YANDICOOGINA (MARILLANA) IRON ORE PROJECT

BHP-UTAH MINERALS INTERNATIONAL

Report and Recommendations
of the
Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 323 March 1988

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i. SUMMARY AND RECOMMENDATIONS

BHP-Utah Minerals International has submitted a proposal to establish a new iron ore mining project at Yandicoogina (Marillana) in the Pilbara region of Western Australia.

The proposal generally involves the mining of iron ore deposits at an initial production rate of about 2 million tonnes per year, with the potential to increase production to a rate of up to 5 million tonnes per year during a projected 20 year mine life. There is, however, further potential for operations to be expanded to a much larger project beyond the scope of the current proposal. This would require further environment impact assessment should such a proposal eventuate.

Initial mining operations would commence on an orebody known as Eastern Mesa 2 which has a relatively low waste to ore ratio by Pilbara standards.

Ore would be extracted using conventional drill and blast techniques and trucked from the minesite to a semi-mobile crushing plant. Following crushing the ore would be conveyed to the rail load-out facility.

It is proposed to transport the ore from the minesite to the existing Newman to Port Hedland railway by constructing a 49 kilometre rail spur.

As the proposed mining operations are remote from any existing townsite, accommodation and other associated infrastructure would be required. It is proposed that facilities be established to service a commuter workforce on a fly-in-fly-out basis.

In initially considering the proposal the Environmental Protection Authority determined that the project's potential for environmental impact was such that it would be required to be assessed under Part IV of the Environmental Protection Act 1986. The level of assessment was set at Public Environmental Report with a public review period of eight weeks.

The major environmental issues considered during the assessment of this proposal were generally related to the following:

- potential impacts on the area's hydrology and the Marillana Creek system through mine dewatering and discharge;
- potential impacts on flora and fauna;
- possible pollution of water resources;
- rehabilitation; and
- impacts associated with project infrastructure.

In its assessment of the proposal the Environmental Protection Authority carefully considered these potential impacts primarily with respect to long-term effects or reversibility of the impact at the cessation of mining operations.

Hydrological impacts on the Marillana Creek system as a result of mine dewatering would only be sustained during the period of operation. Although there is likely to be some vegetation response to the constant saturation of the creek bed alluvials, it is anticipated that these plant communities would gradually return to an approximate pre-mining situation once the discharging of mine water ceases. Vegetation monitoring is proposed to assess any changes that may occur.

Other potential impacts such as the direct disturbance of flora and fauna through mining were also considered in a regional context. It was determined that none of the recorded plant or animal species or their habitats are unique to the mining area and therefore will not become endangered as a result of the proposed mining operations.

Rehabilitation programmes would be designed with the objective of leaving the site in a condition that would minimise erosional impacts over ensuing years.

Upon consideration of the Public Environmental Report that was submitted for the project the Environmental Protection Authority has concluded that the proposal would be environmentally acceptable subject to the following recommendations:

RECOMMENDATION 1

The Environmental Protection Authority concludes that the proposal described in the Public Environmental Report is environmentally acceptable and recommends that it could proceed subject to the Environmental Protection Authority's recommendations in this Assessment Report and the commitments made by the proponent for environmental management including:

- **development of an environmental monitoring and management programme;**
- **stablisation and revegetation of mine waste dumps to conform with the existing topography;**
- **monitoring effects of mine dewatering and discharge on riverine vegetation;**
- **minimisation of the area of disturbance by out of pit dumping by using overburden for bund walls, backfilling of borrow pits and returning a significant portion of waste material to the mine pit; and**
- **continuing management of the area following completion of mining to re-establish pre-existing drainage networks where practicable, continue revegetation programmes to establish stable plant communities and modify the mined out pit to minimise water quality changes caused by evapoconcentration.**

RECOMMENDATION 2

The EPA recommends that regular monitoring of creek bed vegetation and sediment movement is undertaken downstream of the mine water discharge to assess any changes in the creek system that may occur as a result of the discharge. The monitoring programme should be approved by the Authority prior to commissioning the mine. Results of this monitoring should be reported through regular reporting mechanisms required under the Agreement Act.

RECOMMENDATION 3

The Environmental Protection Authority recommends that prior to the completion of this project the proponent prepares and implements a plan for ongoing water quality management in the mined out pit, to the satisfaction of the Environmental Protection Authority.

RECOMMENDATION 4

The Environmental Protection Authority recommends that during all project phases, including construction and contract mining as well as on-going mining by the Proponent, caravans be restricted to a managed caravan park incorporating adequate sewage and other waste disposal facilities.

RECOMMENDATION 5

The Environmental Protection Authority recommends that any proposal to establish a new townsite in the Yandicoogina area be referred to the Environmental Protection Authority for assessment, prior to development.

RECOMMENDATION 6

The Environmental Protection Authority recommends that any future proposals to increase the mining rate beyond 5 million tonnes per year, be referred to the Environmental Protection Authority.

1. BACKGROUND

BHP-Utah Minerals International (Iron Ore) has submitted a proposal to establish a new iron ore mining project at Yandicoogina (Marillana) in the Pilbara region of Western Australia.

As a result of detailed exploration programmes carried out during the period 1979-1986, probable ore reserves of about 320 million tonnes were identified in the Central and Eastern Orebodies located within this area. Pre-development studies commenced in 1986 and included:

- the excavation of a 200 000 tonne bulk sample from Eastern Mesa 2 during 1987 to test the market acceptance of the ore; and

- an examination of the environmental consequences of the proposed Yandicoogina (Marillana) Project.

2. PROJECT DESCRIPTION

The proposal involves the mining of iron ore deposits located in the Yandicoogina (Marillana) area of the Pilbara Region of Western Australia (Figure 1).

Initial production rates are envisaged in the order of about 2 million tonnes per year and may potentially increase to a maximum of about 5 million tonnes per year over a projected 20 year mine life under existing proposals. However, it is recognised that there may be further potential for the operations to be expanded to a much larger project beyond the scope of this proposal, requiring further environmental impact assessment to be undertaken should this eventuate.

Mining is proposed to commence on the Eastern Mesa 2 Orebody (Figure 2) which has a low waste to ore ratio by Pilbara standards.

Following initial overburden removal the pisolitic ore would be extracted using conventional drill and blast mining techniques. A combination of dozers, loaders and trucks would be used to handle the required annual tonnage.

Ore would be trucked from the mine pit to a semi-mobile crushing plant.

Following primary and secondary crushing, the ore would be stockpiled for subsequent conveyor transport to the rail loadout.

The transport of ore from the minesite to Port Hedland would utilise a spur line extension from the existing Mount Newman mining Newman to Port Hedland railroad to the deposit over a distance of 49 km.

It is proposed that as mining progresses vegetation would be cleared and windrowed ahead overburden removal. Topsoil would also be removed and stockpiled for use in rehabilitation and landscaping in areas around the minesite.

The alluvium, clay and weathered pisolite would then be removed by ripper and dozer and stockpiled. Initially, these materials would be used for the construction of bund walls and as fill for borrow pits. All waste stockpiles would be designed for long-term stability and would be progressively revegetated as their status changes from stockpiles to dumps.

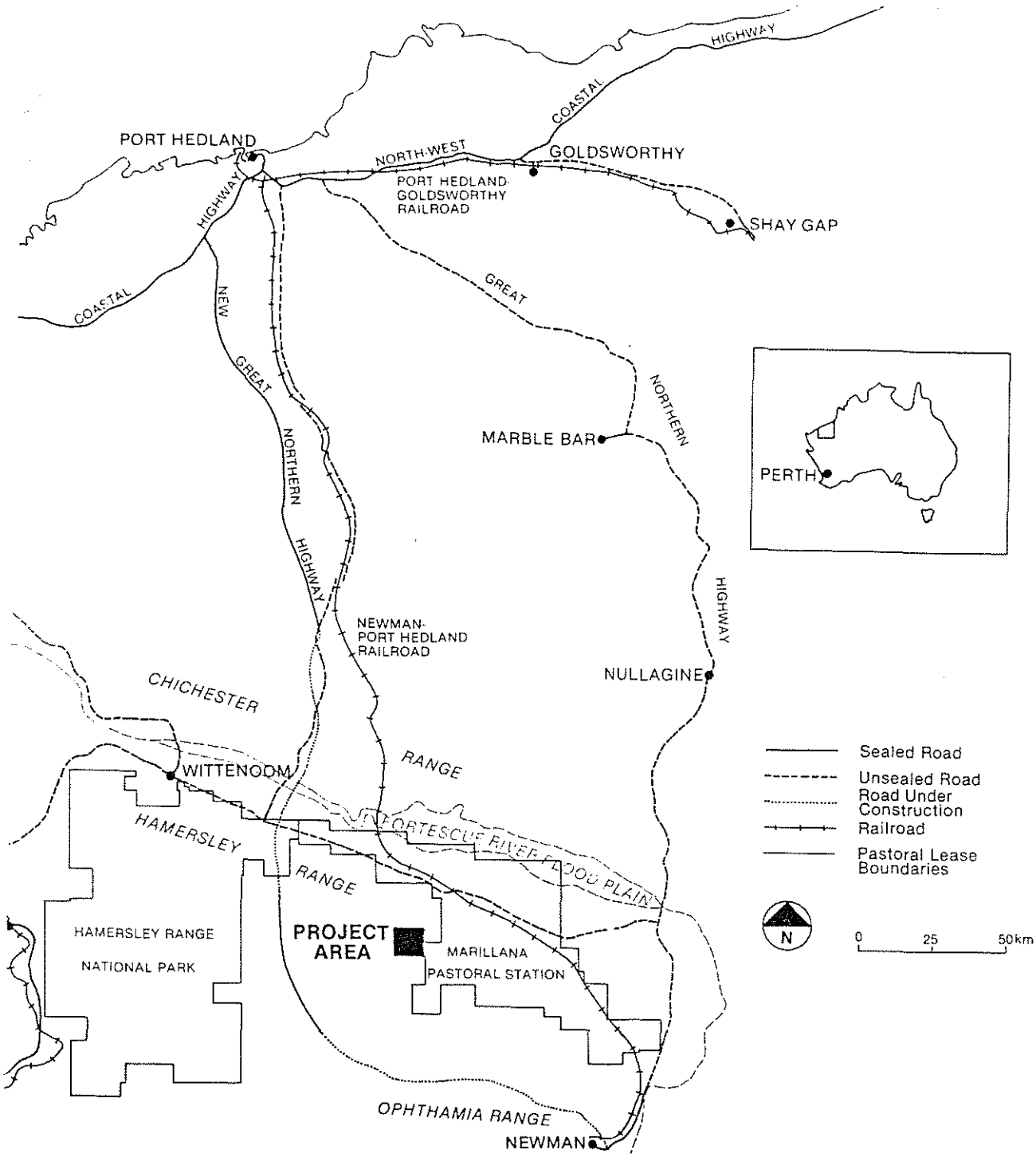


Figure 1: Map of Pilbara Region. Yandicoogina (Marillana) Project.

