae Shale, the Weeli Wolli Formation and Wongarra Volcanics are regarded as relatively impermeable except where fractured (Fig. 2).

The floodplain of both Coondiner and Kalgan Creeks comprises alluvium of clay rich gravels with an incised gravelly creek bed. Drilling along the Coondiner Creek shows 30 m of alluvium adjacent to the creek bed in the eastern part of the catchment (MWH 2008). In the central catchment drilling indicates calcrete and alluvial thickness of 50m (MWH 2008). However immediately above Eagle Rock Falls the alluvium has been down cut and stripped away to expose Wongarra Volcanics in outcrop.

The water table depth ranges from 20 m to 30 m below ground level in the upper catchments away from drainage lines and the direction of groundwater flow is to the north and north east. Recharge is believed to occur indirectly as a result of intermittent creek flow (Dogramaci and Dodson, 2009). Discharge from the area

occurs as groundwater through flow via fractures and preferential pathways and evapotranspiration along the margins of drainage lines.

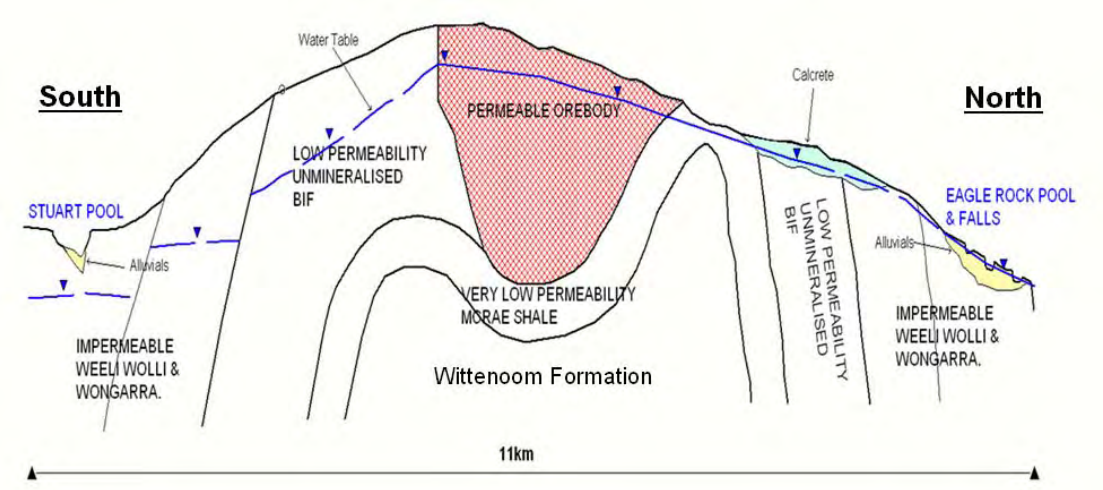

Figure 2 Southwest-northeast cross sections through the eastern end of the HD4 mining area. Location of the cross section is shown in Figure 1.

Hydrogeological drilling investigations confirm that the presence of low permeability Mt McRae Shale and unmineralised BIF will effectively isolate the orebody aquifer from the regional groundwater flow. However, localised connection may occur where conduits for groundwater flow occur due to faulting and fracturing (MWH 2009).

5. Sampling and analytical techniques

Sampling of surface water along Coondiner and Kalgan Creeks and groundwater from various aquifers were carried out in June 2008, and April and August 2009. The sampling program included 14 surface water sites along the axis of the Coondiner Creek, surface water from Kalgan Creek at Stuart, and Kalgan pools, as well as groundwater from Woongarra Formation, Ore body aquifer, calcrete and alluvium aquifers.

The water samples were taken from Stuart Pool and Kalgan Pools, located 16 and 20 km respectively, south and south east of the HD4 orebody aquifer along Kalgan Creek. The chemical analysis of groundwater from the orebody, alluvium, and calcrete aquifers were obtained after an exploration drilling program. In addition, two episodes of rainfall 13 mm and 20 mm respectively at Hope Downs 1 approximately 44 km east of the study area were collected and analysed for major ion chemistry and stable isotopes ($\delta^{2}H$ and $\delta^{18}O$).

Prior to groundwater sampling, three casing volumes from each bore were pumped out to ensure a representative groundwater sample was obtained, or water samples were collected once the pH, Eh and temperature were stabilised. The Eh was measured using a Pt electrode (YSI 3540 ORP) with Ag/AgCl reference calibrated with Zobell solution. The pH was measured using a glass/AgCl combination pH electrode (YSI 3530) calibrated with standard pH 4 and pH 7 buffer solution to an accuracy of ±0.05 pH units. The temperature was measured using TPS field Lab -90 FL series using a silicon transistor built into the tip of the conductivity sensor with

accuracy of ±0.2°C. The concentration of Ca, Mg, Na, and K were determined by Atomic Absorption spectroscopy (AAS). Analysis of SO4 and Cl water in were done by ion chromatography and potentiometric AgNO3 titration respectively.

Water samples were analyzed for $\delta^{2}H$ and $\delta^{18}O$, using an TC/EA coupled with Delta V Mass Spectrometer via Conflo IV in continuous flow mode (Thermo-Fisher Scientific), John de Laeter Centre of Mass Spectrometry, School of Plant Biolog, UWA. Deuterium and $\delta^{18}O$ are expressed in per mil notation (parts per thousand) relative to standard V-SMOW (Vienna Standard Mean Ocean Water).

6. Results

The location of surface and groundwater sampling sites are shown in Figure 1. The concentrations of Cl and stable isotopes in surface water, groundwater and rainfall are given in Table 1 and 2. The Coondiner Creek Catchment sites are arranged in order from the Fortescue Plain upstream (heading south) to Eagle Rock Pool (HD4018), a distance of about 21 kilometers. Most of the surface water sampling sites were isolated pools and no apparent surface flow between the pools was observed. The sampling program was organized to collect the representative samples of surface water along the Creek from Head water at Eagle Rock Falls to the Mouth of the Creek before Fortescue Plain.

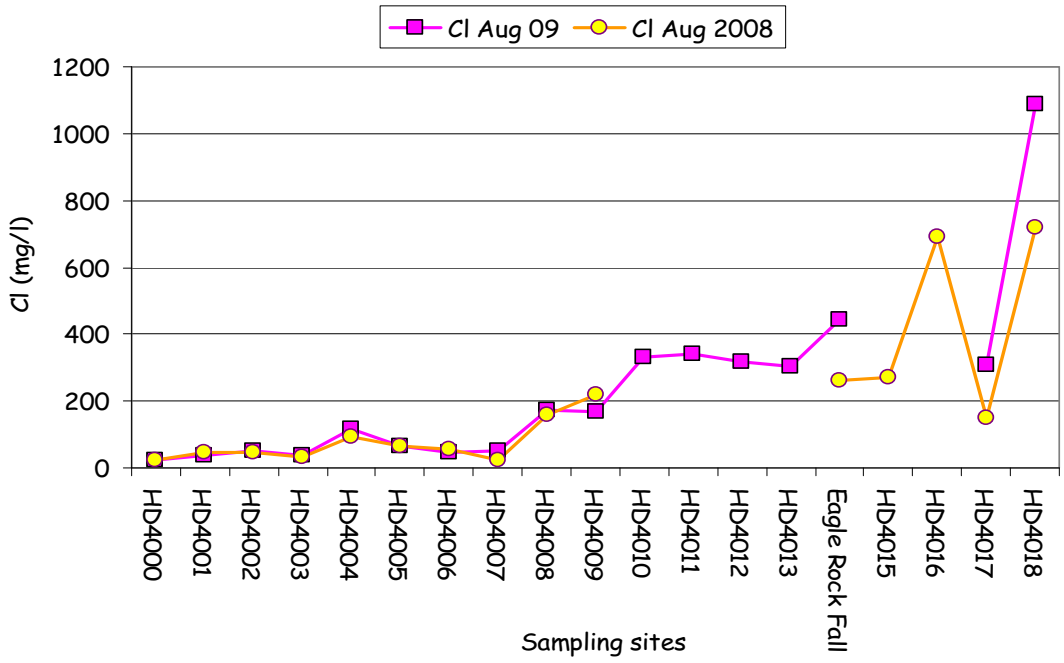

Figure 3. Cl concentrations along the axes of Coondiner Creek measured in August 2008, and 2009. Downstream is to the left, upstream on the right, indicating a dilution affect along the axis of the creek.

Table 1. Chloride δ^2H and $\delta^{18}O$ concentrations of surface water pools (SW) and groundwater (GW) from different aquifers. The concentrations are expressed in milligrams per litre and stable isotope data in per mil (‰ VSMOW).

				Sampling dates											
				6/08/2008				16/04/2009				31/08/2009			
ID	Water Type	E (m)	N (m)	pH	Cl	O-18	D	pH	Cl	O-18	D	pH	Cl	O-18	D
HD4000	GW-Alluvium	772222	7460669	7.3	22			7.8	22.2	-8.0	-58.3				
HD4001	SW-pool	768686	7455690	8.0	48			7.7	44.9	-8.1	-60.2	7.1	38.3	-7.0	-46.0
HD4002	SW-pool	768536	7453730	7.3	49			7.2	43.2	-8.6	-64.9	7.4	51	-6.7	-46.0
HD4003	SW-pool	768551	7453301	8.5	31			7.8	26.3	-7.6	-62.8	7.7	37	-3.8	-37.1
HD4004	SW-pool	768015	7452271	8.5	95			7.9	36.4	-7.7	-62.7	7.5	115	2.8	-5.2
HD4005	SW-pool	767489	7451694	7.7	66			7.8	61.7	-7.5	-56.8	7.7	65.7	-6.2	-38.8
HD4006	SW-pool	766802	7450273	8.0	55			7.8	50.6	-7.4	-53.6	7.5	49	-6.1	-40.2
HD4007	SW-pool	766500	7449298	8.7	21							7.6	52.1	-3.0	-31.8
HD4008	SW-pool	765178	7448280	8.4	160							7.7	172	0.5	-17.0
HD4009	SW-pool	765216	7447934	8.4	220							7.4	169	-1.8	-30.5
HD4010	SW-pool	764905	7447505									7.3	330	-2.1	-25.2
HD4011	SW-pool	764984	7446738									7.5	343	2.9	-6.0
HD4012	SW-pool	765049	7445691									7.4	318	-1.3	-22.8
HD4013	SW-pool	768593	7454050					7.4	218.6	-6.0	-49.7	7.4	305	-1.6	-25.9
HD4014	Eagle rock Fall	764552	7444567	8.1	260			7.9	292	-6.8	-52.4	7.3	445	2.0	-12.0
HD4015	SW-pool	764314	7442940		260	-5.63	-39.1								
HD4016	SW-pool	764289	7443444		260	-5.63	-33.8								
HD4017	SW-pool	764289	7443444	8.1	150				212.4			7.2	308	-3.9	-41.5
HD4018	SW-pool	764236	7441996		689.3	4.15	-0.9		716.5	4.1	-0.9	7.4	1090	0.8	-17.8
HD4019	SW-pool	766598	7433046	7.8	19.5	1.60	5.1	7.2	25.4	-10.4	-78.9	7.3	19	-1.6	-5.1
HD4022	GW-Calcrete	764667	7441695		337.4	-6.05	-41.3		6.9	366	-6.9	-47.7			
HD4023	GW-Volcanic	764807	7441017		138.6	-6.82	-46.5						134	-7.2	-48.1
HD4024	GW-Seep	764460	7442709					7.9	1126						
HD4025	GW-Joffre	763555	7438033					7.5	337.4	-8.1	-53.3	7.7	53	-7.8	-51.0
HD4026	GW-Dale	763481	7437830					6.7	138.6	-7.4	-53.1	7.3	43.9	-7.9	-50.4
HD4028	GW-Joffre	757752	7440249									7.9	44.9	-7.5	-50.4
HD4033	GW-Dale	760560	7440950									7.1	61.7	-8.0	-54.2
HD4034	GW-Dale	760560	7440950									7.0	50.6	-8.0	-54.1

The chloride concentrations of the 14 consecutive pools along the Coondiner Creek in August 2008 and 2009 sampling program range from 720 mg/l (August 2008) and 1090 mg/l (August 2009) at the headwaters (HD4018) to ~ 40 mg/l down gradient at the entrance to the Fortescue valley fluvial plain (HD4001). The systematic decrease in Cl concentrations along the axis of Coondiner Creek was observed in both sampling programs (Fig. 3).

The chloride concentrations in groundwater are characterized by a narrower range from 22 mg/l in the Fortescue valley fluvial plain to 340 mg/l in groundwater from the Woongarra Volcanics. The chloride concentrations in rainfall from five events are <1 mg/l (Table 2). The pH of groundwater and surface water samples are neutral to alkaline and range from 6.9 to 8.7. The δ^2H and $\delta^{18}O$ concentrations measured for the 7 episodes of rainfall at the study area during 2008-2009 season range from –90 ‰ to –12‰ and -13.8 ‰ to 2.0 ‰ respectively. The higher rate of rainfall corresponds to more depleted δ^2H and $\delta^{18}O$ (Table 2).

Table 2. Chloride δ^2H and $\delta^{18}O$ concentrations rainfall. The concentration of Cl is expressed in milligrams per litre and stable isotope data in per mil (‰ VSMOW).

Site	Rainfall (mm)	Date	Cl	δ^2H (‰)	$\delta^{18}O$ (‰)
Yandi	102	1/03/2009	<1	-82	-12.3
Yandi	16	24/06/2009	<1	-12	2.0
HD1	26	22/11/2008	<1	-75	-10.7
HD1	8	28/08/2008	<1	-14	-1.0
HD1	58	25/01/2009	<1	-62	-9.8
HD1	3	4/12/2008	<1	-61	-7.5

The rainfall events in the middle of dry season (28 Aug 2008 and 16 June 2009) are characterised by the relatively enriched δ^2H of – 13 ‰ and -12 ‰ respectively. The δ^2H and $\delta^{18}O$ values in groundwater range from -75 ‰ to -43 ‰ from -12 ‰ to -2 ‰ respectively. Unlike surface water, most of the groundwater data falls on the Meteoric water line (Craig, 1966).

7. Discussion

1. Rain fall isotopes and chemistry

The Local Meteoric Water Line LMWL calculated for the Pilbara region from previous investigation (Dogramaci and Dodson, 2009) is $\delta^2H = 6.2\ \delta^{18}O + 5.2$ demonstrating the characteristically depleted values for rainfall intense cyclonic events with no apparent evaporation effect. This equation may also highlight the impact of the rainout effect that results in a depleted isotope signature in rainfall further inland in comparison to the coast. The LWML falls to the right of the global meteoric water line (GMWL) suggesting a depleted nature for the isotopic composition of rainfall in the Pilbara region compared to the average world annual rainfall (Fig. 4). However, the 8 mm and 18 mm rainfall events that were sampled in August 2008 and June 2009 are characteristically enriched in heavy isotopes, due possibly to “amount and seasonality” effects (Rozanski, K, et al 1993).

The δ^2H and $\delta^{18}O$ composition of water pools are characterised by a wide range of values from -64 ‰ to 1.4 ‰ and from – 8.5 ‰ to 4.15 ‰. The wide range of surface water pools isotopic composition may reflect the source of rainfall (i.e. wet versus dry season events) and evaporation from open water pools. The concentration of Cl in the surface water pools also varies over a wide range of values. The relatively high Cl concentration and enriched δ^2H and $\delta^{18}O$ values in these pools may indicate the evaporation effect. The exception is the relatively low Cl concentration (19 mg/l) and highly enriched δ^2H and $\delta^{18}O$ values of 5.1 ‰ and 1.6 ‰ measured in Stuart pool in August 2008 and 2009.

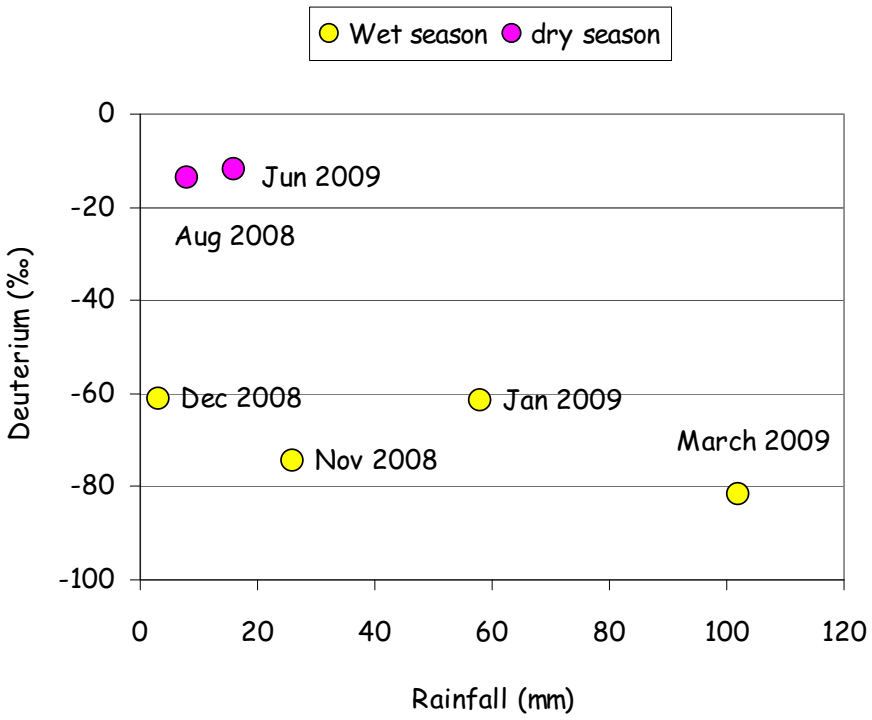

Figure 4 Deuterium concentrations versus amount of rainfall in the study area

Despite the large variation of the amount and distribution of annual rainfall in the study area, the range of δ^2H and $\delta^{18}O$ in groundwater from different geologic formations are remarkably similar ranging from – 53 ‰ to – 41‰ and – 8 ‰ to – 6 ‰ respectively (Fig. 5). The isotopic composition of the groundwater resembles that of the rainfall during the wet season only, suggesting very little recharge to the aquifer from winter rainfall events. Whereas the isotopic composition of water pools can resemble either or wet or dry season rainfall depending on the date the sample was collected. The relatively depleted stable isotope signature of groundwater at Hope Downs 4 is similar to that measured in Marandoo aquifers (120 km) to the northeast and Hope Downs 1 and Yandicoogina aquifers 25 km east and north of the study area respectively (Dogramaci and Dodson, 2009; Hedley et al., 2009).

The study area is mostly covered by native vegetation that is capable of intercepting and transpiring rainfall. Water uptake of infiltrating rainwater (or soil moisture) by these plants increases the major ion concentration in recharge water. However the original δ^2H and $\delta^{18}O$ composition (derived from rainfall) is maintained. This occurs

because no significant fractionation of the heavy isotopes is observed during plant transpiration (Farquha et al., 2007; Allison et al, 1983; Zimmermann, Ehhalt and Munnich, 1967). Therefore, the most likely scenario for the relatively high levels of Cl ions in groundwater is the removal of water by transpiration of native vegetation prior to recharge.

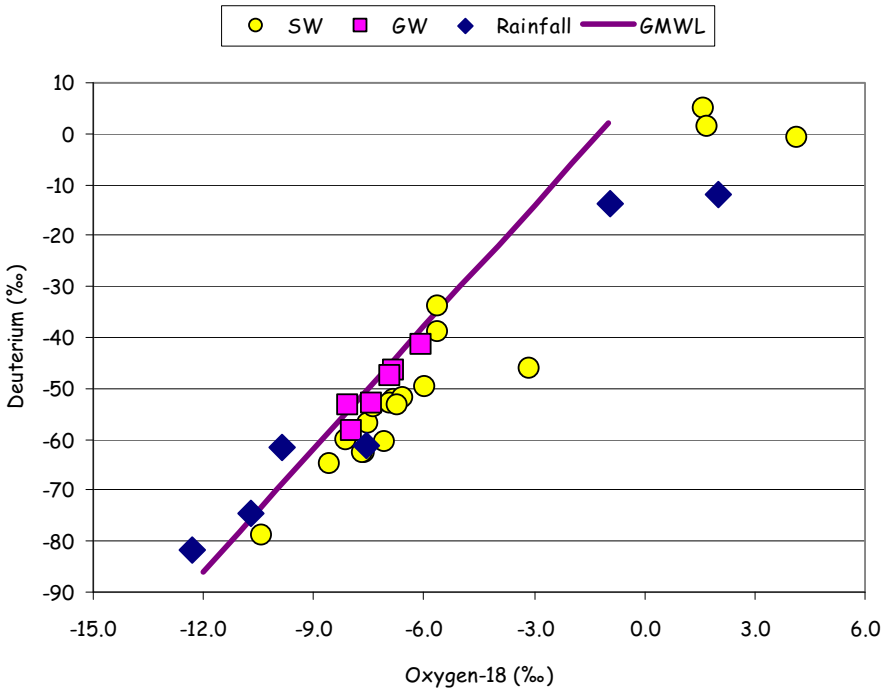

Figure 5 Oxgen-18 concentrations in surface water, groundwater and rainfall in the study area

2. The source of permanent water in Stuart pool

The Cl concentration in Stuart pool remains nearly constant throughout the year ranging from 19 mg/l in August 2009 to 25 mg/l in April 2009. The δ^2H values on the other hand, changes from enriched values of 5.1 ‰ in August 2008 to highly depleted values of -78 ‰ in April 2009 and more enriched values of -5.1 ‰ in August 2009 (Table 1). Deuterium concentration in groundwater at Hope Downs 4 is approximately -70 ‰ depleted compared to that measured in Stuart Pool in August 2008 and 2009. Therefore groundwater seepage is not the process that results in the variation in δ^2H values in Stuart Pool. Evaporation will result in enrichment of heavy isotopes and Cl concentration as is shown in Figure 6.

The calculated enrichment of the heavy isotope trend for the residual water in the pool includes the effects of vapour exchange flux and evaporation in maximum humidity of 35% measured at Hope Downs during the wet season. The model suggests that Cl concentration should increase to values of approximately 900 mg/l if the enrichment of δ^2H isotope were due to evaporation. The constant Cl concentration coupled with the enrichment in δ^2H signature of the pool in August 2009 compared to April 2009, suggests that evaporation is not the process resulting in enriched δ^2H. The only plausible explanation for the constant Cl and large

difference in deuterium concentration is that the water in Stuart Pool is derived entirely from the mixing of dry and wet season rainfall with no significant evaporative effect.

This hypothesis is corroborated by the results of stable isotope analysis of precipitation in the area showing that the isotopic signature of wet season rainfall (δ^2H ~ -60‰) is significantly depleted compared to dry season rainfall (δ^2H ~ -10‰) (Fig. 4). The summer wet season vapour flux is derived largely from the tropical Indian Ocean whereas; in winter the dry season vapour flux is originated from lower latitudes that are characterised by enriched stable isotopes (Yurtsever and Gat, 1981; Rozanski, et al., 1993); and the mixture of lower latitude and tropical band moisture sources may explain the comparably enriched stable isotope signatures observed within seasonal precipitation. The distinct isotopic signature of summer and winter in Stuart Pool is therefore a reflection of the distinct isotopic signature of summer and winter rainfall events.

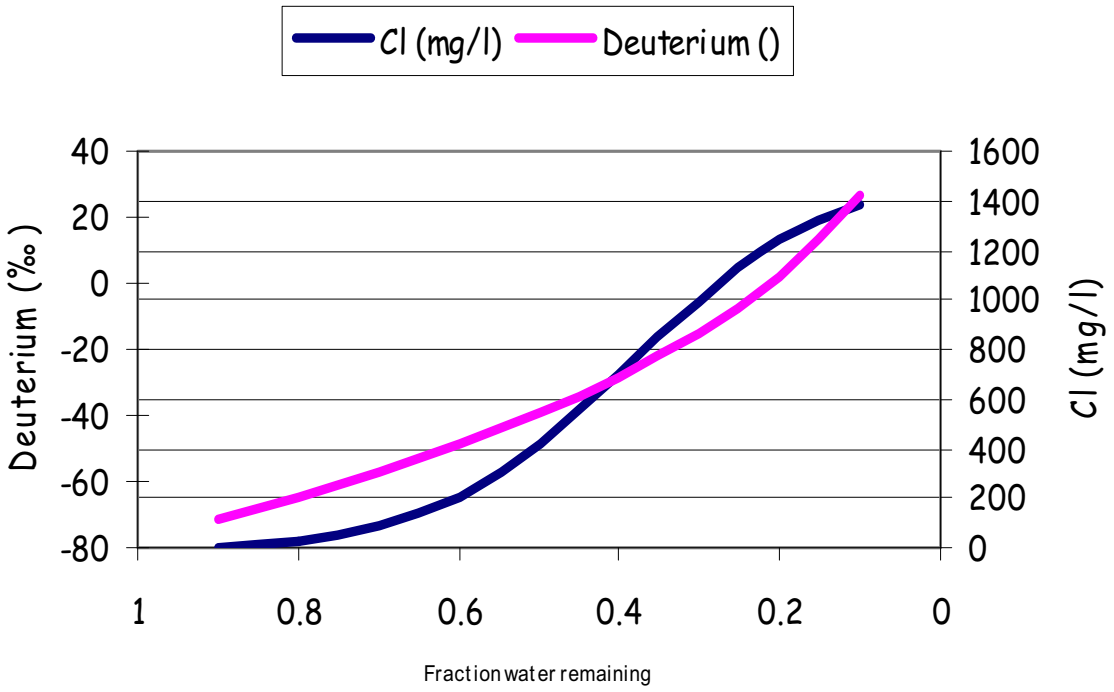

Figure 6 Calculated enrichment of deuterium (humidity 35%) according to Gonfiantini 1986 Model. The corresponding calculated increase in Cl concentration due to evaporation is plotted as a function of remaining water in Stuart Pool.

3. The source of permanent water pools in Coondiner Creek

The chloride concentrations in the permanent pools of Coondiner Creek up gradient and down gradient of Eagle Rock Falls show a similar trend in August 2008 and 2009 with a correlation coefficient of 0.96. Generally, the Cl concentrations are higher in 2009 particularly for the water pools up gradient from Eagle Rock Falls (HD4014).

