Proposed Mesa J iron ore development - Pannawonica

Robe River Iron Associates

Report and recommendations
of the Environmental Protection Authority

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Contents

Figures

Appendices

Summary and recommendations

The proposed Mesa J iron ore mining development is an extension of the existing operations encompassing the mining of discrete mesas adjacent to the Robe River. The proposal includes plans for mining of approximately 600 million tonnes of iron ore over a period in the order of 20 years. The development will require an extension of the proponent's Pannawonica-Cape Lambert railway line to transport the ore to Cape Lambert for processing and export.

Following referral of the proposal, the Environmental Protection Authority required the preparation of a Consultative Environmental Review document. As a result of the consultative review process a number of environmental issues were raised. Of primary concern was the quality of biological information upon which the proponent's identification of impacts and environmental management was based. It was considered by the majority of respondents that this information was lacking. Consequently, further surveys were required to improve the biological data base.

While a number of environmental issues have been considered by the Authority, the two main issues of concern are the impact on the Robe river/Jimmawurrada Creek system and the rehabilitation of the mining operation. The Authority feels confident that with appropriate advice, monitoring and management, impacts on the riverine system can be prevented. Rehabilitation can be acceptably carried out through the appropriate planning, research, and management.

The Environmental Protection Authority is satisfied that this proposal can proceed without causing unacceptable environmental impacts and has recommended accordingly.

Recommendation 1

The Environmental Protection Authority concludes that the proposal to construct and operate an iron ore mining development at Mesa J near Pannawonica, as modified during the process of interaction between the proponent, the Environmental Protection Authority, the public and the government agencies that were consulted, is environmentally acceptable.

In reaching this conclusion, the Environmental Protection Authority identified the main environmental factors requiring detailed consideration as:

- **impact on the Robe River/Jimmawurrada Creek system from both direct disturbance and the effect of dewatering; and**
- **rehabilitation of the disturbed areas.**

The Environmental Protection Authority notes that the environmental factors mentioned above have been addressed adequately by either environmental management commitments given by the proponent, or by the Environmental Protection Authority's recommendations in this report.

Accordingly, the Environmental Protection Authority recommends that the proposal as described in the Consultative Environmental review could proceed subject to:

- **the Environmental Protection Authority's recommendations in this Assessment Report; and**
- **the proponent's commitments to environmental management (Appendix 1)**

Recommendation 2

The Environmental Protection Authority recommends that to ensure protection of the Robe River/Jimmawurrada Creek system from unacceptable detrimental impacts from the mining operation, the proponent should carry out the following:

- **exclude mining for a distance of not less than 100 metres from the edge of the Mesa J escarpment along the Robe River;**

- the alignment of the rail route from Mesa K to Mesa J should utilise the option along the Jimmawurrada Creek escarpment; and
- ensure that a saline water body is not left in the pit after mining has ceased, to the satisfaction of the Environmental Protection Authority.

Recommendation 3

The Environmental Protection Authority recommends that the proponent ensure there are no unacceptable detrimental effects from the construction and mining operations on vegetation, water levels, or water quality in the Robe River/Jimmawurrada Creek system. Accordingly, the proponent should prepare and subsequently implement an environmental management programme to meet this objective, to the satisfaction of the Environmental Protection Authority. The programme should include:

- a drainage management plan to protect the system from the impacts of pollution or sedimentation. This should be carried out prior to construction;
- a dewatering management plan to protect the Robe River/Jimmawurrada Creek system. This plan should be prepared in consultation with the Department of Conservation and Land Management, prior to dewatering commencing.

Should the environmental management programme identify any adverse effects, the proponent should report these immediately to the Environmental Protection Authority together with a plan of remedial action. It should be the responsibility of the proponent to identify and ameliorate any adverse environmental impacts.

Recommendation 4

The Environmental Protection Authority recommends that within six months of the commencement of mining of Mesa J, the proponent should prepare and subsequently implement detailed ongoing rehabilitation plans for the operation to the satisfaction of the Department of Mines. These plans should be updated annually with a brief outline of status and future plans.

Recommendation 5

The Environmental Protection Authority recommends that the proponent should be responsible for final decommissioning and removal of the plant and installations and rehabilitating the site and its environs. Accordingly, at least twelve months prior to final decommissioning the proponent should prepare and subsequently implement, a decommissioning and rehabilitation plan to the satisfaction of the Department of Mines.

Recommendation 6

The Environmental Protection Authority recommends that the proponent implement a programme to monitor the impact of mining on the recreational and tourist use of the Deepdale area in consultation with the Social Impact Unit.

1. Introduction

A proposal to extend iron ore mining at Pannawonica has been assessed by the Environmental Protection Authority. The proposal from Robe River Iron Associates for mining at Mesa J is a continuation of the mining of deposits located in mesas adjacent to the Robe River. The Mesa J deposit is located at Deepdale, 14 km south-west of Pannawonica in the Pilbara region of Western Australia (Figure 1).

The proposal was referred to the Environmental Protection Authority in February 1991. Subsequently, a level of assessment of Consultative Environmental Review was set for the proposal owing to a number of factors including, the proximity to the Robe river/Jimmawurrada Creek system, and dewatering associated with the mining operation.

2. Project description

The proposed Mesa J mining development is a continuation of the sequential development of proven iron ore reserves along the Robe River Valley. This proposal relates to an iron ore mining operation of 600 million tonnes over a period of approximately 20 years.

The major components of the proposed development include:

- Site preparation, including overburden removal and stockpiling of ore which will be extracted along the rail alignment to be constructed on the eastern escarpment of the new Mesa J deposit.
- Construction of a 10.4 km railway to the Cape Lambert - Pannawonica railway, including a new rail yard, a causeway and bridge across the Robe River and a loadout facility adjacent to the new mining area. The proposed railway alignment is along the eastern edge of Mesa K, crossing the Robe River at its confluence with Jimmawurrada Creek, along the eastern edge of Mesa J, then south over flat terrain beyond the mining area (Figure 1).
- Construction of new facilities and associated infrastructure to support the mining operation.
- Provision and upgrading of services (i.e. roads, power) to the mining area. Realignment of the gravel road from Millstream to Deepdale is required due to the location of the proposed pit and railway tail track.
- Development of facilities to enable dewatering of that portion of the ore body below the water table.

The construction workforce will be accommodated in existing company facilities at Pannawonica with possible overflow accommodated in a temporary construction camp located on the site of the previously existing camp.

At Mesa J the blasted ore will be picked up by front end loaders or electric shovels and placed into haul trucks. The trucks will carry the ore across the mesa top to the loadout adjacent to Jimmawurrada Creek on the eastern edge of Mesa J. Ore will then be transported by rail to the existing crushing and ship loading facility at Cape Lambert.

Approximately 42% of the estimated 600 million tonne ore body lies below the water table. Dewatering is required to access this ore progressively through the mine life. Evaluation of dewatering requirements have been investigated based on groundwater studies carried out on the deposit. Dewatering is expected to commence during Year 3 of mining and extend throughout the mine life utilising a combination of bores and sumps to obtain the desired reduction in water table. In accordance with the development plan, it is proposed to dewater ahead of mining using perimeter bores. Water from mine dewatering will be transferred to the downstream section of the Robe River to prevent cyclic ingress to the mining areas.

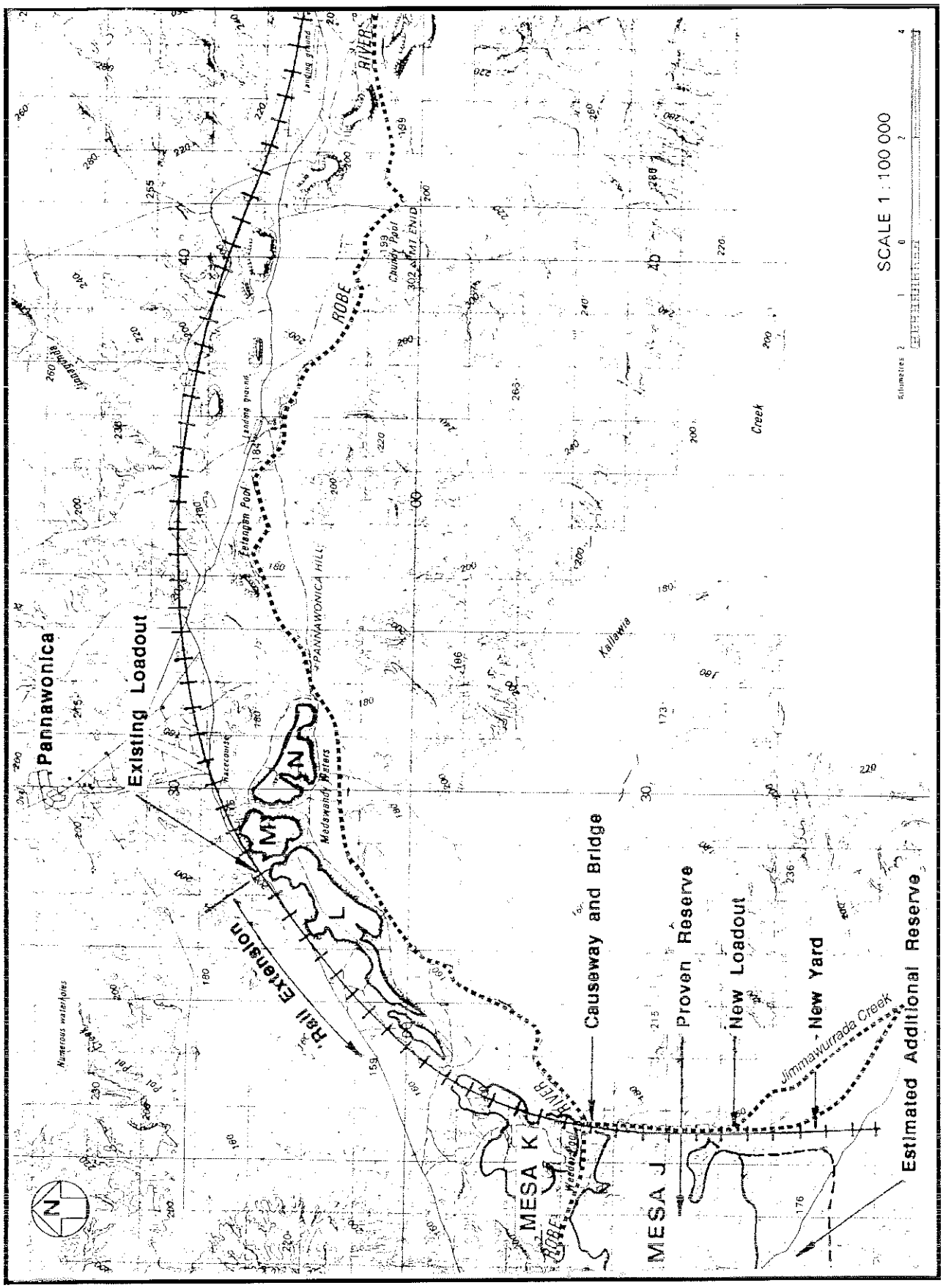

Figure 1. Location of project and facilities

3. Existing environment

The Mesa J development covering an area of 1500 hectares occurs within the Yalleen Station pastoral lease which has an area of 314, 835 ha, the predominant landuse being cattle grazing.

The deposit consists of up to 50 metres thickness of pisolitic ironstone (the Robe Pisolite), overlying basement rocks of Proterozoic age. The Pisolite crops out along the Robe River, and underlies Quaternary sediments elsewhere in the region. The Robe Pisolite in Mesa J occupies an area of approximately 3 x 3.5 km on the south-western side of the Robe River - Jimmawurrada Creek confluence.

The Robe River is the largest drainage in the immediate area, covering a linear distance of 190 km, 63% of which is upstream of Mesa J. Its immediate valley is 300-500 metres wide and is generally underlain by approximately 20 metres of gravelly alluvium with local deposits of deeper sedimentary material. River flows arising from rainfall generally occur at least once per year.

The position of the Mesa J ore deposit in relation to Robe River and Jimmawurrada Creek is shown in Figure 1. Jimmawurrada Creek enters the Robe River between Mesas J and K, and has a catchment of some 1,365 square kilometres. The valley of Jimmawurrada Creek is approximately 350 metres wide at its confluence with the Robe, whilst its floor lies at 150-160 metres AHD.

Both the Robe River and Jimmawurrada Creek drainages are intermittent, however the Robe, in particular, carries significant underflow in its alluvial bed. Permanent pools in the river channel are maintained by this underflow, however their position within the valley tends to change following each seasonal flood event.

Groundwater in the lower reaches of the Robe River is recharged entirely by surface run-off and river flows, downstream of the Kumina Creek area. At present, groundwater from the Mesa J orebody mostly discharges to the river, except during periods of high flows when there is local reversing of the hydraulic gradient and water flows from the river to the pisolite. When the deposit is dewatered and the resultant drawdown reaches the Robe River, water will flow back into the pisolite from the gravels even when the river has no surface flow.

The area has a variety of vegetation types, ranging from spinifex (*Triodia* and *Plectrachne*) grasslands on the mesa, to woodlands and forests along the major creeks and Robe River. It appears that the *Triodia* flats, riverine and mesa scarp habitats support the richest fauna in terms of species and biomass.

The permanent pools of the Robe River are an important component of the river ecosystem supporting a diverse range of aquatic fauna and acting as refuges during periods of drought.