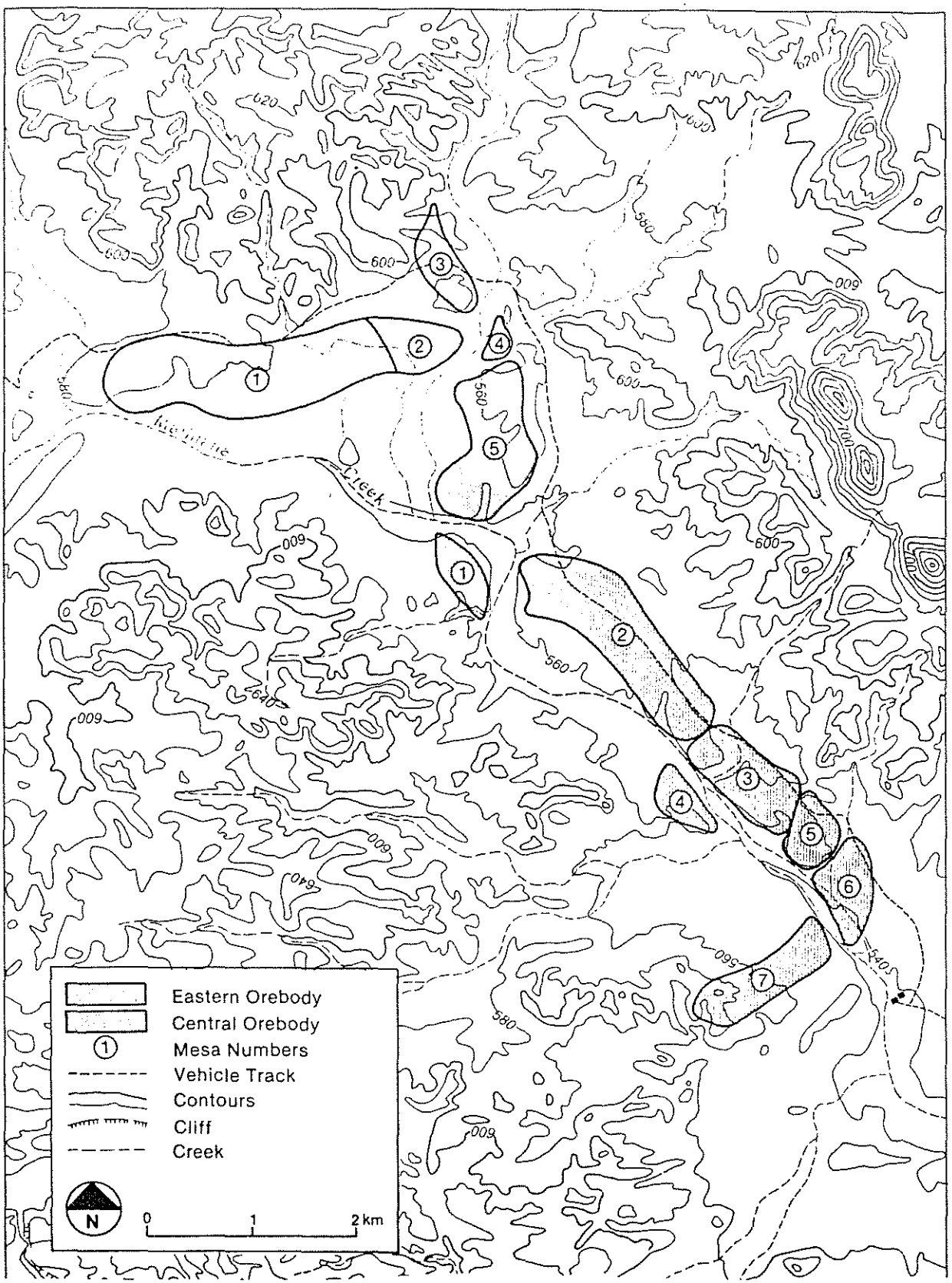


Figure 2: Eastern and Central Orebodies Locality Plan. Yandicoogina (Marillana) Project.

As mining develops to expose the lowest bench of the mine pit, it is proposed that the weathered pisolite overburden would be progressively dumped on the pit floor. This would reduce the requirements for out of pit dumping.

Considerable mine dewatering would be required as much of the ore deposit is below the natural ground water level. Likely dewatering requirements range from approximately 32 500 m^3 per day during the first year of operations reducing to about 17 500 m^3 per day during the second year and further reducing to about 15 500 m^3 per day in the third year of operations. The large initial pumping rate would be a result of the requirement to win ore from deeper benches early in the operations to satisfy ore quality criteria.

This water is generally of a high quality with an ionic composition of about 500 mg/l, mainly comprised bicarbonate salts.

It is envisaged that approximately 4 600 m^3 per day of dewatering discharge could be used around the minesite for dust suppression, ore handling and tree irrigation. The balance of the dewatering water would be discharged to Marillana Creek.

As the proposed minesite development is located in an area remote from any existing townsites new accommodation facilities would need to be constructed to house construction and operations personnel.

It is proposed that initially a temporary construction camp for approximately 200 minesite, rail spur and community construction personnel would be built. This would be located in a small valley some 3 km NNW of the minesite. The camp would be a conventional transportable camp, with catering and general recreational facilities.

Following completion of the construction phase, most of the camp would be removed. The remainder will provide accommodation for the mining contractor's personnel. Later, it may supplement accommodation facilities for subsequent mining operations by the proponent's personnel.

Longer term accommodation facilities are proposed to be developed for a commuter workforce operating on a fly-in-fly-out basis. This site would be located approximately 4 km north of the minesite, in a large valley shielded from the mine by an east-west ridge to the south.

3. EXISTING ENVIRONMENT

The proposed project area is located within the Australian arid zone. The dominating feature of the climate is its dryness, with an annual evaporation exceeding rainfall by as much as 2 500 mm/year. High temperatures and diurnal temperature variations are also characteristic.

Rainfall occurs mostly in the summer period, with about 50% of the total annual precipitation occurring in the January to March period. This rainfall occurs in about 20 rain days, indicating the dominance of cyclonic and thunderstorm activity.

The soils of the area vary widely depending on the terrain, from the coherent loamy soils and gradational red earths of the high level Plains within the Hamersley Plateau, to the cracking red and brown clays with alluvial soils and red brown earths of the Fortescue Plain.

Likewise, the soils also vary widely in erodibility from slight to very high. Most of the soils in the proposed minesite area are moderately erodible red earths and gravels associated with the lower slopes and flanks of ranges and hills.

The orebodies are bounded to the south by Marillana Creek and to the west by an unnamed tributary of Marillana Creek. Streamflow in the area is highly ephemeral, and for most of the year the creeks are dry, except for occasional pools. Large streamflows are associated with rainbearing depressions or high intensity winter rainfall.

The Yandicoogina Biological Study Area as described in the Public Environmental Report is located on the interface between the spinifex (Triodia spp) hummock grasslands of the Hamersley Plateau and the mulga (Acacia aneura) low woodlands of the adjacent plains. Some 280 plant species have been collected from the study area with the most important genera being the wattles (Acacia), gums (Eucalyptus), spinifexes (Triodia and Plectrachne) emu bushes (Eremophila), cassias (Cassia) and mulla mullas (Ptilotus). A more comprehensive species list has been supplied by the Proponent in their response to submissions and is included in this report in Appendix 2.

It was reported in the Public Environmental Report that all of the plant communities described in the Report are well represented in other areas of the Pilbara Region and that no plant species collected from the area is declared to be rare or endangered. One species that was identified Aristida anthoxanthoides is poorly represented in the WA Herbarium collection and is therefore of uncertain status.

A biological survey was conducted over the area identifying 170 species of native vertebrate animals including 3 fishes, 63 herptiles (reptiles and amphibians), 85 birds and 19 mammals.

The fauna is broadly representative of the Hamersley Ranges and is adapted to a complex of essentially rocky habitats dominated by Spinifex (Triodia and Plectrachne sp.) hummock grasslands. However, a few species are more indicative of the sandy or central deserts and the shrublands of the Fortescue Basin.

Of the endemic species surveyed none was unique to the Yandicoogina (Marillana) area and only two of these species are considered to be rare or otherwise in need of special protection.

Pseudomys chapmani (Pebble-mound mouse), although not common in the project area, is well represented in the central Hamersley Range. The status of Borthochitus olivaceus barroni (Pilbara Olive Python) is uncertain, and its current listing as rare or otherwise in need of special protection may change when more is known of its numbers and range.

A comprehensive fauna species list has been compiled by the Proponent and is included as Appendix 2.

4. PUBLIC AND GOVERNMENT SUBMISSIONS

Two public submissions and eight responses from State Government agencies were received during the public review period. A summary of the respondents and issues raised are provided in Tables 1 and 2.

Table 1.

SUMMARY OF SUBMISSIONS

ISSUE	NO OF SUBMISSIONS
Hydrology and Water Management	6
Flora and Fauna	6
Access	5
Pollution of Water Resources	3
Accommodation	3
Infrastructure	3
Mosquito Control	3
Rehabilitation	2
Future Expansion of Mining Operations	1

Table 2.

SUBMISSIONS RECEIVED

LIST OF RESPONDENTS
State Planning Commission
WA Museum
Department of Conservation and Land Management
Dept of Regional Development and the North West
Department of Resources Development
Main Roads Department
Water Authority of Western Australia
Department of Mines
West Pilbara Shire Council
Yandcra Pty Ltd

The predominant concerns were mainly with regard to impacts on the area's hydrology and Marillana Creek system through mine dewatering and discharge, impact on flora and fauna, access, pollution of water resources, rehabilitation and infrastructure associated with the project. A detailed review of the submissions is included in Appendix 1.

The Company has subsequently addressed the issues raised by the public and government agencies in their submission and by the Authority. BHP-UTAH's response is in Appendix 7.

5. ENVIRONMENTAL ISSUES

In considering the Company's initial proposal the Environmental Protection Authority determined that the potential for environmental impact was such that the proposal would require assessment under Part IV of the Environmental Protection Act, 1986, and that the level of assessment would be Public Environmental Report.

A Public Environmental Report has been submitted and has undergone an eight week public review period, which finished on 6 January 1988.

Following a review of the environmental aspects of the proposal, in light of public and government agencies' submissions, the Environmental Protection Authority determined that the proposal would be environmentally acceptable, subject to a number of conditions as discussed in the following sections of this report.

RECOMMENDATION 1

The Environmental Protection Authority concludes that the proposal described in the Public Environmental Report is environmentally acceptable and recommends that it could proceed subject to the Environmental Protection Authority's recommendations in this Assessment Report and the commitments made by the proponent for environmental management including:

- **development of an environmental monitoring and management programme;**
- **stablisation and revegetation of mine waste dumps to conform with the existing topography;**
- **monitoring effects of mine dewatering and discharge on riverine vegetation;**
- **minimisation of the area of disturbance by out of pit dumping by using overburden for bund walls, backfilling of borrow pits and returning a significant portion of waste material to the mine pit; and**
- **continuing management of the area following completion of mining to re-establish pre-existing drainage networks where practicable, continue revegetation programmes to establish stable plant communities and modify the mined out pit to minimise water quality changes caused by evapoconcentration.**

5.1 HYDROLOGY AND WATER MANAGEMENT

Effects on the ground and surface water hydrology were considered during the assessment of the proposal with respect to the following:

(i) impacts of mine dewatering on vegetation particularly those species along Marillana Creek that rely on the ground water table;

(ii) impacts of mine water discharge to Marillana Creek;

(iii) possible pollution of water resources through process and domestic water disposal; and

(iv) general issues relating to existing water quality and possible deterioration of water quality through evaporation from the pit area following cessation of mining activities.

As much of the ore deposit is below the existing ground water table, considerable mine dewatering would be required. This dewatering may result in a lowering of creekbed groundwater levels upstream of the mine. It is envisaged that a lowering of the groundwater level in the creekbed in excess of 2.0 metres over a prolonged period could result in the deaths of some species such as M. leucadendron and E. camaldulensis, which are long-rooted and rely on groundwater supplies.

This issue was addressed by the proponent in the Public Environmental Report. It was proposed that, as part of the environmental monitoring and management programme, a number of discharge points be established along the creek in the area of the mine as well as some distance upstream of the mine to irrigate the phreatophytic vegetation.

It was also proposed that a number of permanent study sites would be established along Marillana Creek. These sites would be monitored to determine adverse impacts on vegetation. Control sites, beyond the impact of mine dewatering, would also be established so that natural, seasonal groundwater fluctuations can be assessed.

The major proportion of mine water would be discharged at a site downstream of mining activities. Based on potential evapotranspiration rates of about 1 000 m^3 per day of water being transpired per kilometer length of river, it has been calculated that dewatering may sustain a surface flow in the river system for up to 17 km downstream of the discharge point. The water discharge would be identical in quality to that extracted from the aquifer (about 500 mg/l TDS) so there should be no deterioration in regional water quality.