The chloride concentrations for both sampling programs are plotted as a function of distance from the Fortescue Plain upstream to collection point HD4018. The results show a general decrease in Cl concentration along the creek axis (Fig. 7). The chloride concentration at the headwaters of the Creek at HD4018 is ~ 9 folds higher in August 2008 and 2009 than Cl concentration in the surface water pool at the mouth of Coondiner Creek (HD4001). The concentration of Cl at HD4031 is 40 mg/l and two folds higher than the underlying groundwater (22 mg/l) at HD4000 site.

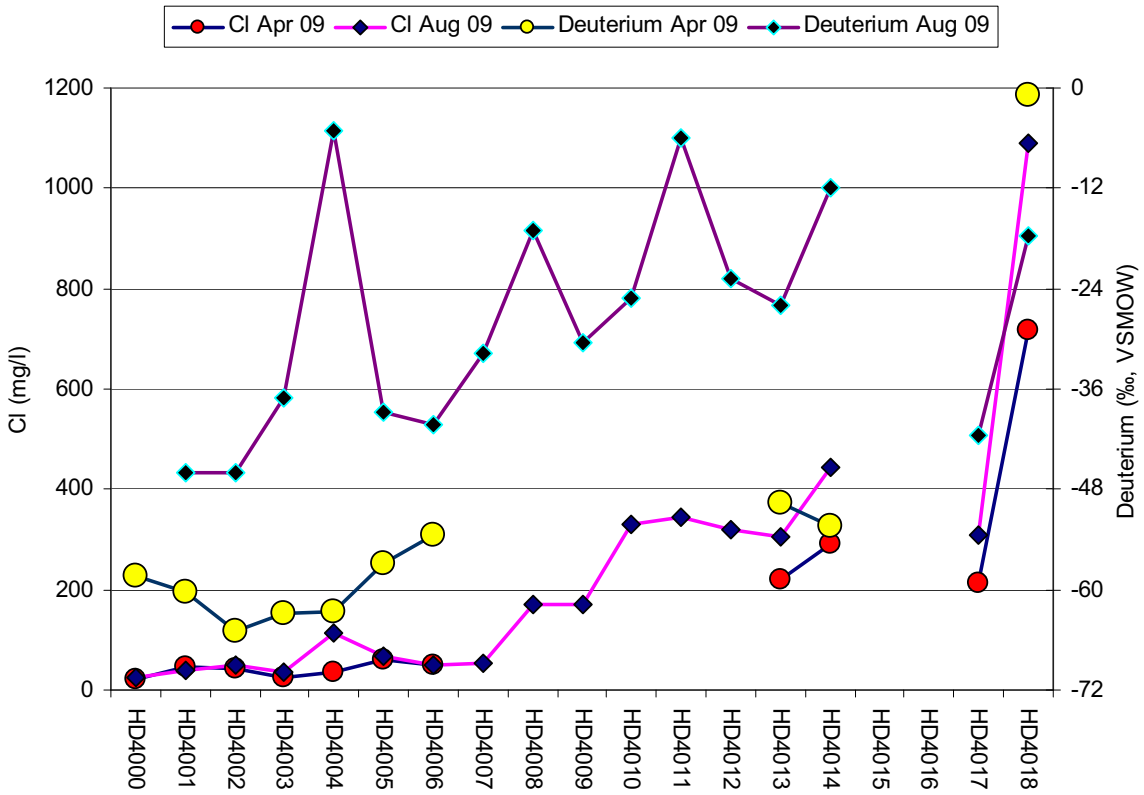

Figure 7 Chloride concentrations along Coondiner Creek. The data is organised from the mouth of Coondiner Creek up gradient to Eagle Rock Falls. The first water sample is taken from groundwater of Fortescue Fluvial Plan.

At the headwaters of the creek, the Cl concentration decrease by 5 fold along a distance of 800m between HD4018 (720 mg/l) and HD4017 (150 mg/l). The HD4018 pool water occurs in alluvium underlain by calcrete whereas HD4017 pool water occurs in the alluvial sediments underlain by Woongarra Volcanics.

The large difference in Cl concentration in the pools may be due to the different sources of groundwater water recharging the two pools. However, chloride concentrations of the groundwater sampled from these formations are different to that in the surface water pools. Chloride concentration in groundwater from the calcrete is 150mg/l and much lower than that measured HD4018 pool water. The Cl concentration measured in groundwater from Woongarra Volcanics on the other hand is 340 mg/l, and over two fold higher than that measured in HD4017 (Table 1).

The relatively lower Cl concentration in HD4017 compared to HD4018 pool water may be explained by mixing of base flow (720 mg/l) with a fresh end member (for example, rainfall). For water sampled from HD4018 to contribute to the down gradient HD4017 concentration via base flow would require considerable mixing with fresher water. The fresh water end member has to be rainfall because the Cl concentration in the underlying groundwater is 340 mg/l and higher than that in the HD4017 pool water (Table 1). Using the Cl concentration of rainfall of 0.5 mg/l as one end member (Table 2) and HD4018 of 720 mg/l as the second end member (Table 1), the result of Cl mass balance calculation suggests that only 20% of water in the HD4017 could be derived from base flow from HD4018 pool water.

The approximately five fold increase in Cl concentration at HD4018 pool from that of groundwater may be explained by seepage of groundwater followed by evaporation. Evaporation also results in enrichment in stable isotope composition of the pool water. The rate of increase of Cl by evaporation can be calculated by comparing δ^2H composition of groundwater and that of pool water in HD4018. This was carried out using the evaporation model developed by Gonfiantini (1986) and measured minimum and maximum humidity at the study site of 30% and 70%. The calculated enrichment of δ^2H is about 0.75 ‰ per 1 % evaporation loss in surface waters. Using measured δ^2H values for calcrete groundwater of – 41.3 ‰ (Table 1), and calculated water loss by evaporation of 80 %, the amount of evaporation causes enrichment in δ^2H of ~ 60 ‰ (80 * 0.75 = 60 ‰).

Accordingly the measured δ^2H of the HD4018 would be 19 ‰. The measured δ^2H value in April and August 2009 are of – 0.95‰ and -17.8 respectively (Table 1) and are much more depleted compared to the calculated values. Therefore, 80% evaporation loss measured for HD4018 pool water is not a plausible process to account for the increase in Cl concentration from that of groundwater. In addition, the seepage of groundwater and subsequent evaporation is not possible because the Cl concentration in groundwater underlying HD4017 pool (800 m down gradient) is 340 mg/l and higher compared to the pool water. The only plausible scenario to explain the high Cl concentration and relatively depleted δ^2H of -17.9‰ is the seepage of groundwater and partial concentration of chloride via evapotranspiration by vegetation surrounding this pool.

Down gradient of HD4017, the chloride concentration increases again from 150 mg/l in HD4016 pool to 690 mg/l in the next pool (HD4015). This apparent increase may be caused by the seepage from Woongarra Volcanics outcrop (HD4021) that occurs adjacent to the pool and characterised by the highest Cl concentration measured (1100 mg/l) in the study area. The high chloride concentration is due to evaporation of seepage from the outcrop at the edge of the pool.

The chloride concentration along the creek decreases again to 260mg/L at Eagle Rock Falls (HD4014). Beyond this sampling point the water in the next three down gradient pools is gradually diluted by the influx of less saline water. The chloride concentration then stabilises with a narrow variation of ± 50 mg/l. HD4001 which occurs at the mouth of the Coondiner Creek before entering into the fluvial plan of Fortescue Valley has the second lowest concentration of 48mg/l measured at site. The groundwater of the Fortescue valley (HD4000) is characterised by the lowest

chloride concentration recorded along the axis of Coondiner Creek of 22 mg/l (Table 1).

The systematic decrease in Cl concentration along the axis of the creek from >1000 mg/l to 40 mg/l in August suggests the occurrence of dilution. The pools located down gradient from Eagle Rock Falls are characterised by lower Cl concentration compared to groundwater, therefore groundwater is not the source for the fresh end member. The near identical Cl concentrations coupled with highly enriched deuterium concentration in August 2009 samples precludes evaporation being the dominant process. The most likely process is the mixing of dry season rainfall that is enriched in deuterium with remnants of evaporated water from wet season rainfall.

If we assume a conservative Cl concentration value for the fresh end member of 50 mg/l of Cl, the results suggest that most of the water in the surface pools down stream of HD4009 is generated from the fresh end member, and the contribution of the saline end member (Eagle Rock Falls) water beyond HD4009 is minimal. Regardless of the source of the fresh end member, the water chemistry indicates that the base flow contribution to the over all water budget of the creek beyond HD40013 is very small.

8. Chemical and isotopic evolution of Surface water pools

The evolution of the surface water chemistry and isotope composition was modelled by combining the binary mixing (Toth and Katz, 2006) and Rayleigh distillation model (Fig. 8). The end members for the binary mixing model are, firstly rainfall from dry season, which is characterised by relatively low Cl concentration and enriched δ^2H composition, and secondly, rainfall from the wet season that also exhibits low Cl but has a depleted δ^2H composition.

The stable isotope and Cl concentration data from most of the surface water pools fall along the horizontal rainfall mixing line (black dashed line) between these two end members (Fig. 8). The Cl and isotopic concentration of these pools are therefore a result of mixing of rainfall with minimal subsequent evaporation. There are however a number of pools that exhibit an increased Cl concentration above the rainfall threshold. These pools show the influence of evapo-concentration, that also results in a relatively enriched isotopic composition.

The enrichment of stable isotopes depends on the fraction of water lost from each pool according to the Rayleigh distillation model. The various lines emanating from the binary mixing line represent the modelled evolution of isotopic signature, with initial concentration determined by the ration of mixing between two isotopically contrasting rainfall events. Theoretically there will be infinite numbers of mixing lines of which only four are depicted in figure 8.

The dashed straight lines illustrate mixing between an evaporated pool with a later rainfall event. Each line represents 100% mixing between these two end-members, therefore an equal proportion of each member will result in a data point halfway along the line. The lines could also theoretically be attached to an infinite number of

locations along the evaporation curve. It should be noted that the fraction of water remaining axis relates only to evaporation processes and not straight line mixing.

Most of the surface water data sampled in August falls on the evaporation line emanating from a 50% mixing ratio point on the horizontal mixing model. This suggests that summer rainfall mixes with winter rainfall and then is subsequently evaporated during the summer months.

These lines combine to create a theoretical boundary for which all pools in the area should fall, if they are sourced entirely from local rainfall. Any sample that falls out of this zone indicates an external source or additional processes such as mixing with water which is characterised by relatively higher chloride concentrations (groundwater for example). The outlier in Figure 8 is the data from HD4018 pool that is characterised by the highest Cl concentration but not the most enriched δ^2H value. The only model that can produce this signature is mixing of groundwater and surface water followed by evapotranspiration by vegetation around the pool.

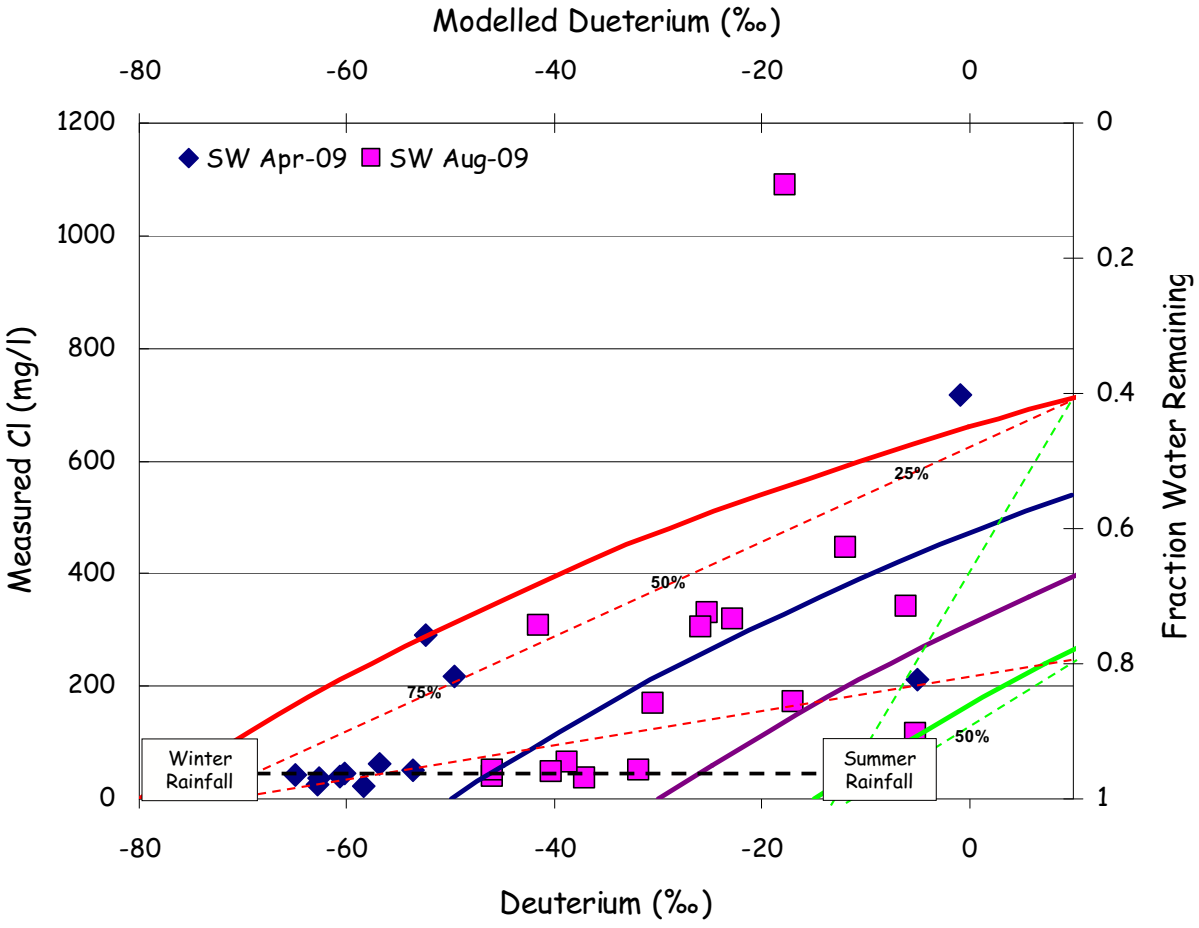

Figure 8 Chloride and deuterium concentrations along Coondiner Creek measured in April and August 2009. The mixing between wet and dry season rainfall is shown as horizontal binary mixing line. The evaporation is modelled for various mixing ratios based on Rayleigh distillation equation. Note that most of the April data fall close to wet season isotopic signature.

9. Conclusions

Understanding the potential contribution of groundwater to the surface water budget of environmentally sensitive ecosystems in the region is a prerequisite for sustainable development of below water table mining in the region. The distinct isotopic signature of summer and winter rainfall in the area is reflected in the isotopic signature of surface water and groundwater. The isotopic signature of permanent surface water of Stuart Pool and groundwater in the region shows that while the surface water pool can provide a reasonably good proxy for the event based precipitation; the isotopic signature of groundwater reflects the long term mean signature of wet season rainfall. Quite simply, larger wet season rainfall, and by inference greater recharge, are associated with the more depleted wet season stable isotope signature.

The chemical evaluation model combining binary mixing and evaporation according to Rayleigh distillation model can accurately predict the Cl concentrations and stable isotope composition of the surface water pools in Hope Downs 4 area.

Ultimately, the application of the model developed in this study may prove an invaluable tool in identifying the sources of water in permanent pools that are ubiquitous in the Hamersley basin region.

9. Acknowledgment

We thank Dr Grzegorz Skrzypek from West Australian Biogeochemistry Centre (John de Later Centre), The University of Western Australia for measurements of δ^2H and δ^{18}O. We also thank the technical input and logistic support provided by Mr Sim Mathwin from Rio Tinto Iron Ore.

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Appendix 3
Short range endemics: survey results from WA Museum

ADDENDUM

THE SHORT RANGE ENDEMIC INVERTEBRATE FAUNA

RECORDED DURING THE SECOND SAMPLING PERIOD

WITHIN THE

PROPOSED HOPE DOWNS 4 PROJECT AREA,

OPTION 6 INFRASTRUCTURE CORRIDOR,

NEAR NEWMAN, WESTERN AUSTRALIA

Prepared for: Mattiske Consulting Pty Ltd

on behalf of Pilbara Iron Company (Services) Pty Ltd

Prepared by: Ninox Wildlife Consulting

January 2010

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ATTACHMENT 1

The Short-Range Endemic Invertebrate Fauna of Hope Downs 4 (Hamersley Range, 60km WNW Newman), Western Australia. Report to Ninox Wildlife Consulting. September 2009.

Volker W. Framenau and Mark S. Harvey. Department of Terrestrial Invertebrates, Western Australian Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia.

ATTACHMENT 2

Report to Ninox Wildlife Consulting. Land Snails from the area of Hope Downs, Western Australia collected by Ninox Wildlife Consulting during April, 2009.

Shirley Slack-Smith and Corey Whisson, December 2009. Department of Aquatic Zoology (Molluscs), Western Australian Museum. Locked Bag 49, Welshpool DC, Western Australia 6986.

1 INTRODUCTION

Two surveys of the proposed Hope Downs 4 Option 6 Infrastructure Corridor (Option 6 IC) were undertaken by Ninox Wildlife Consulting during September 2008 and April 2009 in order to sample short range endemic (SRE) invertebrate species that could occur within the habitats present along this corridor. The results of the spring survey were presented in Ninox Wildlife Consulting (2009a). The results of the second survey, which was conducted between 22nd and 27th April 2009 inclusive, are presented in this Addendum.

The short-range endemic invertebrate fauna of the region was assessed by examination of mygalomorph spiders, millipedes, pseudoscorpions and scorpions collected by staff from Ninox Wildlife Consulting, preserved in ethanol and submitted to the Western Australian Museum for identification on 3rd June 2009 (WAM Acc. No. A6608). The specimens were examined using a Leica dissecting microscope (MZ16) and an Olympus compound microscope (BH-2).

Samples of snail specimens collected during the April 2009 survey were presented for identification and comment to the Department of Aquatic Zoology (Mollusc Section), Western Australian Museum on 3rd June 2009 (WAM Accession No. A6206). The snail specimens were examined and sorted under a Leica MZ95 dissecting microscope, and compared with descriptions and figures in relevant publications and with dry and preserved specimens in the Mollusc Collections of the Western Australian Museum.

The two reports prepared by the Western Australian Museum on the specimens collected during April 2009 are presented as Attachments to this Addendum.

2 METHODS

All of the methods used during the SRE sampling are provided in Ninox Wildlife Consulting (2009a); however, they have been reproduced in this current document for ease of reference.

Prior to the field survey, discussions were held with Dr Mark Harvey and Ms Shirley Slack-Smith of the Western Australian Museum (WAM) in order to identify the target group of potential short range endemic invertebrate taxa in the total Hope Downs 4 project area (Hope Downs 4 mine and village area, Option 1 and Option 6 Infrastructure Corridors). The following groups were identified for targeted sampling:

- mygalomorph spiders
- myriopods (particularly millipedes)
- scorpions
- pseudoscorpions
- terrestrial molluscs (and aquatic if suitable habitat located)

The invertebrate survey ran concurrently with vertebrate sampling along the Option 6 IC during April 2009. Each of the six vertebrate fauna trapping sites within the Option 6 IC was searched systematically by two personnel over a period of five days during both September 2008 and April 2009. Descriptions of these sites are given in Ninox Wildlife Consulting (2009a) which also details the results of the September 2008 survey. Following this systematic collecting in April 2009, a range of other, opportunistic sites were also sampled in various habitats (OP1 to OP3) and in the vicinity of permanent water (OP6). Table 1 shows the type of sampling and duration within each vertebrate fauna trapping site. Brief descriptions are given for the four opportunistic sites following this table.

Search techniques included:

- intensive ground searches;
- digging and collection of mygalomorph spiders;
- hand searching of various microhabitats;
- searching under various suitable vegetation, rocks, bark etc;
- searching through vegetation litter and soils.

At the end of each survey period litter samples were collected from each of the vertebrate fauna trapping sites. Approximately 500ml of leaf litter and surface soils was collected and returned to the Perth laboratory for sorting. Litter and soil were sieved and then spread in a thin layer in a petridish and examined with a stereo microscope for micro specimens of the target taxa.

In addition, each day during the vertebrate fauna pitfall trap inspections a check was done for the invertebrate SRE 'bycatch'.

Table 1 Total sampling time and location of SRE search sites along the Option 6 IC.

Site Number	GPS GDA94 (50K)		Time - hours	Soil & Litter Sorting (minutes)
	mE	mN		
Systematic Sites				
HD11	734 735	7 443 405	27	180
HD12	734 735	7 442 870	27	180
HD13	733 520	7 443 170	27	180
HD14a & b	726 260 725 915	7 444 643 7 444 510	30.5	270
HD15	724 120	7 444 635	22	180
HD16	722 405	7 444 710	21	180
Opportunistic Sites				
OP1	725 590	7 444 225	6	90
OP2	725 325	7 444 725	7	90
OP3	721 360	7 445 100	10	90
OP6	720 915	7 448 225	10	90

OP1: tall Mulga shrubland to 4m over emergent *Eucalyptus* and occasional *Eremophila* to 1m over spinifex on ironstone float on hardpan.

OP2: spinifex rise with bands of *Melaleuca* shrubs to 2.5m in narrow rocky gullies with scattered emergent *Eucalyptus* on stony float on residual soils and rocky outcrops on ridges.

OP3: occasional *Eucalyptus* to 5m over sparse shrubs to 1m over small spinifex clumps with scree on rocky slopes.

OP6: open woodland of *Eucalyptus victrix, Eucalyptus camaldulensis* var. *obtusa, Melaleuca argentea* over *Cyperus vaginatus* on Weeli Wolli Creek, with permanent pool and sandy soils.

At the end of each day during both surveys SRE field staff sorted the day's capture into groups and prepared the specimens to the requirements of the WAM.

Details of weather conditions experienced during the April 2009 sampling session provided below.

Table 2 Minima and maxima temperatures and rainfall experienced during the fauna survey of the Option 6 IC in April 2009.

Date	21 April	22 April	23 April	24 April	25 April	26 April	27 April
Min	20.9	25.5	18.5	11.6	9.2	10.5	15.3
Max	33.5	31.7	28.0	26.3	27.9	29.4	29.7
Rainfall	0	0	0.6	0	0	0	0

3 RESULTS

The samples from Hope Downs 4 (Option 6 IC) submitted to the Western Australian Museum on 3rd June 2009 (WAM Acc. No. A6608) included mygalomorph spiders from two different families (Barychelidae: *Idiommata*; Idiopidae: *Aganippe*), olpiid pseudoscorpions (?*Austrohorus*, *Beierolpium, Euryolpium*), two different scorpion species in the genus *Lychas* (Buthidae) and a pachybolid millipede (*Austrostrophus*).
Whilst some of the pseudoscorpions (e.g. those in the genus *Beierolpium*) may represent short-range endemic species, poor taxonomic knowledge of this group in Australia does not allow an interpretation of their conservation status.

The specimens in the mollusc samples belong to the terrestrial snail families Bulimulidae; Pupillidae and Subulinidae. Species identifications are necessarily based, both in this instance and in previous examinations of survey material, exclusively on external shell characters that, in these families, may vary only slightly within a genus. All of the species identified from this survey are considered to form part of the indigenous Western Australian fauna. An undescribed species of *Bothriembryon was* also represented in the collection.

Table 3 summarises the results presented in Attachment 1 and 2.

Table 3 Summary table of results of the collection of potential SRE fauna from the Option 6 IC during April 2009. (HD site numbers correspond to those described in Ninox Wildlife Consulting [2009a, b and c].)

Family	Genus	Species	Site	SRE	Notes
Spiders					
Barychelidae	*Idiommata*	`MYG111`	HD11		
Barychelidae	*Idiommata*	`MYG111`	HD15		
Idiopidae	*Aganippe*	`sp. (female)`	OP2		
Pseudoscorpions					
Olpiidae	*`Austrohorus?`*		HD14a		
Olpiidae	*Eryolpium*		OP3		
Olpiidae	*Eryolpium*		OP3		
Olpiidae	*Beierolpium*	`sp. 8/4 (small)`	OP1	?X	Also collected from site HD08 (Option 1 IC) & HD03 (HD4 mining area)
Olpiidae	*Beierolpium*	`sp. 8/4 (small)`	OP3	?X	
Olpiidae	*Beierolpium*	`sp. 8/4 (large)`	HD14a	?X	
Olpiidae	*Beierolpium*	`sp. 8/4 (small)`	HD16	?X	
Olpiidae	*Beierolpium*	`sp. 8/4 (large)`	OP2	?X	

Family	Genus	Species	Site	SRE	Notes
Scorpions					
Buthidae	*Lychas*	*`multipunctatus`*	HD15		
Buthidae	*Lychas*	*`multipunctatus`*	HD15		
Buthidae	*Lychas*	*`multipunctatus`*	HD14b		
Buthidae	*Lychas*	*`multipunctatus`*	HD14b		
Buthidae	*Lychas*	*`multipunctatus`*	HD12		
Buthidae	*Lychas*	*`pilbara 1`*	HD15		
Buthidae	*Lychas*	*`pilbara 1`*	HD15		
Millipedes					
Pachybolidae	*Austrostrophus*	*stictopygus*	HD14a		
Pachybolidae	*Austrostrophus*	*stictopygus*	HD12		
Pachybolidae	*Austrostrophus*	*stictopygus*	HD11		
Pachybolidae	*Austrostrophus*	*stictopygus*	HD11		
Pachybolidae	*Austrostrophus*	*stictopygus*	HD12		
Snails					
Bulimulidae	*Bothriembryon*	sp.	HD14a	?X	Also collected from site HD10 (Option 1 IC) & site HD03 (HD4 mining area)
Bulimulidae	*Bothriembryon*	sp.	HD14a	?X	
Subulinidae	*Eremopeas*	*interioris*	HD14a		
Subulinidae	*Eremopeas*	*interioris*	HD15		
Subulinidae	*Eremopeas*	*interioris*	OP3		
Pupillidae	*Gastrocopta*	*mussoni*	HD11		
Pupillidae	*Gastrocopta*	*mussoni*	OP6		
Pupillidae	*Gastrocopta*	sp. c.f. *hedleyi*	HD11		
Pupillidae	*Gastrocopta*	sp. c.f. *hedleyi*	OP1		
Pupillidae	*Gastrocopta*	sp. c.f. *hedleyi*	OP3		
Pupillidae	*Gastrocopta*	sp. c.f. *mussoni*	HD15		
Pupillidae	*Gastrocopta*	sp. c.f. *mussoni*	OP3		
Pupillidae	*Gastrocopta.*	sp.	HD14b		
Pupillidae	*Gastrocopta*	sp.	OP2		
Pupillidae	*Gastrocopta*	sp. juv.	HD14a		
Pupillidae	*Gastrocopta*	sp. juv.	HD14b		
Pupillidae	*Gastrocopta*	sp. juv.	HD15		
Pupillidae	*Gastrocopta*	sp. juv.	OP6		
Pupillidae	*Gastrocopta*	sp. juv.	OP6		
Pupillidae	*Gastrocopta*	sp. juv.	OP1		
Pupillidae	*Gastrocopta*	sp. juv.	OP3		
Pupillidae	*Pupoides*	*pacificus*	OP6		
Pupillidae	*Pupoides*	*beltianus*	OP6		
Pupillidae	*Pupoides*	sp. c.f. *beltianus*	HD14b		

3.1 Spiders

The trapdoor spiders *Idiommata* "MYG111" are not considered to be SRE species as they have been collected from other areas in the Pilbara region. The genus *Aganippe* is common throughout Western Australia and 14 species are described from Australia while many new species await description. Examination of male genitalia is required for accurate species identification; unfortunately the specimen collected at Hope Downs was a mature female and it is therefore not possible to determine if this species represents a short-range endemic. It is recommended that a male specimen is obtained from the collection site of the female.