4. Environmental impacts and their management

Following consideration of the Consultative Environmental Review, submissions from the public and government agencies, and the proponent's response to them, the Environmental Protection Authority has determined that the proponent has satisfactorily addressed the relevant issues associated with the proposed development and that the consequent impacts can be managed. This environmental management of the development can be achieved by a combination of the proponent's original and supplementary commitments and the recommendations of the Environmental Protection Authority.

Recommendation 1

The Environmental Protection Authority concludes that the proposal to construct and operate an iron ore mining development at Mesa J near Pannawonica, as modified during the process of interaction between the proponent, the Environmental Protection Authority, the public and the government agencies that were consulted, is environmentally acceptable.

In reaching this conclusion, the Environmental Protection Authority identified the main environmental factors requiring detailed consideration as:

- **impact on the Robe River/Jimmawurrada Creek system from both direct disturbance and the effect of dewatering; and**
- **rehabilitation of the disturbed areas.**

The Environmental Protection Authority notes that the environmental factors mentioned above have been addressed adequately by either environmental management commitments given by the proponent, or by the Environmental Protection Authority's recommendations in this report.

Accordingly, the Environmental Protection Authority recommends that the proposal as described in the Consultative Environmental review could proceed subject to:

- **the Environmental Protection Authority's recommendations in this Assessment Report; and**
- **the proponent's commitments to environmental management (Appendix 1)**

The Authority notes that during the detailed implementation of proposals, it is often necessary or desirable to make minor and non-substantial changes to the designs and specifications which have been examined as part of the Authority's assessment. The Authority believes that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

The Authority also considers that any approval for the proposal based on this assessment should be limited to five years. Accordingly, if the proposal has not been substantially commenced within five years of the date of this report, then such approval should lapse. After that time, further consideration of the proposal should only occur following a new referral to the Authority.

4.1 General

The majority of submissions on the proposal were critical of the quality of biological information supplied by the proponent in the Consultative Environmental Review. The information supplied was considered to be out of date and not directly applicable to the project area. Given the importance of baseline biological information for both the determination of the importance of an area, and as a data base to assess the significance and severity of environmental impacts of a project, the Authority requested that further biological surveys should be carried out. These surveys have been carried out and have been included in the assessment of the proposal. A summary of the biological surveys is presented in Appendix 3 of this report.

It is understood the proponent does not at this time have firm plans for future mining areas beyond Mesa J. However, as future mining plans become more definitive it would be advantageous to begin biological survey work. This serves to broaden the biological data base of the region in which the proponent is mining which will allow ease of access to information for environmental impact studies for present and future needs. It is important to collate and document the biological variations over the areas studied to allow adequate assessment of their relative importance.

4.2 Impacts on the Robe River/Jimmawurrada Creek system

4.2.1 Mining and transport

From the biological surveys carried out as part of the environmental impact assessment process and presented as an addendum to the Consultative Environmental Review, it is apparent that the Robe River and the adjacent mesa scarp are areas of high conservation value, providing habitats that support a range of flora and fauna. The proponent has recognised the importance of minimising direct impacts upon this environment and has mentioned that the Mesa J escarpment

along the Robe River will be excluded from mining. The Authority considers that this intention should be formalised , and has made a recommendation to this effect (Recommendation 2).

Robe River Iron Associates has put forward a number of options regarding the location of the rail route from Mesa K to Mesa J, ranging from an alignment on the eastern side of Jimmawurrada Creek to one on the top of Mesa J. The two favoured options are similar, with the difference being that one is located within Jimmawurrada Creek and the other is located 100 metres to the west nestled into the creek escarpment. In order to minimise the disturbance to the creek system from the effects of vegetation clearing and increased sediment load from a rail embankment sited within the creek the Authority favours the option of locating the rail route on the Jimmawurrada Creek escarpment. This is a compromise between the location in the creek and the location on the mesa top.

Recommendation 2

The Environmental Protection Authority recommends that to ensure protection of the Robe River/Jimmawurrada Creek system from unacceptable detrimental impacts from the mining operation, the proponent should carry out the following:

- **exclude mining for a distance of not less than 100 metres from the edge of the Mesa J escarpment along the Robe River;**
- **the alignment of the rail route from Mesa K to Mesa J should utilise the option along the Jimmawurrada Creek escarpment; and**
- **ensure that a saline water body is not left in the pit after mining has ceased, to the satisfaction of the Environmental Protection Authority.**

4.2.2 Drainage and dewatering

A number of submissions stressed the importance of the permanent pools and associated riverine vegetation to the river environment. These pools support a diverse range of aquatic fauna and specialised flora species. Two aspects of the mining development have the potential to significantly effect this environment. These are, sedimentation of the pools through turbid drainage water, and dewatering of a portion of the orebody.

Clearing associated with the construction and mining operations, and the presence of unconsolidated stockpile areas has the potential to increase sediment loads in run-off to the river and degrade the water quality in the permanent pools. Proper management of drainage is required to ensure this does not occur.

To allow access to ore reserves below the water table it is proposed to begin dewatering of that portion of the ore body after approximately 3 years of mining. Modelling of dewatering requirements has predicted a significant fall in the water table in the vicinity of the mine. However, the implications for the integrity of the permanent pools and vegetation of the Robe River/Jimmawurrada Creek system from dewatering and the subsequent discharge are not certain. It is therefore important that monitoring be carried out to alert the proponent to any deleterious environmental impacts associated with the dewatering programme on the integrity of the permanent pools and the health of the riverine vegetation. This will allow modification to the programme to ameliorate such impacts.

Recommendation 3

The Environmental Protection Authority recommends that the proponent ensure there are no unacceptable detrimental effects from the construction and mining operations on vegetation, water levels, or water quality in the Robe River/Jimmawurrada Creek system. Accordingly, the proponent should prepare and subsequently implement an environmental management programme to meet

this objective, to the satisfaction of the Environmental Protection Authority. The programme should include:

- **a drainage management plan to protect the system from the impacts of pollution or sedimentation. This should be carried out prior to construction;**
- **a dewatering management plan to protect the Robe River/Jimmawurrada Creek system. This plan should be prepared in consultation with the Department of Conservation and Land Management, prior to dewatering commencing.**

Should the environmental management programme identify any adverse effects, the proponent should report these immediately to the Environmental Protection Authority together with a plan of remedial action. It should be the responsibility of the proponent to identify and ameliorate any adverse environmental impacts.

4.3 Rehabilitation

Community expectations for the rehabilitation of mined lands have increased significantly over the last decade. It is recognised that for rehabilitation to be effective it must be integrated into the mining plans, not left to the conclusion of mining. Rehabilitation is made more difficult by the location of the site in a fragile, arid environment which recovers slowly from disturbance. The proponent has outlined general methods to rehabilitate the site with a commitment to implement land form stabilisation and revegetation programmes at the site. An important part of this programme is the backfilling of the open pit with waste material.

The Environmental Protection Authority considers that the proponent's general outline of the proposed rehabilitation methods are satisfactory. However, a well designed site specific programme will be required.

Recommendation 4

The Environmental Protection Authority recommends that within six months of the commencement of mining of Mesa J, the proponent should prepare and subsequently implement detailed ongoing rehabilitation plans for the operation to the satisfaction of the Department of Mines. These plans should be updated annually with a brief outline of status and future plans.

Recommendation 5

The Environmental Protection Authority recommends that the proponent should be responsible for final decommissioning and removal of the plant and installations and rehabilitating the site and its environs. Accordingly, at least twelve months prior to final decommissioning the proponent should prepare and subsequently implement, a decommissioning and rehabilitation plan to the satisfaction of the Department of Mines.

4.4 Social monitoring

Mining operations at Mesa J appear compatible with general tourist activities in the area such as the Panna regatta in the nearby mining town of Pannawonica as well as tours of the mine site itself. Conflict is apparent however with tourist operators and recreational users seeking an outback, or wilderness experience. The impact of the proposal on the recreational users of the area was a key issue in the Consultative Environmental Review guidelines for the proposal.

The proponent states that while adventure type tours do operate in the region there is none within the vicinity of the proposed mining operation. This statement is contradicted by a tour operator in the region who states that he does operate tours in the Deepdale area. The operator

also expressed concern at the potential for environmental impacts from the mining operation affecting the recreational and tourist values of the Robe River Valley in the area.

The proponent has displayed little appreciation of the potential impact of mining on tourism, maintaining that the area of their mining lease is its only concern and that they have no responsibility to consult with recreational users or tourist operators in the area other than to respond to specific requests for information. As a result there is little information provided in the document or in the proponent's response to submissions about where tourist operators take tours in relation to the proposed mine site, and therefore few conclusions can be drawn about the impact of mining on the tours. Baseline data should be collected by the proponent relating to which areas are used by tourist operators and their relationship to present and future mining activities.

Recommendation 6

The Environmental Protection Authority recommends that the proponent implement a programme to monitor the impact of mining on the recreational and tourist use of the Deepdale area in consultation with the Social Impact Unit.

5. References

Robe River Iron Associates (1991). Proposed Iron Ore Mining at Mesa J, Deepdale - Consultative Environmental Review.

Appendix 1

Summary of proponent's commitments

Summary of commitments

Robe River Iron Associates undertakes to comply with each of the commitments which are made in this CER to the satisfaction of the relevant statutory authorities. Individual commitments that are made are reiterated and enumerated in this section.

1. The proponent will develop and implement environmental monitoring and management programmes for the mining operation and associated activities in the course of project implementation, to comply with the Environmental Protection Act 1986, the Acts administered by the Mines Department, and the Iron Ore (Robe River) Agreement Act, 1964.

2. The proponent will comply with the provisions of other relevant Government Acts and Regulations for the duration of the project, in recognition of the requirements and specifications of the Iron Ore (Robe River) Agreement Act, 1964.

3. The proponent will assign environmental monitoring and management responsibilities to an Environmental Officer for the duration of the project.

4. The proponent will develop and implement an environmental awareness programme for all construction and operational workforce at the implementation phase of the project, and will continue it during ensuing years.

5. The proponent will minimise as far as practicable, recognising the requirements of mining and ore transfer, direct and indirect alteration of the physical environment for the duration of the project to comply with the Environmental Protection Act,1986, the Acts administered by the Mines Department, and the Iron Ore (Robe River) Agreement Act, 1964.

6. The proponent will control and monitor and manage noise, occupational and ambient dust, erosion, stormwater discharge, and sewage disposal for the duration of the project to conform with Acts administered by the Mines Department.

7. The proponent will implement landform stabilization and revegetation programs in the project area for the duration of the project to conform with Acts administered by the Mines Department.

8. The proponent will monitor and manage dewatering of the mining area, and discharge of excess water to adjacent watercourses, to conform to Mines Department and the Water Authority Legislation.

9. The proponent will take appropriate steps to protect, monitor and manage hydrology and vegetation within the adjacent riverine environment, to conform with Acts administered by the Water Authority and the Environmental Protection Act, 1986.

10. The proponent will monitor and manage any scour or siltation in the Robe River and Jimmawurrada Creek adjacent to the project, and will implement remedial works if deemed necessary by expert opinion in consultation with the Water Authority.

11. The proponent will minimise, as far as practical, disturbance to culturally significant sites for the duration of the project, in accordance with the provisions of the Aboriginal Heritage Act, 1972.

12. At the completion of the project, the proponent will prepare the site for abandonment in accordance with the requirements of the Mines Department and in recognition of the requirements of the Iron Ore (Robe River) Agreement Act, 1964, including as applicable.

- Re-establishment of pre-existing drainage patterns as far as can be practicably achieved;
- The initiation of stabilisation and revegetation activities to stablise structures and communities;
- The mining plan will be modified to incorporate the return of as much waste rock to the mined out pit as can be practically achieved.

Appendix 2

Proponent's response to submissions

1. Introduction

This document forms Robe River Iron Associates' principal response to comments regarding the Consultative Environmental Review (CER) for the proposal to mine Iron Ore at Mesa J, Deepdale. Specifically, this document responds to the following:

- Environmental Protection Authority (EPA) correspondence to the Company dated 1st June 1991.
- EPA correspondence to the Company dated 9th July 1991.
- Social Impact Unit correspondence to the EPA regarding the CER, dated 27th July, 1991.

The specific responses to comments are accompanied by Addendum A to the CER, which examines rail alignment options. The appendix to Addendum A examines flood design factors for the project. Both have been previously provided to the EPA for review.

Two further Addendums to the CER, consisting of the detailed findings of recent biological survey work will be provided to the EPA in the near future, when taxonomic processing is complete. Summary reports which describe the preliminary results of the survey work are provided in this document.

2. Responses to specific comments

Summary

1. Summary, Item 7. "The mesa and valley landforms" of the Robe River system are not, as the CER states "similar to many areas" in the Pilbara, nor are they "widespread" in a regional sense.

Response

The Company maintains its general comments regarding the similarity of the mesa and valley landforms of the Robe River to other parts of the Pilbara and offers the following data by way of substantiation.

1.1 Introductory remarks

Before reviewing the regional distribution of mesa landforms in the Pilbara region the fundamental parameters of assessment must be considered and resolved.

Firstly, the level of technical sophistication at which assessment should be carried out must be defined, which in turn requires definition of both the purpose of the assessment, and the characteristics of the "audience" on who's behalf the assessment is being conducted.