Continual mine dewatering and discharge to Marillana Creek would also result in changes in the plant communities in the affected area of the creek bed. Constant inundation may cause a number of trees including some of the River Gums (E. camaldulensis) and other native river bed plant species to die in the immediate flooded areas as has occurred at the Opthalmia Dam. However, it is also expected that there would be a prolific growth of trees along the margin of the saturated alluvials as a result of mine water discharge.

At cessation of mining activities below the water table, mine dewatering and discharge to Marillana Creek would also cease. It is anticipated that the plant communities in the river bed would gradually return to an approximate pre-mining situation.

A loss of vegetation in the flooded zone of the creek bed may also destabilize the creek bed sediments allowing increased volumes of silt and fine sediments to be transported downstream. It is therefore important that a monitoring programme be adopted to monitor water discharge effects on the vegetation and subsequent transport of alluvial material.

Erosion control measures or variation in the mine water discharge strategy may need to be considered if impacts are determined to be significant.

RECOMMENDATION 2

The EPA recommends that regular monitoring of creek bed vegetation and sediment movement is undertaken downstream of the mine water discharge to assess any changes in the creek system that may occur as a result of the discharge. The monitoring programme should be approved by the Environmental Protection Authority prior to commissioning the mine. Results of this monitoring should be reported through regular reporting mechanisms required under the Agreement Act.

Mine process water may include some petroleum products as well as other potential contaminants from activities such as vehicle washdown, ore handling and dust suppression. Accidental spillage of contaminated process water could result in groundwater downstream from the mine being rendered unfit for potable use.

It was proposed in the Public Environmental Report that all water from potentially contaminated areas would be collected in a closed system for treatment. This water would pass through an oil separator before being discharged to an impermeable evaporation pond. Domestic sewage waste from the mine-site would be processed through a sewage treatment plant.

The proponent has made a commitment that the removal of waste materials, ie, oils, sewage, etc. would be undertaken in accordance with Health Department and Local Authorities' requirements.

Although final pit dimensions and boundaries have not yet been established it is envisaged that the pit would remain partially filled with water once mining ceases. There is some concern that this may become concentrating basin for salt accumulation which could result in a deterioration of groundwater quality downstream of the pit.

This issue was addressed by the proponent in its Public Environmental Report where it was proposed that a monitoring programme be established to assess the long-term quality of water in the mined out pit. A post-mining strategy would need to be developed as a result of the monitoring and the mined out pit modified to minimise water quality changes caused by evapotranspiration. One such strategy that was mentioned in the Public Environmental Report would be to open the mined out pit to Marillana Creek to allow occasional flushing of the water remaining in the pit.

RECOMMENDATION 3

The Environmental Protection Authority recommends that prior to the completion of this project the proponent prepares and implements a plan for ongoing water quality management in the mined out pit, to the satisfaction of the Environmental Protection Authority.

5.2 FLORA AND FAUNA

The construction of the mine and associated infrastructure would result in the disturbance of approximately 1 400 ha of native vegetation.

Although a number of fauna species will be displaced from the immediate area by mining activities it is considered that none of these species will become endangered as a result of this proposal. Fauna surveys carried out have not identified any habitats unique to the proposed mining area.

Comprehensive species lists of flora and fauna have been prepared by the proponent and are included in Appendix 2 of this report as part of the Company's responses to submissions.

5.3 REHABILITATION

Rehabilitation of areas disturbed through mining and associated activities was considered by the Authority in its assessment of this proposal.

The primary objective of rehabilitation programmes is stated in the Public Environmental Report as leaving the site in a condition that would minimise erosional impacts over ensuing years.

Proposed rehabilitation works include contouring of the final waste dump to conform with the existing topography with slopes constructed in such a way as to ensure a stable profile regrowth and to prevent water and wind erosion. Revegetation of mine dumps would be achieved using the most successful revegetation techniques available to ensure the creation of self sustaining vegetation communities. Revegetation works would be monitored intensively during the mining phase, and routinely following decommissioning.

A number of commitments have been made by the proponent with respect to rehabilitation as listed in Appendix 3 of this report.

5.4 ACCESS AND PROJECT INFRASTRUCTURE

As proposed mine development is located in an area remote from existing established infrastructure such as accommodation, major transport corridors, airport facilities and water supplies, these facilities would need to be established to service the mining operations.

The environmental impacts of this infrastructure were considered by the Authority in its assessment of the proposal.

In considering the issues related to workforce accommodation the Authority noted that initial development proposals were of a temporary nature during construction and early operations. This would allow for these sites to be easily rehabilitated following the establishment of more permanent accommodation facilities. Rehabilitation would be addressed under the requirements of the Agreement Act and would be to the satisfaction of the Minister responsible for administering that Agreement.

The Company has also made a commitment that, during construction, caravans would be restricted to a managed caravan park.

Following construction, permanent workforce accommodation would be established as a village for a commuter workforce on a fly-in-fly-out basis.

RECOMMENDATION 4

The Environmental Protection Authority recommends that during all project phases, including construction and contract mining as well as on-going mining by the Proponent, caravans be restricted to a managed caravan park incorporating adequate sewage and other waste disposal facilities.

No proposals have been submitted for the establishment of an open townsite as part of this proposal. However, the Environmental Protection Authority notes that, in view of the potential for future expansion of iron ore mining operations in the Yandicoogina area, the State Government has undertaken preliminary investigations to assess the need for a new townsite to be developed in the area. Such development would require further environmental impact assessment at such a time that a proposal is put forward.

RECOMMENDATION 5

The Environmental Protection Authority recommends that any proposal to establish a new townsite in the Yandicoogina area be referred to the Environmental Protection Authority for assessment, prior to development.

In its assessment of the proposal the Environmental Protection Authority also noted that the current proposal is to mine at rates of up to 5 million tonnes per year (Mtpa). For production rates to be increased beyond 5 Mtpa, some changes to the required infrastructure, staffing and operational procedures may be required. As these changes and their likely environmental impacts were not addressed in the current proposal it is considered that further assessment would be required should operations be expanded beyond 5 Mtpa.

RECOMMENDATION 6

The Environmental Protection Authority recommends that any future proposals to increase the mining rate beyond 5 million tonnes per year, be referred to the Environmental Protection Authority.

5.5 MOSQUITO CONTROL

A number of submissions to the Authority on this proposal identified the possibility of increased mosquito numbers in the area through the creation of large areas of surface water as a potential problem.

Mosquitoes in the North West are known to carry Australian Encephalitis which can have severe public health consequences.

The Authority therefore considered that careful management of areas of standing surface water would be required to ensure that any increases in the mosquito population do not cause such consequences.

The Authority notes that the Health Department of Western Australia has an arbovirus surveillance programme, with routine monitoring undertaken by the Local Authority. Accordingly, the Proponent would be required to consult with the Health Department and the Shire of East Pilbara's Health Surveyor to ascertain what monitoring and control measures are required for this project. The Proponent has given a commitment to manage any mosquito problems.

6. CONCLUSION

Upon assessment of the BHP-UTAH Minerals International proposal the Authority has concluded that the proposed Yandicoogina (Marillana) Project would be environmentally acceptable subject to the operations being carried out in accordance with the commitments in the Public Environmental Report and subsequent correspondence (Appendix 3) and the Environmental Protection Authority's Recommendations.

REVIEW OF SUBMISSIONS

HYDROLOGY

A number of submissions expressed concern with regard to impacts on the surface and groundwater regime primarily through mine dewatering.

A major high quality groundwater resource will be affected by mine dewatering (Sections 2.3.4 & 5.3.2) and there is potential for aquifer salinisation (Section 4.3.2), during the proposed mine's operational life and in the post-mining phase due to evaporation loses.

The consequences arising from hydrological changes need to be clarified and enlarged upon. These are: vegetation effects (Sections 3.7.4, 4.1.2, 4.2.2 & 4.2.3, Tables 4.1 & 5.1, current uses of the groundwater in relationship to the long term effects of mine dewatering on local and regional hydrology, the presence of a large mined-out pit on groundwater salinity (Sections 4.3.2 & 4.3.3).

Before an adequate assessment of these issues can be made a more detailed hydrogeological report is recommended. This should include:

- the geometry of aquifer;
- the present water balance and salt balance as well as general water quality parameters;
- a breakdown of groundwater usage from dewatering in order to establish how much water would be discharged;
- whether the groundwater discharged from the mine could be used, in local irrigation for stock food production or arid area horticulture; and
- the release of waste water from the mine dewatering operation into Marillana Creek (Section 2.3.4.2). The review should include possible outlet positions, erosional aspects of the discharge, possible aquifer salination, possible means for enhanced recharge to minimise evaporation; changes in flora/fauna communities in the post-mining phase (Section 4.2.3); and measure to minimise effect of cattle and other feral animals causing vegetation degradation.

The communities likely to be affected are defined by the vegetation description (Section 3.7.2) as characteristic of the valley areas (Community C), the creek bed, embankment and the fringing woodland (Community D). A detailed survey of both flora and fauna should be undertaken to establish the natural level of activity prior to the event of unnatural water discharge into the area and any subsequent dewatering in the Yandcra lease areas.

The Report has not quantified the likely ecological impact of the groundwater withdrawal. It refers to effects on phreatophytes upstream but no indication of the distance over which this will occur.

POLLUTION OF WATER RESOURCES

Pollution of potable or otherwise usable water resources through accidental spills of waste oils, sewage or other potential contaminants was discussed in a number of submissions.

The environmental management plan recognises the significance of the groundwater system (Section 5.3.2) and proposals are given for monitoring water quality at discharge points and observation bores. Monitoring should include detection of chemicals and other hazardous materials (such as domestic sewage treatment effluents) which might contaminate the groundwater through accidental spillage or other discharge within the project area and procedures to eliminate any problems which occur.

Minesite wastes such as washdown water lubricating and other oils, sewage and other general wastes would be required to be discharged in a manner acceptable to the State Health Department, and the Local Authorities Health Surveyor. The location of the sanitary landfill site should be at the discretion of the Health Surveyor and treated in accordance with his directions.

Water quality should be to Health Department requirements, with periodical samples taken by the Local Authorities Health Surveyor. Sampling points would need to be allowed for as directed by the Health Surveyor.

Waste oils should be sold or incinerated. There may be scope for using them as a dust suppression advice in the area without putting water quality at risk, especially on out of pit gravel roads.

FLORA AND FAUNA

Considerable fauna and vegetation data has been accumulated for the proposal area by means of a biological survey, making this area one of the best known in the Pilbara.

The statements on the fauna appear to be comprehensive and extensive, but a total listing of species recorded during the survey would have been useful in making an assessment of the PER and potential environmental impact. This is particularly the case with the ca. 10% of reptiles not caught elsewhere in the Hamersley Range (p 20).

There is no real assessment of the conservation status of the biotic communities in the project area, and the impact of mining is only considered superficially.

No information is provided regarding the effect of the railroad on the environment. It is known that parts of the Weeli Wooli Outwash Fan are highly degraded due to pastoral activity and to some extent as a result of hydrological changes, caused by Mt Newman Mining's railroad. It appears from Figure 3.1 and 3.5 that the railroad crosses some of these sensitive vegetation communities (Mulga) as it heads north west, running parallel to the Weeli Wolli Creek. It is suggested appropriate construction techniques are used to minimise the effect of hydrological changes to vegetation, resulting from the railroads construction.

ACCESS

A number of submissions identified issues relating to vehicle, rail and air access to the site as requiring further discussion.

It was noted that the access will be from a road referred to as the Wittenoom - Meekatharra Road Via Marillana Homestead. It was also pointed out that the road is referred to by Main Roads Department and the Department of Lands Administration as the Wittenoon - Roy Hill Road.

During the exploration stage of the project over 80% of all persons travelling to the site used Mt Newman Mining Companies Railway Access Road as this was 63 km shorter than taking the proposed route. Another reason for persons using the access road, is that during the wet season the Wittenoom - Roy Hill Section especially between Roy Hill and Marillana, is very prone to flooding. The road is also easily damaged by Heavy Transport, as the local earth structure tends to turn to dust.