3.2 Pseudoscorpions

The pseudoscorpion fauna of Hope Downs 4 Option 6 IC was found to consist of several species in three genera of Olpiidae (Atemnidae). Based on current levels of knowledge, the Western Australian Museum cannot determine whether any of these are SREs although it is possible that the genus *Beierolpium* may represent one. While not recorded during the September 2008 survey of the Option 6 IC (Ninox Wildlife Consulting 2009a) this genus was collected from five sites during this later assessment. One specimen was also collected in site HD08 (an open Mulga woodland) along the Option 1 IC which was surveyed in May 2008 (Ninox Wildlife Consulting 2009b). Another specimen was collected from a small gully within site HD03 (the top of a small rocky range) during the assessment of the proposed HD4 mining area (Ninox Wildlife Consulting 2009c).

3.3 Scorpions

None of the scorpion species collected was identified as an SRE.

3.4 Millipedes

The single species of millipede collected during April 2009 did not represent an SRE.

3.5 Snails

The terrestrial snail species submitted from this survey belong to the range of species previously encountered, but were collected from over a wider range of habitats.

The wide spatial range of collecting sites indicates that the smaller species belonging to the families Pupillidae and Subulinidae are, as formerly expected, widely distributed through the area and so could not be regarded as exhibiting short range endemicity. As the Western Australian Museum did not carry out the field survey, they have stated that they have no way of evaluating the relationship of the molluscan taxa to the total of available habitats.

The Western Australian Museum states that the absence of data on the spatial relationship between the collecting sites at which the undescribed *Bothriembryon* species has been found, and the boundaries of the leased area(s) within which the development is proposed, precludes any comment upon the possible effect of any disturbance on the population/populations of this species in the Hope Downs 4 Option 6 IC area. However, this undescribed snail has been collected at site HD08 along the Option 1 IC (Ninox

Wildlife Consulting 2009b) approximately 5 km ENE of site HD14a, and site HD03 within the proposed Hope Downs 4 (HD4) mining area (Ninox Wildlife Consulting 200c), some 40 km east of site HD14a. These sites represent a wide range of habitats and geographical distribution within the total HD4 project area.

4 CONCLUSIONS

Given that only one of the two potential infrastructure corridors (Option 1 and Option 6) will be developed, and that the potential SRE species of pseudoscorpion and snail occur in a range of habitats within both options, it is unlikely that there will be any major impact on the status of these animals when one of the infrastructure corridors is developed.

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ATTACHMENT 1

The Short-Range Endemic Invertebrate Fauna of Hope Downs 4 (Hamersley Range, 60km WNW Newman), Western Australia

Report to Ninox Wildlife Consulting
September 2009

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Summary

The samples from Hope Downs 4 submitted to the Western Australian Museum on 3rd June 2009 (WAM Acc. No. A6608) included mygalomorph spiders in two different families (Barychelidae: *Idiommata*; Idiopidae: *Aganippe*), olpiid pseudoscorpions (?*Austrohorus*, *Beierolpium, Euryolpium*), two different scorpion species in the genus *Lychas* (Buthidae) and a pachybolid millipede (*Austrostrophus*).

Whilst some of the pseudoscorpions (e.g. in the genus *Beierolpium*) may represent short-range endemic species, poor taxonomic knowledge of this group in Australia does not allow an interpretation of its conservation status.

Short-Range Endemism

The terrestrial invertebrate fauna of inland Australia contains a plethora of species, and just the arthropods were recently estimated to consist of more than 250,000 species (Yeates *et al.* 2004). The vast majority of these are found within the Insecta and Arachnida, although significant numbers of millipedes are to be expected. For many years, the prospect of including invertebrates in assessments of biological systems subject to alteration proved daunting, and were largely ignored as being too diverse and too difficult to comprehend to satisfy the rapid turn-around needed for environmental surveys.

In a recent publication, the issue of Short-Range Endemism in the Australian invertebrate fauna was examined (Harvey 2002b), and series of major groups were nominated as having a very high proportion of individual species that satisfied a certain set of criteria. The main criterion nominated for inclusion as a Short-Range Endemic (SRE) was that the species had a naturally small range of less than 10,000 km^2. Harvey (2002b) found that those species possessed a series of ecological and life-history traits, including:

- poor powers of dispersal;
- confinement to discontinuous habitats;
- usually highly seasonal, only active during cooler, wetter periods; and
- low levels of fecundity.

The Western Australian fauna contains a number of SRE taxa, including millipedes, land snails, trap-door spiders, some pseudoscorpions, slaters, and onychophorans and these represent focal groups of Environmental Impact Assessments in the state (EPA 2009). The south coast region is relatively well known compared with other regions of the state (Framenau *et al.* 2008) but there are many poorly known species and gaps in our understanding of the distributions of many species.

The Hope Downs 4 region

The short-range endemic fauna of the region was assessed by examination of mygalomorph spiders, millipedes, pseudoscorpions and scorpions collected by staff from Ninox Wildlife Consulting, preserved in ethanol and submitted to the Western Australian Museum for identification. The specimens were examined using a Leica dissecting microscope (MZ16) and an Olympus compound microscope (BH-2).

ARANEAE (SPIDERS)

Infraorder Mygalomorphae (Trapdoor Spiders)

Mygalomorph ("trapdoor") spiders belong to one of the focal groups in surveys of short-range endemic taxa (Harvey 2002a). Many mygalomorph spiders show low dispersal capabilities, may be restricted to relictual habitats, and have long life cycles with low fecundity. A number of mygalomorph spiders, e.g. *Aganippe castellum*, *Idiosoma nigrum*, *Kwonkan eboracum*, and *Moggidgea tingle*, are listed on Schedule 1 ("Fauna that is rare or likely to become extinct" of the Wildlife Conservation (Specially Protected Fauna) Notice 2008 of the Western Australian Government. The Western Australian mygalomorph fauna is vast and, despite long-term and ongoing research by Drs Barbara Main (University of Western Australia) and Robert Raven (Queensland Museum), remains taxonomically poorly known for many families and genera (e.g. Barychelidae: *Idiommata*; Idiopidae: *Aganippe*; Nemesiidae: *Aname*, *Chenistonia*, *Kwonkan*).
The best taxonomic features to distinguish mygalomorph spiders are found within the genitalia of males. Females or juveniles may be indistinguishable, although burrow morphology may allow identification to species level in some cases (B.Y. Main, personal communication). The Western Australian Museum has recently initiated a **reference collection of male mygalomorph morphospecies** to facilitate an assessment of distribution patterns of these spiders. This collection is assembled in cooperation with Dr Barbara Main and will eventually be consolidated with her collection at the University of Western Australia. Mygalomorph morphospecies are consecutively numbered ("MYG001", "MYG002" etc.) to allow a comparison of taxa between different surveys.

Idiommata sp. 'MYG111' (family Barychelidae)

Members of the Barychelidae, the "Brush-footed Trapdoor Spiders" are cryptic spiders. Their burrow often lacks the firm and thick door of the Idiopidae or the extensive web of the Dipluridae (Raven 1994). *Idiommata* are distinguished from other Australian barychelid genera by very dense scopula on the legs, paired claws half the size of the claw tufts, and the presence of a distinct lyra (15-120 clavate setae) on the maxillae in most species. The genus includes the largest barychelids in Western Australia and is known mostly from xeric areas; however, it also occurs in rainforests throughout Australia (Raven 1994). The genus currently includes four Australian species but many undescribed species do exist. It was not treated in the most recent monograph of Australian Barychelidae (Raven 1994).
Idiommata "MYG111" has been reported from other areas in the Pilbara and is currently not considered a short-range endemic species.

***Aganippe* sp. (female) (family Idiopidae)**

The idiopid genus *Aganippe* is common throughout Western Australia. Fourteen species are described from Australia and many new species await description (Main 1985). Examination of male genitalia is required for accurate species identification, however the specimen collected at Hope Downs was a mature female. It is therefore not possible to determine if this species represents a short-range endemic and it is recommended to obtain a male specimen from the collection site of the female.

PSEUDOSCORPIONS

The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats. The pseudoscorpion fauna of Hope Downs 4 was found to consist of several species in three genera of Olpiidae (Atemnidae) (Appendix 1).

***Austrohorus?* sp. (family Olpiidae)**

A single female from Hope Downs 4 was tentatively placed into *Austrohorus*. Based on our current levels of knowledge, it is not possible to state whether this specimen represents a short-range endemic species.

***Beierolpium* 'sp. 8/4 (small)' (family Olpiidae)**

A single species of the genus *Beierolpium* was collected at Hope Downs 4 (Appendix 1). The systematic status of members of this genus in the Pilbara has not been fully assessed. At present it is not possible to firmly establish the identity of the species until a complete systematic revision of the Western Australian members of *Beierolpium* is undertaken. It is possible that the specimens represent short-range endemic species, but a full taxonomic revision of the genus *Beierolpium* in the Pilbara region, and other regions of WA, is necessary to confirm their status.

***Euryolpium* sp. (family Olpiidae)**

Species of *Euryolpium* are commonly found under bark and under rocks throughout northern Australia. They can be locally abundant, and at least one species is quite widespread across northern Australia, including Hope Downs 4 (Appendix 1). Based on our current levels of knowledge, it appears that this species is not a short-range endemic species.

SCORPIONS.

***Lychas* '*multipunctatus*' Volschenk, in press (family Buthidae)**

A number of mature males and females of *Lychas* '*multipunctatus*' were found at Hope Downs 4 (Appendix 1). This species is widespread throughout the Pilbara and Kimberley region of Western Australia. Within the Pilbara, it also occurs in the Hamersley Ranges and Barrow Island. It is not a short-range endemic species.

***Lychas* '*pilbara 1*` Volschenk, in press (family Buthidae)**

Two specimens of *Lychas 'pilbara 1'* were found at Hope Downs 4 (Appendix 1). This species has been found at a number of occasions throughout the Pilbara region of Western Australia. It does not represent a short-range endemic species (E.S. Volschenk, personal communication).

MILLIPEDES

Order Spirobolida

***Austrostrophus stictopygus* (family Pachybolidae)**

The samples Hope Downs 4 included a number of specimens of the pachybolid millipede *Austrostrophus stictopygus* (Appendix 1). Following its original description (Hoffman 2003), *A. stictopygus* has been shown to be fairly widespread throughout the Pilbara region of Western Australia. It is not considered a short-range endemic species.

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Appendix 1. Terrestrial Invertebrates from Hope Downs 4 (Hamersley Range, 60km WNW Newman)

REGNO	FLDNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	LATITUDE	LONGITUDE	NO.
97350	HD4-11-1sp	Arachnida	Araneae	Barychelidae	*Idiommata*	`MYG111`	23°06`11.1"S	119°17`30.4"E	1
97351	HD4-15-1sp	Arachnida	Araneae	Barychelidae	*Idiommata*	`MYG111`	23°05`31.1"S	119°11`15.7"E	1
97352	HD4-opp.2-1sp	Arachnida	Araneae	Idiopidae	*Aganippe*	`sp. (female)`	23°05`27.1"S	119°11`59.3"E	1
97358	HD4-14a-2ps	Arachnida	Pseudoscorpiones	Olpiidae	*`Austrohorus?`*		23°05`29.0"S	119°12`32.3"E	1
97359	HD4-opp.3-2ps	Arachnida	Pseudoscorpiones	Olpiidae	*Eryolpium*		23°05`16.9"S	119°09`39.7"E	1
97360	HD4-opp.3-1ps	Arachnida	Pseudoscorpiones	Olpiidae	*Eryolpium*		23°05`16.9"S	119°09`39.7"E	1
97361	HD4-opp.1-1ps	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/4 (small)`	23°05`43.0"S	119°12`08.8"E	1
97362	HD4-opp.3-3ps	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/4 (small)`	23°05`16.9"S	119°09`39.7"E	1
97363	HD4-14a-1ps	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/4 (large)`	23°05`29.0"S	119°12`32.3"E	3
97364	HD4-16-2ps	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/4 (small)`	23°05`28.7"S	119°10`16.7"E	1
97365	HD4-opp.2-1ps	Arachnida	Pseudoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/4 (large)`	23°05`27.1"S	119°11`59.3"E	2
97366	HD4-15-3sc	Arachnida	Scorpiones	Buthidae	*Lychas*	*`multipunctatus`*	23°05`31.1"S	119°11`15.7"E	1
97367	HD4-15-4sc	Arachnida	Scorpiones	Buthidae	*Lychas*	*`multipunctatus`*	23°05`31.1"S	119°11`15.7"E	1
97372	HD4-14b-1sc	Arachnida	Scorpiones	Buthidae	*Lychas*	*`multipunctatus`*	23°05`33.2"S	119°12`21.3"E	1
97369	HD4-14b-2sc	Arachnida	Scorpiones	Buthidae	*Lychas*	*`multipunctatus`*	23°05`33.2"S	119°12`21.3"E	1
97370	HD4-12-1sc	Arachnida	Scorpiones	Buthidae	*Lychas*	*`multipunctatus`*	23°06`20.0"S	119°17`30.7"E	1
97371	HD4-15-2sc	Arachnida	Scorpiones	Buthidae	*Lychas*	*`pilbara 1`*	23°05`31.1"S	119°11`15.7"E	1
97368	HD4-15-1sc	Arachnida	Scorpiones	Buthidae	*Lychas*	*`pilbara 1`*	23°05`31.1"S	119°11`15.7"E	1
97353	HD4-14a-1m	Diplopoda	Spirobolida	Pachybolidae	*Austrostrophus*	*stictopygus*	23°05`29.0"S	119°12`32.3"E	1
97354	HD4-12-1m	Diplopoda	Spirobolida	Pachybolidae	*Austrostrophus*	*stictopygus*	23°06`20.0"S	119°17`30.7"E	2
97355	HD4-11-1m	Diplopoda	Spirobolida	Pachybolidae	*Austrostrophus*	*stictopygus*	23°06`11.1"S	119°17`30.4"E	1
97356	HD4-11-2m	Diplopoda	Spirobolida	Pachybolidae	*Austrostrophus*	*stictopygus*	23°06`11.1"S	119°17`30.4"E	1
97357	HD4-12-2m	Diplopoda	Spirobolida	Pachybolidae	*Austrostrophus*	*stictopygus*	23°06`20.0"S	119°17`30.7"E	1

ATTACHMENT 2

Report to *Ninox Wildlife Consulting*

Land Snails from the area of Hope Downs, Western Australia

collected by *Ninox Wildlife Consulting* during April, 2009

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November 2009

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Background

Samples of snail specimens, collected by staff of the environmental consultancy company, *Ninox Wildlife Consulting*, were presented for identification and comment to the Department of Aquatic Zoology (Mollusc Section), Western Australian Museum on June 3, 2009 (WAM Accession No. A6206).

The samples had been collected at a number of sites during a short-range endemic survey of the *Hope Downs 4* area, approximately 100 kilometres north-west of Newman in the Pilbara area of WA. This follows earlier surveys (March 2008, May 2008 and September 2008) of this area by *Ninox Wildlife Consulting (*see Whisson and Slack-Smith 2008a, 2008b, 2009). Specimen and habitat data, including the collecting dates and methods, and the site co-ordinates were provided with the specimens (see Appendix A).

Procedures

The snail specimens were examined and sorted under a Leica MZ95 dissecting microscope, and compared with descriptions and figures in relevant publications and with dry and preserved specimens in the Mollusc Collections of the Western Australian Museum, including those from previous *Hope Downs* surveys (Whisson & Slack-Smith 2008, Slack-Smith & Whisson 2009),.

Apart from those specimens collected by *Ninox Wildlife Consulting* during their previous surveys, the non-marine molluscs from the area around the Hope Downs tenements are not well represented in the collections of the Western Australian Museum, so all material from this survey has been registered and lodged there as a valuable addition.

Results

The specimens in these samples belong to the terrestrial snail families Bulimulidae; Pupillidae and Subulinidae (see Appendix A). Species identifications are necessarily based, both in this instance and in previous examinations of survey material, exclusively on shell characters that, in these families, may vary only slightly within a genus.

All of the species identified from this survey are considered to form part of the indigenous Western Australian fauna.

Family Bulimulidae

As noted in previous reports on the Hope Downs surveys (Whisson & Slack-Smith 2008, Slack-Smith & Whisson 2009), the family Bulimulidae is of Gondwanan derivation and is represented in Western Australia by the single genus *Bothriembryon*. The Hamersley Range population/populations are, apparently, relicts of a former more-widespread distribution of the genus.

Bothriembryon sp**.**

As previously reported, details of neither the limits of the distributional range of this currently un-named taxon nor the degree of interconnectedness of its populations are known.

Family Subulinidae

Eremopeas interioris (Tate, 1894)

The records of the occurrence of this widespread northern Australian species in the Pilbara Region are increasing with each survey, indicating a more southerly distribution than had been known in the 1980s. (see Solem 1988)

Family Pupillidae

Sub-family Pupillinae

Pupoides beltianus & *P.* sp. c.f. *P. beltianus* (Tate, 1894)

The difficulty in identifying these specimens reflects the discussion in a previous report (Slack-Smith & Whisson 2009)

Pupoides pacificus (Pfeiffer, 1846)

Recently-collected specimens housed in the Mollusc Collections of the Western Australian Museum indicate that this species is more widely spread throughout the Pilbara region than had earlier been apparent to Solem (1988, 1991)

Subfamily *Gastrocoptinae*

Gastrocopta sp. c.f. G. hedleyi Pilsbry, 1917

Recently-collected specimens from areas near to those of this survey have raised the possibility that they - and these specimens - might belong to outlying populations of the species *G. hedleyi,* earlier thought to have been confined to the Murray Darling Basin (Iredale 1937, Smith 1992).

Gastrocopta mussoni & *G.* sp. c.f. *G mussoni* Pilsbry, 1917

The species names *Gastrocopta larapinta deserti* Pilsbry, H.A. 1917 and *Australbinula helmsiana* Iredale, 1939 are now considered to be junior synonyms of the species *Gastrocopta mussoni*, which is widespread in all but the south-eastern areas of Australia (Pokryszko 1996).

Remarks

The terrestrial species submitted from this survey belong to the range of species previously encountered but were collected from over a wider range of habitats.

As we did not carry out the field survey, we have no way of evaluating the relationship of the molluscan taxa to the total of available habitats. However, the wider spatial range of collecting sites indicates that the smaller species belonging to the families Pupillidae and Subulinidae are, as formerly expected, widely distributed through the area and so could not be regarded as exhibiting short range endemicity.

However the survival of the population of the undescribed species of *Bothriembryon* is still of some concern. In the absence of data on the spatial relationship between the collecting sites at which this species has been found and the boundaries of the leased area(s) within which the development is

proposed, we cannot comment upon the possible effect of any disturbance on the population/populations of this species in the *Hope Downs 4* area.

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Appendix A: *Hope Downs* #4, WA, Hamersley Range (approx. 60 km WNW of Newman)

Site - HD4	Date	Co-ordinates WGS 84	Habitats	Techniques	Identification
11-1sn	27/4/09	23°05'33.2"S 119°12'21.3"E	Open *Acacia* woodland to 4m, over occasional *Ptilotus* sp. to 0.5m, & scattered *Triodia* sp. over sparse grasses; on brown loamy clay soils with laterite pebbles and pesoliths; occasional termite mounds	Hand collected in litter	*Gastrocopta* sp. c.f. *G. hedleyi* *Gastrocopta mussoni*
14a-1sn	27/4/09	23°05'29.0"S 119°12'32.3"E	Large *Triodia* sp. hummocks with emergent eucalypts to 4 m; mid-slope, laterite & ironstone rocks on brown loamy clays.	Hand collected in leaf litter	No specimen found in Survey material
14a-1sn	22/4/09	23°05'29.0"S 119°12'32.3"E	Large *Triodia* sp. hummocks with emergent eucalypts to 4 m; mid-slope, laterite & ironstone rocks on brown loamy clays.	Hand collected in eucalypt litter	*Eremopeas interioris* *Gastrocopta* sp. juv.
14a-2sn	22/4/09	23°05'29.0"S 119°12'32.3"E	Large *Triodia* sp. hummocks with emergent eucalypts to 4 m; mid-slope, laterite & ironstone rocks on brown loamy clays.	Hand collected in soil under eucalypt litter	*Bothriembryon* sp.
14a-3sn	22/4/09	23°05'29.0"S 119°12'32.3"E	Large *Triodia* sp. hummocks with emergent eucalypts to 4 m; mid-slope, laterite & ironstone rocks on brown loamy clays.	Hand collected in soil under eucalypt litter	*Bothriembryon* sp.
14b-1sn	27/4/09	23°05'33.2"S 119°12'21.3"E	Large *Triodia* sp. hummocks with emergent eucalypts to 4 m; mid-slope with quartz pebbles, laterite & ironstone rocks on brown loamy clays	Hand collected in litter	*Gastrocopta* sp. juv.
14b-2sn	27/4/09	23°05'33.2"S 119°12'21.3"E	Large *Triodia* sp. hummocks with emergent eucalypts to 4 m; mid-slope with quartz pebbles, laterite & ironstone rocks on brown loamy clays	Hand collected in litter	*Gastrocopta* sp. *Pupoides* sp. c.f. *P.beltianus*
15-1sn	27/4/09	23°05'31.1"S 119°11'15.7"E	Creek margins with eucalypts to 4 m, over occasional mixed shrubs to 2.5 m, over grasses to 0.5 m; on soft fine silt loams	Hand collected in litter	*Gastrocopta* sp. juv.
15-2sn	27/4/09	23°05'31.1"S 119°11'15.7"E	Creek margins with eucalypts to 4 m, over occasional mixed shrubs to 2.5 m, over grasses to 0.5 m; on soft fine silt loams	Hand collected in litter	*Gastrocopta* sp. c.f. *G. mussoni* *Eremopeas interioris*
Pool-1sn	24/4/09	23°06'11.1"S 119°17'30.4"E	Open woodland of eucalypts & *Melaleuca* on major creek lines with pools; alluvial river sands	Hand collected in litter	*Pupoides beltianus* *Pupoides pacificus*

Site - HD4	Date	Co-ordinates WGS 84	Habitats	Techniques	Identification
Pool-2sn	24/4/09	23°06'11.1"S 119°17'30.4"E	Open woodland of eucalypts & *Melaleuca* on major creek lines with pools; alluvial river sands	Hand collected in litter	*Gastrocopta mussoni*
Pool-3sn	24/4/09	23°06'11.1"S 119°17'30.4"E	Open woodland of eucalypts & *Melaleuca* on major creek lines with pools; alluvial river sands	Hand collected in litter	*Gastrocopta* sp. juv.
Pool-4sn	24/4/09	23°06'11.1"S 119°17'30.4"E	Open woodland of eucalypts & *Melaleuca* on major creek lines with pools; alluvial river sands	Hand collected in litter	*Gastrocopta* sp. juv.
Opp.-1-1sn	25/4/09	23°05'43"S 119°12'08.8"E	Tall mulga shrubland to 4m, over emergent eucalypts and occasional *Eremophila* to 1m, over spinifex; on ironstone float on hardpan	Hand collected in litter	*Gastrocopta* sp. c.f. *G. hedleyi* *Gastrocopta* sp. juv.
Opp.-2-1sn	25/4/09	23°05'27.1"S 119°11'59.3"E	Spinifex rise with bands of *Melaleuca* shrubs to 2.5m in narrow rocky gullies with scattered emergent eucalypts; on stony flat on residual soils and rocky outcrops on ridges	Hand collected in litter	*Gastrocopta* sp.
Opp.-3-1sn	27/4/09	23°05'16.9"S 119°09'39.7"E	Occasional eucalypts to 5m, over sparse shrubs to 1 m, over small spinifex clumps; scree on rocky slope	Hand collected in litter	*Eremopeas interioris*
Opp.-3-2sn	27/4/09	23°05'16.9"S 119°09'39.7"E	Occasional eucalypts to 5m, over sparse shrubs to 1 m, over small spinifex clumps; scree on rocky slope	Hand collected in litter	*Gastrocopta* sp. juv.
Opp.-3-3sn	27/4/09	23°05'16.9"S 119°09'39.7"E	Occasional eucalypts to 5m, over sparse shrubs to 1 m, over small spinifex clumps; scree on rocky slope	Hand collected in litter	*Gastrocopta* sp. c.f. *G. mussoni*
Opp.-3-4sn	27/4/09	23°05'16.9"S 119°09'39.7"E	Occasional eucalypts to 5m, over sparse shrubs to 1 m, over small spinifex clumps; scree on rocky slope	Hand collected in litter	*Gastrocopta* sp. c.f. *G. hedleyi*