The purpose of examining landform/landscape characteristics is to determine the degree to which changes to the Mesa J landform/landscape will affect regional amenity in relation to beneficial uses. By definition, and within the context of this assessment process, principal beneficial uses would include passive recreation-landscape appreciation and environmental protection with reference to more scientifically sophisticated technical definitions and assessment criteria.

Within the broader community, on whose behalf this work is being carried out, the beneficiaries of the landscape/environmental resources under review are considered here in two fundamental groups:

1. The general public, which is by far the largest group and can be fairly characterised as having a comparatively low level of technical knowledge of geomorphology and landforms, but sometimes well formed opinions regarding aesthetic qualities.

2. The more technically educated sector of the community, which is the minority group.

This review recognises the distinctions which are made above and discusses the regional representation of mesa and related landforms at two levels of technical detail, appropriate to the two community groups.

1.2 Regional perspective - General landform/landscape factors

Mesa J is not a true mesa in the strict sense, in that it is not bounded by escarpments on all sides but merges with gently undulating plains in its southern quarter. Its fundamental landform features are the escarpment, gullies and gorges, scree slopes and gently undulating upland surface (see Plates 1 to 3).

Of the landform features noted above, those which are principal contributors to Mesa J's aesthetic dimensions in terms of landscape, could be reasonably defined as the deep-red rocky escarpment, the gullies and gorges and the scree slopes. The adjacent riverine vegetation is also distinctive.

The scope of review now broadens to the characteristic landscape features of the coastal parts of the Pilbara in general. Of the prevailing landscape features it is reasonable to conclude that deep-red rocky escarpments are the most visually remarkable and distinguishing landscape feature, whether they are manifest within the landscape as heavily dissected gorges or as discrete boundaries to residual mesa landforms. Plains and scree-slopes with hummock-grass cover are distinctive and common, whilst winding tracts of riverine vegetation are also distinctive and common, but on a regional scale occupy a much smaller total area.

Three geological formations in the Robe River area develop landforms featuring the characteristic deep-red rocky faces and associated gorges and gullies which typify the Mesa J escarpment and are characteristic of the area. These are:

- The Robe Pisolite, which forms the Mesa J deposit, other mesas both to the east and west of the project area on the Robe River, and many other active and former drainages in the region (see Plate 1);
- the Marra Mamba Formation which forms the western escarpment of Mesa J, and the northern escarpments of Jimmawurrada Creek (see Plate 4), and
- the Brockman Iron Formation which forms the tall faces of Yeera Bluff to the west of Mesa J (see Plate 5), and is extensive throughout the Hamersley Ranges.

Similar distinguishing features of the escarpments which are developed from these formations are as follows:

- Under the influence of internal structure and erosion, each develops steep or near vertical escarpments at the boundary of their outcrop, which may vary in scale and proportion but are nevertheless escarpment landforms. To the untrained eye, and even with some instruction, it is difficult to distinguish from which geological formation a particular escarpment has been formed.
- To varying degrees, each geological formation forms escarpments which have a definable scree slope.
- Each of the geological formations develop escarpments in which the rocky faces have the typical deep-red colouring, which is characteristic of a much broader area within the Pilbara.

When the distribution of landforms and landscapes with these general attributes is examined in detail, it may be concluded that many similar areas exist. This applies particularly in the regions to the south and south-east of the project area within a radius of approximately 150km from Mesa J, and also to the west within a distance of 50km.

Similar landform/landscape areas also exist at more remote locations to the east, over distances of up to 300km.

These include discrete mesas, escarpments backed by flat stony plains (Mesa J), or higher more weathered sediments, bluffs, gorges and gullies which may be widely observed adjacent to the Robe, Cane and Fortescue River areas.

For confirmation of the regional distribution of Robe Pisolite, Marra Mamba and Brockman Iron Formations, reference is made to the Geological Survey of Western Australia 1:250,000 Geological Series and Explanatory Notes, with specific reference to the following sheets:

- Yarraloola (1972)
- Wyloo (1986)
- Pyramid (1966)
- Mt Bruce (1964)
- Marble Bar (1978)
- Roy Hill (1965).

In addition, for confirmation of the topographic characteristics of the outcrop areas of the formations noted above, reference is made to the Australia 1:100,000 Topographic Survey Map Series, with specific reference to the following sheets:

- Yarraloola (1976)
- Cane River (1977)
- Pannawonica (1976)
- Mt Stuart (1979)
- Elvire (1974)
- Farquar (1975)
- Hardey (1977)
- Cooya Pooya (1975)
- Millstream (1990)
- Jeerinah (1989)
- Rocklea (1989)

This mapping data provides confirmation of the wide distribution of the general landform types discussed above.

1.3 Regional perspective - vegetation structure

Vegetation is a further factor requiring consideration when evaluating landscape on a regional basis. For an assessment of fundamental attributes using comparability criteria appropriate to the community group 1 defined above, vegetation structure is considered to be the most appropriate measure of comparability.

For an assessment of the characteristic vegetation structures which are found at Mesa J and in adjacent terrain, reference is made to the document Vegetation Survey of Western Australia-Pilbara 1:1,000,000 Sheet 5 and Explanatory Notes (Beard, 1975).

In mapping vegetation structures at scale 1:1,000,000, the need to use broad categories to achieve a meaningful distribution map has resulted in the use of very simplified structural descriptions for the vegetation. It is considered that the structural categories which were used by Beard have good application to the assessment of vegetation structure in the context of landscape characteristics, and have been widely accepted for general assessment where more detailed information is unavailable.

Sheet 5 (Beard 1975) describes the Mesa J vegetation as "Shrub Steppe", which is further characterised as hummock grassland with sparse shrub overstorey.

The distribution of vegetation which has shrub steppe structural form is shown on Figure 1.

It is also relevant to note that the "tree steppe" structural form mapping unit utilised by Beard in the noted reference, occupies a broad expanse of adjacent terrain to the shrub-steppe structural form and from a general landscape perspective has a similar appearance to shrub steppe. The fundamental distinction between these two vegetation structures is the relative abundance of trees.

Plates 6 and 7 illustrate the local examples of areas mapped as shrub steppe and tree steppe for comparison.

The purpose of providing this data is not to assert that there are large areas of precisely equivalent vegetation to that which occurs on Mesa J, but to demonstrate that there is a continuum of vegetation in the region which has quite consistently similar structural (and to some extent floristic) characteristics over a wide area, of which Mesa J is only a small part.

The riverine vegetation in the vicinity of Mesa J consists predominantly of *Eucalyptus camaldulensis*, *E. coolibah*, and *Melaleuca leucadendra* in associations of varying densities and spatial distribution. An open forest of *Eucalyptus camaldulensis* and *Melaleuca leucadendra* occurs mostly in the siliceous alluvial sands and ironstone shingle beds of the main drainage channels of the Robe, flanked by the same species but in an open woodland formation. On the drier fringes *M. leucodendron* is lost and the complex is dominated by *E. camaldulensis*, with *E. coolibah* on slightly higher ground.

The regional distribution of the above species and associations has been documented in the EPA publications; "Inland Waters of the Pilbara, Parts 1 and 2" (1988 and 1989 respectively). Riverine habitats where *E. camaldulensis* and *M. leucadendra* occur together include the Ashburton, Fortescue, Yule, Shaw, De Grey, Oakover and Davis Rivers. Associations of *E. coolibah* and *M. leucadendra* have been recorded from the Fortescue , Turner, De Grey and Oakover Rivers. Associations where all three species have been recorded at individual survey sites include the Fortescue River, approximately 50 km north of Mesa J, and on the Turner River approximately 275 km north east of Mesa J.

It should be noted that due to taxonomic difficulty in separating *E. camaldulensis* and *E. coolibah* unless the specimens are flowering or fruiting, associations of all three species may be more frequent than the present data base indicates. Nonetheless, the above data confirms that vegetation structural forms comprising these three riverine species found commonly in the Robe River valley, have a wide regional distribution.

More detailed botanical data describing the vegetation and flora of the Mesa J project area and surrounds, has been developed by detailed survey carried out in July 1991. The findings of the survey work are described in the addendum to the CER which will be provided separately to this document (see Addendum B).

1.4 Distribution Of Robe Pisolite

A more technically sophisticated consideration of the regional distribution of mesa landforms can be carried out by restricting reference to mesa formations to those which are formed from the Robe Pisolite.

Surface expressions of the Robe Pisolite Formation occur at a very large number of locations throughout the region, associated with former or active drainage lines. Using the 1:250,000 Geological Series as the basis for review, the occurrences of Robe Pisolite are summarised and described below.

Not all occurrences of the Robe Pisolite are in mesa formations identical to those of the Robe River Valley, however each expression has at least some (if not all) of the essential morphological features found in the Deepdale area. There is a definable family of mesa and related landforms of which the Deepdale deposits, including Mesa J, are members. The generally discernable forms are described as follows;

Type A. Discrete mesas, individually or in groups separated by scree slopes and coalescing piedmont such as those along the Robe River (see Plate 8) and near Red Hill Creek, Beasley River and Hardy River;

Type B. 'Partial' mesa formations in which one or more sides of the outcrop are scarped, whilst the remainder merges with plains (such as Mesa J), or gently undulating or more elevated and dissected terrain (see Plate 2);

Type C. Escarpments which are overlain by and/or merge with topographically higher and/or more dissected sediments, typically Brockman Iron Formation, such as those in the Robe Gorges (see Plate 9).

The distribution of the various mesa forms noted above and of the Robe Pisolite in general, as described on the 1:250,000 geological sheets, is summarised below. Figures 2 to 5 illustrate the location and distribution of Robe Pisolite on the Yarraloola, Wyloo, Pyramid and Mt Bruce sheets.

a) Yarraloola Sheet

Robe Pisolite mesa landforms occur at the following locations:

i) Dukes Creek headwaters - **seven** small discernable mesas.

ii) Peters Creek Headwaters - **six** small discernable mesas.

iii) Robe River Valley between North West Coastal Highway and the headwaters adjacent to Mt Elvire and south - **seventy nine** individual occurrences.

iv) Jimmawurrada Creek - **twenty eight** mapped occurrences (mainly small).

v) Bungaroo Creek - **thirteen** mapped outcrops.

vi) Red Hill Creek - **fifteen** mapped outcrops.

vii) Waramboo Creek - **ten** mapped outcrops.

viii) North of Three Peak Hills - **eight** mapped outcrops.

Within the area encompassed by the Yarraloola sheet, it is reasonable to conclude that the Mesa J general landform/landscape type, with **166 discernable occurrences,** is common.

The occurrences listed above are within an oval shaped area with length 75-100 km and width 50 km and therefore could also be reasonably described as widespread within this area.

b) Wyloo Sheet

Outcrops of Robe Pisolite are often narrow or relatively small but are numerous and widespread on this sheet. In addition to Type A above, which is common on the Cane River, (for example), the mesas also occur as the escarpments of valley and gorge formations in association with Wyloo group sediments, in a similar topographic configuration to Type C above.

The following occurrences are discernable:

i) Cane River - **forty three** occurrences, generally Type A above.

ii) Urandy Creek - **four** occurrences, mainly Type A above.

iii) Near Urandy Well - **six** occurrences.

iv) Bulgeeda Creek area - **seventy two** outcrops in association with Brockman Iron formation and Jeerinah Formation.

v) Duck Creek area - **eleven** outcrops

vi) Area north of Hardy River - **thirty one** outcrops similar to Type C above.

A total of **167** individual areas of Robe Pisolite are discernable on the Wyloo sheet, spanning an area of approximately 150km by 40 km.

c) Mt Bruce Sheet

Robe Pisolite is common on this geological sheet, in close association with drainages which are presently active, and mainly as Types A and C above. Deposits include the following:

i) Duck Creek tributaries - **thirty nine** occurrences.

ii) Beasley River - **twenty three** outcrops of very similar topography to the Robe River deposits.

iii) Hardy River deposits - **eighteen** outcrops several of which closely resemble Mesa J in topographic form.

iv) Mt Tom Price area - **eight** discernable deposits.

v) Mt King area - **twenty eight** mapped outcrops similar to Type C.

In total, **116** mapped deposits of Robe Pisolite occur on this sheet, within an area of approximately 50km by 30km.

d) Pyramid Sheet

Robe Pisolite landforms occur at the following locations:

(i) Portland and Dawson River - **27 occurrences.**

(ii) Kanjenjce Creek - **5 occurrences.**

(iii) Balveerina Creek - **1 occurrence.**

(iv) Cheeny Well area - **9 occurrences.**

(v) Robe River area - **five occurrences** as discreet mesas.

In total, **forty-seven** Robe Pisolite outcrops are evident on the Pyramid Sheet.

e) Marble Bar and Roy Hill Sheets

In terms of geographical distribution, these sheets have slightly more restricted occurrences of Robe Pisolite compared to the areas previously discussed. However in certain areas of occurrence as noted below, the outcrops are locally abundant along the drainage lines.

i) Beabea Creek - **eight** small occurrences.

ii) Turner River area - **twelve** small occurrences.

iii) East Strelley River - **one** occurrence.

iv) Dales Gorge - **four** discrete escarpments of Type C above.

v) Yandicoogina Creek - **forty-two** occurrences, mainly Type A.

vi) Weeli Wolli Creek - **four** small discrete areas.

vii) Mindy Creek - **three** discrete areas.

viii) Shaw River - **nineteen** discrete occurrences.

ix) Bonnie Creek - **sixteen** discrete occurrences.

x) Nullagine River - **nine** discrete occurrences.