Liaison would be needed with BHP-UTAH on the junction of the access road and Wittenoom - Roy Hill Road to select a suitable location for the junction to ensure drainage and sight distance criteria are met.

Roads shown in the PER may change if the accommodation site is altered. It is also likely that a link to the new national highway will be needed to accommodate growing tourist traffic in the area when the development commences operations.

The 'airstrip' description is sketchy but would need to be sealed and lit (for commercial operations), so can be expected to be more likely of 'airport' standard. The siting of the airstrip may suit the project but may not suit other potential developments in the area.

ACCOMMODATION

The issue of operating workforce and construction workforce accommodation was raised in some of the submissions.

It was also considered that the accommodation site shown in the PER may not be final. State Cabinet has recently approved the establishment of a committee to consider the need for a town to service all potential developments in the general vicinity of Yandicoogina.

Tourists may be attracted to the area but the question catering for these tourists is not addressed in the PER. One submission enquired as to whether the construction camp facilities would include a caravan park and if so would if be envisaged that families would live in the park. A similar concern was expressed with regard to workforce accommodation.

The PER does not indicate the complement of the construction (including peak) and operations workforce.

INFRASTRUCTURE

The document does not detail the location of the proposed potable water supply borefield, water supply lines and power lines, with associated access roads. It does not quantify the requirement for water and power.

MOSQUITO CONTROL

The report recognises the problems associated with Australian Encephalitis yet it does not suggest appropriate action.

It is generally acknowledged that mosquitoes in the North West of the State carry Australian Encephalitis which can have fatal consequences. Any increase in the mosquito population is unacceptable.

The Health Department of WA has a arbovirus surveillance programme, however, the day to day monitoring of this programme is undertaken by the Local Authority, with the cooperation of the environmental officers from the Companies. Management requirements for the Project area should be discussed with the Local Authority.

FUTURE EXPANSION OF PROPOSED MINING OPERATIONS

The report shows that the project will be one of low production rates (ie 2.0 million tonnes per annum which may increase to 5.0 MTPA or more at a later date).

The size of the ore body indicates that the project could expand to a far higher production rate, as has occurred with previous iron ore projects. Care should be taken to ensure that consideration is given to all relevant areas should there be an expansion of the project.

REHABILITATION

Sections 2.3, 5.3 and 5.4 discuss the operational and post-mining phases of the project, however, no information is provided regarding final land form and rehabilitation procedures. The following comments need to be considered: Final outside slopes of waste dumps should be shaped to generally fit into the surrounding topography. Top soil should be removed from all disturbed areas and stock piled for future use or used immediately in the rehabilitation should be undertaken on continuous basis.

No information is provided regarding the final pit morphology and since it is envisaged that the mine will become a major water body, consideration should be given to developing this area into a wetland system. It is therefore suggested that consideration be given to a final pit design and morphology which encourages the development of fringing vegetation which in time would create habitats suitable for species attracted to the area because of presence of the large water body.

There is only passing reference to revegetation of overburden. A clearer indication should be made on the revegetation techniques and species that will be adopted in the early stages and avenues of research that will be followed to refine these techniques over time.

YANDICOOGINA (MARILLANA) PROJECT

PUBLIC ENVIRONMENTAL REPORT

RESPONSE TO SUBMISSIONS

FEBRUARY 1988

REPORT NO: EP-R1911

FEBRUARY 1988

DH:JS:2216H

CONTENTS

1.0 GENERAL

The Proponent has reviewed submissions detailed by the Environmental Protection Authority. The submissions made are related to five main aspects of the Project, namely

- hydrology
- flora and fauna
- infrastructure
- mosquito control
- rehabilitation

Some reference was made in the submissions to areas which were not covered by the PER, or only described briefly. In all cases these areas were seen to have little bearing on potential environment issues and were reported on accordingly. Comprehensive species lists, for example had been compiled but were not published due to the requirement to reduce the overall bulk of the PER document.

Submissions relating to the use of dewatering discharge for agricultural pursuits were seen to be beyond the scope of this PER.

Stock management on the property is expected to reduce any impact by cattle on the local environment due to presence of surface water from the dewatering discharge.

2.0 HYDROLOGY

2.1 WATER BALANCE OF THE PROJECT AREA

A detailed hydrology and dewatering study has been reported and was referenced for preparation of the PER.

The hydrology of the arid areas of the Pilbara is dominated by the large potential evaporation excess over rainfall. Within the Project Area, considerable study into the components of water balance has been undertaken, both to describe the existing status, and to assess modification caused by the mining (dewatering) operations.

The orebodies are part of an ancient paleochannel aquifer which is of the order of 500 metres wide and 70 metres deep and which meanders from upstream of the deposit along Marillana Creek to downstream where it has a confluence with the Weeli Wolli Creek paleochannel aquifer. This aquifer continues northwards and is expected to discharge eventually to groundwaters associated with the Fortescue Flood Plain.

A schematic summary of the dominant water flow components for the existing situation is given in Figure 1 attached to this report.

Streamflow in the area is highly ephemeral and annual average flow at the minesite has been estimated to be about 33 million cubic metres. This is expected to be highly variable due to the nature of cyclonic and thunderstorm activities.

Groundwater throughflow in the paleochannel aquifer is expected to be of the order of 1 million cubic metres per annum, and under existing conditions this is expected to be relatively constant with only small fluctuations during periods of intense recharge, or during long term drought periods. The generally high quality of the paleochannel groundwater reflects its ready interchange with surface water by inflow/outflow, and with rainfall recharge, and lack of evapotranspirative concentration of salts within the aquifer.

The paleochannel aquifer in which the orebody resides abuts and is overlain in places by the alluvial creek system. These alluvials may be as much as twenty metres thick and many contain rock bars in various areas. Consequently, the groundwater balance components are not readily quantified, in particular in estimating the evapotranspirative losses by the creek phreatophytes.

The creek alluvials, however play an important role in the hydrology of the paleochannel aquifer, acting as a water source or water sink depending on the relative levels of water in the creek (or in the alluvial gravels) and groundwater in the aquifer.

Given this model of the local hydrology, the mine operations were assessed to determine any impacts and hydrological issues that may occur.

2.2 CHANGES TO THE LOCAL HYDROLOGY CAUSED BY MINING

In the long term, it has been estimated that mine dewatering will amount to pumping about 6 million cubic metres per annum from the paleochannel aquifer. Of this, about 3 million cubic metres per annum will be discharged into the alluvial creek system in the vicinity of the mine.

Figure 2 attached to this report gives a schematic of the water flow components of the area during the mine operations.

In view of the interaction between the creek alluvials and the orebody aquifer, some of the discharge will tend to maintain water levels in the creek and will be recirculated to the paleochannel aquifer.

The flow components of the water balance in Figure 2 cannot be quantified with any accuracy that would improve the assessment of hydrological impacts of the operations.

Section 2.3.4.2 of the PER indicates the net loss of water will be about one million cubic metres per annum (dust suppression, ore handling etc). In terms of the overall hydrology of the area, this will have minimal impact, away from the immediate minesite area, given the magnitude of natural water flow components.

Groundwater lowering due to mine dewatering will occur for a distance of about two kilometres upstream of the mine where there has been shown to be an hydraulic barrier.

Two kilometres downstream of the mine, the dewatering discharge will be reinjected into the creek alluvials where it is expected to recharge back into the paleochannel aquifer.

2.3 WATER QUALITY IMPACTS

Paleochannel and river alluvial groundwater quality is high, total salts generally being less than about 500 mg/l, and changes to the quality caused by the mining operations were given careful consideration during the hydrological studies.

Some evaporation from the mine pit may lead to small concentration of the eventual dewatering discharge, but following disposal of excess discharge the water would be subject to natural concentrating conditions within the creek alluvials.

As part of the specified monitoring programme, a detailed water quality sampling and analysis programme will be adopted (PER, Section 5.3.2, Table 5.1).

3.0 DISPOSAL OF POLLUTANTS

The removal of waste materials, i.e., oils, sewage, etc has been discussed in the P.E.R. and will be undertaken in accordance with Health Department and Local Authorities requirements.

4.0 FLORA AND FAUNA

Some comments were made regarding the omission of detailed flora and fauna lists of the area. These lists have been prepared and have been attached to this report in Appendix 1.

Seasonal vegetation surveys will be undertaken during mining.

5.0 INFRASTRUCTURE

5.1 ACCESS

Public access to the site is to be via the Wittenoom - Roy Hill Road and southwards to the minesite via the existing unsealed access road. The MNM railroad line access road can only be used by personnel on company business. Where the Wittenoon - Roy Hill Road crosses the Yandicoogina Rail Spur, the intersection will be fully designed to ensure drainage and sight distance criteria are met.

5.2 AIRSTRIP

During the 'contractor operated' phase of the Project the airstrip will be an unsealed gravel strip constructed according to Department of Aviation requirements and standards. The area selected for the strip has been evaluated in terms of its environmental attributes including aboriginal ethnography and archeaology.

5.3 WATER SUPPLY, ROADS AND POWER

Water supply requirements for the minesite operations are specified in Section 2.3.4.2. Potable and camp water supply requirements were not seen to be an issue since adequate high quality groundwater is plentiful.

General location of mine infrastructure and associated access roads are shown in Figure 2.1 and services will generally be located within the road reserve. Any further detail is regarded as superfluous to the overall environmental assessment.

5.4 RAILROAD SPUR LINE TO THE MINESITE

The Proponent has direct experience of the interaction of the environment and the Newman railroad in the vicinity of the proposed Yandicoogina Spur. Consideration is being given in the rail spur design to minimise the effects on drainage, and hence the vegetation, of the area.

As part of the general monitoring and management program, the proponent proposes to undertake environmental interaction studies to identify any impacts and methods of management.

5.5 OTHER

During construction, caravans will be restricted to a managed caravan park.

Any needs for picnic facilities and tourist facilities will be identified during the mining operation and managed as the needs arise.

6.0 MOSQUITO CONTROL

Managing the effects of mosquitoes is to be discussed with the Health Department of Western Australia (PER Section 5.3.6). Some work may be required to identify any potential problems following mine construction and during operation.

The proponent, as part of the general monitoring and management programme, proposes to

- identify and control potential mosquito breeding sites,
- monitor mosquito species to assess disease potential,
- carry out necessary fogging, spraying and baiting should it be required.

7.0 FUTURE EXPANSION OF THE OPERATIONS

The current proposal is to mine at rates of up to 5 Mtpa. Were the operations to expand beyond 5 Mtpa, some changes to the required infrastructure, staffing and operational procedures may be required although these changes are not expected to be substantial. Initially assessments of potential increases in production indicate that:

- there would be little or no changes to the dewatering requirements since mining at even low rates requires mining ore from the lowest benches for blending purposes.

- the operation would change from contractor to company operation with more permanent ore handling facilities being required.