Appendix 4
Flora assessment: additional data and DEC correspondence

Table 1 Species by M3 and M6 communities

(numbers in table cells indicate the number of sites species was recorded from)

Species	Vegetation Code	
	M3	M6
Abutilon oxycarpum	1	0
Acacia acradenia	1	0
Acacia ancistrocarpa	1	0
Acacia aneura var. aneura	9	3
Acacia aneura var. major	1	0
Acacia ayersiana	2	0
Acacia bivenosa	2	0
Acacia citrinoviridis	1	1
Acacia distans	2	0
Acacia holosericea	1	0
Acacia inaequilatera	1	0
Acacia orthocarpa	1	1
Acacia pruinocarpa	6	0
Acacia rhodophloia	3	0
Acacia sclerosperma	1	0
Acacia sibirica	1	0
Acacia tenuissima	1	1
Acacia tetragonophylla	5	1
Acacia victoriae	4	3
Amyema fitzgeraldii	1	1
Anthobolus leptomerioides	1	0
Aristida contorta	9	4
Aristida holathera var. holathera	1	0
Aristida pruinosa	1	0
Aristida sp.	1	0
**Bidens bipinnata*	1	0
Boerhavia gardneri	1	0
Boerhavia sp.	1	1
Brachyachne convergens	1	0
**Cenchrus ciliaris*	4	2
Cheilanthes austrotenuifolia	1	0
Cheilanthes sieberi subsp. sieberi	1	1
Chrysopogon fallax	4	0
Cleome oxalidea	1	0
Cleome viscosa	2	1
Codonocarpus cotinifolius	6	0
Corchorus lasiocarpus	1	0
Corchorus lasiocarpus subsp. lasiocarpus	1	0
Corchorus lasiocarpus subsp. parvus	1	0
Corchorus sp.	0	1

Species	Vegetation Code	
	M3	M6
Corchorus walcottii	0	1
Corymbia aspera	2	0
Corymbia hamersleyana	1	0
Corymbia opaca	1	0
Cymbopogon obtectus	2	1
Dactyloctenium radulans	2	2
Dodonaea petiolaris	1	0
Duperreya commixta	5	0
Dysphania rhadinostachya subsp. rhadinostachya	1	0
Enchylaena tomentosa	0	1
Enneapogon caerulescens	1	2
Enneapogon polyphyllus	1	1
Enneapogon purpurascens	0	1
Eragrostis cumingii	1	0
Eragrostis dielsii	1	0
Eragrostis eriopoda	1	0
Eragrostis leptocarpa	1	0
Eragrostis sp.	1	0
Eremophila cuneifolia	0	1
Eremophila forrestii	1	3
Eremophila forrestii subsp. forrestii	3	1
Eremophila fraseri	5	0
Eremophila latrobei	2	0
Eremophila latrobei subsp. latrobei	0	1
Eremophila longifolia	0	1
Eremophila maculata	0	1
Eriachne mucronata	3	1
Eriachne pulchella	0	1
Eucalyptus ?sheathiana	1	0
Eucalyptus leucophloia	0	1
Eucalyptus xerothermica	2	0
Evolvulus alsinoides	4	1
Fimbristylis dichotoma	1	1
Gomphrena canescens	3	0
Goodenia ?muelleriana	1	0
Goodenia triodiophila	0	1
Grevillea berryana	3	2
Grevillea stenobotrya	0	1
Hakea chordophylla	0	1
Hakea lorea	1	0
Heliotropium heteranthum	1	0
Hibiscus burtonii	1	0
Hibiscus coatesii	1	0
Keraudrenia nephrosperma	2	0

Species	Vegetation Code	
	M3	M6
Maireana georgei	0	5
Maireana tomentosa	0	1
Maireana villosa	1	0
Maireana sp.	1	0
Marsilea hirsuta	1	0
Mollugo molluginea	1	0
Panicum effusum	0	1
Paraneurachne muelleri	1	0
Perotis rara	1	1
Petalostylis labicheoides	2	0
Psydrax latifolia	4	0
Psydrax suaveolens	2	0
Pterocaulon sphaeranthoides	1	0
Ptilotus aervoides	0	1
Ptilotus astrolasius	1	0
Ptilotus calostachyus	3	1
Ptilotus exaltatus	2	2
Ptilotus exaltatus var. exaltatus	3	0
Ptilotus gaudichaudii	0	1
Ptilotus helipteroides	2	1
Ptilotus obovatus	1	0
Ptilotus obovatus var. obovatus	2	1
Ptilotus polystachyus	3	0
Ptilotus roei	1	0
Rulingia loxophylla	1	0
Salsola tragus	0	1
Scaevola parvifolia	0	1
Sclerolaena convexula	0	1
Sclerolaena eriacantha	2	2
Senna ?glaucifolia	1	1
Senna artemisioides subsp. helmsii	1	1
Senna artemisioides subsp. oligophylla	2	2
Senna artemisioides subsp. oligophylla x helmsii	1	0
Senna glaucifolia	0	1
Senna glutinosa	0	1
Senna glutinosa subsp. pruinosa	2	0
Senna notabilis	2	0
Senna oligophylla	0	1
Senna sericea	1	0
Sida arenicola	2	0
Sida fibulifera	3	1
Solanum lasiophyllum	10	4
Sorghum plumosum	1	0
Sporobolus australasicus	3	0

Species	Vegetation Code	
	M3	M6
Streptoglossa tenuiflora	1	0
Stylobasium spathulatum	1	1
Trianthema glossostigma	0	2
Tribulus suberosus	1	0
Triodia angusta	0	1
Triodia basedowii	1	0
Triodia brizoides	1	0
Triodia epactia	2	0
Triodia lanigera	1	0
Triodia longiceps	0	1
Triodia pungens	7	1
Triodia wiseana	0	1
Wahlenbergia tumidifructa	1	0
Xerochrysum bracteatum	1	0

Table 2 Species within the M3 and M6 communities by site

Mattiske job code (survey code)	HP4							RTT0903							HP4Corr	
Vegetation Code	M3											M6				
Site Number	70	119	B022	B233	C126	C127	C128	DA03	DA06	LM03	LM8B	LM04	MA11	MA12	HC046	HC130
Abutilon oxycarpum										x						
Acacia acradenia						x										
Acacia ancistrocarpa							x									
Acacia aneura var. aneura	x	x	x	x	x	x	x		x		x	x			x	x
Acacia aneura var. major				x												
Acacia ayersiana						x	x									
Acacia bivenosa									x		x					
Acacia citrinoviridis											x				x	
Acacia distans	x			x												
Acacia holosericea			x													
Acacia inaequilatera	x															
Acacia orthocarpa										x		x				
Acacia pruinocarpa			x	x	x	x	x				x					
Acacia rhodophloia	x					x	x									
Acacia sclerosperma								x								
Acacia sibirica					x											
Acacia tenuissima	x												x			
Acacia tetragonophylla			x		x		x		x	x		x				
Acacia victoriae								x	x	x	x	x	x	x		
Amyema fitzgeraldii											x	x				
Anthobolus leptomerioides						x										
Aristida contorta			x	x	x	x	x	x	x	x	x	x	x	x		x
Aristida holathera var. holathera			x													
Aristida pruinosa			x													
Aristida sp.			x													
**Bidens bipinnata*				x												

Mattiske job code (survey code)	HP4							RTT0903							HP4Corr	
Boerhavia gardneri											x					
Boerhavia sp.										x		x				
Brachyachne convergens					x											
**Cenchrus ciliaris*								x	x	x	x	x		x		
Cheilanthes austrotenuifolia				x												
Cheilanthes sieberi subsp. sieberi			x													x
Chrysopogon fallax	x	x	x								x					
Cleome oxalidea				x												
Cleome viscosa								x			x			x		
Codonocarpus cotinifolius			x	x	x	x	x				x					
Corchorus lasiocarpus										x						
Corchorus lasiocarpus subsp. lasiocarpus										x						
Corchorus lasiocarpus subsp. parvus	x															
Corchorus sp.													x			
Corchorus walcottii												x				
Corymbia aspera				x	x											
Corymbia hamersleyana								x								
Corymbia opaca			x													
Cymbopogon obtectus								x	x							x
Dactyloctenium radulans										x	x	x		x		
Dodonaea petiolaris			x													
Duperreya commixta	x		x		x					x	x					
Dysphania rhadinostachya subsp. rhadinostachya			x													
Enchylaena tomentosa														x		
Enneapogon caerulescens					x							x				x
Enneapogon polyphyllus			x													x
Enneapogon purpurascens																x

Mattiske job code (survey code)	HP4							RTT0903							HP4Corr	
Eragrostis cumingii			x													
Eragrostis dielsii											x					
Eragrostis eriopoda		x														
Eragrostis leptocarpa		x														
Eragrostis sp.						x										
Eremophila cuneifolia												x				
Eremophila forrestii										x		x	x	x		
Eremophila forrestii subsp. forrestii			x	x		x									x	
Eremophila fraseri	x	x	x			x	x									
Eremophila latrobei				x							x					
Eremophila latrobei subsp. latrobei																x
Eremophila longifolia															x	
Eremophila maculata																x
Eriachne mucronata				x		x					x				x	
Eriachne pulchella														x		
Eucalyptus ?sheathiana		x														
Eucalyptus leucophloia															x	
Eucalyptus xerothermica		x			x											
Evolvulus alsinoides				x				x	x	x						x
Fimbristylis dichotoma										x						x
Gomphrena canescens								x	x	x						
Goodenia ?muelleriana									x							
Goodenia triodiophila																x
Grevillea berryana			x	x		x						x			x	
Grevillea stenobotrya															x	
Hakea chordophylla																x
Hakea lorea								x								
Heliotropium heteranthum									x							
Hibiscus burtonii			x													

Mattiske job code (survey code)	HP4							RTT0903							HP4Corr	
Hibiscus coatesii		x														
Keraudrenia nephrosperma	x					x										
Maireana georgei												x	x	x	x	x
Maireana tomentosa												x				
Maireana villosa				x												
Maireana sp.			x													
Marsilea hirsuta											x					
Mollugo molluginea										x						
Panicum effusum																x
Paraneurachne muelleri										x						
Perotis rara											x					x
Petalostylis labicheoides			x		x											
Psydrax latifolia	x		x	x	x											
Psydrax suaveolens			x	x												
Pterocaulon sphaeranthoides			x													
Ptilotus aervoides																x
Ptilotus astrolasius										x						
Ptilotus calostachyus	x		x	x												x
Ptilotus exaltatus									x	x		x		x		
Ptilotus exaltatus var. exaltatus	x	x	x													
Ptilotus gaudichaudii																x
Ptilotus helipteroides									x	x		x				
Ptilotus obovatus										x						
Ptilotus obovatus var. obovatus					x		x									x
Ptilotus polystachyus					x	x	x									
Ptilotus roei				x												
Rulingia loxophylla					x											
Salsola tragus														x		
Scaevola parvifolia												x				
Sclerolaena convexula														x		

Mattiske job code (survey code)	HP4							RTT0903							HP4Corr	
Sclerolaena eriacantha										x	x	x		x		
Senna ?glaucifolia										x				x		
Senna artemisioides subsp. helmsii						x						x				
Senna artemisioides subsp. oligophylla								x		x			x	x		
Senna artemisioides subsp. oligophylla x helmsii											x					
Senna glaucifolia												x				
Senna glutinosa													x			
Senna glutinosa subsp. pruinosa										x	x					
Senna notabilis									x	x						
Senna oligophylla												x				
Senna sericea									x							
Sida arenicola	x		x													
Sida fibulifera			x	x							x					x
Solanum lasiophyllum	x	x	x	x	x	x	x	x	x	x		x	x	x		x
Sorghum plumosum				x												
Sporobolus australasicus			x		x						x					
Streptoglossa tenuiflora		x														
Stylobasium spathulatum									x						x	
Trianthema glossostigma															x	x
Tribulus suberosus											x					
Triodia angusta															x	
Triodia basedowii							x									
Triodia brizoides						x										
Triodia epactia		x			x											
Triodia lanigera	x															
Triodia longiceps													x			
Triodia pungens			x			x	x	x	x	x	x	x				

Mattiske job code (survey code)	HP4							RTT0903							HP4Corr	
Triodia wiseana															x	
Wahlenbergia tumidifructa			x													
Xerochrysum bracteatum		x														

From: Van Leeuwen, Stephen [Stephen.VanLeeuwen@dec.wa.gov.au]
Sent: Monday, 22 March 2010 12:42 PM
To: 'libby@mattiske.com.au'
Cc: Pryde, Jill; Jones, Anthea; Woolfrey, Nicholas; Neiman, Jody (RTIO)
Subject: RE: PEC Data - Brockman Iron Cracking Clay
Libby

I don't have any data that I could retrieve in that time frame, sorry. And as for the Pilbara Survey data, it is still a work in progress. So we are left with just the description.

Basically the DEC request was for access to the data (from quadrats) that was used to describe the M6 and M3 communities so that I could review in regards to my understanding of the Brockman Iron cracking clay community. We are unable to tell from the data and maps supplied in the PER if these community types actually include cracking clays and the extent or distribution of these cracking clays. Therefore DEC requests assess to the species list for sites on cracking clay within these mapped M6 and M3 vegetation types. DEC would also like better maps as those provided with the PER are of too low a quality and inappropriate scale to actually know where the M6 and M3 communities occur.

In regards to methodological issues we require a reconciliation of the structural mapping with the floristics as this provide a far more informative appreciation of where species are located and their distribution across the landscape. As you know structural mapping is not very informative for assessing the impacts of a development on the floristic values of an area, especially in fire prone environments like the Pilbara. Yes structural mapping has it place and is informative for issues like fauna habitat but in respect to flora alone it is of limited values unless it can be readily associated/reconciled with floristic attributes, in particular species presence/occurrences and ideally the fidelity of species to community types.

Hence, DEC request access to:

- better vegetation maps at an appropriate scale and resolution; and
- the species list from quadrats in each of the M6 and M3 vegetation structural types.

Cheers

Stephen

From: Pryde, Jill
Sent: Friday, 19 March 2010 10:54 AM
To: 'libby@mattiske.com.au'
Cc: Van Leeuwen, Stephen
Subject: RE: PEC Data - Brockman Iron Cracking Clay

Hello Libby

I understand that Stephen will be back in the office next week.

Stephen may have results from data collected during his survey of this community in the late 1990s and from the DEC Pilbara survey that included additional sites.

Jill Pryde
A/Snr Ecologist
Species and Communities Branch
Department of Environment and Conservation (DEC)

T: (08) 9334 0263 | F: (08) 9334 0300 | E: jill.pryde@dec.wa.gov.au
17 Dick Perry Ave KENSINGTON | Locked Bag 104 Bentley DC WA 6983 | www.dec.wa.gov.au

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From: Libby Mattiske [mailto:libby@mattiske.com.au]
Sent: Thursday, 18 March 2010 10:23 AM
To: Pryde, Jill
Cc: Van Leeuwen, Stephen; 'Neiman, Jody (RTIO)'
Subject: PEC Data - Brockman Iron Cracking Clay

Jill and Stephen

Do you have any data behind the request from DEC to analyse the potential alignment with the PEC (Brockman Iron

cracking clay communities of the Hamersley Ranges).

Is there any specific data or just the description. I need this data next week so I can respond for Rio Tinto on this matter.

If there is data:

1. I will merge data set.
2. Send merged data set back to DEC for confirmation of reconciled lists.
3. On receiving the accepted reconciled list back then analyse data.
4. Finally send the species by site, site data and also analyses via the client in a response to this request.

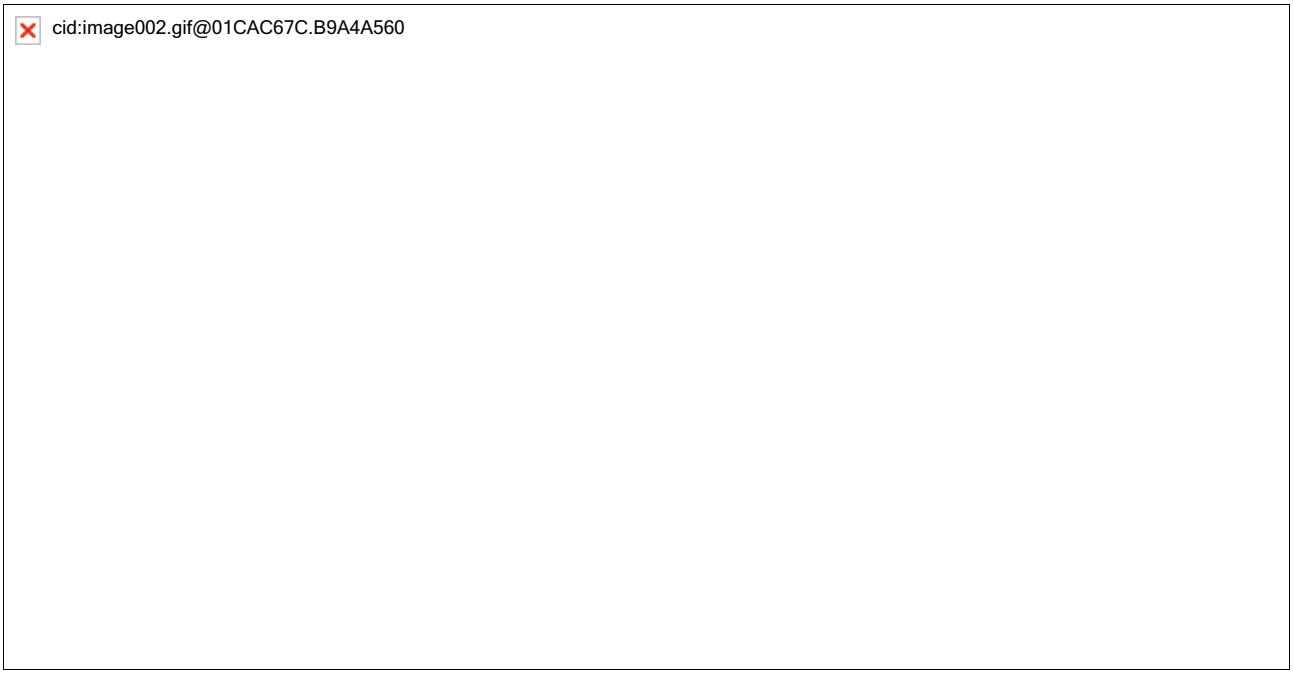
In mapping vegetation it is important to include structural as well as floristic data (as accepted internationally). This was done in the mapping.

To comply with the request we need the DEC data or confirmation that there is no data.

Regards

Libby

cc. Jody Neiman (Rio Tinto)



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Appendix 5
Hope Downs 4 Management Plans: Spontaneous Combustion & ARD (SCARD) and Mineral Waste

RIO TINTO

Hope Downs 4: Spontaneous Combustion and ARD (SCARD) Management Plan for Operations

(Formerly known as Black Shale Management Plan)

Spontaneous Combustion and ARD Management Plan for Operations

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TABLE OF FIGURES

Spontaneous Combustion and ARD Management Plan for Operations

1 Purpose

The Acid Rock Drainage (ARD) and Spontaneous Combustion Management Plan for operations outline the groups accountable and activities for the management of the environmental, safety and health risks associated with black shale.

2 Assessing if a Site needs to Implement this Management Plan

The RTIO mineral waste management plan describes the ARD, spontaneous combustion and mineral waste work that must be undertaken in the development of new deposits or significant expansions of current operations. A detailed ARD Risk Assessment should be undertaken for any new deposits or significant expansions of current operations to identify whether excavated sulfides will represent a risk to health, safety and environment. If risks are deemed to be minimal then a management plan will not be required. If a risk assessment has already been undertaken at a site then for any additional significant resource drilling or expansions of the operation the risk assessment should be updated. For any mine site that exposes or could potentially expose sulfidic material that presents a significant ARD risk this SCARD Management Plan will need to be implemented.

3 Requirements, Accountabilities and References for Black Shale

The accountability for the management of Spontaneous Combustion and ARD issues associated with black shale are listed at superintendent and manager level in the following section. Figure 1 provides an overview of black shale management at Pilbara Iron from initial characterisation and modelling, through project development, mine planning, production and closure. Pilbara Iron's black shale management strategy is broadly based upon the following principles: 1) identification of black shale distribution and character, 2) minimising the exposure and mining of black shale to the extent possible, 3) identification and special handling of black shale that must be mined, 4) encapsulation of black shale inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated, and 5) placement of black shale below the water table in backfilled open pits to limit oxygen contact.

Black shale management during mining operations is conducted in accordance with Figure 2. The mining protocols are designed to 1) minimise the risk of unplanned detonations in charged blast holes, 2) ensure that hot and cold black shale truck loads are transported and placed in designated black shale dumps according to design requirements, 3) ensure that the location and geometry of all black shale repositories is recorded and 4) refine geological block models and block-out procedures.

Black shale (BS) is divided into cold (Category S) and hot (Category SR) black shale based on position with the stratigraphy. The upper parts of the Mount McRae Shale are classified as cold or Category S based on a low risk for spontaneous combustion. The lower member of the Mount McRae shale is classified as hot or Category SR based on an increased risk of spontaneous combustion. The cold and hot black shale are management differently within waste dumps to account for the different risks.

Spontaneous Combustion and ARD Management Plan for Operations

Requirements

3.1 Mine Planning

3.1.1 Five year plans should estimate hot and cold BS production and compare to inert waste production to ensure that sufficient material will be available for dump construction.

3.1.2 For significant modification to the pit shell within MCS, use geological block models to predict hot and cold BS production volumes for different whittle shell, production and final pit designs.

3.1.3 Life of Mine Plans and Reserve Models should include estimates for hot and cold BS production.

3.1.4 Black shale dumps should be sited to minimise long term environmental impacts and financial liabilities. Obtain signoff from Environment and Hydrogeology.

3.1.5 Ensure that final pit and dump designs are consistent with Appendix 1, Appendix 2 and Appendix 3. Obtain signoff from Environment and Hydrogeology.

3.1.6 When planning open pits that will intersect black shale, the possibility of dewatering becoming acidic should be considered so that appropriate dewatering infrastructure can be installed.

3.2 Site Planning

3.2.1 Annual and Quarterly (short and medium term) plans should predict hot and cold BS production from each pit and delivery to each dump. Sufficient inert waste should be produced for encapsulation in accordance with the specifications in Appendix 1 and that sequencing will allow dump construction to occur as required.

3.2.2 Receive environmental sign-off before major modifications to BS dump designs are implemented.

3.2.3 Plan and design works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 1, Appendix 2 and Appendix 3.

3.2.4 Black shale exposures on the waste rock dumps should be minimised during the rainy season (Appendix 1).

3.2.5 Plan and implement rehabilitation works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 1, Appendix 2 and Appendix 3.

3.3 Geology

Blasting

3.3.1 Identify BS in drill hole cuttings and blue flag holes that contain BS. Place a white flag on holes that do not contain BS.

3.3.2 Alert key personnel in Operational Planning and Pit Operations of the location of BS blast holes via e-mail.

Dumping

3.3.3 Based on visual inspection, total S values and stratigraphy, designate holes as cold BS, hot BS or inert waste. Create Block-outs that show contacts between waste types within blast pattern.

3.3.4 Enter Block-out data into the Modular Mining system to allow BS waste to be tracked.

3.3.5 Perform periodic reconciliations between the Block-outs and the geological block model.

3.3.6 Periodically provide representative samples of upper, middle and lower MCS to the Site Environmental Officer for full ABA and NAG analysis. Also provide unoxidised black shale within Whaleback Shale and other black shale found within the BIF units.

3.3.7 Review as necessary, the boundary between cold black shale and hot black shale to ensure it is still valid and has not changed as mining progresses deeper. Advice the Mineral Waste management team of the results and undertake change management if necessary.

3.4 Survey

3.4.1 Maintain as-built dump designs in Vulcan that include a 3D plan showing approximate locations and volumes of BS.

3.4.2 Ensure contacts between hot BS, cold BS and inert waste are pegged on the blasted bench consistent with the Mine Geology Block-outs.

3.4.3 Ensure that monthly face pick-up surveys are conducted on all active BS waste dumps

Spontaneous Combustion and ARD Management Plan for Operations

Requirements

3.5 Operational Planning

3.5.1 Create a "Waste Dump Progression Plan" at least every three months to implement the detailed dump designs in the field.

3.5.2 Create "PLOD" sheets to aid dig operators in waste assignment and check that the modular mining system is working.

3.5.3 Monitor and adjust to reconcile rehabilitation plans with original designs as appropriate.

3.5.4 Perform field inspections to ensure that black shale is transported to the proper dump locations and placed as required. Register non-conformances in SAP.

3.5.5 Ensure monthly reports from PowerView contain hot and cold BS volumes delivered to every dump.

3.5.6 In consultation with Mine Geology perform six-monthly reconciliations between Block-outs, survey and Modular Mining data for hot and cold black shale volumes.

3.5.7 Black shale exposures on the waste rock dumps must be minimised during the rainy season.

3.6 Drill, Blast and Development

Drill and Blast

3.6.1 Ensure all safety procedures related to BS management are followed during the charging and firing of blast holes i.e. temperature logging, timing.

3.6.2 Maintain site specific Drill and Blast SWPs and ensure it is consistent with this management plan and other SWPs and guidance notes.

Dewatering

3.6.3 Runoff water in the open pits should be diverted around black shale exposures to the extent possible.

3.6.4 Any acidic contact water (pH of less than 5.0) will require special handling for both health and safety, operational and environmental reasons.

3.6.5 Acidic contact water must be contained on site and it should be segregated so it does not contaminate clean water. Acidic contact water must be stored in a manner that will not lead to groundwater quality degradation and potential loss of the beneficial use of down gradient aquifers. Where possible acidic water should be treated and put to a beneficial use rather than stored and discharged.

3.7 Load and Haul

3.7.1 Ensure that BS is properly identified and placed in the correct dump location consistent with PLOD sheets, modular mining assignments and the Waste Dump Progression Plan from Operations Planning.

3.7.2 Perform field inspections to ensure that black shale is transported to the proper dump locations and placed as required. Register non-conformances in SAP.

3.7.3 Ensure that "Exclusions" in Modular Mining are reviewed and corrected in the field as required.

3.7.4 The time between blasting and hauling of black shale should be minimised and generally should occur within three weeks or less during the wet season and within 12 weeks during the dry season. This will limit the amount of time the material has to oxidise in an uncontrolled manner.