In total, **118** mapped deposits of Robe Pisolite occur on these sheets.

1.5 Conclusion

The comments noted above regarding landform, landscape, vegetation and geology are all derived from verified data available in the public domain, and in the Company's opinion demonstrate the validity of statements contained in the CER.

2. Summary, Item 8. The Iron Ore Agreement Act of 1964 is not a good demonstration of 1991 environmental commitment to environmental management. Reference to it is almost irrelevant.

Response

The Iron Ore (Robe River) Agreement Act (1964) is the fundamental code of practice and operations with which the Company must abide. The Act was amended in 1987 to include requirements for environmental monitoring to determine the effectiveness of management measures, and to report the results of monitoring at specified intervals. An appropriate extract from the Act is given as Appendix 1. Reference to the Agreement Act is fundamental and routine in day to day operations, and reference to the Act cannot be considered irrelevant.

It should be noted that Robe River Iron Associates has in place an ongoing programme of environmental management and reporting for the whole of the mining and materials export operation, which is in the care of the various internal divisions and a full-time Environmental Affairs Manager and assisting staff.

Environmental monitoring work which has been carried out by the company at its own initiation include the following programmes.

- Colour and infra-red photographic monitoring of shoreline and mangrove communities at Cape Lambert and surrounding areas, which has been carried out annually since 1977, to monitor the biological status of mangrove communities in the zone of possible influence from port operations.
- Baseline sediment, water and biological monitoring programmes of coastal and mangrove environments to determine whether export operations contribute contaminants to the local environment.
- Monitoring of the status of the marine environment by bi-annual underwater photographic survey and ecological research of regional conditions and relative factors.
- Routine surveys of oil management and active recycling of oil waste to the power station to be used for energy recovery.
- Routine management and monitoring of dust and noise.
- Progressive research, development and implementation of mine rehabilitation methods.
- Ongoing review and assessment of alternative methods for power station cooling water circuit fouling control by chlorination which is the current practice, in relation to environmental factors.

In conclusion, the Company conforms with, and in many instances exceeds, its Statutory obligations for Environmental Management and for the most part has implemented this work at its own initiative.

3. Summary Item 9. Although there is a commitment to minimise environmental impacts and to monitor, there is no commitment to make good any problems identified in the course of monitoring, particularly problems not anticipated or outlined in the CER. Monitoring programme reporting requirements must be determined by EPA.

Response

The purposes of the monitoring programmes to which commitment has been given are:

- to determine the success of environmental management methods;
- to enable improvement and refinement of management approaches, and
- to detect and resolve any impacts which have not been anticipated.

The monitoring programmes which have been anticipated and planned by the Company since the outset of the Mesa J development programme are described in the CER.

Reporting requirements in relation to environmental monitoring programmes are incorporated in the agreement Act as previously mentioned, and will be observed together with any additional reporting which is considered necessary.

Evaluation of Alternatives

4. Section 3.0 (page 11). On-site discussions held with Mr Daryl Calvin, Mr Mat Daly, Mr David Button (all of Robe River Iron Associates) Mr Steve Vellacott (EPA) and Mr Keith Collins and Mr Denny Roberts (both of Department of State Development) revealed that the proponent had considered several detailed options during planning for the project. Keith Collins, Denny Roberts and Steve Vellacott stressed the need for Robe to clearly identify these options (preferably with plans) indicating alternative rail routes, road haul routes and even alternative mining sequences, in the CER document. This has not been done.

Response

The level of information provided by the CER was considered by the Company to be appropriate for a Consultative Environmental Review document. The company also notes that following review of the draft CER it was found to be suitable for distribution, subject to some minor amendments, which were duly incorporated. There was no request for additional

information following the review of the draft document, although this could readily have been supplied.

As requested, a more detailed treatise covering the engineering alternatives which were considered in the course of developing the present preferred approach, has been prepared and is presented as Addendum A to the CER. Reference to this document is made in relation to this comment. The additional information supplied in the addendum is a summary of the extensive analysis of engineering alternatives which has been carried out over recent years to identify the most acceptable approach to the development of the Mesa J deposit.

The contents of Addendum A have also been presented and explained to the EPA Project Officer and an opportunity given for direct questions and comments.

Project Description

5. Section 4.2.1 (page 13). Mentions assessing the "likely effect of alternative bridges and rail causeways upon Robe River flood levels ..." but these assessments relate only to variations in design at only one site. They do not discuss the costs and benefits of alternative sites, or of trestle spans beyond 200 metres in length (see Section 6.2.3). The reasons for selecting a 300m bridge length compared to 200m (or 800m for that matter) are not explained in this Section, nor adequately explained in Section 6.1.1.

Response

This matter is addressed in detail within addendum A to the CER.

6. Section 4.2.1. (page 16). The construction of a heavy haulage road and light vehicle access road across Robe River has significant potential for environmental impact. An outstanding Cadjeput (Melaleuca leucadendra) forest exists in this part of the river valley, and significant wetlands also occur in the vicinity. The proposed routes and specifications should have been clearly elucidated in the report as should the proposed load-out facility and the proposed realignment of the Millstream-Deepdale road.

Response

The location of the proposed new loadout is shown clearly on Figure 4.1 of the CER.

Addendum A to the CER contains information which will clarify the proposed locations and design specifications for the heavy haulage and light vehicle access road, together with the route proposal for re-alignment of the Millstream-Deepdale Road. The Department of State Development, on behalf of the Company, will liaise with the Shire of Ashburton regarding the realignment, in accordance with the 1964 State Agreement Act.

The Company is well aware of the inherent qualities of the *Melaleuca* forest vegetation in the Robe River both in this specific project area and in other locations in the general area. Every effort will be made to minimise the environmental impact of creating a service corridor across the Robe River. Whilst the creation of the corridor will require some *Melaleuca* forest vegetation to be removed, and the Company is regretful of this requirement, it should be clearly recognised that this service is an **essential** part of the project. The road will be necessary for the initial construction of mining service facilities for the Mesa J project, and will also be the principal access between the project area and existing mining facilities and workforce accommodation at Pannawonica.

7. Section 4.2.3 (page 18). EPA should be advised of additional bore location and proposed pipeline route prior to its development if an additional potable water supply is required for the mine.

Response

The EPA will be advised of water supply proposals prior to their implementation, as a matter of routine.

8. Section 4.3.1 (page 19). There needs to be a commitment that mine (rock) waste will be returned to the mined out areas as a matter of on-going mine plan policy, except where this is clearly impractical.

Response

The company commits to the replacement of mine waste rock within the excavation area to the greatest practical extent, for the lifetime of the project.

9. Section 4.3.4 (page 22). Washdown water will contain oils and other contaminants. A "land application" method of disposal should be considered. Also, incineration of waste oils should be in power station or such other use, rather than incineration without deriving any energy value from it. Scrap steel should be separated from "general rubbish" for recycling. All fuel and lubricant drums should be recycled.

Response

The company will manage washdown water in accordance with requirements. Land application is one possible option for management which is presently under review.

The Company's present management practice is to recycle waste oil as fuel for the power station at Cape Lambert and it is anticipated that this practice will continue, provided there are no future technical constraints in terms of power station operation.

Whilst recycling of scrap steel will be carried out as far as practical, there are difficulties in re-use of 200 litre fuel drums as local fuel suppliers will not accept empty drums. The company would be pleased to participate in recycling schemes should these be implemented.

10. Section 4.3.5 (page 22). Now that Robe has approval to produce 32Mt per annum, dewatering may commence in less than 3 years. The increased rate of mining might also mean an increased rate of pumping. Proponent should advise EPA of revisions as they are made. Disturbance of wetlands is a primary concern, as is the potential for weed infestation and drowning of vegetation.

Response

Increases to the rate of mining will not require the volumetric pumping rate to be increased, however, the timetable for dewatering will be modified. The company will advise the EPA of any revisions which are needed regarding the mine dewatering programme.

Environmental management objectives implicit to the dewatering programme will incorporate weed management and protection of riverine vegetation from both excessive water levels and excessive periods of inundation.

Existing Environment

11. Section 5.1 (page 28). Makes reference to a sparsely distributed pastoral population, but this Section and Section 1.6 both neglect to inform the reader of the relationship between the proponent and the lessee other than to say the proponent doesn't expect a significant impact.

Response

The Company maintains a written agreement with the operators of the local Pastoral lease regarding the procedures which must be observed by both parties, as joint users of the general area and specific locations.

Whilst relationships with local pastoral interests have always been harmonious and the Company will continue to foster this position, the agreement is a confidential matter which the Company does not wish to discuss in the public domain. However, the agreement can be sighted by appropriate EPA representatives at the Company's head office in Perth, should this be considered necessary.

12. Section 5.4.1 (page 33). What statistical and other evidence is there to support the estimated 1 in 100 year flood stream flow of 16,000m^3/second? What margins of scientific error? Without good reliability on this figure, rail alignment, bridge design and potential environmental impact may be somewhat different to what is predicted.

Response

The hydrology of the Robe River and Jimmawurrada Creek has been studied in detail by specialist Hydrology and Engineering Consultants. A copy of the most up to date of a series of reports prepared by the consultants on the company's behalf, has previously been provided to the EPA for review, and a further copy is provided as Appendix 1 to Addendum A.

The statistical reliability of the hydrological data base is consistent with traditional engineering standards for structures of this type and of this level of importance to the success of the project.

Inadequate attention to hydrological factors in design of the rail service infrastructure would risk the security of ore supply and therefore the ability of the Company to meet its contractual obligations, and also to the safety of personnel. To this extent, the Company does not consider itself to be in need of superintendence regarding engineering design standards.

13. Section 5.4.2 (page 36). How high is "high hardness"? This is relevant to the long term water quality of the lake in the finished mine.

Response

For reference purposes, groundwater quality data which is representative of the local groundwater and which will be the source of water in any future water body is provided in Appendix 2. This data has been collected from water samples taken during groundwater hydrological investigations which have been in progress since 1984.

In terms of the implications for lake water quality, the Company now plans to fill the mined out pit as far as is practical, as detailed in Response 40.

14. (i) As has been mentioned by other submissions (CALM) the biological information is inadequate. In terms of determining the environmental impacts of the proposal this deficiency makes it impossible to measure without adequate baseline information. Similarly this lack of data makes any substantive discussion of regional conservation issues meaningless.

Response

The biological data base held by the Company for the Mesa J area is more extensive than that which was presented in the CER. The purpose of limiting the data incorporated within the CER was to reduce its overall size and bulk, although additional more detailed data could have been readily incorporated following review of the draft document.

Additional detailed biological surveys of the project area have recently been conducted by the Company in response to the EPA's stated position and are separately reported in Addendum B and C. It should be noted that the Company's internal environmental management programme has always incorporated plans for additional and ongoing biological survey work for the Mesa J Project (see Commitments 1 and 9 in the CER), but not necessarily within the timeframe which has now been specified by the EPA.

It should also be noted that in preparing the CER for the Mesa J project, reference was made to previous environmental assessment documents for similar mining projects in the area. In this regard, particular reference was made to the Public Environmental Review (PER) for the Yandicoogina (Marrilana Creek) Project. The level of biological information provided in the Mesa J CER was of a very similar nature to that provided in the above PER, even though the assessment level for the current proposal is lower.

It is also noted that the biological data supplied for the Yandicoogina project area was collected in 1981, some seven years prior to the referral of this project to the EPA, but was considered adequate for assessment.

14. (ii) Section 5.5 (page 36,37). Melaleuca leucadendron should be Melaleuca leucadendra. There is no mention of Eucalyptus coolibah (should be between B and D). Eucalyptus terminales should be E. terminalis. Acacia citrinoviridus and A. xiphophylla should not be found on elevated mesa tops. E. dichromophloia is now E. terminalis. E. brevifolia is more likely to be E. leucaphloia.

Response

(i) This response document and future management reports will utilise the spelling according to Green (1985), i.e. *Melaleuca. leucadendra*..

The spelling of the *Melaleuca* species in question has been found to vary between reference documents. The documents listed below utilise the spelling given in the CER, ie "*M. leucadendron* ".

- Sharr, F.A. (1978).Western Australian Plant Names and their Meanings. UWA Press
- Beard, J.S. (1975). Vegetation Survey of Western Australia, Pilbara 1:1,000,000 Vegetation Series, Explanatory Notes to Sheet 5, UWA Press.
- Wells, B. and B., (1982.). The Wild Pilbara. The Jaycees Community Foundation Inc.

It is also noted that the Environmental Protection Authority Publication entitled "Inland Waters of the Pilbara, Western Australia, (Part 1 and 2)", Technical Series No 10, January 1988 uses the spelling *M. leucadendran*, which is a third variation of spelling for this species.

(ii) *Eucalyptus coolibah* is often very difficult to distinguish from *E. camaldulensis*, particularly if flowering material or fruit cannot be obtained for inspection. The recent survey work confirmed the presence of *E. coolibah* in the project area, occurring on slightly higher ground than the *E. camaldulensis*. For further detail regarding this matter reference is made to Addendum B to the CER.

(iii) It is acknowledged that *Eucalyptus terminales* should be spelled *E. terminalis*, and that *E. dichromophloia* is now *E. terminalis*.