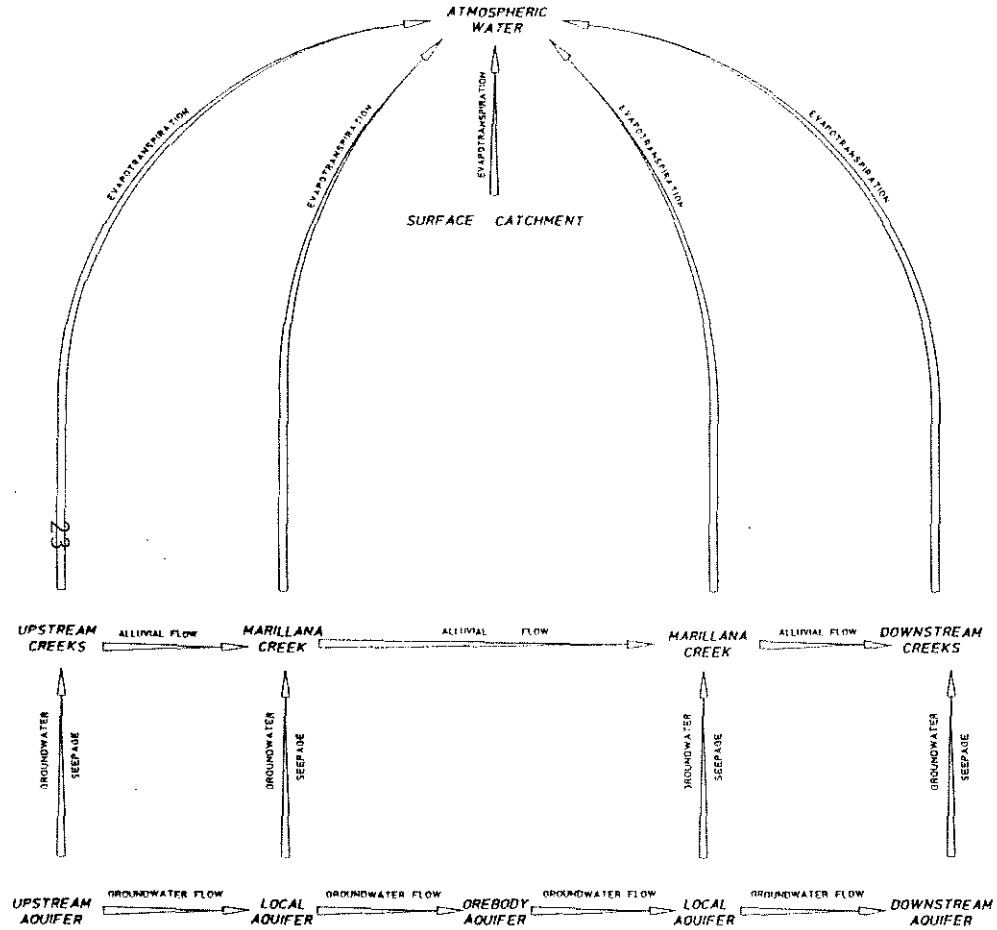
- the accommodation at the minesite would change from contractor camp to a company fly in fly out type village.

Requirements for production levels beyond this have not been assessed for this PER. Consideration will be given to all aspects should there be further expansion of the Project.

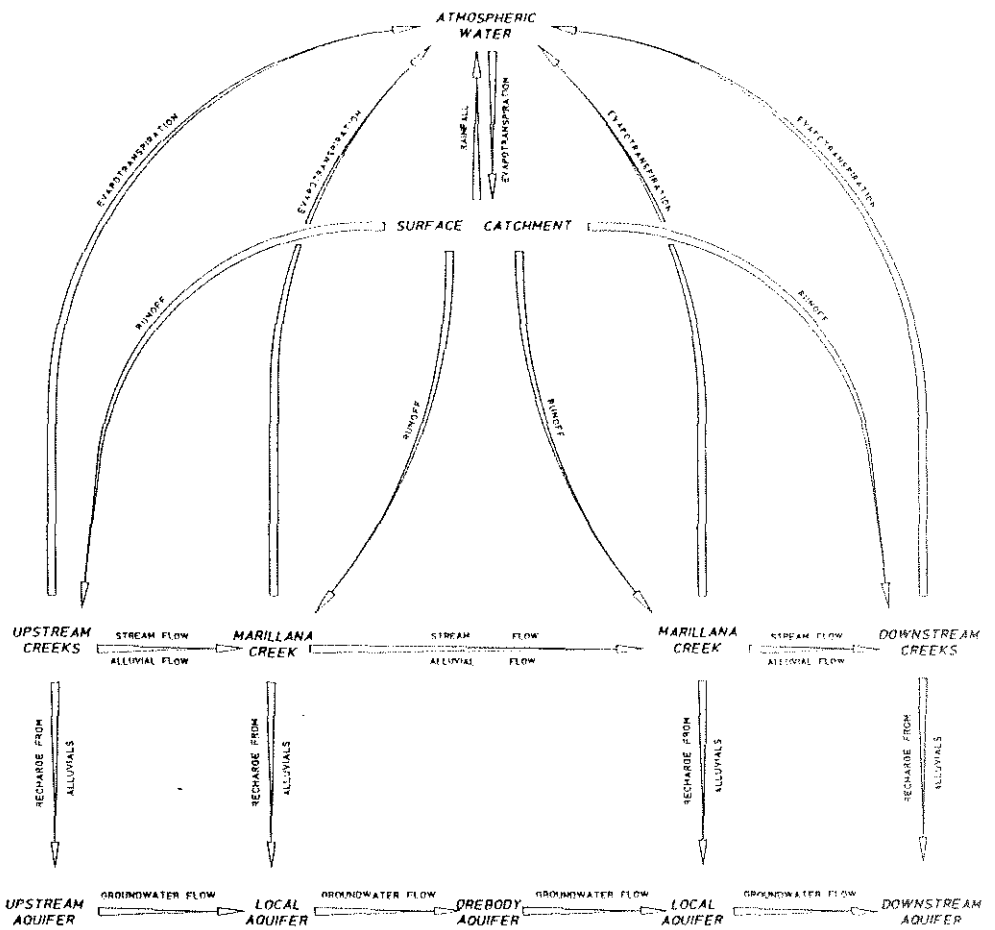
8.0 REHABILITATION

The final waste dump will conform with the existing topography. Dump slopes will be constructed to ensure a stable profile regrowth and to prevent water and wind erosion. Revegetation of the mine dumps will be achieved using the most successful revegetation techniques available. This should ensure the creation of self sustaining vegetation communities. The revegetation programme will be monitored intensively during the mining phase, and routinely following decommissioning.

The final shape of the mine pit is not known. There are advantages/disadvantages in having a permanent water body in the pit. The final pit design and maintenance will be given consideration for long term management during the course of the operations.



NO STREAMFLOW

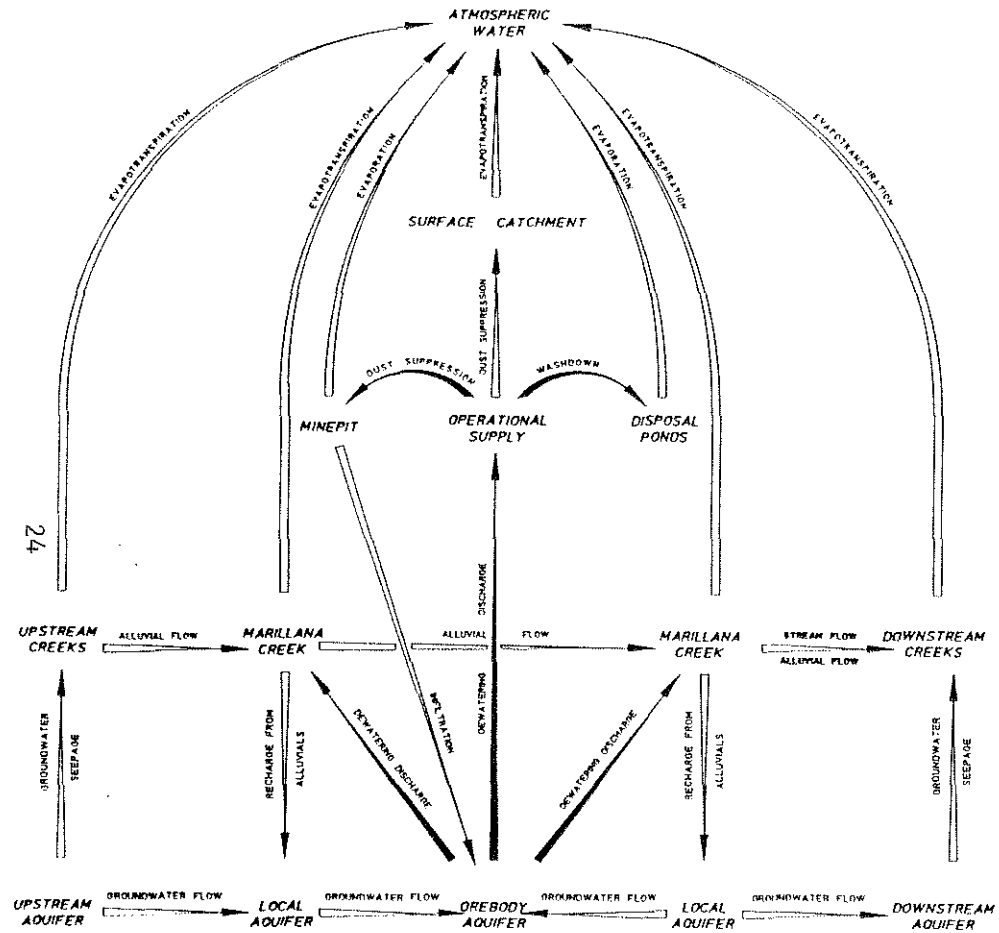


STREAMFLOW

YANDICOOGINA (MARILLANA) PROJECT

LOCAL HYDROLOGY SCHEMATIC

FIGURE 1



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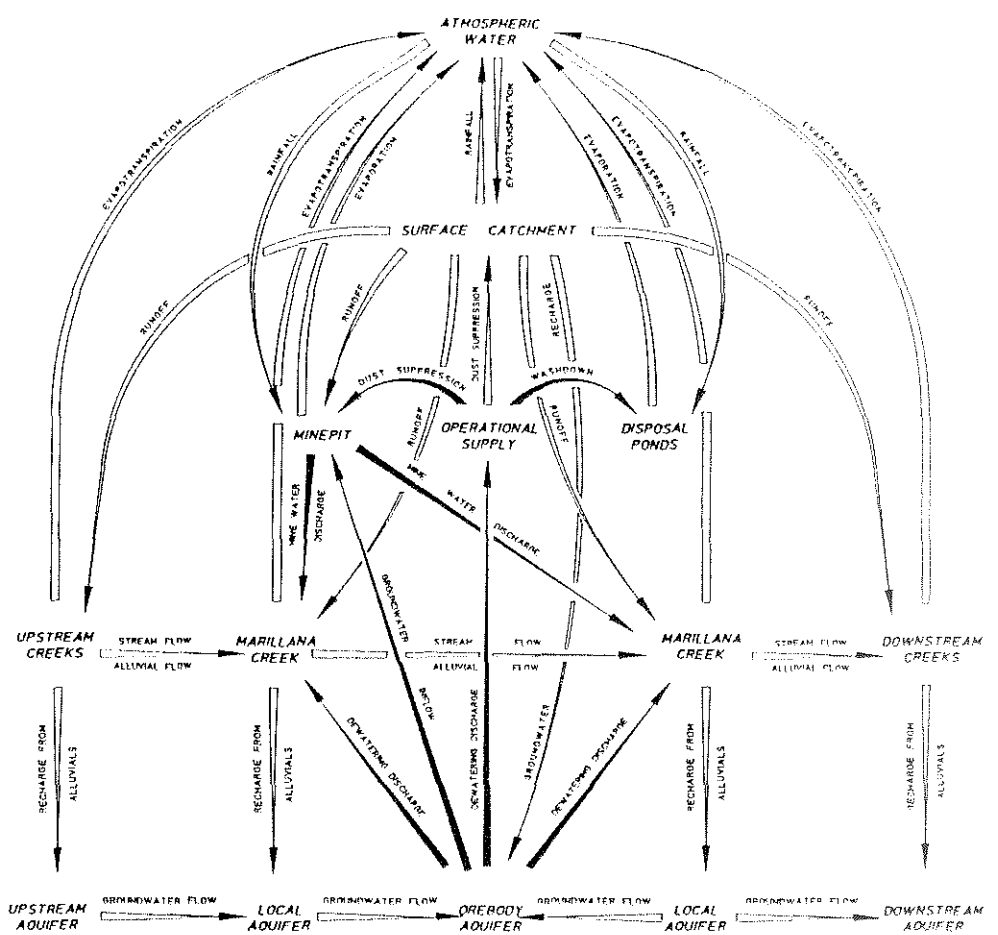

STREAMFLOW

YANDICOOGINA (MARILLANA) PROJECT
LOCAL HYDROLOGY FOLLOWING MINING - SCHEMATIC
FIGURE 2

APPENDIX 1

COMPREHENSIVE SPECIES LISTS

The following species lists were compiled from data supplied by Integrated Environmental Services (IES) and Natural Systems Research (NSR) over the period 1980/1981. Details of survey procedure and additional information is contained in their reports IES (1981) Ecological Appraisal of the Yandicoogina Project Area; NSR (1981) Vegetation and Fauna Studies: Yandicoogina Prospect, W.A.