3.7.5 Whenever possible the outer inert waste rock "skin" of a black shale lift should be constructed first. This will ensure that black shale lifts are not extended beyond the design footprint of the black shale dump, will limit convective oxygen transport through the uncompacted sides of the black shale dump lift, and will help contain contaminated contact water on the dump.

3.7.6 Hot black shale lifts should be covered as rapidly as possible with the overlying inert waste rock layer, particularly during the wet season. Ideally, hot black shale should be covered within two weeks of placement in the waste rock dump. If rapid covering is not possible the paddock-dumped hot black shale piles should at least be dozed into a planar surface as soon as possible. This will help minimise infiltration and oxygen transport into the material.

3.7.7 Modular data that are entered into the Vulcan system should be used to record the location and volume of all black shale repositories so that a three dimensional plan of black shale distribution within each dump is maintained by the survey group.

Spontaneous Combustion and ARD Management Plan for Operations

Requirements	
3.8	**Hydrogeology**
3.8.1	Maintain and implement a site specific plans and SWPs to deal with poor quality water that has contacted BS exposures or waste dumps.
3.8.2	Ensure that water management and storage practices do not cause offsite surface water impacts or groundwater quality degradation in down gradient aquifers.
3.8.3	Provide technical overview and support during planning for above-ground and in-pit BS waste disposal.
3.9	**Environment**
3.9.1	An annual documented ARD inspection program of all black shale dumps and open pits with black shale exposures should be performed. This should occur during the wet season or immediately after a significant rainfall event. Samples of key runoff water flows should be collected.
3.9.2	Perform field inspections to ensure BS management, dump construction, rehabilitation and store and release cover performance is consistent with the requirements of the SCARD Management Plan. Register non-conformances in SAP.
3.9.3	Ensure that routine sampling and visual inspection is performed of groundwater monitoring wells (surrounding black shale dumps and pits), dewatering water and surface water bodies (including inactive open pits that contain black shale exposures). The sampling should occur at least quarterly.
3.9.4	Ensure routine sampling for water quality and visual inspection of permanent or seasonal natural water bodies surrounding the mine. The sampling should occur at least quarterly.
3.9.5	Interpret the environmental data that is collected and ensure it is stored in a user-friendly database. All monitoring data should be assigned a unique sample number and sampling date. Ensure problems are brought to the attention of the Mineral Waste Management team and that corrective actions are taken if required.
3.9.6	Analysis of water quality trends for, at a minimum, sulfate, pH and dissolved metals should be made on an annual basis to monitor the long-term behaviour of the system. Significant changes in water quality, infiltration rate or other key parameters should be investigated and mitigation actions should be instituted if required.
3.9.7	Ensure that regular ABA, NAG testing and other characterisation work is carried out on black shale samples (MCS, Whaleback Shale and other shale units within BIF).
3.9.8	Ensure that the SCARD Management Plan is periodically refined and updated so that it is consistent with the latest characterisation data and current best practice. Alert the Mineral Waste Management team at other mine sites of any changes that are necessary to this plan and that may impact other sites. Any changes to this management plan need to be approved by the IEMS Steering Committee.
3.9.9	Perform all required reporting, permitting notifications and other external communications relating to ARD, closure and general black shale management issues.
3.9.10	IEMS modules on dust management and ARD should be presented every 2 years to groups working with black shale. The IEMS modules should be updated annually to reflect the current management plan and should describe the hazards, incident reporting and the relevant procedures to each working group that has responsibilities for any aspect of black shale management.
3.9.11	Report the tonnes of sulfidic material excavated and dumped at the end of each year.
3.9.12	Record black shale environment risks in a site risk register and annually review these risks.
Rehabilitation	
3.9.13	Plan and implement rehabilitation works for final waste rock dump surfaces and inactive open pits in a manner consistent with Appendix 1, Appendix 2 and Appendix 3.

Spontaneous Combustion and ARD Management Plan for Operations

Requirements	
3.10	**Health and Safety**
3.10.1	Monitor the occupational gas and dust exposures surrounding black shale. Ensure data is captured in a user friendly database. Ensure problems are brought to the attention of the Mineral Waste Management team.
3.10.2	Train occupational exposure groups on the correct use of respiratory equipment and monitors. Competency should be assessed and recorded in SAP.
3.10.3	Perform field inspections particularly during the wet season to ensure black shale health and safety procedures are followed. Register non-conformances in SAP.
3.10.4	Ensure safety guidance notes and SWPs are periodically refined and updated so it is consistent with current best practice.
3.10.5	Record black shale health and safety risks in a site risk register and annually review these risks.
3.11	**Mineral Waste Management Team**
3.11.1	A Mineral Waste Management Team must be formed and meet on a regular basis. It must include representatives of every Department that has responsibilities related to BS management.
3.11.2	The primary function of the Mineral Waste Management Team is to ensure on-going improvement and implementation of the SCARD Management Plan.
3.11.3	Agenda items and meeting minutes must be produced for every meeting.
3.11.4	Develop emergency and contingency plans related to spontaneous combustion, ARD and black shale management on an as need basis.
3.11.5	Coordinate a technical review of BS management by an external expert every two years. Track progress against outstanding actions at each meeting.
3.11.6	Coordinate all research related to black shale characterisation, black shale management, spontaneous combustion and ARD.
3.11.7	Ensure the SCARD management plan, related SWPs and guidance notes represent current practise and are up to date.
3.12	**Management**
3.12.1	An overview of black shale issues must be included in any introductory environmental training provided to new employees and contractors. To aid in the training, role descriptions should include ARD-related responsibilities.
3.12.2	Ensure progress is made against outstanding spontaneous combustion and ARD audit actions.

Figure 1: Black Shale (BS) management overview.

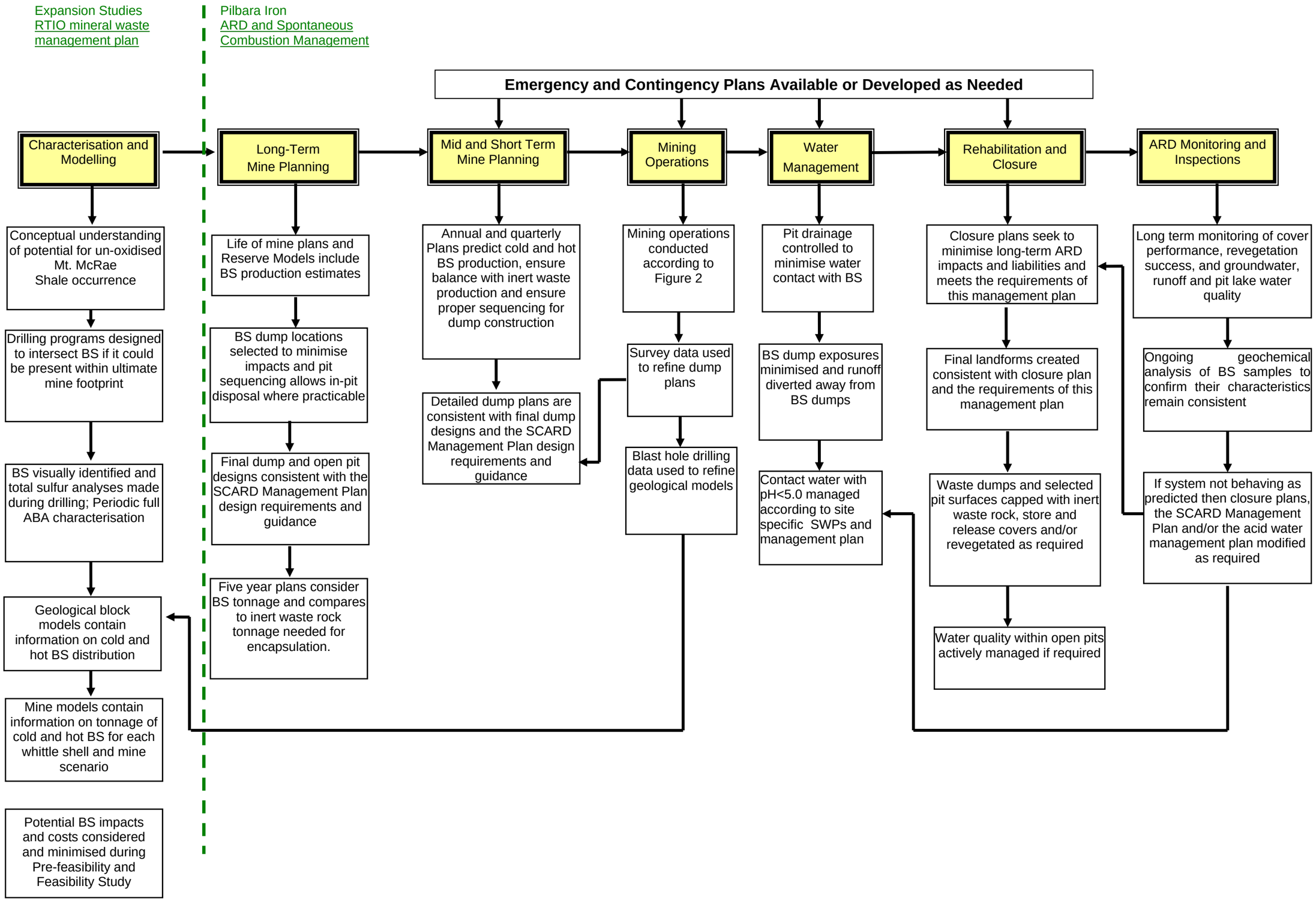
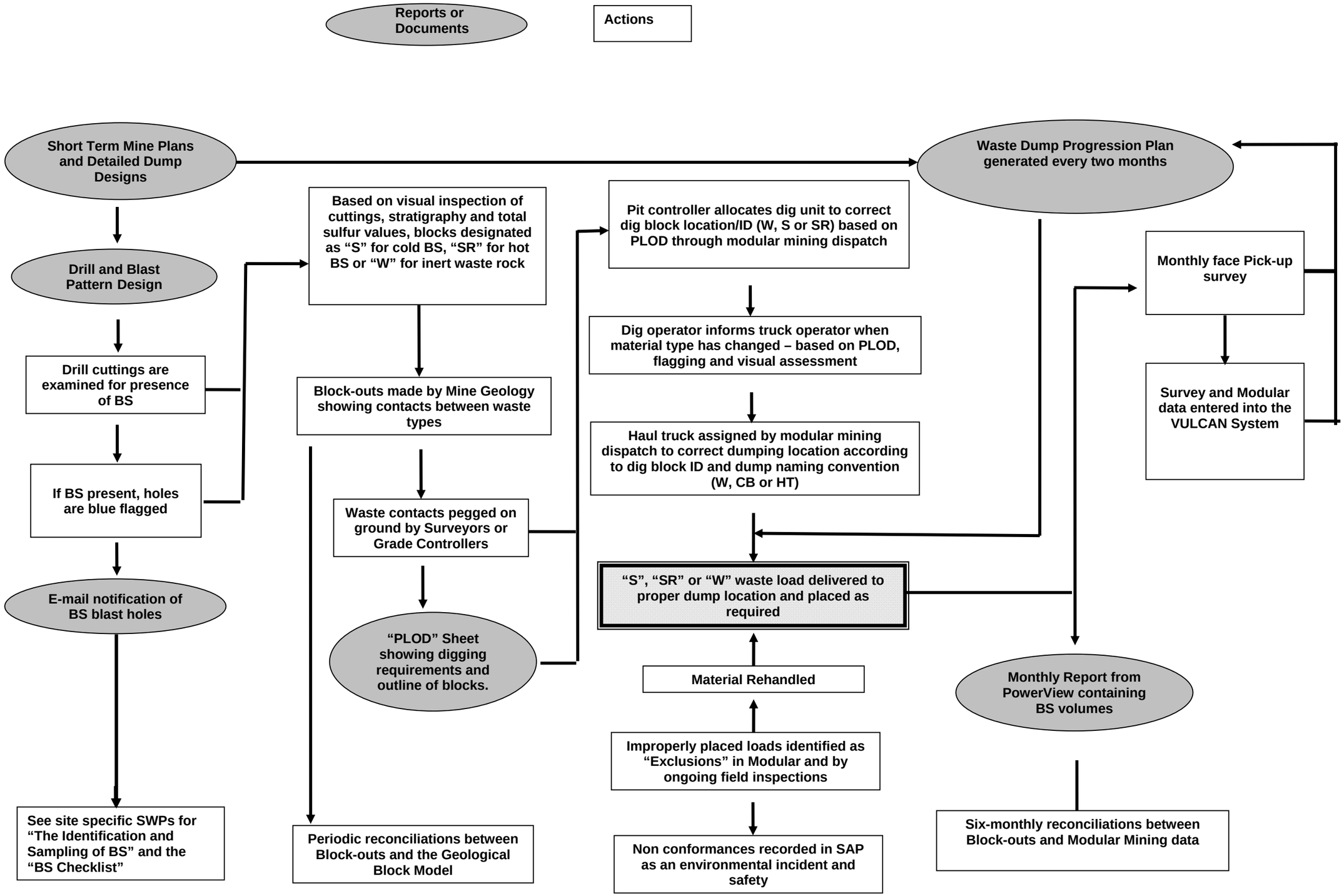


Figure 2: Black Shale (BS) management during mining operations



Appendix 1 : Dump Specifications for Category S and Category SR Material

Spontaneous Combustion and ARD Management Plan for Operations

Management of sulfides within black shale needs to be considered during all phases of waste rock dump design, from initial selection of dump locations during the long-term planning process (five year and longer time horizon) to the detailed dump designs generated during short term planning (time horizon less than a year). The Waste Dump Design Checklist is to be filled in for all new waste dump designs to help ensure environmental issues are adequately considered.

A1.1 Selection of Dump Locations

When designing new sulfide dumps, the dump location and footprint should be selected to minimise potential long term environmental impacts and financial liabilities. Dump designs should try where possible to adhere to the following guidelines:

- Under no circumstances should material containing sulfides be used for works such as windrows, construction fill, ramps, fantails, roads or any other use that would disperse the material over a broad area in an uncontrolled manner.
- The sulfides dump location should not receive runoff from surrounding areas. In particular waste dumps must not be sited in established drainages with significant upstream catchments.
- In pit disposal should be considered a priority instead of the construction of above ground waste rock dumps.
- Placement of sulfides in pits that already contain sulfide exposures is preferable to placement in pits that do not have sulfides exposed on the pit walls.
- Sulfide dumps should not be placed over or adjacent to significant regional aquifers such as saturated valley fill alluvial deposits or fractured bedrock aquifers such as the Wittenoom formation.
- Sulfide dumps should not be placed over ore grade or near ore grade CID or BIF-derived deposits. These not only have potential economic value, but may act as significant local aquifers.
- Sulfide dumps should not be placed over or adjacent to significant seeps or springs.
- Avoid siting new sulfide dumps in catchment basins that do not already contain sulfide dumps.
- The number of sites containing sulfides and the footprint of the sulfide dumps should be kept to a minimum.
- Sulfide dumps should be located near sources of clean waste rock for encapsulation.
- Background groundwater quality surrounding the dump location must be measured before any material is dumped. This will require the installation of groundwater monitoring bores. These bores will be used to provide a temporal record of groundwater quality in the vicinity of the dump.

A1.2 In-Pit Disposal Requirements

In pit disposal of sulfides is generally more secure than disposal in above ground waste rock dumps. Where practicable, in pit disposal should be considered the preferred disposal alternative because it:

- Reduces the risk of erosion exposing sulfides in the long term,
- Inhibits convective oxygen transport because the waste is surrounded by relatively impermeable rock walls,
- Reduces the footprint of the waste disposal facilities,
- Reduces the volume of inert or net neutralising waste needed to encapsulate the sulfides, and
- May help to prevent the formation of acidic or hyper-saline pit lakes if the pit can be filled to above the post-mining water table.

Note that in some pits it may be possible to place sulfides both above and below the water table with a minimum 10 metre thick inert waste layer placed against the predicted mean post-mining water table.

A1.2.1 In Pit Disposal Below the Water Table

If sulfides are placed below the post-mining water table, they will become permanently flooded and control subsequent pyrite oxidation and acid release will be controlled. In the long term, placement below the water table is the most secure and low risk disposal option available for sulfidic material. It is particularly beneficial for Category SR material because it completely removes the long-term risk of spontaneous combustion. If a pit can be backfilled so that the fill elevation is above the pre-mining water table elevation, it is likely that the water table will eventually rebound to at or near the pre-mining elevation. If it is only partially backfilled to below the pre-mining water table, it is likely that a very shallow intermittent, seasonal or permanent pit lake will form on top of the fill material.

For sulfides placed below the post-mining water table the following minimum design criteria apply:

- For pits backfilled above the predicted post-mining water table, the top of the sulfide backfill must be at least 5 metres below the mean predicted post-mining water table (Figure 3).

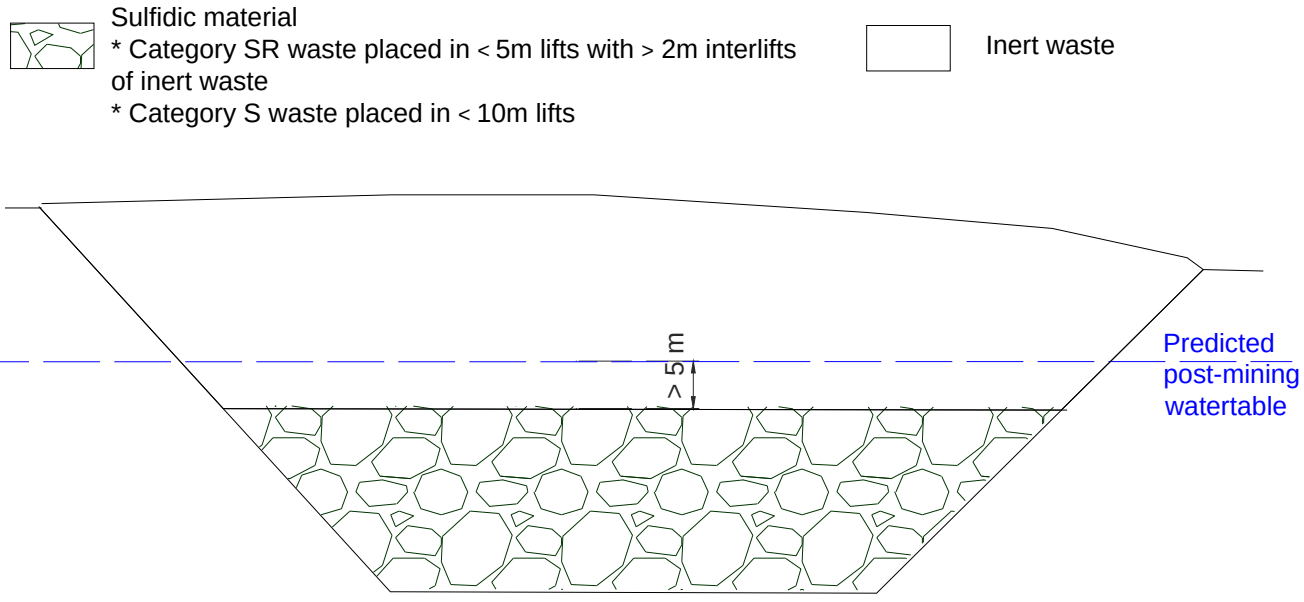


Figure 3: Example of sulfidic material placed below the water table and with the pit completely backfilled.

- For pits that are only partially backfilled to below the pre-mining water table, the top of the sulfide backfill must be at least 5 metres below the estimated mean pre-mining water table and at least 5 metres below the predicted post-backfilling water table (Figure 4). In this situation it can generally be assumed that the mean post-mining water table will be at the top of the backfill. Thus, the sulfidic waste will be covered by at least 5 metres of inert waste.

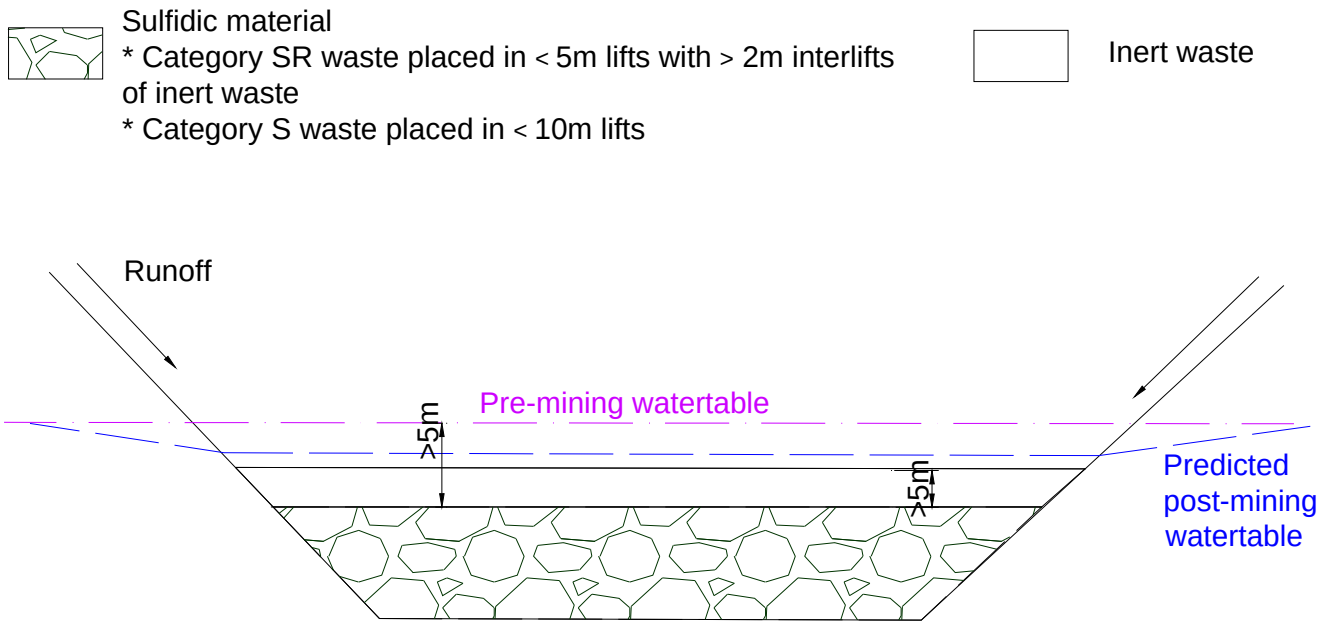


Figure 4: Example of sulfidic material placed below the water table and with the pit partially backfilled.

- The thickness of each Category SR material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each Category SR layer.
- The thickness of each Category S material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between Category S lifts.
- The uppermost lift of both Category S and Category SR material must be covered with a minimum 5 metre layer of inert or net neutralising waste rock.
- Each lift must be placed so that it ties into the pit walls on all sides to minimise the risk of convective oxygen transport until the waste is flooded.
- If backfilled to above the post-mining water table, the upper inert waste rock surface must be revegetated.
- A store and release cover is not needed if all sulfidic material in a pit is placed below the water table.

In addition to the minimum design requirements lists above, the optimum design for in-pit disposal below the water table also includes:

- Enough inert or net neutralising backfill should be placed on top of the sulfidic waste to raise the fill level to at least above the post-mining water table (preventing the formation of a pit lake) and preferably above the pit walls so that runoff is not directed into the pit fill. Figure 3 is an example of this preferred alternative.
- If required, flooding of the backfilled waste should be enhanced by diverting surface water flows into the pit or directing dewatering water from active open pits into the backfilled pit. The more rapidly the waste can be flooded, the less pyrite will ultimately oxidise. Rapid flooding will minimise the build up of soluble sulfide oxidation products in the material. As long as geotechnical safety requirements are met, construction of waste lifts into standing water on the pit floor is acceptable.

A1.2.2 In Pit Disposal Above the Water Table

If sulfidic material is placed above the post-mining water table it must be ensured that long-term variations in the water table elevation do not allow water to rise into the overlying sulfidic material. Intermittent contact with infiltrating water from above must also be minimised. For sulfidic material placed above the post-mining water table the following minimum design criteria apply:

- The base of the sulfidic material backfill must be at least 5 metres above the predicted mean post-mining water table.
- At least 5 metres of inert or net neutralising waste rock must be placed at the base of the open pit before sulfidic backfill is placed. The most likely location for a perched water table to form is at the base of the backfilled pit because of the permeability contrast between the bedrock and the backfill.
- The thickness of each Category SR material lift must not exceed 5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock between each Category SR layer.
- The thickness of each Category S material lift must not exceed 10 metres. No inert or net neutralising waste rock layer is needed between Category S material lifts.
- The uppermost lift of both Category S and Category SR material must be covered with a minimum 2 metre layer of inert or net neutralising waste rock. This will prevent runoff water from contacting the underlying sulfidic material until the minimum 4 metre-thick store and release cover can be constructed (see Section 4.5.2 for cover construction details).
- If the pit can be completely backfilled so that no high walls are exposed above the inert waste rock fill, then each inert, Category S and Category SR material layer should tie into the pit walls on all sides to minimise the risk of convective oxygen transport (see Figure 5 and Figure 6 for examples).