(iv) The CER stated that *Acacia citrinoviridus* or *A. xiphophylla* occurs on the elevated mesa tops. Site investigations have confirmed that *A. xiphophylla* does indeed occur on the elevated mesa tops adjacent to the Robe River. *A. citrinoviridus* has been identified on slopes between the elevated mesa surface and Jimmawurrada Creek in the southeast of the deposit.

14. (iii) Section 5.6 (page 40). A systematic survey of fish and invertebrate fauna should be carried out for the study area, and the regional significance of the species and their habitat should be determined. The EPA has rightly recognised wetlands as having very significant conservation values. The whole Robe River system missed out on inventory work carried out for the "Inland Waters of the Pilbara" studies. Aquatic plants also need to be recorded and their regional significance determined.

Response

A systematic survey of the fish and invertebrates of the project area has been carried out and further monitoring work is planned. The results of the survey work are reported in detail in Addendum C to the CER. The aquatic flora of the project area has also been surveyed and is described in Addendum B.

15. Section 5.6 (page 40). Caves extending up to 15 metres into escarpments are identified as a habitat, but there is no discussion on what inhabits them. Caves of this depth are not widespread and common, and because fauna using them are isolated from other similar habitat, they require some investigation.

Response

Recent field surveys of fauna populations at the project area gave special emphasis to cave habitats within the mesa escarpment and the species which utilised these habitats.

For discussion of the survey findings reference is made to the preliminary summary report of the fauna survey which is given here in Section G.

As noted in other responses, much of the Mesa J escarpment along the Robe River will be excluded from mining.

16. Section 5.6 (page 41). There is no referencing of surveys done in the past on fauna sampling, etc. It is therefore not possible to verify the integrity of the data. The importance of *Diplodactylis savagei* should not be dismissed with a comment that it is a cryptic species. The 3 endemic species (a frog and two lizards) are not identified, and their regional significance is not discussed. The occurrence of the rock wallaby (*Petrogale rothschildi*) in the area is also significant. The "poor trapping results" should have been overcome by further work over the past ten years. It is possible that the rare (Schedule 1 of Wildlife Conservation Act) Pebble Mound Mouse (*Pseudomys chapmani*) and Olive Python (*Morelia olivacea barroni*) may be in the area.

Response

The first sentence of Section 5.6 identifies the author of the fauna studies as Natural Systems Research Pty Ltd, referenced as BHP (1980b). Natural Systems Research Pty Ltd also completed fauna species lists for the Yandicoogina iron ore project, published in EPA Bulletin 323, 1988.

A detailed survey of the fauna of the Mesa J area has recently been carried out to supplement the data previously collected, as presented in Addendum C. The importance and occurrence of Savage's Gecko (*Diplodactylis savagei*), the rock wallaby (*Petrogale rothschildi*), Pebble-mound Mouse (*Pseudomys chapmani*) and the Olive Python (*Morelia olivacea barroni*) are discussed in the above report.

In brief, six Pebble-mound Mouse nests were found in the south west corner of the deposit, however none were extant, with estimated most recent usage of between 5 and 10 years ago. The Pilbara Olive Python was not recorded during the course of the survey. Ongoing survey work will monitor this area.

The three endemic Pilbara herpetofauna identified in the CER as occurring in the area are the frog *Pseudophryne douglasi*, and the two lizard species *Diplodactylis savagei* and *Ctenotus duricola*. Their occurrence and regional importance are also discussed in Addendum C.

17. Section 5.7.2 (page 45). The name of the tribe to which the consulted Aboriginal people belong is not mentioned. Only neighbouring tribes are mentioned in Section 1.6. Is the W.A. Museum satisfied with the consultation and site clearances? The aims of the "consultative field trip" relate to checking the overall ethnographic data base and clearing the river crossing. There is no discussion on dialogue between the custodians and the proponent concerning sites not impacted by the river crossing, but potentially impacted by the mining operation and other ancillary activity.

Response

The tribe to which the consulted aboriginal people belong is the Chalyana Clan, who are the traditional owners of the Deepdale region.

A submission regarding the Mesa J project has been made to the Registrar, Department of Aboriginal Sites and will be reviewed by the appropriate Committees on the 2nd of August, 1991.

ENVIRONMENTAL IMPACTS

18. Section 6.1.1. (page 49). The proponent refers to leaving portions of Mesa J intact. These areas should be identified on the air photo/plan. Some impressions of final visual nature of landform should also be given. Where very significant Aboriginal sites exist and require protection from disturbance, a management plan should be prepared to avoid inadvertent disturbance.

Appendix 3 of this document provides a colour aerial photograph of the project area at scale 1:40,000, with those areas which will be isolated from the influence of mining clearly marked-up.

Management requirements for the project will be resolved in consultation with the Department of Aboriginal Sites.

19. The preservation of Jimmawurrada Creek escarpment and the vegetation of Jimmawurrada Creek is a significant aspect of the proposal. A detailed plan of the proposed rail alignment, the disposition of the ore beneath it, and discussion of the likely scouring of the rail embankment during significant river flows are required. Options for alignment of the railway on the mesa should have been discussed in detail with an assessment of costs and benefits.

Response

Options for the alignment are discussed in detail in Addendum A, as are comments regarding rail embankment scour protection and detailed plans of the proposed rail alignment. Details of ore sterilisation resulting from rail alignment options are also provided in this report.

20. The reasons for a 350 metre long embankment on the southern part of the river crossing are said to be the requirement for siding and restrictions on load bearing capacity. However, the environmental impacts of this length of embankment are not well discussed. For example, the extent to which the embankments would close off the river is not clear, potential for downstream erosion from modification to river, and the potential for pollution of river from trains and rolling stock using the proposed siding in river valley.

Response

Technical reports prepared by specialist Hydrological Consultants, regarding the effect of bridge construction on river flow, have previously been provided to the EPA for review and are included in this correspondence as Appendix 1 to Addendum A.

21. Conditions relating to de-commissioning of the project should not be limited to those in the 1964 Agreement Act. Leaving the "improvements" in situ may not be appropriate in the twenty first century. A commitment to providing a detailed decommissioning proposal 12 months prior to closure would be more appropriate.

Response

It is not possible for the Company to determine what will be appropriate with regard to decommissioning in the twenty first century. However, the Company has at this present time a commitment to abide by it's State Agreement Act, which specifically includes retention of the railway line and associated infrastructure (see Appendix 4) Page 33 of Amendment Act (1987). Decommissioning procedures will be developed in consultation with appropriate regulatory authorities, as the project approaches completion.

22. Section 6.1.2 (page 50). There has been insufficient work on local and regional flora and fauna to suggest that localised impacts "are not considered significant" in relation to rare and endangered species.

Response

Additional flora and fauna survey work for the study area has been completed, and localised impacts in relation to rare and endangered species have been assessed. Survey results are presented in Addendum B and Addendum C. In brief, no gazetted rare flora or fauna have been recorded from the Mesa J area as noted in the preliminary summary reports, which are attached.

23. Section 6.1.2 (page 51). Erosion of bare areas around the mine site may result in turbidity and sedimentation in river pools, especially when local thunderstorms (a regular summer event) cause local run-off, even in the absence of river flood flows. This eventuality requires management.

Response

It must be recognised that the natural characteristics of the area, with very large erosional surfaces, results in sedimentation of pools during any summer rainfall runoff event in both mined and unmined areas alike, and is not exclusively restricted to times of river flow.

As reported in the CER, it is proposed to retain much of the Mesa J escarpment adjacent to the Robe River. The escarpment structure, in conjunction with stormwater management, will prevent stormwater containing minesite sediment from entering Robe River pools. There are no pools in Jimmawurrada Creek adjacent to the project area.

The Company restates its' commitment with regard to erosion and stormwater, as contained within CER Commitment 6, that it will control, monitor and manage erosion and stormwater discharge for the duration of the project.

24. Modifications of the Weedai Pool landform should not be permitted to occur without thorough assessment of the pools' conservation value, understanding with traditional custodians, a monitoring programme and a commitment to correct any disturbance which degrades the values of the pool. A commitment to ensure protection of all permanent pools in the project area should be given.

Response

Weedai Pool is only one of a large number of pools occurring along the Robe River both upstream and downstream of the proposed minesite, which require management to protect their inherent values. The biology and conservation status of these pools from a botanical and faunistic perspective are detailed in Addendum B and Addendum C. It should be noted that the 1:100,000 series topographic map incorrectly names Weedai pool. The pool noted as Weedai, is actually Yarramudda Pool. The real Weedai pool is located adjacent to the Mesa J escarpment.

The company recognises the importance of Weedai and other pools, and will monitor and manage these pools as discussed in Response 26.

In terms of understanding with tribal custodians, the information provided in the CER regarding Weedai Pool has been confirmed by previously conducted on-site meetings, archaeological and ethnographical surveys. The tribal custodians are familiar with the proposed river crossing, and have given their permission for it to proceed.

25. Section 6.2.1 (page 52). The mining operation is to result in a final pit of 30m depth below surrounding topography, and only two benches are involved. The final configuration of the pit must be such that it is safe to enter (for future recreation, or other use) and stable in the long term. Vertical bench faces may not satisfy this requirement. The proponent should elaborate on how future use options will be retained as far as possible, and give a pictorial indication of what the pit will look like from an oblique aerial view. It is not sufficient to state that particulate matter will erode without a commitment to the preparation of, and adherence to a detailed environmental management and rehabilitation plan.

Response

The final pit depth will now be significantly less than the previously estimated 30m below the surrounding topography, due to a commitment to backfill the mined out area (see Response 40).

The Company restates that, as documented in CER Commitment 12, prior to decommissioning, the mine site will be prepared for abandonment in accordance with the requirements of the Mines Department, which includes the stability of slopes and the safety of future users of the area.

The Company questions the need for "a pictorial indication of what the pit will look like from an oblique aerial view". Future uses would not be determined by the mine sites' aerial appearance.

As stated in the CER, particulate matter may erode from the surface of dumps by water and wind. As also stated in the CER, erosional material from the ground surface, where any eroded dump material will eventually deposit, will be controlled and managed.

An environmental management and rehabilitation plan for the project will be prepared in the near future in consultation with the EPA.

26. Section 6.2.2 (page 55). The hydrologic modelling, among other aspects of the report relates to a 350Mt mine scenario for Mesa J. If and when the proponent decides to go beyond 350Mt, EPA may require referral and assessment.

The ethnographic and biological impacts of shallowing or dried out permanent pools may be very significant. A monitoring and contingency plan is required as is a plan for riverine vegetation. A management plan for the discharge area is also required to ensure evaporation does not lead to increasing salinity, weeds do not become a problem and vegetation stress due to drowning is minimised. Fuel spillages and other chemical hazards should be limited mainly to workshop areas, refuelling depots, etc. A corporate policy is required to ensure spillages are minimised and cleared up (even "small" spills).

Response

This proposal is for an iron ore mining operation of 600M tonnes at the Mesa J deposit at Deepdale.

The Company agrees that the drying out of previously permanent pools due to mining activity must not be allowed to occur, as it is recognised that these pools contain important genetic stock essential for the recolonisation of the aquatic environment during and following flow events, and that riverine vegetation adjacent to these pools also depend upon surface and subsurface water for survival.

The Company therefore commits to the preparation of a water discharge management plan prior to the commencement of dewatering procedures, and to baseline monitoring to begin as soon as is practically possible.

Fuel spillages will be dealt with in accordance with practices which will be specified in the environmental management and rehabilitation plan for the project.

27. Section 6.2.3 (pages 56, 57). What sort of "steam training" features are proposed? These need referral and assessment. What is reliability of predicted 1:100 year flows? What is "RORB" model?

Response

The proposed stream training features necessary for the protection of the riverine environment and the rail crossing are described in detail in Addendum A.

A RORB (Runoff Route) model is a general runoff and streamflow routing computer model developed by Monash University, used to calculate flood hydrographs from rainfall and other stream inputs and outputs. It adjusts rainfall for catchment losses to produce rainfall-excess and routes this through conceptual storages, which represent the storage effect of the catchment drainage lines, to produce a streamflow hydrograph.

The reliability of the predicted 1:100 year flows, which have been calculated by specialist hydrological consultants (AG Consulting Group), are the same as those predictions for any 1:100 year flood, based on accepted engineering principles. To ascertain the accuracy of flood hydrograph calculations, two accepted methods (RORB and MRD Rational Method) were critically compared. From the results, the RORB model was considered to be the more representative of the two approaches undertaken because it has the facility to account for catchment shape, stream network, mainstream length and slope and rainfall losses.

A copy of the latest and most up to date in a series of hydrological/engineering reports which describes the model analysis and results in detail, is provided in Appendix 1 to Addendum A.

28. Section 6.2.4 (page 59). The workforce will not only need to be reminded of requirements of the State Agreement, but also of new conditions resulting from the assessment of this new proposal.

Response

The Company conducts a comprehensive induction course for both mining personnel based at the mine site, and contractors visiting the site. The Company will expand the induction course to ensure that new exclusion areas are strictly observed, and any other issues or conditions resulting from the assessment of the Mesa J proposal.

The Company reiterates CER Commitment 4, that it will develop an environmental awareness programme for all construction and operational workforce at the implementation phase of the project, and will continue it in ensuing years.

29. Section 6.2.5 (page 60). Discussion on fauna is questionable given lack of knowledge of local and regional fauna.

Response

The response to Comment 1 establishes that topographic, geomorphic, and geological data suggests that the general habitats which occur in the Mesa J project area are not restricted to the Deepdale area, but occur over a much broader area of the Pilbara.