Botanical Nomenclature after:

Green (1981)

Zoological Nomenclature after:

Kitchener & Vicker (1981) – native mammals

Hyett & Shaw (1980) – introduced mammals

Schodde et al. (1978) – birds

Cogger et al. (1983) – reptiles and amphibians

Allen (1982) – fishes

FLORA OF THE YANDICOOGINA STUDY AREA

* Flowering and fruiting records for the field periods are given in the right-hand columns.

\+ Naturalised species not native to any part of Western Australia (Green, 1981).

		*Sept	Nov	Dec	Mar
RUPPIACEAE					
Ruppia sp			+		
POTAMOGETONACEAE					
Potamogeton	javanicus Hassk		+		
ADIANTACEAE					
Cheilanthes	lasiophylla Pic. Ser.	S		–	–
	tenuifolia (Burm. f.) Sw.	S		–	–
POACEAE					
Aristida	anthoxanthoides (Domin.) Henr.				F
	contorta F. Muell.	FS		–	FS
+ Cenchrus	ciliaris L.	FS		–	F
Chloris	pumilio R.Br.				F
Chrysopogon	fallax S.T. Blake				F
Cymbopogon	ambiguus A. Camus	–	+	–	FS
Dactyloctenium	radulans (R.Br.) Beauv.				FS
Dichanthium	affine (R.Br.) A. Camus	FS		–	F
Enneapogon	caerulescens (Gaud.) N.T. Burbidge	FS		–	F
	pallidus (R.Br.) Beauv.	FS		–	F
Eragrostis	eriopoda Benth.	FS		–	F
	japonica (Thunb.) Trin.	S		–	FS
	pergracilis S.T. Blake				F
	setifolia Nees				F
Eriachne	aristidea F. Muell.				F
	benthamii W. Hartley	–		–	FS
	mucronata R.Br.	FS	+	–	–
	pulchella Domin.	S		–	F

			*Sept	Nov	Dec	Mar
	Eulalia	fulva (R.Br.) Kuntze				FS
	Paraneurache	muelleri (Hack.) S.T. Blake		+		
	Paspalidium	gracile (R.Br.) Hughes				F
		rarum (R.Br.) Hughes				F
	Panicum	australiense S.T. Blake				FS
		whitei J.M. Black				F
	Perotis	rara R.Br.				FS
	Plectrachne	schinzii Henr.				F
+	Setaria	verticillata (L.) Beauv.			F	F
	Themeda	australis (R.Br.) Stapf.	FS		-	F
	Tragus	australianus S.T. Blake				FS
	Triodia	basedowii E. Pritzel	-		-	FS
		longiceps J.M. Black	-		-	FS
		pungens R.Br.	-	+	-	FS
		wiseana C.A. Garden.	-	+	-	FS
CYPERACEAE						
	Bulbostylis	barbata (Rottb.) C.B. Clarke	S		-	F
	Cyperus	bulbosus Vahl.	-		-	-
		vaginatus R.Br.	FS	+	-	-
	Eleocharis	atropurpurea (Retz.) Kunth.			F	F
	Fimbristylis	microcarya F. Muell.				F
	Scirpus	litoralis Schrad.		+		
MORACEAE						
	Ficus	platypoda A. Cunn.	S	+	-	-
PROTEACEAE						
	Grevillea	berryana Ewart & J. White		+		
		pyramidalis A. Cunn.	F	+	-	-
		wickhamii Meissn.	FS	+	-	F
	Hakea	chordophylla F. Muell.		+		
		suberea S. Moore	F		-	-

		*Sept	Nov	Dec	Mar
SANTALACEAE					
Anthobolus	leptomerioides F. Muell.	FS		–	–
Santalum	lanceolatum R.Br.	–	+	–	F
LORANTHACEAE					
Amyena	fitzgeraldii (Blakely) Danser	S	+	F	F
	gibberulum var. gibberulum (Tate) Danser.	FS	+	–	F
	preissii (Miq.) Tiegh.	S		–	F
	sanguineum (F. Muell.) Danser	–	+	–	–
Lysiana	casuarinae (Miq.) Tieghem.		+		
POLYGONACEAE					
+ Rumex	conglomeratus Murray	S		–	–
CHENOPODIACEAE					
Bassia	clavata Ising.	S		–	–
Dysphania	kalpari P.G. Wilson	S		–	F
	rhadinostachya (F. Muell.) A.J. Scott	S		–	F
Enchylaena	tomentosa R.Br.	S		–	–
Maireana	plantifolia (F. Muell.) P.G. Wilson	S		–	–
Rhagodia	eremaea P.G. Wilson	–		–	F
Salsola	kali Linn.	S		–	–
Sclerolaena	birchii (F. Muell.) Domin		+		
	muricata (Moq.) Domin		+		
AMARANTACEAE					
+ Aerva	javanica (N.L. Burman) Juss ex Schultes	FS		–	F
Alternanthera	nodiflora R.Br.	S		–	–
Amaranthus	mitchellii Benth.	FS	+	–	F
Gomphrena	cunninghamii (Miq.) Druce	FS		–	–

		*Sept	Nov	Dec	Mar
Ptilotus	aervoides (F. Muell.) F. Muell.	FS		–	–
	astrolasius F. Muell.	F		S	F
	calostachyus F. Muell.		+		
	clementii (Farmar) Benl.		+		
	exaltatus Nees.	FS	+	–	–
	fusiformis (R. Br.) Poir.		+		
	gaudichaudii (Steud.) J.M.Black	FS		–	–
	helipteroides (F. Muell.) F. Muell.	FS		–	–
	obovatus Gaud.	F		–	–
	polystachyus (Gaud.) F. Muell.	FS		–	F
	rotundifolius (F. Muell.) F. Muell.	FS	+	–	–
	schwartzii F. Muell. ex Tate	FS		–	F
NYCTAGINACEAE					
Boerhavia	diffusa L.	FS	+	–	F
AIZOACEAE					
Mollugo	molluginis (F. Muell.) Druce	FS		–	F
Trianthema	glossostigma F. Muell.	FS		–	F
PORTULACACEAE					
Calandrinia	eremaea Ewart				F
CARYOPHYLLACEAE					
Polycarpaea	holtzei Maiden & Betche	FS		–	F
	longiflora F. Muell.	F		–	–
MENISPERMACEAE					
Tinospora	smilacina Benth.		+		
PAPAVERACEAE					
+ Argemone	mexicana L.	FS	+	–	–

		*Sept	Nov	Dec	Mar
CAPPARACEAE					
Capparis	spinosa L.	–		FS	FS
	aff. mitchellii (Lindl. ex F. Muell) Benth.		+		
Cleome	viscosa Linn.	FS	+	–	FS
BRASSICACEAE					
Lepidium	rotundum DC.	FS		–	–
STYLOBASIACEAE					
Stylobasium	spathulatum Desf.	S		–	–
MIMOSACEAE					
Acacia	adoxa Pedley	FS	+	S	–
	ampliceps Maslin		+		
	ancistrocarpa Maiden & Blakely	S	+	–	F
	aneura F. Muell. ex Benth.	S	+	–	–
	arida Benth.		+		
	bivenosa DC.	FS	+	–	–
	citrinoviridis Tindale & Maslin	S		–	F
	coriacea DC.	S		–	F
	cowleana Tate	S		–	–
	dictyophleba F. Muell.	S	+	F	F
	farnesiana (L.) Willd.	FS	+	–	–
	hamersleyensis M.S. B. Maslin.		+		
	hilliana Maiden	FS	+	–	F
	inaequilatera Domin.	FS	+	–	–
	maitlandii F. Muell.	FS	+	–	–
	monticola J.M. Black	S	+	–	–
	pachyacra Maiden & Blakely	F	+	–	–
	pruinocarpa Tindale	–	+	FS	–
	pyrifolia DC.	FS	+	–	–
	sclerosperma F. Muell.				F
	spondylophylla F. Muell.	FS	+	–	–
	stowardii Maiden	S	+	–	F

		*Sept	Nov	Dec	Mar
	tenuissima F. Muell.	S		–	–
	tetragonophylla F. Muell.	–	+	–	–
	tumida F. Muell.	S	+	–	–
	victoriae Benth.	F	+	–	–
CAESALPINIACEAE					
Cassia	artemisioides Gaud. ex DC.	S		–	–
	aff. ferraria D.E. Symon.		+		
	glutinosa DC.	FS		–	–
	helmsii Symon.	FS		–	–
	notabilis F. Muell.	S	+	–	F
	oligophylla F. Muell.	FS	+	–	–
	pruinosa F. Muell.	FS	+	–	–
	venusta F. Muell.	S	+	–	–
Petalostylis	labicheoides R.Br.	F	+	–	–
PAPILIONOIDEAE					
Burtonia	polyzyga (F. Muell.) Benth.	F		–	–
Clianthus	formosus (G. Don.) Ford & Vickery	FS		–	–
Crotalaria	novae-hollandiae DC.	FS	+	–	F
	trifoliastrum Willd.	FS	+	–	F
Indigofera	hirsuta L.				F
	linifolia Retz.				F
	monophylla DC.	S		–	S
	rugosa Benth.		+		
Isotropis	atropurpurea F. Muell.	S		–	–
Kennedia	prorepens F. Muell.	S		–	–
Mirbelia	viminalis (A. Cunn.) C.A. Gardn.	S	+	–	–
Psoralea	lachnostachys var. hirsuta N.T. Burbidge	FS	+	–	–
	leucantha F. Muell.	FS		–	–
	martinii F. Muell.				F
	patens Lindl.				FS
Rhynchosia	sp.		+		
Sesbania	cannabina var. cannabina (Retz.) Poir.				–

		*Sept	Nov	Dec	Mar
Swainsona	stenodonta F. Muell.	FS		–	–
Tephrosia	bidwillii Benth.		+		
	rosea (F. Muell.) Benth.	FS	+	–	–
	uniovulata F. Muell.	FS		–	–
Vigna	lanceolata Benth.	S		–	–
ZYGOPHYLLACEAE					
Kallstroemia	hirsuta (Benth.) Engl.	S		–	FS
	platyptera (Benth.) Engl.	–	+	–	FS
Tribulus	macrocarpus Benth.				FS
POLYGALACEAE					
Polygala	chinensis Linn.	–		–	F
EUPHORBIACEAE					
Adriana	tomentosa Gaud.	S		–	–
Euphorbia	atoto Forst.	FS	+	–	F
	australis Boiss.	S		–	F
	boophthona C.A. Gardn.	FS	+	–	F
	coghlani F.M. Bailey	S		–	F
	schultzii Benth.	S		–	F
	aff. tannensis Spreng.		+		
Phyllanthus	ciccoides Muell. Arg.	–		–	–
SAPINDACEAE					
Atalaya	hemiglauca (F. Muell.) Benth.	–	+	FS	–
Dodonaea	attenuata A. Cunn.	–		–	F
	coriacea (Ewart & O.B. Davies) D. McGillivray	FS		–	–
	lanceolata F. Muell.	S	+	–	–
STACKHOUSIACEAE					
Stackhousia	viminea Sm.	FS		–	FS