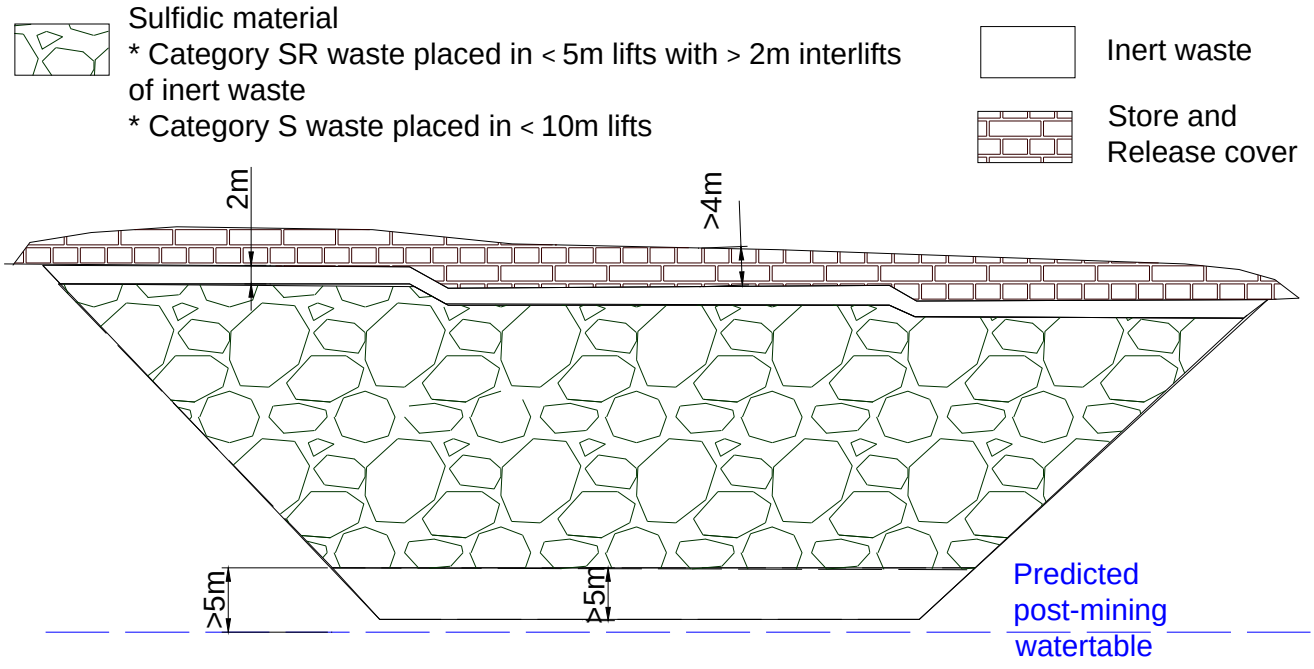


Figure 5: Example of sulfidic material placed in a dry pit that is completely backfilled.

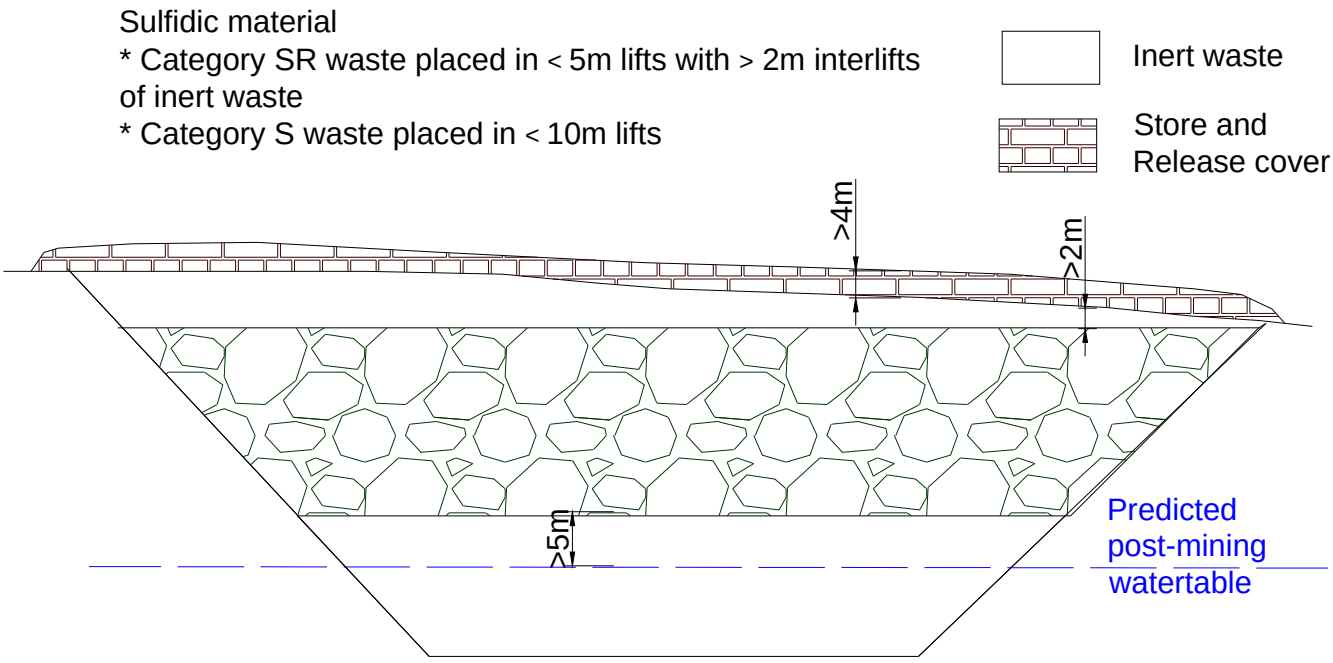


Figure 6: Example of sulfidic material placed above the water table and with the pit completely backfilled.

- If the pit will only be partially backfilled so that some highwalls are exposed above the final backfill surface and so that runoff from the remaining highwalls will flow towards the backfill, then a minimum five metre (measured both horizontally and vertically) buffer of inert waste rock must be placed between the pit walls and each sulfide material lift where possible (see Figure 7 for an example). A 2 meter high by 5 metre wide abandonment bund will also need to be placed adjacent to the exposed high walls to prevent run on water from infiltrating into the cover over the sulfidic material.

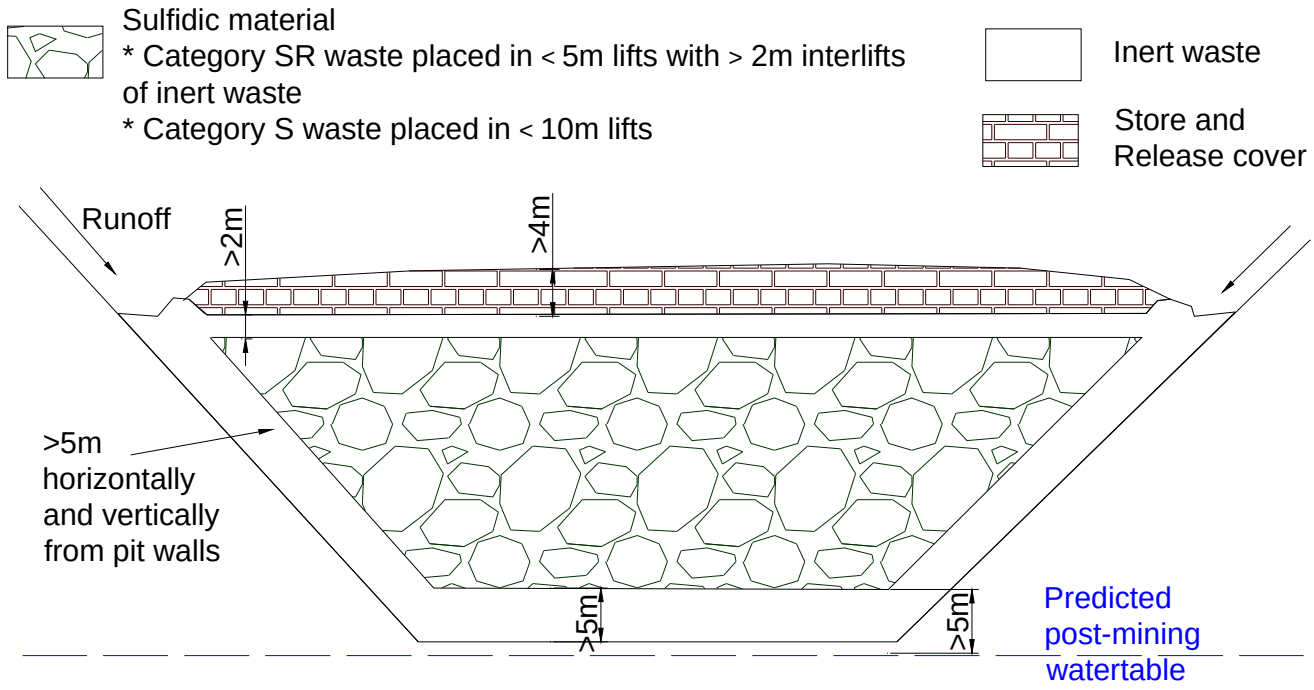


Figure 7: Example of sulfidic material placed above the water table and with the pit partially backfilled.

In addition to the minimum design requirements lists above, the optimum design for in-pit disposal above the water table also includes:

- If possible, the pit should be backfilled above the lowest point on the pits walls so that the final backfill surface can be sloped to allow runoff water to flow out of the pit footprint.
- The optimum design would be to backfill the pit so that there are no highwalls exposed that could direct runoff onto the store and release cover and underlying sulfidic material (Figure 5 and Figure 6).

A1.3 Above Ground Disposal Requirements

If sulfidic material waste rock dumps are to be constructed on top of the original ground surface, more stringent design criteria are required than for in-pit disposal because of the risk of erosion exposing encapsulated sulfidic material and because of the likelihood of the convective transport of oxygen through the side slopes of the dump. Design criteria for Category SR dumps are also more stringent than for Category S dumps.

A1.3.1 Design of Outer Waste Rock Dump Slopes

To the extent possible, Category S and Category SR material should be excluded from beneath final waste rock dump slopes. There are several issues associated with the placement of Category S and Category SR beneath waste rock dump slopes:

- There is an increased risk of slope erosion damaging vegetation and covers in the short term, or in the long term exposing the underlying material.
- The probability of convective oxygen transport to the sulfidic material is higher than for Category S and Category SR material only placed in the dump interior.

- Store and release covers cannot be built on slopes because they must be constructed with more erodable fine-grained materials. It is likely that infiltration rates into the underlying Category S and Category SR material will be higher on slopes than on flat surfaces with a store and release cover, which could result in increased ARD.
- Uncertainties with the requirements for final dump slopes may require the importation of additional inert material to allow slopes to be reduced to less than 20 degrees if required while preserving the minimum 5 metres of inert cover over the sulfidic material.

The minimum design criteria in the following section reduce but do not completely mitigate these risks. **For this reason, the volume of Category SR, and to a lesser extent Category S, material placed beneath final dumps slopes should be minimised wherever possible.** The greatest benefit can be derived from excluding Category SR material from beneath the slopes because it not only has the potential to spontaneously combust, but also has anywhere from 2 to 70 times more acid producing potential on average than the Category S material.

A1.3.2 Category SR

Figure 8 shows the optimum design for the waste rock dumps in which Category SR is completely excluded from beneath the footprint of the final recontoured slope.

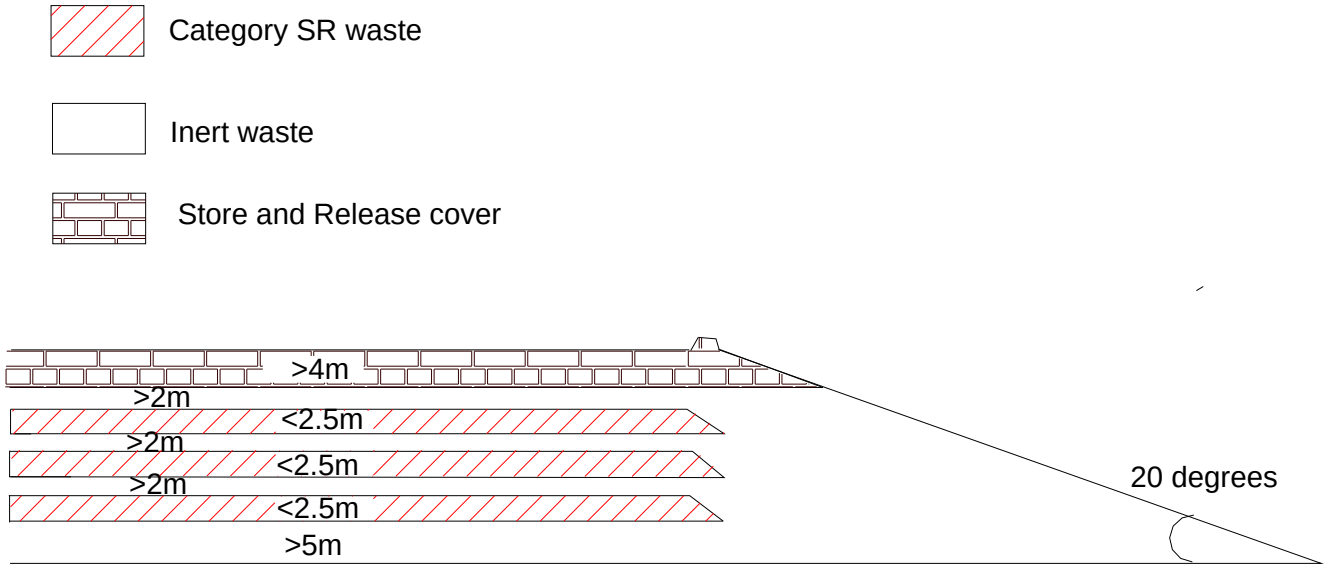


Figure 8: Example of optimum design for Category SR dumps.

An example of a Category SR waste rock dump constructed according to the minimum dump design criteria is shown in Figure 9. The minimum design criteria for Category SR dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.

- Enough inert waste rock must be placed against hillsides so that sulfidic material is not located within 5 metres of the hillside as measured both vertically and horizontally.
- The thickness of each Category SR sulfide material lift must not exceed 2.5 metres followed by a minimum 2 metre lift of inert or net neutralising waste rock. Lifts are to be constructed by paddock dumping so that Category SR sulfidic material can cool and so that incident vehicle traffic helps create a compacted layer every 2 to 2.5 metres to inhibit water movement and convective oxygen transport.
- Enough inert or net neutralising waste rock must be placed on the outer skin of the Category SR sulfidic material waste rock dump so that no sulfidic material is located within 5 metres (measured across the shortest distance) of the final dump surface after the slope has been recontoured at closure. For design purposes it should be assumed that all outer dump slopes will be reduced to 20 degrees or less at closure.
- The final lift on a Category SR sulfide material waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying sulfidic material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- During construction and at closure, the upper dump surface of the Category SR sulfidic material waste dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

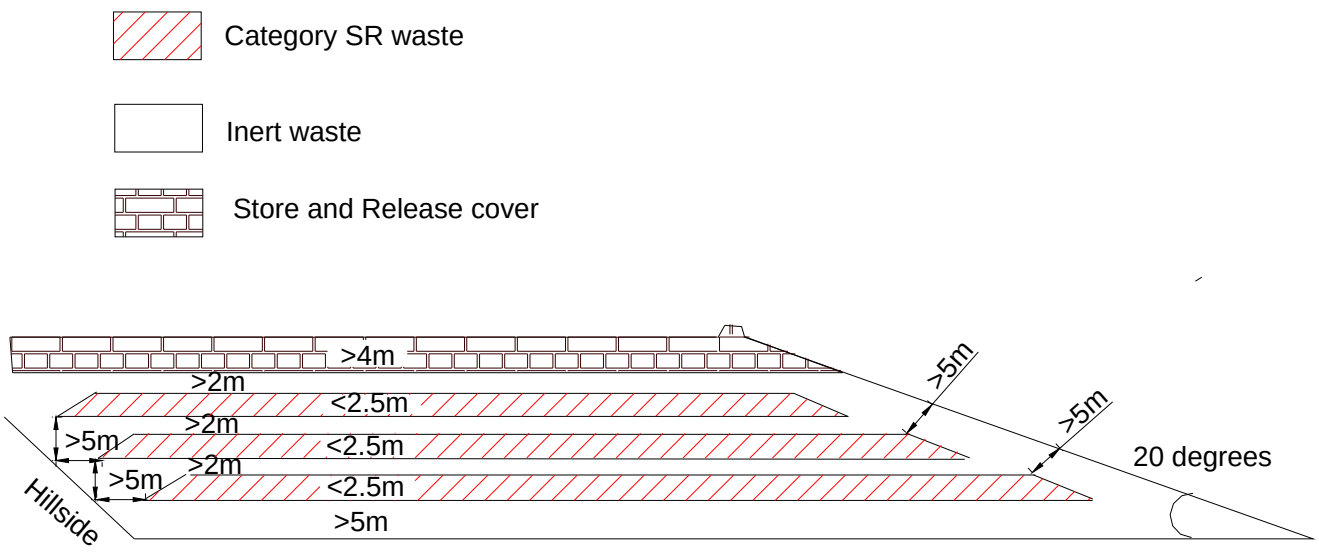


Figure 9: Example of the minimum design criteria for Category SR dumps (if Figure 8 can not be constructed).

A1.3.3 Category S

An example of a Category S waste rock dump constructed according to the minimum dump design criteria is shown in Figure 10. The minimum design criteria for Category S dumps are:

- A minimum of 5 metres of inert or net neutralising waste rock must be placed on the original land surface at the base of the dump.
- Enough inert waste rock must be placed against hillsides so that Category S material is not located within 5 metres of the hillside as measured both vertically or horizontally.
- The thickness of each lift of Category S material must not exceed 10 metres. This will create a vehicle compacted layer every 10 metres in the dump to inhibit water movement and convective oxygen transport[1].
- No inert or net neutralising waste rock layer is needed between Category S lifts.
- Enough inert or net neutralising waste rock must be placed on the outer skin of the Category S waste rock dump so that no material is located within 5 metres of the final dump surface after the slope has been recontoured at closure. For design purposes it should be assumed that all outer dumps slopes will be reduced to 20 degrees or less at closure.
- The final lift on a Category S waste rock dump must be composed of a minimum 2 metre-thick inert or net neutralising layer. This will prevent runoff water from contacting the underlying material until the minimum 4 metre-thick store and release cover can be constructed (see Section A2.2 for cover construction details).
- During construction and at closure, the upper dump surface of the Category S dump should be designed so that it only receives incident rainfall with no run-on from adjacent areas.

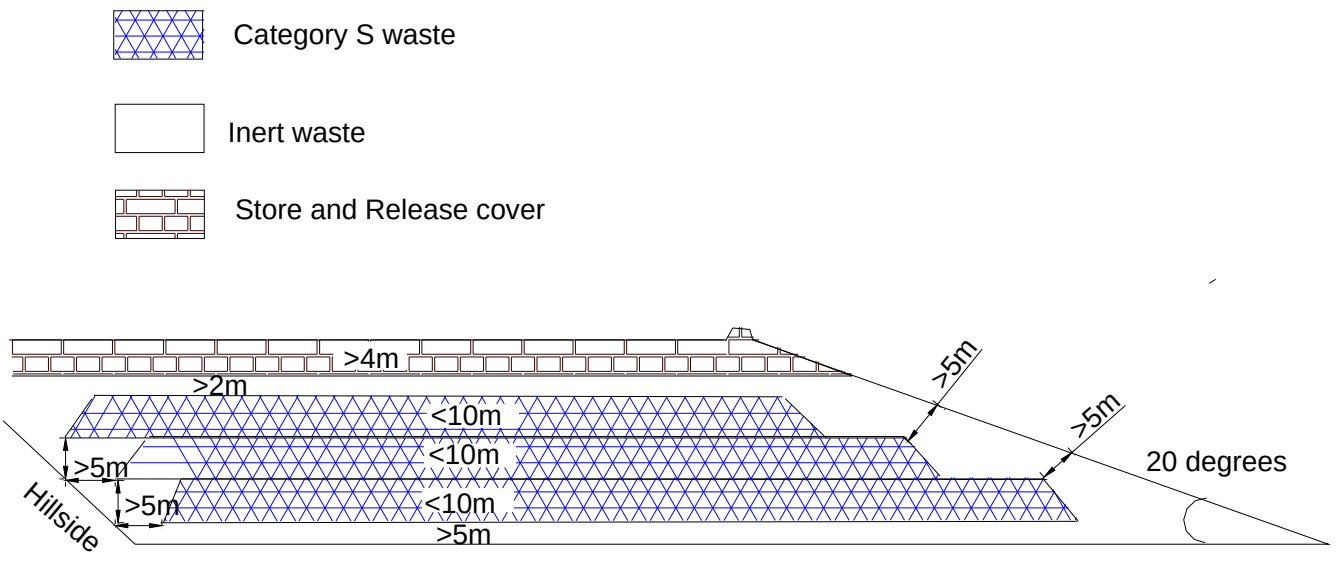


Figure 10: Example of the minimum design criteria for Category S dumps.

[1] Note that this has been changed from 5 m lifts as the gas movement through waste dumps has been shown during ANSTO testing to be diffusive and it is likely that the difference in ARD generation between 10 and 5 m lifts will be negligible. Refer to Feb 2006 ARD meeting minutes.

A1.3.4 Composite Designs

Figure 11 shows an example of a composite Category SR and Category S dump in which Category SR material is excluded from the beneath the slope and Category S material is placed below the slope. Composite dumps of this kind may significantly reduce the residual risk associated with the dump slopes without significantly reducing the total storage capacity for sulfidic material within the dump. There must be at least a one metre buffer (measured horizontally or vertically) between the Category SR and Category S material where they are in close contact on the outer slopes of the Category SR repository.

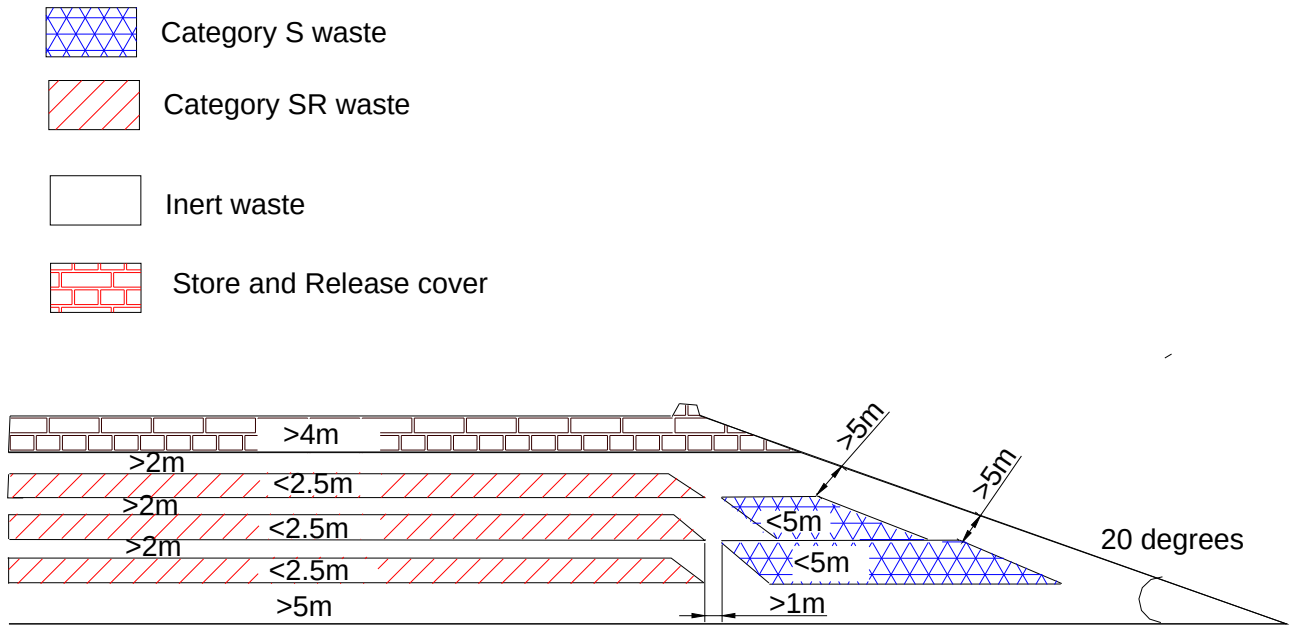


Figure 11: Example of optimum composite designs for Category S and SR dumps.

Appendix 2 : Rehabilitation and Closure

A2.1 Final Landforms

To reduce the risk of erosion and to minimise infiltration, final landforms should be designed in accordance with the following criteria:

- Final waste rock dump slopes must not exceed 20 degrees and may need to be reduced to a shallower angle if the slope is very long and/or if the material is fine-grained and erodable. Design of slopes that are steeper than 20 degrees will require signoff by key stakeholders.
- If a dump slope over a sulfidic material repository needs to be reduced to less than 20 degrees, it must be assured that no sulfidic material will be within 5 metres of the recontoured dump slope as measured perpendicular to the slope. This will most likely require that inert waste rock fill be imported and placed at the toe of the slope rather than significantly expanding the cut made at the top of the slope.
- Final landforms must be designed so that runoff is not directed onto surfaces that are underlain by sulfidic material.
- A 2 metre high by 5 metre wide abandonment bund must be placed around the top of each dump slope. This will prevent runoff water flowing from the dump surface over the slopes and causing erosion.
- If sulfidic material is exposed during the recontouring of waste rock dumps that were created before waste rock segregation was practiced, it must be covered with at least 2 metres of inert waste rock. This will help ensure that the entire final dump surface is able to support vegetation.
-

A2.2 Store and Release Covers

Store and release covers must be constructed on all flat surfaces over Category S and Category SR repositories and over some sulfide/black shale exposures within open pits. Store and release covers are designed to limit infiltration into the underlying waste rock by maximising the evapo-transpiration of incident rain water. The cover is designed to store water near the surface during the wet season so that it can be removed from the cover material and returned to the atmosphere during the dry season by evaporation and plant transpiration.

Waste rock that is used to construct store and release covers must contain sufficient fine-grained material to have both a high moisture retention capacity and a relatively low permeability (i.e. large boulders should not be placed on the cover). Waste rock composed of well-graded clayey, silty, sandy gravel or clayey silty gravely sand makes the best store and release cover material. As a rough guide, waste rock containing more than 1/3 coarse sand size and finer particles (< 5 mm) will make a suitable cover material. **Blocky BIF composed of gravel with very little silt, sand or clay is not ideal** for use in cover construction and should be avoided if another more suitable waste type is available (Figure 12). When possible, oxidised shale should be used in preference to BIF on covers.

During construction there should be regular quality control checks to ensure large boulders have not been placed into the cover.