Addendum C describes the fauna and habitat characteristics of the project area in detail, and comments on regional aspects.

30. Section 6.2.6 (page 60). The proponent should elucidate commitments to dust suppression techniques.

Response

The Company is well experienced in dust suppression and will continue to utilise the current techniques, which have been proven to be successful over many years of operation.

Dust suppression methods will include:

- The use of water sprays at the loadout. Water sprays are automatically activated during dumping and the suppression water is carried into the rail cars and exported from site.
- Haul road preparation using a lignin binding agent (Wes-lig), which is mixed into the materials which form the surface layer of the road before compaction of the surface with rubber tyred vehicles to form a tightly bound layer which will not create dust. Dust which is carried by the Haulpaks from the pit areas onto the haul roads is recovered by mechanised brooming, as required.
- Dust control within the pits is achieved by spraying water over the ground surface, as required.
- Dust monitoring includes the quarterly completion of personnel monitoring programmes using gravimetric collection devices, and the deployment of high volume sampling apparatus for routine surveillance.

31. Section 6.2.7 (page 61). Comments on tourism need to discuss possible downstream effects of mining affecting tourism, (e.g. noise, dust, aesthetics, long term mining plans). The realignment of road from Deepdale to Millstream also needs more detailed consideration and assessment.

Response

(i) Noise

With the exception of isolated blasting, noise from mining activity is not readily apparent outside of the immediate mine area. All minesite equipment is fitted with noise suppression devices to comply with Australian Standards. There is no known or recorded instance where noise from the minesite has created nuisance conditions to tourists.

It would also be reasonable to comment that iron ore mining, for which the Pilbara is internationally famous, would be of interest to many passing tourists, and that any audible noise would be accepted as part of the mining operation. Tours of the mining area can be arranged through the company's Pannawonica offices.

(ii) Dust

As noted in earlier responses, the Company successfully manages dust at each of its operational sites and will continue this practice for the life of the Mesa J project.

(iii) Aesthetics

Road access to the project area and the immediate surrounds is poor and relies largely on roads and tracks established by the Company for its exploration programmes. It should be noted that these roads are not public roads and any access to the Mining Lease areas is in strict terms, unauthorised. With the onset of productive mining it will be necessary to formally restrict public access to the immediate project area for reasons of safety.

Visual access to the mining area is not readily achievable from surrounding land because of poor access and topographic conditions, and therefore any aesthetic impacts from the mining operation are unlikely to be evident to tourists using those of the local roads which will be unaffected by security restrictions.

(iv) Long Term Mining Plans

Long term mining plans of the Company are not definitive and will vary over long periods of time in response to changes in world markets and technology. As a result of the uncertainty involved in predicting future activities, the Company considers it would not be appropriate to deal with this matter within the scope of this project proposal.

(v) Millstream Road

The realignment of the road from Deepdale to Millstream will be resolved on the Company's behalf by the Department of State Resources.

32. Section 6.3.2 (page 62). Deviation of flows from Jimmawurrada Creek into the post-mining pit is not acceptable, and nor is increasing salinity within the pit. The downstream areas of Jimmawurrada and the Robe would suffer as a result. The salt balance question is a very significant issue which requires careful thought, planning and commitment now, prior to approvals being granted.

In response to the stated EPA preference, the mining plan will be modified to incorporate the return of as much waste rock to the mined out pit as can be practically achieved. This will involve double handling of waste rock materials, particularly at the initial stages of the project and will therefore have a significant cost penalty.

The status of the backfilling programme, in terms of practicality, success and costs will be reviewed as an ongoing matter. Whilst it appears unlikely that a residual water body will remain following the completion of mining, in practice, it may not be possible to fill each and every excavation area to a level higher than the natural water table, due to the low waste to ore ratios characteristic of the deposit. In this event, any water body which is anticipated will be preferentially designed to ensure a low surface area to volume ratio, which will therefore reduce evapo-transpirative effects to a minimum and minimise risk of evapo-concentration effects.

The status of backfilling and forward planning of the mine area will be reviewed at appropriate times in the future, in consultation with regulatory authorities.

Commitments to the above are given in Response 40.

ENVIRONMENTAL MANAGEMENT

33. Section 7.1 (page 64). Robe River Iron has a designated Environmental Officer located at Cape Lambert for all Robe River environmental management. The new Mesa J proposal will require more time (particularly during construction) than that one person can provide. The appointment of an officer on-site at Mesa J should be strongly recommended to ensure adequate management and adherence to commitments and conditions takes place. Reporting on Environmental protection and management in a "general sense" under Agreement Act 1964 is not adequate, particularly in regard to dewatering effects.

Response

Staff numbers and the delegation of management responsibilities is an internal matter, which is to be managed by the company in response to its preferred approach.

The Iron Ore (Robe River) Agreement Act, 1964 was updated in 1987 to include requirements for environmental monitoring and reporting. The relevant extract is included as Appendix 1.

The Company will comply with reasonable requirements for additional monitoring and reporting of matters such as the dewatering programme. The company is well aware of the importance of managing the dewatering programme and will take every practicable measure to ensure that the environmental impacts of dewatering and water disposal are kept to the absolute minimum.

34. Section 7.4.4 (page 68). A detailed monitoring and management plan needs to be referred to EPA for approval.

Response

The company will compile a detailed environmental monitoring and management plan for EPA assessment. (See CER Commitment 7).

35. Section 7.4.5 (page 68). The company needs to do much more work on fauna as pointed out earlier.

Response

Extensive additional fauna information has been compiled and is presented as Addendum C. Further fauna assessment work will be carried out periodically. Specifications of this work will be detailed in the monitoring and management plan noted in the response to comment 34.

36. Section 7.4.6 (page 69). Dust must also be controlled in accordance with E.P. Act (1986) licence.

Response

The Company currently controls dust in accordance with the E.P. Act (1986), and will continue to comply with regulatory requirements for the life of the project. (see CER Commitment 6).

37. Section 7.5 (page 69, 70). Detailed rehabilitation plan required to be submitted.

Response

As previously discussed with officers of the EPA, it is not possible to submit a fixed detailed rehabilitation plan at present because of the uncertainty associated with the progression of the mine plan over the lifetime of the project. However, the Company reiterates Commitment 7 of the CER, that it will implement landform stabilisation and revegetation programmes for the duration of the project. Rehabilitation philosophy will be discussed in the environmental management and rehabilitation plan which will be prepared in the near future.

38. Section 8.0 (page 72). To say "There are no features .... nor flora or fauna listed as rare or endangered ...." cannot be said with any significant degree of certainty. Robe River Iron Associates has had no previous experience in managing dewatering, and limited experience in mine site rehabilitation.

Response

The issue of features has been extensively covered in Response 1.

The issue of rare and endangered flora and fauna in the Mesa J area and on a regional scale is discussed in Addendum B and Addendum C.

In terms of dewatering experience, it is reasonable to comment that the Company has had no specific experience in this respect. However, the Company has engaged appropriate specialist consultants in the fields of hydrological, engineering and environmental management to supplement the Company's internal expertise as needed to achieve management objectives. The Company confirms its intention to continue this practice as required to meet environmental and engineering management requirements, for the life of the project.

In terms of minesite rehabilitation, the Company has demonstrated its' experience in environmental monitoring and management in Response 2, Summary Item 8, and within the text of the CER.

COMMITMENTS

39. The "Summary of Commitments" does not meet the (a) - (d) requirements as set out in guidelines under "Detailed list of environmental commitments".

Response

The Company offers the following response for clarification of the above definitions for the Authority:

a) **who will do the work:** Robe River Iron Associates, or it's consultant or authorised representative, will do the work.

b) **what the work is:** the work is whatever physical action is considered necessary by the Company in consultation with regulatory authorities, as detailed in the CER text and summarised in the commitments.

c) **when the work will be carried out:** the work will be carried out as necessary in consultation with regulatory authorities, and in accordance with the mine plan.

d) **to whose satisfaction the work will be carried out to:** The company will meet its legal obligations regarding the management commitments made in the CER and in supplementary correspondence and reporting. However, the company is extremely concerned regarding the use of the term "satisfaction" as this term could be applied to force compliance with requirements which are additional to and beyond its legal obligations.

   The Company does not anticipate that non-compliance on its own part will eventuate but wishes to exclude the potential incorporation of extraneous opinions and views as could eventuate within the scope of meaning of the term 'satisfaction', in the formulation of work programmes to which it is legally bound.

40. Guidelines state that "where an environmental problem has the potential to occur, there should be a commitment to rectify it". Commitment No. 12 does not ensure rectification of a potentially very significant long term impact of the proposal - that of salination of the post-mining lake, and its wider effects on the Jimmawurrada Creek and Robe River systems.

Response

The Company retains its' commitments detailed in Commitment 12; to re establish pre-existing drainage patterns and for the continuation of stabilisation and revegetation activities until stable structures and communities are achieved.

However, the Company also agrees to a modification of Commitment 12 in accordance with the information given in Response 32, to include the sentence:

"The mining plan will be modified to incorporate the return of as much waste rock to the mined out pit as can be practically achieved. "

As the project develops and a realistic understanding of the practical constraints of pit design, backfilling success, logistics and cost is developed, the design specifications of any surface water body which cannot be eliminated from the mining area will be developed in consultation with appropriate regulatory authorities.

41. Section 9.0 (page 73). The development and implementation of monitoring and management plans for mining and associated activities "in the course of project implementation" is not adequate. Baseline data and planning is required prior to project implementation.

Response

Baseline and more technically sophisticated resource data regarding the Mesa J deposit has been available for several years, however the Company did not consider the technical information relevant for inclusion given the level of assessment designated to the project by the EPA (ie CER).

Additional back-up survey work has now been completed, as requested by the EPA. Whilst detailed reports from the specialist consultants are not yet at hand in final form, progress reports from the Consultants in summary form and from verbal discussion indicate that the findings of the initial work presented in summary form in the CER, have been validated by the recent survey programmes.

The development and implementation of monitoring and management plans will proceed with the benefit of the total database which is available.

42. Commitment 5 isn't very different to commitment 2.

Response

Commitment 5 in the CER differs from Commitment 2 in that the former deals with a commitment to minimise physical alteration to the environment, whereas the latter commits the Company to comply with statutory legislation, which encompasses areas other than physical alteration.

Traditional Owners

43. The CER states that consultations were carried out between company representatives and tribal elders with authority to 'speak' for the area that will be affected by the proposal.

Is the sites department of the WA Museum satisfied with the level of consultation and site clearances?

Response

Appropriate submissions to the Registrar, Aboriginal Sites Department have been made, in accordance with statutory requirements.

44. Much of the information about consultation with Aboriginal people related to sites impacted by the river crossing.

Were the traditional owners consulted about the area covered by the actual mining operation and any ancillary activities?

Response

The company's Ethnographic and Archaeological Consultants were fully briefed as to the Project, and consultation with the traditional owners incorporated all relevant aspects.

The Company's submission to the Aboriginal Sites Department fully describes the nature of consultations and their outcome.

Tourist Operations

45. A statement is made in the document that "Adventure type tours are operated in the region, however not within the vicinity of the proposed mining operation, there will therefore be no impacts on these operations".

Submissions have been received indicating that tourist operations use the area downstream of the proposed operation.

What will the proponent do to monitor the indirect impacts of mining on the tourist operations and to ensure that they are not adversely affected by the operations?

Response

The onset of preparatory work and productive mining will require the mining area to be closed to public access for safety reasons. Entry to the mining area without specific permission will be prohibited. Should it be the case that tourist operators have previously gained access to the mining lease area, in strict terms this use has been unauthorised, as all roads are private.

The company will comply with appropriate environmental management conditions which will ensure that the amenity of the surrounding areas with respect to tourist operations will not diminish. In addition, the company's Induction programme for employees, will identify exclusion areas, and will contain environmental awareness components. The intent of these measures is to minimise the influence of the operations workforce on surrounding land and other users.

For those tourists and operators who would wish to inspect the mining operation, tours can be arranged at the company's Pannawonica offices.

Recreational Users

46. The document does not discuss potential effects of mining operations on recreational areas that are, or may be used by the workforce.

What will the proponent do to monitor the use of recreational areas in the vicinity of the mine to ensure that users are not directly affected by mining operations?

Response

Recreational areas which are known to be important to the workforce will not be affected by the project. In this regard, permanent river pools located beyond the range of significant influence of the project, are the focus of local recreation.

Compliance with environmental management objectives for the project, including monitoring programmes, will also address this aspect of the project.

Realignment of the Deepdale-Millstream Road

47. The document explains that the proposed mining activity will result in a realignment of the Millstream-Deepdale road.

Will this realignment affect the traditional owners of the area, or any road users? If so, how will the proponent minimise the effects?

Response

Under the provisions of the State Agreement Act, the Department of State Resources will resolve the company's requirements in regard to realignment of this road.

It should be noted that the Deepdale-Millstream Road consists of a marginally upgraded station track, not a formed road. Realignment in the vicinity of the mining area will not detract from the present function of this road. Appropriate measures will be taken to ensure that any sites which are important to the traditional owners are not disturbed by the realignment works.

Comments

48. Concern about cumulative and regional impacts of mining activities in the area was conveyed in the submissions. The comments contained in the submissions indicated a general concern about indirect impacts that may come about as a result of the proposed mining activity.