		*Sept	Nov	Dec	Mar
TILIACEAE					
Corchorus	parviflorus Domin.	FS		–	FS
	tomentellus		+		
	walcottii F. Muell.	FS		–	F
Triumfetta	bradshawii F. Muell.	FS		–	F
MALVACEAE					
Abutilon	fraseri Hook.	FS		–	F
	Lepidium (F. Muell) A.S. Mitchell		+		
Gossypium	australe F. Muell. ex Todara	FS	+	–	F
	robinsonii F. Muell.	F	+	–	–
Hibiscus	coatesii F. Muell.	S	+	–	F
Malvastrum	americanum (L.) Torrey	S		–	F
Sida	calyxhymenia J. Gay	FS		–	–
	aff. cardiophylla F. Muell.	FS		–	F
	fibulifera Lindl.	S		–	F
	rohlenae Domin.	FS		–	F
	virgata Hook.	S		–	–
STERCULIACEAE					
Brachychiton	australe (Schott.) Terr.	–		–	–
Rulingia	kempeana F. Muell.	S		–	–
Waltheria	indica Linn.	S		–	F
ELATINACEAE					
Bergia	pedicellaris (F. Muell.) Benth.	FS		–	–
VIOLACEAE					
Hybanthus	aurantiacus (F. Muell.) Melch.	FS		–	F
LYTHRACEAE					
Aumannia	baccifera L.		+		
MYRTACEAE					
Calytrix	longiflora F. Muell.	FS		–	–

		*Sept	Nov	Dec	Mar
Eucalyptus	aspera F. Muell.	–	+	–	–
	camaldulensis Dehn.	–	+	FS	S
	coolibah Blakely & Jacobs	–		–	S
	dichromophloia F. Muell.	–	+	–	FS
	gamophylla F. Muell.	F	+	S	S
	leucophloia Brooker	S	+	–	FS
	microtheca F. Muell.		+		
	aff. patellaris F. Muell.		+		
Melaleuca	genistifolia Sm.		+		
	glomerata F. Muell.	–	+	FS	–
	leucadendron Linn.	–	+	F	–
HALORAGACEAE					
Haloragis	gossei F. Muell.	FS		–	FS
ARALIACEAE					
Astrotricha	hamptonii F. Muell.	FS		–	–
APIACEAE					
Trachymene	glaucifolia (F. Muell.) Benth.	FS		–	–
	oleracea (Domin.) B.L. Burtt		+		–
PRIMULACEAE					
Samolus	junceus R. Br.		+		
PLUMBAGINACEAE					
Plumbago	auriculata Lam.				FS
OLEACEAE					
Jasminum	lineare R.Br.	–		–	–
GENTIANACEAE					
+ Centaurium	spicatum (L.) Fritsch.	F	+	–	–

		*Sept	Nov	Dec	Mar
ASCLEPIADACEAE					
Cynanchum	floribundum R.Br.	FS		-	-
Pentatropis	linearis (Decaisne) K.L. Wilson				S
CONVOLVULACEAE					
Bonamia	media (R.Br.) H. Hallier	FS		-	F
	rosea (F. Muell.) Hall. f.	S		-	-
Convolvulus	erubescens Sims.		+		
Evolvulus	alsinoides Linn.	S		-	F
Ipomoea	muelleri Benth.	F	+	-	F
Operculina	brownii Ooststr.				FS
Polymeria	calycina R.Br.	FS	+	-	-
Porana	sericea (Gaud.) F. Muell.	FS		-	F
BORAGINACEAE					
Heliotropium	heteranthum F. Muell.	FS		-	-
	ovalifolium Forsk.	FS		-	-
	tenuifolium R.Br.	FS	+	-	F
Trichodesma	zeylanicum (Linn.) R.Br.	F	+	-	-
VERBENACEAE					
Clerodendrum	lanceolatum F. Muell.	S	+	-	-
CHLOANTHACEAE					
Dicrastylis	gilesii F. Muell.	FS		-	F
LAMIACEAE					
Coleus	scutellarioides Benth.	-		-	FS
Prostanthera	striatiflora F. Muell.	FS		-	-
SOLANACEAE					
Datura	leichhardtii F. Muell.	-		-	-
Nicotiana	benthamiana Domin.	FS		-	-
	occidentalis subsp. hesperis Wheeler	FS		-	-

		*Sept	Nov	Dec	Mar
Solanum	gabrielae A. Cunn. ex Benth.	F		–	–
	horridum Dunal.		+		–
	lasiophyllum Dun.	FS	+	S	F
	morrisonii Domin.	S		–	F
	phlomoides A. Cumm. Ex Benth.		+		
SCROPHULARIACEAE					
Stemodia	grossa Benth.	FS		–	–
	viscosa Roxb.		+		
Striga	multiflora Benth.				FS
BIGNONIACEAE					
Pandorea	doratoxylon J.M. Black	–		–	–
ACANTHACEAE					
Dicladanthera	forrestii F. Muell.	FS		–	F
Ruellia	primulacea F. Muell.				F
MYOPORACEAE					
Eremophila	cuneifolia Kraenzlin.	FS		–	–
	aff. decipiens Ostf.	S		–	FS
	fraseri F. Muell.	FS	+	–	F
	freelingii F. Muell.	S		–	–
	lachnocalyx C.A. Gardner		+		
	latrobei F. Muell.	S	+	–	–
	leucophylla Benth.	S	+	–	–
	longifolia F. Muell.	S	+	–	FS
	punicea S. Moore	FS		–	–
RUBIACEAE					
Canthium	latifolium F. Muell. ex Benth.	–	+	–	FS
Oldenlandia	crouchiana F. Muell.	S		–	–
CUCURBITACEAE					
Mukia	maderaspatana (L.) M. Roemer	FS	+	–	–

		*Sept	Nov	Dec	Mar
CAMPANULACEAE					
Wahlenbergia	gracilis A. DC.		+		
	tumidifructa P.J. Smith	FS		–	F
LOBELIACEAE					
Lobelia	heterophylla Labill.	F		–	–
GOODENIACEAE					
Dampiera	candicans F. Muell.	FS	+	–	–
Goodenia	muelleriana Carolin.	FS		–	F
	prostrata Carolin.	FS		–	–
	scaevolina subsp. stobbsiana (F. Muell.) Carolin.	F	+		
Scaevola	parvifolia (F. Muell.) Benth.	FS		–	F
	aff. sericophylla F. Muell. Ex Benth.		+		
	spinescens R.Br.				F
Brunonia	australis Sm.	FS		–	–
ASTERACEAE					
+ Bidens	bipinnata L.				F
Brachycome	ciliocarpa W.V. Fitzg.	FS		–	–
Calocephalus	francisii F. Muell.	F	+	–	–
	multiflorus (Turcz.) Benth.	FS		–	–
Calotis	multicaulis (Turcz.) Druce	–		–	–
	cunninghamii (DC.) A. Br. et Aschers.		+		
Centipeda	minima (L.) A.Br. & Aschers	S		–	FS
Flaveria	australasica Hook.	FS		–	–
Helichrysum	apiculatum (Labill.) D. Don		+		F
Helipterum	cirratum A. Morrison	F		–	–
	floribundum DC.		+		
	margarethae F. Muell.	F		–	–
Ixiochlamys	cuneifolia (R.Br.) F. Muell. & Sonder ex Sonder	FS		–	–
Pterocaulon	sphaeranthoides (DC) F. Muell.	FS	+	–	–

		*Sept	Nov	Dec	Mar
Senecio	magnificus F. Muell.	FS		–	–
Sonchus	asper (L.) Hill	FS		–	F
Streptoglossa	decurrens (DC.) Dunlop	FS	+	–	–
	aff. liatroides (Turcz.) Dunlop	FS		–	–

*KEY

F = flowering
S = fruiting
– = observed but non–reproductive
+ = observed but reproductive condition not noted
blank = not observed

MAMMALS OF THE YANDICOOGINA STUDY AREA

Museum Systematic Name	Common Name	*Source of Record	WA Accession Number
TACHYGLOSSIDAE			
Tachyglossus aculeatus	Echidna	O	
MACROPODIDAE			
Macropus robustus	Euro	O	
Megaleia rufa	Red kangaroo	O	
Petrogale penicillata	Brush-tailed rock wallaby	RO	
DASYURIDAE			
Antechinus rosamondae	Little red antechinus	P	M18824
Ningaui timealeyi	Pilbara ningaui	P	M18807
Planigale maculata	Giant planigale	P	M18979
Sminthopsis macroura	Larapinta	P	M18975
MURIDAE			
Notomys alexis	Spinifex hopping mouse	H	
Pseudomys chapmani	Pebble-mound mouse	P	M18977
P. hermannsburgensis	Sandy inland mouse	P	M18993
Mus musculus	House mouse	P	M18796
VERSPERTILIONIDAE			
Chalinolobus gouldii	Gould's wattled bat	M	M18801
Eptesicus pumilus	Little cave bat	M	M18825
Nycticeius greyi	Little broad-nosed bat	M	M18799
Nyctophilus geoffroyi	Lesser long-earred bat	M	M18961
N. major	Western long-earred bat	M	M18976
MOLOSSIDAE			
Tadarida cf beccarii	Beccarii's mastiff bat	M	M18802
T. jobensis	Northern mastiff bat	M	M18803

Museum Systematic Name	Common Name	*Source of Record	WA Accession Number
EMBALLIONIDAE			
Taphozous flaviventris	White-bellied shealth-tailed bat	M	M19406
CANIDAE			
Canis familiaris dingo	Dingo	O	
FELIDAE			
Felis catus	Feral cat	O	
BOVIDAE			
Bos taurus	Cattle	O	
EQUIDAE			
Equus caballus	Horse	O	

* Source of record

O – Species observed in area

RO – Species reported in the area by a secondary observer

P – Pit trapped specimen

M – Mist-netted specimen

H – Hand-collected specimen

BIRDS OF THE YANDICOOGINA STUDY AREA

Systematic Name	Common Name	*Sept	Nov	Dec	Mar
DROMAIIDAE					
Dromaius novaehollandiae	Emu	+[b]	+	+[b]	+
PELECANIDAE					
Pelecanus conspicillatus	Australian pelican	+			
PHALACROCORACIDAE					
Phalacrocorax sulcirostris	Little black cormorant			+	
ARDEIDAE					
Ardea pacifica	Pacific heron	+	+	+	
A. novaehollandiae	White-faced heron		+	+	
Egretta alba	Great egret			+	
ANATIDAE					
Cygnus atratus	Black swan				+
Anas superciliosa	Pacific black duck	+	+		
A. gibberifrons	Grey teal	+	+		+
ACCIPITRIDAE					
Elanus notatus	Black-shouldered kite				+
Milvus migrans	Black kite	+			
Haliastur sphenurus	Whistling kite	+		+	
Accipiter fasciatus	Brown goshawk			+	+
A. cirrhocephalus	Collared sparrowhawk	+		+	+
Aquila audax	Wedge-tailed eagle	+		+	
Circus assimilis	Spotted harrier	+	+	+	+
FALCONIDAE					
Falco longipennis	Australian hobby	+		+	+
F. peregrinus	Peregrine falcon		+		
F. hypoleucos	Grey falcon			+	
F. berigora	Brown falcon	+	+	+	+
F. cenchroides	Australian kestrel	+		+	+

Systematic Name	Common Name	*Sept	Nov	Dec	Mar
TURNICIDAE					
Turnix velox	Little button-quail	+	+	+	+
OTIDIDAE					
Ardeotis australis	Australian bustard		+	+	+
CHARADRIIDAE					
Charadrius melanops	Black-fronted plover	+[b]	+	+	+[b]
RECURVIROSTRIIDAE					
Himantopus himantopus	Black-winged stilt	+			
SCOLOPACIDAE					
Tringa hypoleucos	Common sandpiper		+		
COLUMBIDAE					
Geopelia cuneata	Diamond dove	+		+	+
G. placida	Peaceful dove		+		
Phaps chalcoptera	Common bronzewing	+	+	+	+
Ocyphaps lophotes	Crested pigeon	+[b]	+	+	+
Petrophassa plumifera	Spinifex pigeon	+[b]	+	+	+[b]
CACATUIDAE					
Cacatua roseicapilla	Galah	+[b]	+	+	+
C. tenuirostris	Long-billed corella	+	+	+	+
POLYTELITIDAE					
Nymphicus hollandicus	Cockatiel	+			+
PLATYCERCIDAE					
Melopsittacus undulatus	Budgerigar	+[b]	+	+[b]	+[b]
Barnardius zonarius	Port Lincoln ringneck	+	+	+	+
Neophema bourkii	Bourke's parrot			+	