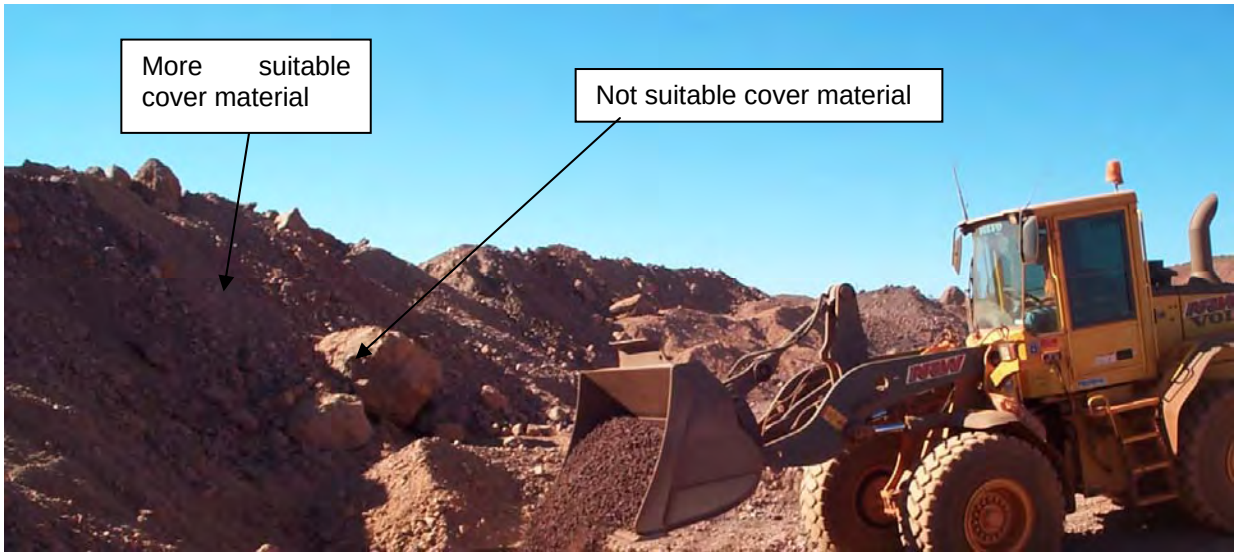


Figure 12: An example of suitable and not suitable material to be used in the construction of a store and release cover.

Waste rock that is used to construct store and release covers must also be able to support vegetation, so materials with high salinity, and acidic or very basic pH should be avoided. The waste rock should be placed in a manner that minimises segregation of the material into coarse and fine particles. For this reason covers should be paddock dumped, they should never be constructed by dumping in two or four metre lifts.

Store and release covers should be constructed as follows (Figure 13):

- Paddock-dump store and release cover material on top of a vehicle compacted surface so that the average depth of the cover material is greater than 2 metres.
- A dozer should then be used to knock down the crest of each paddock dump pile and to fill in the depressions between piles to create a trafficable surface.
- Paddock-dump a second layer of store and release cover material on top of the first lift so that the average depth of the second lift is greater than 2 metres. Vehicle traffic during this dumping will create a compacted layer on top of the first store and release cover layer.
- A dozer should again knock down the crest of each paddock dump pile in the second layer and fill in the depressions between piles to create a surface that is nearly planar.
- Topsoil should be placed on top of the second store and release cover layer. The surface should then be ripped and seeded. Ripping needs to be deep enough (> 0.3 metres) to mix in the topsoil and to ensure that there are not compacted zones that could inhibit plant growth and rooting on top of the upper layer.

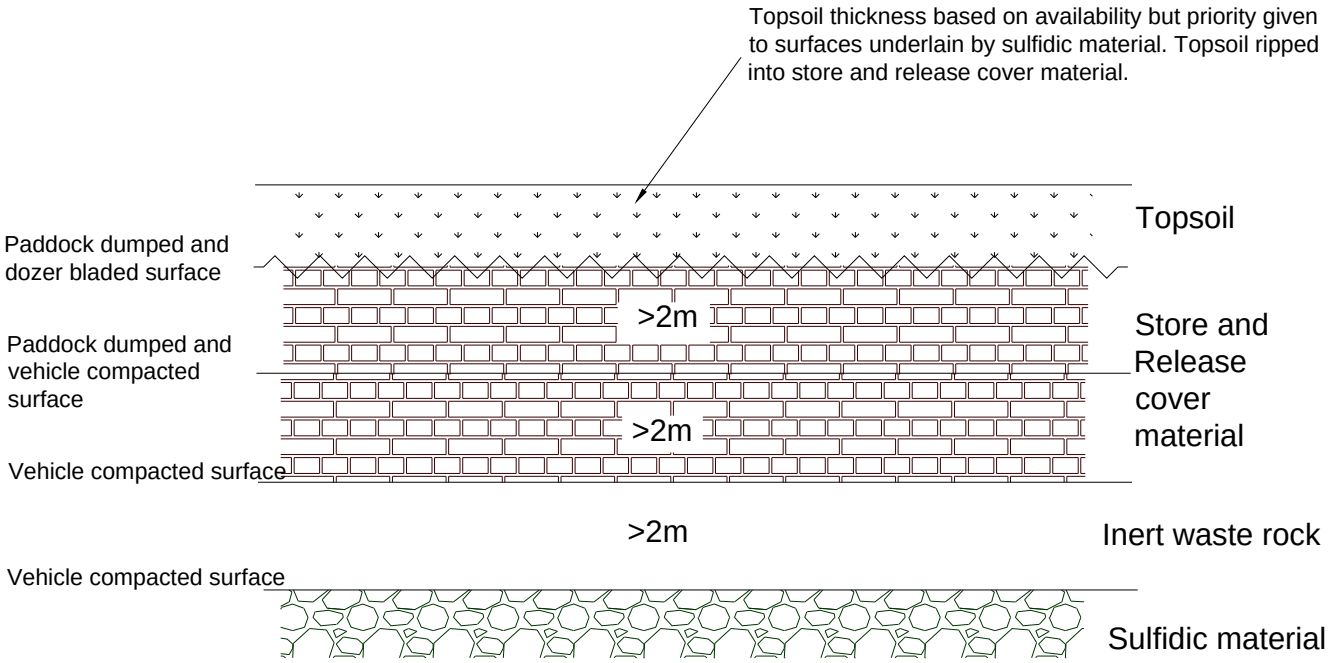


Figure 13: Detail of store and release cover design.

A2.3 Topsoil Management

Although direct planting into inert waste rock is feasible, topsoil placement can greatly accelerate the establishment of native vegetation on waste rock surfaces. This in turn will help to maximise evapo-transpiration, minimise infiltration into the underlying waste rock and inhibit erosion on dump slopes. If topsoil resources are limited, the most benefit for ARD management can be gained by preferentially utilising topsoil for the revegetation of waste rock dumps that contain sulfidic material. In decreasing order of importance, topsoil should be placed on:

1. Dump slopes underlain by Category SR material;
2. Dump slopes underlain by Category S material;
3. Flat store and release cover dump surfaces underlain by Category SR material;
4. Flat store and release cover dump surfaces underlain by Category S material;
5. Store and release covers within open pits;
6. Waste rock dumps that were created before waste rock segregation was practiced and which may contain dispersed black shale or material containing sulfides;
7. Assessable inert waste rock surfaces within pits that contain black shale or sulfidic material exposures; and
8. Waste rock dumps that do not contain any black shale or sulfidic material.

A2.4 Open Pit Closure

The geology and hydrogeology of an open pit will largely control the potential closure issues associated with the final void. Open pits that are located above the water table and which do not contain any black shale or sulfidic material exposures should not pose any geochemical risks at closure. Open pits that intersect the water table but

do not contain any black shale or sulfidic material exposures may ultimately contain saline water bodies with neutral pH that could impact down gradient groundwater. Open pits that contain black shale or sulfidic material exposures will likely contain ephemeral or permanent acidic and potentially saline water bodies that could impact down gradient groundwater and could represent a direct exposure risk to wildlife or humans.

Government guidance clearly indicates that hypersaline pit lakes are considered acceptable as long as down-gradient beneficial use is not impacted. However, the existing guidance also indicates that mitigation measures are required if net acid generating materials such as pyritic black shale are exposed on the final pit walls. In pits with extensive exposures of pyritic black shale that will not be backfilled to above the water table, long term mitigation measures will likely be required to attain the proposed water quality criteria.

The hydrogeological and geochemical behaviour of each pit should be predicted so that it can be managed appropriately at closure to minimise significant groundwater impacts and surface water exposures to wildlife and humans. As discussed in Sections A1.2.1 and A1.2.2 the most protective pit closure strategy is to completely backfill the pit or to backfill the pit to above the estimated pre-mining water table where practicable. Backfilling to above the pre-mining water table should lead to a near complete recovery of the water table elevation and should cut off oxygen to the majority of black shale or sulfidic material exposed on the pit walls.

In order of decreasing benefit, pit backfilling should be prioritised as follows: 1) pits with black shale or sulfidic material exposures that intersect the water table and will discharge to groundwater at closure, 2) pits with black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, 3) pits with black shale or sulfidic material exposures that are above the water table, 4) pits without black shale or sulfidic material exposures that intersect the water table and that will discharge water to groundwater at closure, 5) pits without black shale or sulfidic material exposures that intersect the water table but that will not discharge to groundwater at closure, and 6) pits that do not contain any black shale or sulfidic material exposures and that are above the water table. The proximity to nearby regionally significant aquifers or ecologically significant seeps and springs should also be considered when evaluating potential pit closure issues.

Extensive backfilling is not practicable for many open pits because of the size of the final void and because of pit sequencing issues. Where backfilling is not practicable the following actions should be taken:

- Haul roads and accessible benches that are underlain by inert waste rock should be ripped and seeded to minimise runoff, to promote vegetation establishment and to maximise evapo-transpiration.
- A minimum 4 metre store and release cover system should be constructed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located above the water table and that will not be periodically flooded by cyclone events.
- A minimum 5 metre lift of inert or net neutralising rock should be placed on top of accessible black shale or sulfidic material exposures for those portions of the pit that will be located below the water table or that will be periodically flooded by cyclone events.
- Consideration should be given to covering black shale or sulfidic material exposed on pit highwalls with inert or net neutralising material pushed or dumped from the sides.

An example of these pit closure strategies is illustrated in Figure 14.

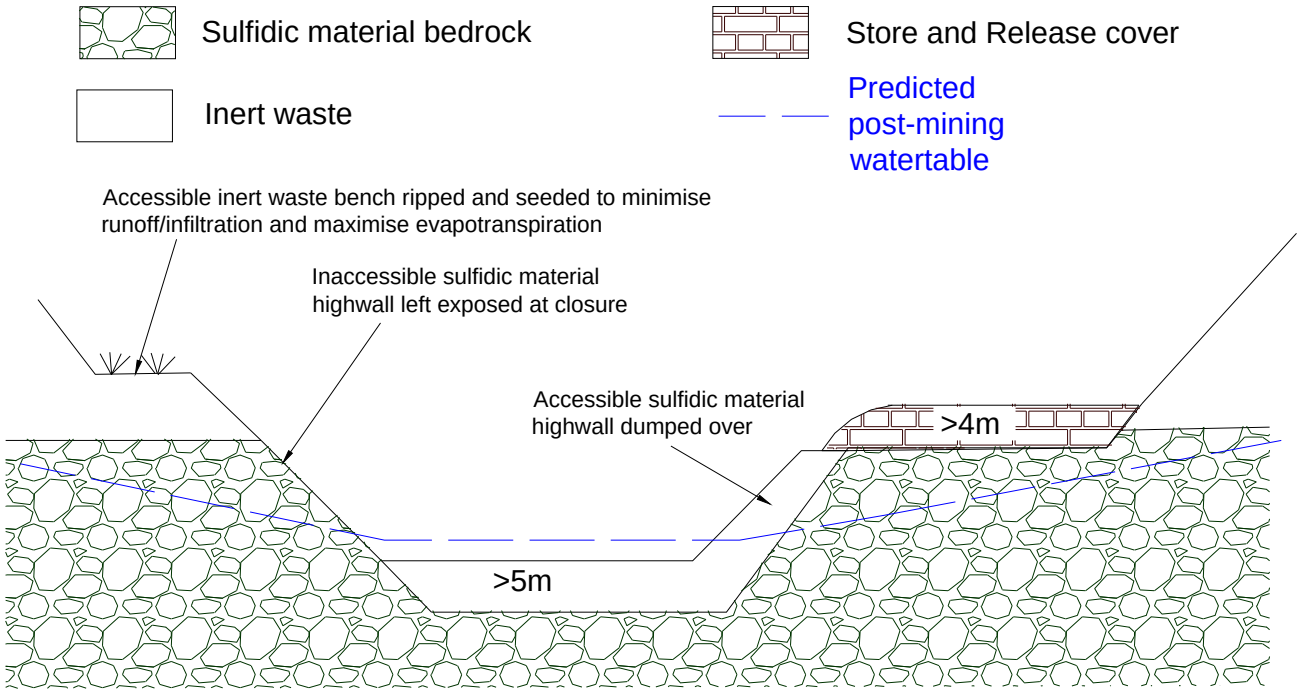


Figure 14: Examples of closure strategies for a pit with sulfidic material that will not be backfilled

Appendix 3 : Contingency Planning

Contingency plans for most upset conditions and unexpected impacts related to sulfidic material management will need to be developed on a case by case basis. Contingency plans will generally be developed by the site Mineral Waste Management team or at a minimum they must be approved by the Team. Contingency plans for spontaneous combustion and inert materials shortages are outlined in the following sections.

A3.1 Spontaneous Combustion

Site specific pit safety procedures should be followed.

All occurrences of burning black shale or lignites must be reported to Mine 2 and the pit safety team as soon as possible. If possible, fires should be extinguished by rapid burial of the burning material under at least five metres of inert waste rock. For locations where this may be difficult such as beneath pit ramps, the black shale or lignite should be covered with as much inert material as practicable. The inert material should be placed so that the upper surface is well compacted and so that side slopes are adequately covered to prevent lateral convective transport of oxygen to the burning rock mass. If rapid coverage is not an option, the material can be excavated and transported to the toe of an advancing inert dump lift where it can be rapidly buried. Water should not be used to extinguish the fire because this could actually enhance the spontaneous combustion risk of black shale or lignite that is not already burning and because the volumes of water that would be required are generally prohibitively high.

A3.2 Inert Materials Shortages

Medium and short term mine plans should be designed so that inert waste rock is produced in adequate volumes and at appropriate times to allow timely encapsulation of sulfidic material. Category SR material requires the highest volumes of inert material (approximately 1:1) because of the requirement for an inert interlayer every 2.5 metres. If there were temporary shortages of inert material, Category SR dumps could be designed with Category S material if it contains a low sulfide concentration, some neutralising potential and low organic carbon (i.e. no black shale or lignite) material. The appropriate material to use in the heat dissipating interlayer should be confirmed as appropriate by Mine Geology. But under no circumstances should Category S material with both elevated sulfide and organic carbon concentrations (i.e. sulfidic shale or lignites) be used. If acid base accounting tests prove the material to be non-acid forming, coarse tails could be used as inert waste in dumps (i.e. EGi 2007). If there is a shortage of inert material then inert waste in other waste dumps may need to be rehandled and transported to the black shale waste dump.

A3.3 Surface Water Management

Every endeavour should be made to divert surface water runoff from contacting black shale or sulfides exposed on pit walls. Site specific cyclone water management plans should be developed that plan for the appropriate disposal of potentially acidic water in pits with black shale exposures.

Waste dumps should have all sulfide exposures covered with inert material during the wet season. A bund at the top of the waste dump surface will reduce any surface water from travelling over the sulfidic material and transporting contaminated drainage into the surrounding environment.

Pipelines transporting acidic water should be shut down and repaired if there is a leak. Acid water pipelines should be labelled with purple stripes and non-acidic pipelines can be labelled with green stripes (as per Australian Standards).

A3.4 Geotechnical Stability

A3.4.1 Pit Walls

Pit walls excavated in Mt McRae Shale are designed with the same concept as for other stratigraphic units. That is, generally we design for a Factor of Safety of at least 1.20 and a Probability of Failure of around 10% on the inter-ramp scale and up to 30% for the batter scale. The management of slopes excavated in Mt McRae Shale is therefore no different from that of any other stratigraphic unit, whereby a process called Geotechnical Design Management is utilised. This involves identifying hazards and hence risks associated with the geotechnical design and undertaking a risk management strategy to minimise these risks. Actions include design review, geotechnical investigation, mapping, conformance to design and monitoring. Contingency plans are established through Slope Management Plans in consultation with mine management.

The occurrence of Mt McRae Shale is of little consequence to the geotechnical management process.

A3.4.2 Dump failures

Whilst no specific stability analyses have been undertaken on Black Shale Waste Dumps, they can generally be considered stable due to the process of encapsulation of the material well within a dump. Also, the process of undertaking earthworks to prepare the encapsulation is considered to add a significant contribution to the stability of the dump location. It is anticipated that future stability analyses may be documented in a Waste Dump Management Plan.

RIO TINTO

Hope Downs 4:
Mineral Waste Management Plan

Mineral Waste Management Plan

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Mineral Waste Management Plan

1 Purpose

This objective of this plan is to detail the mineral waste activities and accountabilities during Expansion Studies and Mine Operation.

The purpose of this document is to plan for management of, and monitor, mineral waste risks. Once a risk is identified a separate plan is required to manage the risk i.e. the Spontaneous Combustion and ARD (SCARD) Management Plan for Operations, site specific process waste/tailings operating plans and site specific asbestiform management plans.

2 Scope

This procedure covers the management of mineral wastes at the Pilbara Iron and Expansion Projects business units of the RTIO (WA) product group. Mineral wastes generated at RTIO (WA) operations include:

- Non-mineralised waste rock (mining overburden)
- Mineralised waste rock (low grade)
- Processed waste rock (tailings)
- Waste rock exposures (pit walls)
- Dredging materials (spoil)
- Quarried rock extracted for construction

Although not a waste, mineralised waste rock or low-grade may have many of the same characteristics and pose many of the same risks as mineral wastes and should also be assessed as a potential contaminant sources.

For the purpose of this document mineral waste excludes:

- Management of landfills
- Products imported to site i.e. hydrocarbons (see Biofarm Remediation Facility and Spill Response procedures)
- Management of sewerage farms
- Dust

3 Requirements, Accountabilities and References for Expansion Studies

This plan provides guideline for mineral waste management that should be undertaken at the different phases of project development. The amount of work in the study stages of order of magnitude, pre-feasibility and feasibility can vary for different projects and therefore work programs should be adapted for each specific project. If a stage such as pre-feasibility is skipped then work that has been identified for this stage must be completed in the feasibility stage of the project (or preferably earlier).

Mineral Waste Management Plan

Requirements

3.1 Resource Evaluation and Mine Planning

The level of mineral waste analysis required must be determined at the scoping stage of the model progression. If it is likely that the deposit will be developed then the Second Phase of mineral waste work can occur immediately without a First Phase program. The minimum amount of work is within Items 3.1.1 to 3.1.5 and work that must be completed before the end of the study is with Items 3.1.6 to 3.1.12.

First Phase

Initial drilling program to broadly define a known mineral deposit (e.g. 400 m x 100 m program).

3.1.1 Visually identify oxidised shale (SHL), black carbonaceous shale (SHC), lignite (LIG) and pyrite (PYT) in all drilled holes and log lithological sequences.

3.1.2 Perform total sulfur analyses on all sampled intervals. The total sulfur results must be compiled in a format that can be used to construct block models.

3.1.3 Analyse representative samples from each waste lithology that surrounds the ore body for the standard chemistry suite.

Drill holes should extend past the orebody to define all waste that could be reasonably disturbed by mining. The samples should have adequate spatial and volumetric representation to reflect possible variability in the lithology and regional structural features.

3.1.4 Measure water table elevation in all drill holes that intersect groundwater.

3.1.5 Follow relevant SWPs and site Management Plans for asbestiform material. Fibre occurrence data should also be recorded. This information should be sent to the relevant Environmental Advisor and the relevant Health and Safety Advisor for notification to the Department of Industry and Resources, and RTIO and Contractor Management.

Second Phase

Infill drilling program to define the orebody for development (e.g. 50 m x 50m)

ARD and Spontaneous Combustion - MCS

See Items 3.1.1 to 3.1.4

3.1.6 If Mount McRae Shale (MCS) might be encountered during future mining, ensure that sufficient drill holes are extended into the MCS to accurately define the geometry of the Footwall Zone/upper MCS contact, define the transition from oxidised to un-oxidised MCS and to define the transition from cold to hot black shale. Sample for total to provide representative samples of FWZ, upper, middle and lower MCS to the Resource Development Specialist Environmental Advisor for full acid/base accounting. Consult a recognised ARD expert to review the results.

3.1.7 Develop resource models for ore bodies that can be used to predict cold and hot black shale production for different pit scenarios. Ensure new resource models classify potential waste rock into no risk (0), low risk (1), moderate risk (2), or high risk (3) sulfide categories.

3.1.8 Unless identified as fully oxidised by drill hole logging, occurrences of MCS below the water table must be assigned to one of the sulfide risk categories (2 or 3).

ARD and Spontaneous Combustion – Sulfides in other Lithologies

3.1.9 If elevated total sulfur concentrations are found in other lithologies contact the relevant Environmental Advisor to arrange a laboratory to send the samples for full acid/base accounting analysis. Consult a recognised ARD expert to review the results.

3.1.10 For elevated sulfides (i.e. S > 0.1%) that are not within MCS (e.g. sulfides in detritals and BIF, whaleback shale, DG) assign it a value in the sulfide risk variable of the Resource model block definition file. Sulfur should always be included in Resource models.

Requirements

Geochemical Risk

3.1.11 In all lithologies sufficient drill holes should extend below the ore body to allow geochemical characterisation of waste material that could be mined. The samples should have adequate spatial and volumetric representation to reflect possible variability in the lithology. In non-sulfide lithologies undertake relevant geochemical analyses of ore and waste.

Asbestos and Asbestiform Minerals

See Item 3.1.5

3.1.12 If asbestiform material is likely to be mined, the model should classify the material into one of the four fibre risk categories: low risk (0), potential risk (1), significant risk (2), known fibre intersects (3) or indicator minerals (9).

3.2 Conceptual/Order of Magnitude

Geology

See Item 3.1

3.2.1 Consider the mineral waste risks of the deposit from know site specific geology information.

Environment

3.2.2 In consultation with relevant groups complete the ARD Hazard Assessment Scorecard. Consult a recognised mineral waste expert for any moderate risks or if there are any doubts with the assessment.

3.2.3 Assess the mineral waste risks based on known characteristics of the ore and waste that will be mined including the amount that will be below the water table (i.e likely quantity of unoxidised material).

3.2.4 Include assessed risks in the Operational Environmental Risk Register (OERR).

3.3 Pre-Feasibility

Geology

See Items 3.2.1

Environment

See Item 3.2.2 to 3.2.4

3.3.1 During pre-feasibility study there should be a conceptual understanding of all potential mineral waste related impacts. Consideration should be given to potential risks from:

- ARD

From waste dumps, pits, dewatering of orebody, dewatering for geotechnical depressurisation.

- Spontaneous combustion in dumps or while using explosives

If pyrite and carbon are present in sufficient quantities.

- Asbestiform material

If intersected during drilling or if fresh BIF is identified for mining.

- Contaminated seepage or surface runoff

If enriched or elevated contaminants in the waste leach into water.

- Salinity

From waste dumps (containing either reactive or inert waste), tailings or pits.

- Nitrogen compounds

From ANFO explosives.

3.3.2 Based on the geochemistry of drill hole data determined by the Geologist, determine the geochemical risk of any enriched contaminants in the waste and ore. Make recommendations for monitoring, management and further analysis. Consult a recognised mineral waste expert as necessary.

3.3.3 Quarry rock should be geochemically characterised. The likely presence of asbestiform material should be

Requirements

reviewed based on the geology.

3.3.4 If the mineral waste is soil or dredged material it should be analysed. Site specific soil or dredge spoil management plans should be developed and followed.

3.3.5 Ensure background surface water quality information is collected (at a suitable frequency to build up the data set). Make recommendations for site groundwater and surface water monitoring based on enriched elements identified by the Geologist.

3.3.6 Make recommendations for monitoring of drinking water bores that potentially contain asbestiform material.

3.3.7 Provide advice for monitoring, management and analysis of mineral waste risks that are flagged by the Evaluation and EP project environment groups.

Hydrogeology Drilling

3.3.8 See Item 3.1.1.

3.3.9 For temporary water bores (< 3 months of use) that intersected sulfidic or black shale material in a location that will not be 100% submerged by water at all times (i.e. the black shale will have some exposure to oxygen or the pump is located near black shale or sulfides) one representative sample should be collected and analysed for the appropriate water chemistry

Compare the results to the relevant ANZECC (2000) or background water chemistry. A hydrogeologist should review the results and determine if the likely ongoing water quality is suitable for purpose. Measurement of pH and EC should be regularly collected and assessed to determine if results are acceptable and do not increase significantly over the period that the water is extracted. If EC concentrations increase significantly another full water chemistry sample should be collected.

3.3.10 For permanent water extraction bores that intercept sulfides or black shale in a location that will not be 100% submerged by water at all times (i.e. the black shale will have some exposure to oxygen or the pump is located near black shale or sulfides), the full water chemistry should be measure during pump testing. Collect a sample 1 hour after the test begins and 1 hour before it finishes. Analyse for the appropriate water chemistry.

Prior to commissioning the bore determine if the water is of acceptable quality. A hydrogeologist should review the results and determine if the likely ongoing water quality is suitable for purpose. Permanent water bores should be analysed for full water chemistry once a year.

3.3.11 For each new deposit that is assessed in pre-feasibility ensure sufficient groundwater samples are collected to represent the background water quality and spatial variability at the site. Enough samples should be collected to represent seasonal variability.

3.3.12 See Item 3.1.5. Determine if there is a risk of intersecting asbestiform material and if so appropriate drilling methods and precautions should be taken, complying with the relevant SWPs and site management plans. Enter data into acQuire such that it is captured in new models that are developed for the site. Information on fibre occurrences should be sent to the relevant Health and Safety Advisor for notification to the Department of Industry and Resources, and RTIO and Contractor Management.

Geotechnical Drilling

See Item 3.3.12

3.3.13 See Item 3.1.1. Waste samples that are in the mining zone should be collected for standard assaying.

3.3.14 If de-pressurisation horizontal dewatering is required (in black shale) the ARD Specialist should be alerted so an ARD risk assessment can be undertaken.

Mine Planning

Mine Planner should consult the SCARD Management Plan for dump specifications, dump locations and open pit closure.

3.3.15 Designs should attempt to minimise potential black shale, sulfidic material or asbestiform material impacts and costs.