Most of the questions posed above could be addressed by commitment to a social monitoring programme aimed at identifying and addressing indirect and unforseen impacts on the local community. The social monitoring programme

should also ensure that mitigation strategies outlined for identified impacts are adequate.

Response

The overwhelming majority of the local community are members of the Company's workforce and are well aware of the implications of the Mesa J Project. Pannawonica is a Company town towards which the Company has an ongoing role in community well being. The Company is also the owner of substantial local pastoral interests, and to this extent there is no risk of unsatisfactory influences on the existing community.

Appendix 3

Summary of biological surveys

SUMMARY OF ADDENDUM B TO THE CER FOR PROPOSED IRON ORE MINING AT MESA J, DEEPDALE

FLORA AND VEGETATION SURVEY OF THE MESA J AREA, DEEPDALE

1. Introduction

It is proposed to mine iron ore at Mesa J in the Deepdale (Robe River) area of the Pilbara, Western Australia.

To assess the potential significance of the mining proposal on flora and vegetation and to determine the conservation value of the riverine vegetation of the Robe River, field studies of Mesa J and surrounding areas were carried out to complement data held on file from previous survey work.

This report presents preliminary findings of the field survey in summary form. The findings will be expanded to a full and detailed report following identification of specimens collected in the field, and a review of relevant literature.

Mesa J is a relatively large mesa and has a moderate diversity of plant habitats. These are: the undulating plains on the mesa top, the various aspect slopes below the mesa breakaway and a variety of flowlines, small to large creeklines and valleys on and through the mesa and adjoining it.

The Robe River and the Jimmawurrada Creek occur on the north and east sides of the mesa respectively, and alluvial plains occur along flow lines to the south and south-west of the mesa. The Robe River supported a series of pools at the time of survey, some of which appear to be permanent i.e. contain water year round.

2. Methodology

Vegetation and flora surveys were carried out from 13-18th July 1991 (inclusive) to determine the vegetation complexes associated with representative upland sites (Mesa J surface), scree slopes, riverine areas and aquatic (pool) habitats. Surveys were also undertaken to evaluate vegetation types where fauna trapping was in progress.

Sites were examined in representative landform areas. All flora species at each of these sites was recorded, with estimates of the height and percentage cover of each. Specimens of flora species were collected from the transects, labelled and pressed in the field for later identification. Aquatic habitats (Robe River pools) were sampled on an opportunistic basis, and these samples were also dried and pressed for later identification. Flowering or fruiting specimens were collected where possible. To obtain a broad botanical comparison, two other mesas were also surveyed, although not to the same level of detail as Mesa J.

Selection of sites was aided by the use of recent (stereo) aerial photography. A low level flight in a light plane assisted in gaining a regional perspective on the interpretation of the ground survey.

3. Results

3.1 Vegetation

The vegetation on Mesa J is dominated by *Triodia wiseana* and a *Plectrachne* species ("spinifexes") which form hummock grasslands with scattered trees and shrubs over them. Along the flow lines on the mesa there are shrublands of *Acacia* species with *Eucalyptus cf. terminalis* occurring in patches. The mesa slopes also have the two spinifexes but have *Eucalyptus leucophloia* as an emergent as well as *Eucalyptus cf. terminalis*.

Some parts of the mesa top (and some gully slopes) have small areas of open woodland of *Acacia citrinoviridis*, a species which usually occurs in creeklines but which does occasionally occur on hills. The heads of gullies often have small stands of *Eucalyptus ferreticola* with *Acacia* species.

The larger creeklines through the mesa have mixed woodlands of *Eucalyptus* aff. *aspera* and *Eucalyptus* cf. *terminalis* over understories of a variety of shrubs and grasses.

The mesas in the Pannawonica area differ both in the presence and absence of individual vegetation types, for example a small mesa east of Pannawonica was found to support a vegetation type (*Plumbago zeylanica* open shrubland over *Themeda australis* grassland, around the base of part of the breakaway), not seen on the other mesas visited. The same mesa did not have one of the major vegetation types found on Mesa J, a hummock grassland dominated by a *Plectrachne* (rather than *Triodia wiseana*, the most abundant spinifex on the mesas).

The Robe River between Mesa J and Mesa K is dominated by riverine woodlands and forests of *Eucalyptus camaldulensis* (River Red Gum), *E. coolibah* (Coolibah or Blackheart) and *Melaleuca leucadendra* (Cadjeput) in various mixtures. The lower tree layer is sparse with *Sesbania formosa* present in the Robe River and *E.* aff. *aspera* (Cabbage Gum) present along the creek margins and in small tributaries.

At the understorey level the variation within the riverine vegetation in the region is more significant with numerous different shrub understories being developed. In the Robe River between Mesa J and K three major understorey types were recognised;

(i) a sedgeland of *Cyperus vaginatus*,
(ii) a shrubland of *Acacia trachycarpa*, and
(iii) an open type with only scattered shrubs and a very stony soil surface.

The *Cyperus* sedgelands are particularly well developed (probably reflecting the closeness to the surface and/or consistency of underground flow in the bed of the Robe at this point), and while this species is widespread such development of good stands is not very common. *Acacia trachycarpa* is also widespread but does not commonly form discrete stands (in the Hamersley Ranges at least) as the dominant species. Open areas are generally quite common.

3.2 Flora

More than 150 (and probably about 200) plant species were recorded from Mesa J and the surrounding area. A detailed species list is not available at present, however this will be available as soon as identifications are completed. The flora recorded probably represents about 70-80% of the flora of Mesa J.

The flora collected and recorded in the study area reflects the diversity of habitat found within it. The most diverse habitats were moderate to large creeklines with loamy beds, the floodplains of major creeks, and the alluvial plains with loamier soils. At some sites these habitats had more than forty species. The habitats with lowest diversity were the undulating plains of the mesa top and some of the breakaway slopes. In places these habitats has less then 10 species at a site however, this does not include species that would only germinate at these sites after fire, which temporarily removes competition from the spinifex (*Triodia* and *Plectrachne* species).

Variation between the flora found on different mesas was not great, except that the smaller mesas had much fewer species. However, a few species were found on the smaller mesas visited which were not recorded on Mesa J.

The most noteworthy plants recorded during the survey were the aquatic species from the pools in the Robe River. Of particular interest was the presence of large amounts of *Utricularia australis*. This species has only been collected once before in the Fortescue Botanical District

(at Millstream), although it has a wide range outside that District. It may be that the abundance of this species currently present in the pools in the Robe River is a "bloom" event that has been triggered by specific conditions or it may be always at this population level after significant rainfall. *Eleocharis dulcis* (a tall, perennial sedge) was also fairly common in the survey area forming stands in pools. Although also known from the Kimberleys, the only specimen of this species in the Western Australian Herbarium from the Fortescue Botanical District is from Millstream. This species was not recorded in the study of the inland waters of the Pilbara (EPA Technical Series No.'s 10 and 24).

No gazetted rare species were recorded during the study, although some species such as *Utricularia australis* and *Eleocharis dulcis* are only known from small populations in the Fortescue Botanical District and thus are not common in that Botanical District. It is likely that a few of the other species collected, but not yet identified, are either not well collected or restricted in habitat.

4. Discussion

The study area has a variety of vegetation types, ranging from spinifex (*Triodia* and *Plectrachne*) grasslands on the mesa, to woodlands and forests along the major creeks and Robe River. The conservation significance of these varies depending on their development in other parts of the Fortescue Botanical District.

However, high conservation significance for the vegetation can be confined to the riverine vegetation, and especially the habitats (i.e. pools) where the aquatic species such as *Utricularia australis* and *Eleocharis dulcis* are found.

At a broad level, riverine woodlands and forests of *Eucalyptus camaldulensis* (River Red Gum), *Eucalyptus coolibah* (Coolibah or Blackheart) and *Melaleuca leucadendra* (Cadjeput), in various mixtures, are found along most of the major rivers and creeks in the Pilbara, and thus can be termed widespread. However, the considerable variation in the Fortescue Botanical District in the lower tree and shrub layers of these woodlands and forests must also be considered, as it complicates the assessment of the conservation value of the riverine vegetation between Mesa's J and K.

Species that commonly form lower tree layers in these forests and woodlands in other parts of the Fortescue Botanical District are *Acacia citrinoviridis* (very commonly), *Sesbania formosa* (fairly commonly), *Acacia coriacea* (less commonly) and *Terminalia canescens* (less commonly). The Robe River between Mesa J and K has only one of these (*Sesbania formosa*) and thus even at this fairly simple level, is noticeably different from the most common situation which has a lower tree layer of *Acacia citrinoviridis*. In the Pannawonica area, *Eucalyptus* aff. *aspera* (Cabbage Gum) is also present along the margins and in side creeks. This species is not present in many areas surveyed in the Fortescue Botanical District.

The variation in permanent pools is also significant on a regional basis with differences in species compositions and dominance. The abundance of *Utricularia australis* in the Robe River pools is significant, although this may be an unusual "bloom" situation. Examination of three areas at Millstream and pools between Millstream and Karratha did not locate other populations of this species although it was collected at Millstream in 1954.
The three mesa's visited indicate that while they have much in common in their vegetation and flora, they do have significant differences. These differences relate only partly to size, with another factor appearing to be the differential development of habitats and thus vegetation types. The smaller mesa's obviously have less habitat diversity and the top of the smallest mesa surveyed had no flow lines or streams. The reduced diversity of habitat on smaller mesas therefore reduces the diversity of flora found on them directly, by certain habitats (particularly large creeks) not being present.

With the varying size of mesas, particularly the small ones surrounded by cliffs, random loss of species and difficulty of re-invasion is likely to mean that even where appropriate habitat is developed, the species diversity may be less than in the same habitat on larger mesas.

5. Conclusion

In general terms, the survey has demonstrated that the vegetation on Mesa J itself is reasonably typical of similar environments in the Fortescue Botanical District. However, vegetation types associated with the Robe River environment, particularly the aquatic habitats, are significant and warrant careful management. Jimmawurrada Creek does not contain permanent pools, and is therefore less likely to require management to the same degree necessary for the protection of the Robe River pools and associated vegetation complexes. However, in view of the comparatively smaller area of riverine vegetation which occurs in the region, impacts should be minimised as far as practical.

More information will be available when the flora specimens collected have been fully identified, however the discussion presented here gives an accurate overall assessment of the conservation significance of the Mesa J area.

SUMMARY OF ADDENDUM C TO THE CER FOR PROPOSED IRON ORE MINING AT MESA J, DEEPDALE

TERRESTRIAL AND AQUATIC FAUNA SURVEY OF THE MESA J AREA, DEEPDALE

I TERRESTRIAL FAUNA

1. Introduction

The proposed iron ore mining of Mesa J at Deepdale in the Pilbara Region of Western Australia has the potential to impact terrestrial and aquatic fauna on and adjacent to the specific mine site.

To assess the likely significance and conservational status of fauna species of the area, a detailed site survey was carried out in accordance with the Department of Mines Western Australia "Guidelines for Mining Project Approval" and Environmental Protection Authority requirements.

The survey has provided additional baseline information on the fauna of the project area and when completed will include:

(a) An inventory of;

- vertebrate species, including recent published and unpublished records.
- valuable faunal habitats and critical resources.
- species which might be expected to occur but whose presence is as yet unrecorded.

(b) A review of:

- biologically significant species including rare fauna.
- introduced exotic or declared pest species and their impact.
- environmental impacts and recommendations for fauna management.
- appropriate impact monitoring procedures.

(c) An assessment of:

- the relationship between flora and fauna.
- the regional and local conservation value of the intended development area's fauna.

This report is a summary of the findings of the fauna survey to date, which will be expanded to a full and detailed report following analysis of data collected in the field, and a review of current literature.

2. Methodology

A) Pit-trapping: 10 lines of 5 160 x 400mm PVC tube pit traps, with 10m fly wire drift fence, placed 20 metres apart sampled six major terrestrial vertebrate habitats in the project area with two replicates of each habitat. Each trap array was operated for a minimum of 7 trap days yielding a total of 437 pit trap days.

B) Elliot box traps: 10 grids of 20 medium sized Elliot traps, placed 20 metres apart in 2 lines of 10, were established in the same sample locations as the pit-trap arrays. Each trap array was operated for a minimum of 7 trap days, yielding a total of 1706 Elliot trap days.

C) Quantitative assessment of bird habitat utilisation centred on 200m x 200m Bird Observation Quadrats located at sites in all major terrestrial vertebrate habitats in the project area. Bird observations were collected between 0700hrs and 1700hrs by systematic foot traverses through the quadrats for 30 minutes. Total species and number of each species present were recorded for each quadrat.

D) Opportunistic fauna sightings were recorded while searching or travelling. All major habitats were searched for cyptic species and nocturnal species were assessed by spot-lighting and head-torch searching. A total of 35.5 person hours spot-lighting and night searching were undertaken.

E) A quantitative assessment of the Mesa J scarp cave system was undertaken. Cave and overhang dimensions, species richness and abundance of fauna present and cave location were recorded. Caves and overhangs were defined as a cavity greater than 1 metre depth. Approximately 80% of the scarp system was inspected by foot traverse.

F) Field survey for specific rare fauna such as the Pebble-mound Mouse *Pseudomys chapmani* and Rock Wallabies. Systematic searching of optimal habitats for target rare fauna species was carried out within the project area.