Systematic Name	Common Name	*Sept	Nov	Dec	Mar
CUCULIDAE					
Cuculus pallidus	Pallid cuckoo		+	+[b]	
STRIGIDAE					
Ninox novaeseelandiae	Southern boobook		+	+	
AEGOTHELIDAE					
Aegotheles cristatus	Australian owlet – nightjar		+		
CAPRIMULGIDAE					
Caprimulgus guttatus	Spotted nightjar	+		+	+
ALCEDINIDAE					
Halcyon pyrrhopygia	Red-backed kingfisher	+		+[b]	+
H. sancta	Sacred kingfisher		+	+	+
MEROPIDAE					
Merops ornatus	Rainbow bee-eater		+	+	+
HIRUNDINIDAE					
Cheramoeca leucosternum	White-backed swallow	+			
Cecropis arial	Fairy martin		+		
MOTACILLIDAE					
Anthus novaeseelandiae	Richard's pipit		+		
CAMPEPHAGIDAE					
Coracina novaehollandiae	Black-faced cuckoo-shrike	+	+	+	+
Lalage sueurii	White-winged triller		+		+

Systematic Name	Common Name	*Sept	Nov	Dec	Mar
MUSCICAPIDAE					
Petroica goodenovii	Red-capped robin				+
Melanodryas cucullata	Hooded robin	+	+	+	+
Pachycephala rufiventris	Rufous whistler	+	+	+	+
Colluricincla harmonica	Grey shrike - thursh	+[b]	+	+	+
Oreoica gutturalis	Crested bellbird	+[b]	+	+	+
Rhipidura leucophrys	Willie wagtail	+	+	+	+
TIMALIIDAE					
Pomatostomus temporalis	Grey-crowned babbler	+	+		
P. superciliosus	White-browed babbler	+[b]		+	+
SYLVIIDAE					
Eremiornis carteri	Spinifexbird	+		+	
Cinclorhamphus mathewsi	Rufous songlark			+	
MALURIDAE					
Malurus lamberti	Variegated fairy-wren	+	+	+	+
M. leucopterus	White-winged fairy - wren				+
ACANTHIZIDAE					
Smicrornis brevirostris	Weebill	+	+	+	+
Acanthiza uropygialis	Chestnut-rumped thornbill	+			
CLIMACTERIDAE					
Climacteris melanura	Black-tailed treecreeper	+			
MELIPHAGIDAE					
Lichmera indistincta	Brown honeyeater		+	+	+
Certhionyx niger	Black honeyeater			+	
Lichenostomus virescens	Singing honeyeater	+		+	+

Systematic Name	Common Name	*Sept	Nov	Dec	Mar
L. keartlandi	Grey-headed honeyeater	+	+		
L. penicillatus	White-plumed honeyeater	+[b]	+	+	+
Melithreptus gularis	Black-chinned honeyeater			+	
Manorina flavigula	Yellow-throated miner	+	+		+
Acanthagenys rufogularis	Spiny-cheeked honeyeater			+	+
EPHTHIANURIDAE					
Ephthianura tricolor	Crimson chat		+	+	+
PARDALOTIDAE					
Pardalotus striatus	Striated pardalote	+			
PLOCEIDAE					
Emblema picta	Painted firetail	+[b]	+		+[b]
Poephila guttata	Zebra finch	+	+	+	+
PARADISAEIDAE					
Chlamydera maculata	Spotted bowerbird	+[b]		+	+
GRALLINIDAE					
Grallina cyanoleuca	Australian magpie-lark	+	+	+	+
ARTAMIDAE					
Artamus cinereus	Black-faced Woodswallow	+	+	+	+
A. miner	Little woodswallow	+	+	+	+

Systematic Name	Common Name	*Sept	Nov	Dec	Mar
CRACTICIDAE					
Cracticus torquatus	Grey butcherbird	+		+[b]	+
C. nigrogularis	Pied butcherbird	+	+	+	+
Gymnorhina tibicen	Australian magpie	+	+	+	+
CORVIDAE					
Corvus bennetti	Little crow			+	+
C. orru	Torresian crow	+	+	+	+

* KEY

+ = present during this month

b = breeding record for this month

HERPETOFAUNA OF THE YANDICOOGINA STUDY AREA

Systematic Name	Common Name	*Source of Record	WA Museum Accession Number
HYLIDAE	TREE FROGS		
Litoria rubella	Desert tree frog	H	R73163
Cyclorana maini	Main's frog	P	R73151
MYOBATRACHIDAE			
Uperoleia sp.		H	R73162
CHELIDAE			
Chelodina steindachneri	Flat-shelled tortoise	O	
GEKKONIDAE	GECKOES		
Diplodactylus ciliaris	Spiny-tailed gecko	P	
D. conspicillatus	Flat-tailed gecko	P	R73593
D. elderi	Jewelled gecko	P	R70748
D. stenodactylus		P	R70759
D. taeniatus	Yellow-striped gecko	P	R73606
D. wombeyi			
Gehyra pilbara	Pilbara dtella	H	R73613
G. punctata	Spotted dtella	P	R70786
G. variegata			
Heteronota binoei	Bynoe's gecko	P	R70792
Nephrurus wheeleri cinctus		H	R73160
Oedura marmorata			
Rhynchoedura ornata	Beaked gecko	P	R70788
PYGOPODIDAE	LEGLESS LIZARDS		
Delma nasuta		P	R70750
D. pax		P	R73604
D. tincta		P	R70757
Lialis burtonis	Burton's snake-lizard	P	R70758

Systematic Name	Common Name	*Source of Record	WA Museum Accession Number
AGAMIDAE	DRAGON LIZARDS		
Amphibolurus caudicinctus caudicinctus	Ring-tailed dragon	P	R70776
A. nuchalis	Defenceless dragon	P	R70777
A. isolepis	Military dragon	P	R70765
A. minor minor			
A.? mitchelli		H	R70789
Lophognathus longirostris	Long-nosed water dragon	P	R70795
SCINCIDAE	SKINKS		
Carlia foliorum		P	R70783
Cryptoblepharus plagiocephalus		O	
Ctenotus piankai		P	R70768
C. duricola			
C. helenae		P	R70766
C. pantherinus		P	R70782
C. saxatilis		P	R70772
C. serventyi		P	R73617
Egernia formosa		H	
Lerista labialis		P	R70796
L. neander	(in gut of Varanus tristis)		R73140
Menetia surda			
Morethia ruficauda exquisita	Fire-tailed skink	P	R70779
Proablepharus reginae		P	R70781
Tiliqua multifasciata	Central blue-tongue	P	R70755
T. branchialis		P	R73149
VARANIDAE	GOANNAS		
Varanus acanthurus	Spiny-tailed goanna	P	R70760
V. brevicauda	Pygmy goanna	P	R70773
V. caudolineatus	Stripe-tailed goanna	P	R73142
V. giganteus	Perentie	O	
V. gouldii	Bungarra	H	R73159

Systematic Name	Common Name	*Source of Record	WA Museum Accession Number
V. panoptes rubidus		H	R70802
V. tristis	Black-headed goanna	H	R70796
TYPHLOPIDAE	BLIND SNAKES		
Ramphotyphlops diversus ammodytes		P	R70780
R. grypus		P	R70754
BOIDAE	PYTHONS		
Bothrochilus childreni	Children's python	O	
B. olivaceus barroni	Pilbara olive python	H	R70801
B. perthensis		P	R75153
ELAPIDAE	FRONT-FANGED SNAKES		
Acanthophis pyrrhus	Desert death adder	P	R73134
Demansia psammophis cupreiceps	Yellow-faced whip snake	P	R73133
Denisonia fasciata	Rosen's snake	P	R73598
Unechis monachus	Hooded snake	P	R73599
Pseudechis australis	King brown snake	H	
Pseudonaja modesta	Ringed brown snake	P	R73597
P. nuchalis	Gwardar	H	R73161
Simoselaps approximans		P	R73145

*Record P – Pit trapped specimen
H – Specimen shot or collected by hand
O – Species observed but not collected

FISHES OF THE YANDICOOGINA STUDY AREA

Systematic Name	Common Name
PLOTOSIDAE	
Neosilurus hyrtlii	Common eel-tailed catfish
MELANOTAENIIDAE	
Melanotaenia splendida australis	Western rainbowfish
TERAPONIDAE	
Leiopotherapon unicolor	Spangled perch

APPENDIX 3

ENVIRONMENTAL MANAGEMENT COMMITMENTS

1. The Proponent will submit an environmental monitoring and management programme with the mining proposals to the State in accordance with the State Agreement Act.

2. Regular assessment of monitoring results and management effectiveness are to be reported as part of the monitoring and management programme. Reports will be submitted to the responsible Minister at intervals specified in the Act.

3. The Proponent will comply with the provisions of all relevant Government Acts and Regulations that may apply to the operations.

4. An Environmental officer will be responsible for all environmental monitoring and management activities for the Project.

5. Environmental awareness programmes will be provided for all construction, contractor and operational workforce.

6. During the construction phase minimum alteration to the existing topography will be achieved. Once construction is complete, areas no longer required will be contoured, slopes stabilised, topsoil replaced and revegetated.

7. Borrow pits, where possible, will be located in areas not visible from the accommodation sites or access roads. The pits will be reshaped and revegetated. Drainage control will be employed to reduce surface water ponding.

8. Erosion will be managed by contouring, stabilising and vegetation.

9. Minimisation of disturbance to archeological sites will be achieved by reducing any operations on the sites. Where a site may need to be disturbed, the Proponent will comply with any conditions imposed by the Minister for Aboriginal Affairs.

10. The area of disturbance will be reduced by using overburden for bund walls, fill for borrow pits and by returning overburden and waste ore to the mined out areas of the pit.

11. Surface dumps of overburden including bund walls, refilled borrow pits and the main overburden dump area will be stabilised to minimise wind and water erosion. The final waste dump will be constructed as to conform with the existing topography.

12. Revegetation of the mine dumps will be achieved using the most successful vegetation techniques available. The revegetation programme will be monitored intensively during the mining phase, and routinely following decommissioning.

13. Mine dewatering will be affected by pumping the minimum amount of groundwater to achieve optimum mining conditions.

14. Mine dewatering discharge will be fed into Marillana Creek and used as irrigation water to support phreatophytic vegetation.

ENVIRONMENTAL MANAGEMENT COMMITMENTS (Cont'd)

15. No contaminated process water from the operation will be allowed to discharge to the creek system or to the groundwater. A detailed water quality sampling and analysis programme will be adopted as part of the monitoring programme.

16. The removal of waste materials, ie. oils, sewage, etc. will be undertaken in accordance with Health Department and Local Authorities' requirements.

17. Monitoring of the dewatering effects on the riverine phreatophytes will be undertaken. Management will be effected by irrigation of affected areas with mine dewatering discharge.

18. Occupational and ambient dust levels will be managed by controlling dust emissions at their source. Dust monitoring programmes will be implemented, and dust emissions controlled by water spraying.

19. Seasonal vegetation surveys will be undertaken during mining.

20. During construction, caravans will be restricted to a managed caravan park.

21. As part of the general monitoring and management programme, the following mosquito control practices will be adopted:

    . identify and control potential mosquito breeding sites;

    . monitor mosquito species to assess disease potential; and

    . carry out necessary fogging, spraying and baiting should it be required.

22. Management of the area following completion of mining will be undertaken:

    . Pre-existing drainage networks will be reestablished where applicable.

    . Revegetation activities will continue until stable communities are established.

    . The mined out pit will be modified to minimise water quality changes caused by evapoconcentration.