3.3.16 Use Reserve models to predict production volumes for potential ARD and asbestiform material.

3.3.17 Five year plans should estimate hot and cold black shale production or sulfidic material production if the

Requirements

sulfides are not in MCS. Quantities should be compared to inert waste production to ensure that sufficient material will be available for dump construction. See the Category S and Category SR dump specifications in the SCARD Management Plan for operations.

3.3.18 Ensure that dumps of black shale or sulfidic material (in BIF or detritals) are sited to minimise long term environmental impacts and financial liabilities. Ensure that appropriate Environment and Hydrogeology groups have been consulted before finalisation of designs.

3.3.19 Final pit and dump designs should be consistent with the requirements of the SCARD Management Plan for operations or existing site Asbestiform Management Plans. If management plans do not exist consult with a recognised ARD expert.

3.3.20 The extent of sulfidic material exposures on final pit walls should be determined.

3.3.21 During feasibility studies, financial analyses should include the additional costs associated with any mineral waste management.

3.3.22 Identify a closure vision, final landform plan and post-closure land use option. Closure studies should consider long term mineral waste risks in the knowledge base.

3.4 Feasibility

Geology

See Section 3.3: Pre-Feasibility

Mine Planning

See Section 3.3: Pre-Feasibility

Hydrogeology/Hydrology/Geotechnical Drilling

See Section 3.3: Pre-Feasibility

Metallurgy

3.4.1 Test work should be performed to determine the geochemical composition of likely fine and coarse process wastes to be produced from the ore of any new development.

Environment

3.4.2 Mine Planning waste dump designs should be reviewed to ensure the long term environmental impact is minimised.

3.4.3 Final pit and dump designs should be reviewed to ensure consistency with the SCARD Management Plan and the Mineral Waste Management Plan (this plan).

3.4.4 If the ARD Hazard Assessment Scorecard indicates there is a moderate ARD risk then a more detailed risk assessment should be completed. The detailed risk assessment should review:

- Background and surrounding environment
- Lithology chemistry
- Chemical Enrichment
- Acid Base Accounting
- Recommendations

The purpose of the detailed ARD risk assessment is to identify the assimilative capacity and ecological sensitivity of the receiving environment and identify work required for a management plan.

3.4.5 If existing management plans cannot be used an ARD, asbestiform or other geochemical risk site specific management plan, should be developed as required.

3.4.6

3.5 Mine Site Development

Study

3.5.1 Any significant volumes of material that are excavated from another site for fill or for the placement of mine

Requirements

infrastructure should be assessed geochemically. This material should also be assessed for the likely presence of asbestiform material. If asbestiform material may be present then an asbestiform management plan should be developed and applied during the excavation.

3.6 Expansion Project General Requirements

Environment

3.6.1 Ensure that Section 3 of this management plan is periodically refined and updated so that it is consistent with current best practice and other management plans and procedures. Any changes to this plan need to be approved by the IEMS steering committee before it is accepted as final.

3.6.2 Coordinate a technical review of Expansion Studies compliance with this mineral waste management plan every two years. It will be sufficient to review 1 case study + a general review of procedures and practices.

3.6.3 Develop, maintain and present a mineral waste training package on relevant aspects of this management plan to all groups involved with mineral waste management in Expansion Studies.

Resource Development

3.6.4 If there are a significant number of mineral waste related actions, develop a study mineral waste working group which meet on a monthly basis to discuss implementation of this management plan, progress, issues and the way forward. Agenda items and meeting minutes should be produced. Draw in expertise into this group from other RTIO, RT and external business units as necessary.

4 Requirements, Accountabilities and References for Operating Mine Sites

The mineral waste management plan for an operating mine site has been written with the following assumptions:

- ❖ No sulfidic material is put through processing plants (i.e. fresh FWZ from Southern Ridge at Tom Price); and
- ❖ Sulfides, asbestiform material and process wastes are the only mineral waste risks in the Hamersley group geology that require special management.

If there is a change to any of these assumptions then this management plan will need to be revised.

Requirements

4.1 Mine Planning

Mine Planning

4.1.1 Inert waste disposal facilities are located in accordance with the Pilbara Iron Landform Design Guidelines and sulfidic waste in accordance with the SCARD Management Plan. To minimise long term environmental impacts and financial liability the waste disposal design should consider:

- Locations that do not impact identified sensitive habitats or culturally significant areas.
- Where unavoidable impacts have been identified in the mine plan, these impacts are at or preferably better outcomes than agreed criteria.
- Locations to minimise contact with surface water bodies, including the diversion of up-gradient surface water flows.
- Designs that maximise their geotechnical stability and to minimise the risk of deep-seated catastrophic failures.
- Designs that facilitates their ultimate closure requirements (such as integration with natural topography and stair-stepping outer dump faces).

4.1.2 Plan and design works for final inert waste rock dump surfaces and inactive open pits in a manner consistent with landform and rehabilitation guidelines. Plan and design works for final sulfidic waste rock dump surfaces and inactive open pits in a manner consistent with the SCARD Management Plan.

4.1.3 All land disturbance projects must consider topsoil recovery and storage in accordance with the Soil Resource Management Plan.

4.1.4 Life of Mine Plans, Reserve models and Five year plans must include estimates of waste production by the different material types. Material with negligible risk can be grouped together however material with higher risk (i.e. asbestiform material and sulfides) should be separated. The life of mine plan for overburden storage should include financial analysis of the different closure options.

4.1.5 Five year plans should include estimates for the first 2 years on:

- The material type, volume and source location of waste (pit by pit), separating out material with a mineral waste risk (i.e asbestiform material and sulfides);
- The volume of process wastes;
- Waste dump locations, footprint and dump capacity;
- Pit and waste dump development strategies – land bridges;
- Clearance areas, topsoil volumes and dump locations;
- Available rehabilitation areas

Any waste with a geochemical (see Section 3.1.7) or asbestiform risk (see Section 3.1.12) should be flagged as a different material type and waste volumes should be calculated.

4.1.6 Any material flagged with a geochemical or fibrous material risk should be managed in accordance with a specific management plan. Currently aside from individual site asbestiform and process wastes/tailings management plans there is the SCARD Management Plan for black shale.

4.1.7 Final pit walls for mine closure must be designed with consideration of geotechnical stability. An

Requirements

abandonment bund outside the zone of geotechnical stability should be included in the design.

Closure Planning

See Item 3.3.22

4.1.8 Review and update the closure management plan with significant changes to the knowledge base and cost estimates.

4.1.9 Undertake a comprehensive technical review of the closure management plans and ensure the plan is externally audited.

Site Planning

4.1.10 Medium term mine plans (2 year plan horizon) should be developed to include:

- Approval request status and action plan
- The material type, volume and source of waste (by pit), separating out material with a mineral waste risk (i.e asbestiform material and sulfides);
- The volume of process wastes;
- Waste dump locations, footprint and dump capacity;
- Pit and waste dump development strategies;
- Clearance areas, topsoil and subsoil volumes and stockpile locations; and
- Available rehabilitation areas.

Any waste with a geochemical (see Section 3.1.7) or asbestiform risk (see Section 3.1.12) should be flagged as a different material type and waste volumes need to be calculated.

4.1.11 Short term plans should be developed monthly to include:

- Material type, volume and source location of the waste (pit by pit), separating out material with a mineral waste risk (i.e asbestiform material and sulfides);
- The volume of process wastes;
- Waste dump locations, 'footprint' and dump capacity;
- Pit and waste dump development strategies;
- As-built designs incorporated into the Mine Design Program; and
- Topsoil and subsoil volumes, source locations and stockpile locations.

Any waste with a geochemical (see Section 3.1.7) or asbestiform risk (see Section 3.1.12) should be flagged as a different material type and waste volumes should be calculated.

4.1.12 Plan and design works for final inert waste rock dump surfaces and inactive open pits in a manner consistent with Pilbara Iron Landform guidelines and the Rehabilitation Handbook. Plan and design works for final sulfidic waste rock dump surfaces and inactive open pits in a manner consistent with the SCARD Management Plan.

4.1.13 All land disturbance projects should consider topsoil and subsoil recovery and storage in accordance with the Soil Resource Management Plan.

Mine Geology

4.1.14 Sulfidic material should be characterised according to the SCARD Management Plan and relevant SWPs

4.1.15 Representative samples from each waste type (including process wastes) reflecting the spatial, physical and volumetric variation should be analysed for solid and liquid extract geochemistry. The samples should represent the spatial and volumetric variability of the lithology in the deposit and should not just be collected from the 1 location in 1 batch. Results should be compared to trigger concentrations and that of the previous years to ensure that they are consistent with the modelled geochemical characteristics of the waste (reactive or inert).

4.1.16 Undertake systematic geochemical characterisation of new materials (new rock types, changed ore mix or type, changed processing or deposition).

4.1.17 Undertake waste material characterisation through the process of blast hole logging and sampling. Waste grade blocks should be generated in the Mine Design Program based on the Mine Geology System (MGS) material type logging and assay results and should be saved in the production database (TPPS). All waste shots that do not have a geochemical risk or asbestiform risk should be tagged by destination as 'W'.

Requirements

Sulfidic material should be tagged according to the SCARD Management Plan and asbestiform materials need to be managed according to the site Asbestiform Management Plan.

4.1.18 Examine any material that is suspected of containing asbestiform material and follow the site asbestiform management plan.

Hydrogeology

4.1.19 For pits that intersect the water table, compile a 'Pit Conceptual Model'.

4.1.20 Geochemical, hydrogeology and hydrology modelling to determine contaminant release from the pit should be undertaken if the report (in Item 4.1.19) finds a significant geochemical risk (i.e. a significant amount of sulfidic material exposed on the pit wall, a significant amount of dewatering occurring over many years, a likely saline and flow through water body etc).

Operational Planning

4.1.21 Create a "Waste Dump Progression Plan" at least every three months to implement the detailed dump designs in the field.

4.1.22 Create "PLOD" sheets to aid dig operators in waste assignment and ensure the Fleet Dispatch Program is working.

4.1.23 Plan and implement rehabilitation works for final waste rock dump surfaces and inactive open pits in a manner consistent with the requirements of the Technical Services Site Planning Group.

4.1.24 Monitor and adjust to reconcile rehabilitation designs with as built specifications as appropriate.

4.1.25 Track material placement so that the mass of inert waste, sulfidic waste, asbestiform material or any other material with geochemical risks delivered to each dump or impoundment is recorded. Record this information within Fleet Dispatch Program.

4.1.26 Perform field inspections to ensure waste is placed as required in dump designs from site planning.

Environment

4.1.27 With assistance of a mineral waste specialist where necessary, analyse the solid and liquid extract geochemistry results that are collected by Mine Geology. If there is deemed to be a geochemical risk in a waste material type then further analytical work should be undertaken and a management plan should be written.

4.1.28 Develop, maintain and present a mineral waste training package on relevant aspects of this management plan to all groups involved with mineral waste management in active operating mine sites. Every 2 years present the training package with assessment of individual's competencies for recording within the Rio Tinto compliance database.

4.1.29 Identify the waste storage facilities at each site that contains mineral waste with a potential geochemical risk to the surrounding environment. The risk of waste within the dump leaching contaminants into the surrounding environment should be assessed and if a risk is identified consult a Mineral Waste expert. Column leach tests may be required to further investigate the risk.

4.1.30 For material identified in 4.1.29 with a mineral waste risk (i.e sulfide or mineral waste asbestos dumps) compile a 'Conceptual Model' that considers environmental risk.

4.1.31 A geochemical model should be created and updated as required for process waste/wet tailings dams.

4.1.32 Ensure that Section 4 of this management plan is periodically refined and updated so that it is consistent with current best practice and other management plans and procedures. Any changes to this plan need to be approved by the IEMS steering committee before it is accepted as final.

4.2 Monitoring

Environment

4.2.1 Organise a once off independent and external review of major inert waste storage facilities. High risk facilities (i.e sulfide and mineral waste asbestiform dumps) should be reviewed every 2 years for compliance with the operational component of this management plan, SCARD Management Plan and site specific management plans. Process wastes/tailings audits are arranged by the plant manager and are excluded from this. Significant issues/actions are to be tracked internally.

4.2.2 Determine the environmental risk of the sites mineral waste based on the annual geochemical

Mineral Waste Management Plan

Requirements

characterisation undertaken by the geologists. Consult a recognised mineral waste expert as required. If a mineral waste risk is identified organise the development of a management plan or modification to the SCARD Management Plan.

4.2.3 Monitor the groundwater levels and water chemistry surrounding geochemically reactive waste facilities and all process wastes/tailings facilities. Advise relevant operations personnel if there are significant changes or non compliance. All monitoring data should be stored in a user friendly database and assigned a unique sample number and sampling date.

4.2.4 Groundwater monitoring should be increased (spatially and temporally) as is deemed necessary in response to any groundwater changes.

4.2.5 Ensure that routine sampling and visual inspection is performed on dewatering discharges and any other water (including water bodies) that may occasionally discharge off site i.e. some tailings facilities. Advice relevant operational personnel if there are significant changes or new non-compliances. All monitoring data should be stored in a user friendly database and assigned a unique sample number and sampling date. Ensure problems are rectified.

4.2.6 Annually investigate the long term trends in water quality. Significant changes in water quality, infiltration rate or other key parameters should be investigated and mitigation actions should be instituted if required.

4.2.7 Perform field inspections to ensure sump construction, rehabilitation and store and release cover performance is consistent with the requirements of the RTIO (WA) Landform guidelines, Rehabilitation Handbook and SCARD Management Plan.

4.2.8 Monitor topsoil in accordance with the Soil Resource Management Plan

4.2.9 Review annually the quantity of material with geochemical risk in each waste dump (i.e. sulfides, asbestos and process wastes/tailings).

Geotechnical

4.2.10 Undertake a regular waste dump audit (active and inactive dumps) to assess conformance to design, impacts on infrastructure and emergency access. Any hazards identified should be reported to Mine Operations.

4.2.11 Monitor the stability of pit wall excavations during operations and make recommendations to Mine Planning for stable pit walls on mine closure.

4.2.12 Inspect process waste/tailings storage facilities monthly. Record any non-conformities as incidents in the Rio Tinto compliance database. Recommend remedial action for any non-conformities. Distribute summaries of the monitoring results for the month and observations of any movements which may have occurred to Shift Supervisors and Superintendents at the plant.

4.2.13 Perform non-routine inspections of the process waste/tailings facility following a heavy rainfall event.
Follow the procedure specified in the site process waste/tailings operating manual.

Pit

4.2.14 Undertake remedial work for actions that arise from the quarterly geotechnical stability audit of waste dumps undertaken by Technical Services. Ensure there is continual follow up of remedial actions.

Plant/Process Wastes

4.2.15 Annually report on the tonnes of coarse and fine process wastes produced to the site environment advisor.

4.2.16 Ensure an independent (of design and ongoing management) audit and review of the wet tailings storage facility occurs annually. External reviews should occur every 2 years. Audit findings and recommended actions should provided to the Plant Manager for distribution and action.

4.2.17 Undertake remedial work for actions arising from the monthly geotechnical stability audits and the annual external audit of the tailings facilities. Ensure there is continual tracking of remedial actions in the Rio Tinto compliance database.

4.2.18 Maintain a current operating plan for the wet tailings storage facility.

4.2.19 Inspect wet tailings facilities at least once per shift and complete a site specific inspection log. Record any non-conformities as incidents in the Rio Tinto compliance database

4.2.20 Prior to entering the wet tailings facility cell for repairs to pumps or pipes the protocol in the site tailings

Requirements

operating manual should be followed.

4.2.21 Ensure the wet tailings facility is regularly maintained in accordance with the site process waste/tailings operating plan.

4.2.22 Maintain a tailings dam failure emergency plan.

4.2.23 Undertake progressive rehabilitation where possible.

4.2.24 Update the tailings management plan every 2 years.

ALL

4.2.25 Any significant modifications in mineral waste generation, handling and disposal processes should be accompanied by a change management process. Changes need to be made to this document by the Site environment Advisor who will need to ensure the document is approved by the IEMS steering committee.

Appendix 6
Flora dust assessment:
Biota (2009)

Biota Environmental Sciences

Biota (n): The living creatures of an area; the flora and fauna together

3 December 2009

Jody Neiman
Environmental Approvals Specialist
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Dear Jody

An Assessment of Dust Loading Impacts on Threatened Flora at Hope Downs 4

Introduction

Biota Environmental Sciences (Biota) was commissioned to carry out a risk assessment of the impacts of dust deposition on Declared Rare Flora (DRF) and Priority flora at the proposed Hope Downs 4 mining operations.

The scope of the review was to identify the dust loading potential of several DRF and Priority flora by examining plant characteristics, as these characteristics influence leaf dust accumulation. This assessment was facilitated using a model developed during University of Western Australia Honours research conducted by Ms Rachel Butler of Biota (Butler 2009).

Methodology

Each species of interest was assigned to a Plant Functional Type (PFT) using the plant characteristics presented in Table 1. This includes a range of relevant leaf morphological traits that may contribute to physical loading and accumulation of deposited dust. Attributes were scored using taxonomic literature relevant to the species, and by verification against type specimens at the Western Australian Herbarium. In some cases, suitable literature was not available (i.e. species with phrase names e.g. *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727)) (see Table 2).

Species were then scored in binary format according to their attributes (see Appendix 1) and resulting scores were compared to functional classification used for perennial species of mulga woodland near West Angelas (Butler 2009). This vegetation type was considered to be sufficiently close for comparison purposes. Using the PFT groupings, dust loading[1] results from Butler (2009) were extrapolated to assess the vulnerability of the species in question to dust deposition.

[1] Dust loading = milligrams of dust per square centimetre of leaf.

Table 1: Plant characteristics used for PFT classification (after Butler (2009)).

Plant characteristics	Categories			
Leaf shape	Linear	Elliptic	Broad	
Height max	Short (< 1 m)	Medium (< 2 m)	Tall (< 5 m)	Very tall (> 5 m)
Leaf size	< 1 cm^2	< 10 cm^2	<50 cm^2	<100 cm^2
Petiole length	None	Short (< 1 cm)	Long (> 1 cm)	
Leaf hairiness	Glabrous	Sparsely hairy	Very hairy	
Leaf resin	Resinous	Non resinous		
Leaf texture	Smooth	Somewhat rough	Rough	Other
Habit	Grass	Herb	Shrub	Tree

Table 2: Details of species of interest.

Species	Family	Resources used for PFT classification	
Rostellularia adscendens var. *latifolia*	Acanthaceae	Adelaide Botanic Garden (1992). Journal of the Adelaide Botanic Gardens 9:266.	Type specimens at WA herbarium
Gymnanthera cunninghamii	Asclepiadaceae	Forster P. I. (1991). A taxonomic revision of *Gymnanthera* R. Br. (Asclepiadaceae: Perplocoideae) in Australia. Australian Systematic Botany 4, 563-569.	Type specimens at WA herbarium
Lepidium catapycnon	Brassicaceae	Hewson H. J. (1981). The genus *Lepidium* L. (Brassicaceae) in Australia. *Brunonia* 4, 217-308.	Type specimens at WA herbarium
Rhagodia sp. Hamersely (M.E. Trudgen 17794)	Chenopodiaceae	Wilson P. G. (1984). *Rhagodia*, Flora of Australia 4: 164-175.	Type specimens at WA herbarium
Goodenia purpurascens	Goodeniaceae	Carolin R. C. (1992). *Goodenia*, Flora of Australia 35: 147-281.	Type specimens at WA herbarium
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	Goodeniaceae	No literature available	Type specimens at WA herbarium
Eremophila youngii subsp. *lepidota*	Myoporacea	Chinnock R. J. (2007). *Eremophila* and Allied Genera, A Monograph of the Myoporaceae, 453-454.	Type specimens at WA herbarium
Eremophila forrestii subsp. *viridis*	Myoporaceae	Chinnock R. J. (2007). *Eremophila* and Allied Genera, A Monograph of the Myoporaceae, 490-495.	Type specimens at WA herbarium
Eremophila magnifica subsp. *magnifica*	Myoporaceae	Chinnock R. J. (2007). *Eremophila* and Allied Genera, A Monograph of the Myoporaceae, 395-397.	Type specimens at WA herbarium
Themeda sp. Hamersely Station (M.E. Trudgen 11431)	Poaceae	Sharp, D., Simon, B. K. (2002). AusGrass: grasses of Australia. CSIRO Publishing. (CD-Rom)	Type specimens at WA herbarium

Results

All of the species except for *Rostellularia adscendens* var. *latifolia* could be placed into PFTs. There were no matches for this species therefore inferences cannot readily be made regarding its susceptibility to dust deposition. A reliable assessment also could not be made in respect of *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727), as this species is an annual and the original PFT analysis of Butler (2009) did not include annual species.

Dust loading potentials were able to be assigned to the remaining eight species (Table 3). Representatives of PFTs 3, 4, 5 and 6 were present amongst the Threatened flora species in question. PFT 3 was not included in the research of Butler (2009) as there were insufficient representatives at the field sites examined in that study, limiting conclusions on the two species belonging to that PFT here. Based on the findings of Butler (2009), susceptibility to dust loading for the remaining species was classified into three categories: Very High, High and Low (Table 3).

Table 3: PFT and dust loading potential of the species examined.

Species	Genus	PFT	Dust loading Potential
Goodenia purpurascens	Goodeniaceae	PFT 3	Undetermined [1]
Lepidium catapycnon	Brassicaceae	PFT 3	Undetermined [1]
Rhagodia sp. Hamersely (M.E. Trudgen 17794)	Chenopodiaceae	PFT 4	Low
Eremophila youngii subsp. l*epidota*	Myoporacea	PFT 4	Low
Eremophila magnifica subsp. *magnifica*	Myoporaceae	PFT 4	Low
Themeda sp. Hamersely Station (M.E. Trudgen 11431)	Poaceae	PFT 4	Low
Gymnanthera cunninghamii	Asclepiadaceae	PFT 5	Low
Eremophila forrestii subsp. *viridis*	Myoporaceae	PFT 6	Very High
Rostellularia adscendens var. l*atifolia*	Acanthaceae	No matches	NA [2]

[1] Annual species for which no reference data are available in Butler (2009).

[2] Species could not be assigned to one of the PFTs of Butler (2009).

The majority of the species of interest belonged to PFTs 4 and 5, both of which have a Low dust loading potential (Table 3; Butler 2009). Only *Eremophila forrestii* subsp. *viridis* is likely to have Very High dust loading potential. However this result may be insignificant as the record of this species from Hope Downs 4 appears likely to be a misidentification. Although *Eremophila forrestii* subsp. *viridis* is shown on FloraBase as occurring from Onslow in the Carnarvon bioregion to as far east as the Great Sandy Desert bioregion, Mr Andrew Brown (*Eremophila* specialist with the Department of Environment and Conservation) recently commented that none of the specimens that he has seen from inland areas have proven to be this taxon. He suspects that subspecies *viridis* is geographically restricted, occurring only in the Onslow locality (A. Brown, pers. comm. to M. Maier, 2009). In addition, it is possible that *Goodenia purpurescens* is also a misidentification as the presence of this species at Hope Downs would be a range extension.

No impacts on plant physiological function were detected for any species studied by Butler (2009), regardless of dust loading. This finding was, however, not fully conclusive as this lack of relationship with dust loading was limited to the specific physiological parameters measured (Butler 2009).

Conclusions and Recommendations

While it is most likely that *Eremophila forrestii* will be most at risk for high dust loading potential, the available data indicate that this dust loading will not significantly impact plant physiological function as measured by Butler (2009). Further research, specific to this taxon and potentially utilising other physiological measures would be needed to refine this assessment. It is also recommended that the identification of *Goodenia purpurescens* is re-confirmed.

The remaining five Priority flora species have Low dust loading potential, and it would appear unlikely that they would be at risk of physiological impacts from this source.

Please contact me, or Garth Humphreys, should you wish to discuss the above.
Yours sincerely,

Biota Environmental Sciences Pty Ltd

Rachel Butler
Botanist

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Hewson, H. J. (1981). The genus *Lepidium* L. (Brassicaceae) in Australia. Brunonia 4, 217-308.

Sharp, D., Simon, B. K. (2002). AusGrass: grasses of Australia. CSIRO Publishing. (CD-Rom)

Wilson, P. G. (1984). *Rhagodia*, Flora of Australia 4: 164-175.

Appendix 1: Scoring of plant attributes

		Species								
Plant Characteristic		*Rostellularia adscendens* var. *latifolia*	*Gymnanthera cunninghamii*	*Lepidium catapycnon*	*Rhagodia* sp. Hamersley	*Goodenia purpurascens*	*Eremophila youngii* subsp. *lepidota*	*Eremophila forrestii* subsp. *viridis*	*Eremophila magnifica* subsp. *magnifica*	*Themeda* sp. Hamersely Station
Leaf texture	Smooth	1	1	0	1	1	0	1	1	1
	Somewhat rough	0	0	1	0	0	1	0	0	0
	Rough	0	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0
Height	Short	1	0	1	0	1	0	0	0	0
	Medium	0	1	0	1	0	1	1	1	1
	Tall	0	0	0	0	0	0	0	0	0
	Very tall	0	0	0	0	0	0	0	0	0
Leaf size	<1	1	0	1	0	0	0	0	0	0
	<10	0	0	0	1	1	1	1	1	0
	<50	0	1	0	0	0	0	0	0	1
	<100	0	0	0	0	0	0	0	0	0
	>100	0	0	0	0	0	0	0	0	0
Hairiness	Glabrous	0	1	1	1	1	0	0	1	1
	Sparsely hairy	1	0	0	0	0	1	1	0	0
	Very hairy	0	0	0	0	0	0	0	0	0
Resin	Resinous	0	0	0	0	0	0	1	0	0
Habit	Grass	0	0	0	0	0	0	0	0	1
	Herb	1	0	0	0	1	0	0	0	0
	Shrub	0	1	1	1	0	1	1	1	0
	Tree	0	0	0	0	0	0	0	0	0
Leaf shape	Linear	0	0	1	1	1	1	0	0	1
	Broad	0	0	0	0	0	0	1	0	0
	Elliptic	1	1	0	0	0	0	0	1	0
Petiole length	None	0	0	1	1	1	1	1	1	1
	Short	1	0	0	0	0	0	0	0	0
	Long	0	1	0	0	0	0	0	0	0
PFT		No match	Group 5	Group 3	Group 4	Group 3	Group 4	Group 6	Group 4	Group 4