3. Results

Systematic trapping and opportunistic collecting yielded a total of 15 native mammal, 33 reptile, 2 frog and 70 bird species. The survey added an additional one frog, nine reptile and ten mammal species previously unrecorded for the area. The record of the skink *Notoscincus butleri* represents a significant range extension to the south for this species. This Pilbara endemic has been previously recorded from the Harding River and coastal areas in the vicinity of Karratha.

The project area supports sizable populations of many terrestrial vertebrate species, particularly the Northern Native Cat *Dasyurus hallucatus*, and the Little Red Antechinus *Dasykaluka rosamondae*.

3.1 Declared rare fauna

Potentially five Schedule 1 "rare fauna" species (Spectacled Hare-wallaby *Largochestes conspicillatus*, Pebble-mound Mouse *Pseudomys chapmani*, Lesser Stick-nest rat *Leporillus apicalis*, grey Falcon *Falco hyoleucos* and Grey Honeyeater *Conopophila whitei*) and two Schedule 2 species "fauna in need of special protection" (Pilbara Olive Python *Morelia olivacea barroni* and Peregrine Falcon *Falco peregrinus*) occur in the project area. The indications of the presence of two Schedule 1 species were recorded *Pseudomys chapmani* and *Leporillus apicalis*. However current data indicates that neither of the species is currently extant in the area.

The former presence of the Pebble-mound Mouse *Pseudomys chapmani* was recorded from the foot-slopes of the south-western perimeter of the mesa. Six inactive mounds were located indicating previous occupation of the area by the species. It is estimated that the mounds were abandoned as recently as five years ago.

Lesser Stick-nest Rat *Leporillus apicalis*. This large rat species is gazetted "rare possibly extinct". It formerly ranged over much of central Australia as is evident by the nest remains found in small caves and breakaways, but has not been seen since 1933. However there are several unconfirmed reports of contemporary nests in the Canning Stock Route area. Within

the species did inhabit the area previously. It is estimated that the nest had been abandoned for several decades.

No sightings or indications of other gazetted species were recorded during the current survey.

It is expected that the Pilbara Olive Python *Morelia olivacea barroni* is present in the project area within the mesa scarp system. The survey was conducted during the period of maximal inactivity for the species, thus greatly reducing the probability of sightings. The species, if present, is expected to persist in the area in low numbers due to the small area of suitable habitat and low frequency of deep caves.

Peregrine Falcon *Falco peregrinus.* Gazetted as "in need of special protection". This species is widely distributed throughout Australia. It's status is considered to be "generally uncommon, probably declining in settled regions; still well established in remote areas (Pizzey, 1983)". While potentially occurring in the project area it is a wide ranging species.

The Grey Falcon and Grey Honeyeater were not recorded during the current survey. These species are widely distributed throughout in arid Western Australia, and are rare and nomadic.

The rock wallabies present in the Deepdale area have been confirmed as Rothschild's Rock-wallaby *Petrogale rothschildi*, not the Schedule 1 species, the Black-footed Rock Wallaby *Petrogale lateralis.*

A total of 118 caves and overhangs were recorded and mapped for the Mesa J scarp system. Only five caves exceeded a depth of 10 metres. Within these caves three bat species were recorded, two of which are widely distributed arid species. *Taphozous georgianus* and *Eptesicus pumilus.* These species were present in low numbers. The largest population recorded was six *Taphozous georgianus* in the largest cave, approximately 20 metres deep. All other caves and overhangs support an abundant and diverse fauna typical of the mesa scarp habitat.

3.2 Fauna habitats

Five major terrestrial faunal habitats were identified:

a) Mesa scarp system.

b) Riverine habitat, areas of *Eucalyptus camaldulensis* and *Melaleuca leucadendra.*

c) Drainage lines dominated by *Acacia* species over spinifex understorey.

d) Triodia Steppe on mesa plateau.

e) *Triodia pungens* flats with low open shrublands.

4. Discussion

Based on preliminary analysis of the survey data it appears that the *Triodia pungens* flats, riverine and mesa scarp habitats support the richest fauna in terms of species and biomass. However there is low overlap in fauna composition between each of the major terrestrial habitats. The critical habitats in terms of local and regional representation are the riverine and scarp habitats. These habitats provide refugia for species with conservation significance and for migratory species. The other habitats, while retaining diverse and abundant communities, are widely represented locally and within the Pilbara.

The major perceived impacts of significance would be the loss of the Mesa scarp facade and impacts to the riverine wetland system. While no gazetted rare species are present or dependent upon these habitats, a significant component of the project area's fauna is dependent upon the integrity of these systems. It is expected that full analysis of the data will reveal significant

biotic and abiotic relationships between the fauna, flora and physical characteristics of these habitats.

Potential significant impacts arising from the proposed project are:

a) Loss of mesa scarp system beyond the scarp facade.

b) Impact to riverine habitat from drawdown.

c) Loss of pool systems from drawdown and sedimentation.

Recommendations and management plans for the project would need to include a comprehensive monitoring programme for the riverine habitat, both aquatic and terrestrial components, and the retention of a maximal area of mesa scarp habitat including gorge systems. It is considered that retention of the scarp system is also essential to the preservation of the integrity of the riverine habitat. While it is considered that the proposed project is ultimately environmentally acceptable and manageable, the ecological significance and sensitivity of some habitats dictates detailed rigorous scientific management planning and implementation coupled with a long term commitment to such strategies to maintain the integrity of these systems.

II AQUATIC FAUNA

1. Introduction

This study represents a pre-impact assessment of the status of wetlands associated with the Robe River upstream and downstream of the proposed Mesa J development. The proposal has the potential to impact aquatic fauna from both a water quality and quantity perspective. The final report will outline where comparable information is available, the regional significance of the aquatic biology of the area and allow for baseline data for future monitoring work. The upstream sites serve as controls and the downstream sites the possibly impacted areas. The study incorporates detailed systematic information on aquatic invertebrates (planktonic and benthic) and vertebrates (fish and tortoises etc). Baseline measurements were also made of water chemistry and sediments.

This report summarises the aquatic vertebrate, invertebrate and water chemistry data available at present, and provides broad conclusions regarding the significance of the riverine pools confined to areas of the Robe River.

2. Methodology

A total of 11 sites, both associated with and above and below the proposed Mesa J development were investigated.

To adequately sample the resident aquatic fauna, the programme used replicated quantitative sampling and concentrated on two dominant faunal components of a wetland; the planktonic community (zooplankton) and the benthic (substrate) community. Other opportunistic qualitative sampling of the wetlands was used to collect from as many habitats as possible to compile an extensive species list.

(a) Macroinvertebrates. At each wetland a sweep net (FBA; Freshwater Biological Association, 250µm) was used to collect from as many habitats as possible. Generally each habitat was sampled proportional to its percent cover. The collected samples were immediately fixed in a 10% Formaldehyde solution.

(b) Benthic samples. At replicate areas in each significant wetland, a core sampler (diameter = 9.7cm) was used to collect macroinvertebrates in the substrate. These samples are preserved as above. Additional samples were collected with a sweep net to collect from as many habitats as possible.

(c) Fish and other aquatic vertebrates, were collected, identified, measured and all native species returned to the water. The association of each fish species collected and habitat will be noted. Similarly, other aquatic vertebrate fauna, including tortoises, were collected.

In the laboratory invertebrate specimens will be identified to the lowest taxon possible (usually species) and preserved in ethanol.

At each site water temperatures, dissolved oxygen and pH were determined by direct measurement. Water samples were taken for analysis for salinity and the dominant cations and anions.

A range of pools were investigated from the most upstream site (Site 1) to the most downstream (Site 11). The Table below summarises the location and characteristics of each sampling site.

Site	Size	Name	Position
1	12m x 6m x 1m deep	Unnamed	25km upstream from Panna
2	80m x 8m x 1.5m deep	Homestead	20km upstream from Panna
3	140m x 12m x 0.9m deep	Unnamed	3km upstream Jimmawurrada
4	120m x 6m x 1m deep	Weedai (S)	downstream Jimmawurrada
5	250m x 10m x 1.2m deep	Weedai (L)	downstream Jimmawurrada
6	110m x 8m x 2m deep	Unnamed	Adjacent to the Mesa
7	70m x 12m x 2.5m deep	Unnamed	Adjacent to the Mesa
8	370m x 30m x 3m deep	Permanent	Adjacent to the Mesa
9	50m x 9m x 1.2m deep	Deepdale	Adjacent to Deepdale Station
10	400m x 12m x 2.8m deep	Gnieraoora	Downstream Deepdale
11	75m x 20m x 0.7m deep	Unnamed	2km downstream Deepdale

The location of these sites will be specified in the detailed report, which will be available in the near future.

3. Results

Water Chemistry

At each site measurements were made of turbidity (Secchi depth), dissolved oxygen, temperature, pH and samples taken for salinity and cations/anions. Most of the temperatures were around 20°C, with saturated levels of dissolved oxygen with the exception of Site 1 (3mg L^{-1}) and Site 9 (4mg L^{-1}). At Site 1 there was considerable sediment and this would have smothered the bottom of the pool and caused anoxia. At Site 9 there was large amounts of livestock manure in the pool, this causes increased bacterial production which removes oxygen from the water column. Values of pH were all around 7.8 -9 at all sites.

Macroinvertebrates

Extensive sampling was carried out at each site for macroinvertebrates both with sweep and core sampling. Macroinvertebrates are at the base of the food web in aquatic ecosystems and are sensitive indicators to changes in water quality. Due to time constraints, effort will be concentrated to specific groups (i.e. the Dragonflies (as in Millstream), Molluscs (snails) and the *Chironomidae* (midge larvae). There has been no extensive sampling for macroinvertebrates in the Pilbara and many new species are expected.

Fish

A total of six species were collected, identified and returned to the water. These were:

Spangled Perch (*Leiopotherapon unicolor*)

Barred Grunter (*Amniataba percoides*)

Western Rainbow Fish (*Melanataenia splendida australis*)

Fortescue Grunter (*Leiopotherapon aheneus*)

Bony Bream (*Nemalulosa erebi*)

Eel-Tailed Catfish (*Neosilurus hyrtlii*)

This represents a very diverse fish community and includes the Pilbara endemic *Leiopotherapon aheneus*. Two other species may be present, the V-tailed Catfish and possibly Freshwater Eels.

Using a classification technique (TWINSPAN), the sites were classified and a model was tested using MDA (Multiple Discriminant Analysis), incorporating the physico-chemical data available to date. These results showed simply that the pools with the high numbers of fish species had significant areas greater than 2m deep. These deeper pools have the Bony Bream and to a lesser extent the Spangled Perch and Eel-tailed Catfish.

Other Vertebrates

Steindachner's Tortoise (*Chelodina steindachneri*)

This species, endemic to the north-west, was observed in the deeper pools i.e. Permanent Pool and Gnieraoora Pool.

4. Discussion

At this early stage the pools appear to represent a very important component of the Robe River ecosystem and need to be very carefully managed. There are two possible impacts which would adversely effect the resident species and the functioning of these pools.

(a) Sedimentation
One pool sampled (Site 1) had high levels of sediment (about 30cm). This site was very low in species (one fish species only) and had an associated degraded water quality. Whilst sedimentation during summer would probably not pose a great threat due to the vast discharges from the Robe River after a cyclone, winter rainfall and lower discharge rates allow the sediment to settle out of the water column into the substrate.

(b) Drawdown
Essentially the larger pools support the majority of the fauna, and the water levels in these systems need to be maintained. Drawdown is potentially the impact posing the most risk to the aquatic system.

5. Conclusions

The permanent pools of the Robe River appear to support a diverse range of aquatic fauna in a relatively hostile environment, however the full extent of their diversity will not be realised until the completion of the identification of macroinvertebrate samples, and the data can be compared to that of other studies (where available).

At the time of the survey the Robe River was reduced to a series of pools. These pools act as refuges, and as such, are a very important component of the river ecosystem. The aquatic fauna contracts to these water-bodies and re-invades the river during increased flows. If these pools are disturbed then the fauna of the entire river maybe at risk, due to the limited ability of the fauna to re-colonise from other areas i.e. the Fortescue River.

A number of components of the biology of the pools should be monitored, possibly two to three times a year; winter, just before summer rains (at this time the conditions in the pools would be the most stressful to the fauna), and possibly after the summer rain.

Monitoring should include; general water chemistry (salinity, turbidity, dissolved oxygen) and morphological parameters, particularly pool depth. Certain macroinvertebrate groups such as the Molluscs (snails) and Odonata (dragonflies), are sensitive to changes in water quality and could form the basis of a biological monitoring programme. These groups have previously been used successfully elsewhere.

The fish species should also be carefully monitored. Because they spend all their life-cycle within freshwater, they are potentially at risk through changes in water levels and quality.

The tortoises should be censused to obtain population sizes and this monitored to assess future changes.

The local significance of the pools adjacent to Mesa J depends on the extent of similar pools in the Robe River. If all the deeper pools are concentrated adjacent to Mesa J this greatly increases the need for very careful management, however if there are a number of pools both upstream and downstream then this would tend to reduce the local significance of these pools. Downstream from Gnieraoora Pool the Robe River looked very dry and the upstream sites, were in places, very sedimented. Therefore it may be necessary to identify the source of the water in these pools, and the extent of deep pools within the river system.