ASSESSMENT REPORT 54

McArthur River Mine Open Cut Project

McArthur River Mining Pty Ltd

ENVIRONMENTAL ASSESSMENT REPORT

August 2006

epa
northern territory
program

Environment Protection Agency (EPA) Program

Northern Territory Government
Department of Natural Resources, Environment and the Arts

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Abbreviations

AAPA	Aboriginal Areas Protection Authority
AC	Acid Consuming
Administrative Procedures	*Environmental Assessment Administrative Procedures (1984)*
AEP	Annual Exceedance Probability
AFANT	Amateur Fishing Association of the Northern Territory
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australia and New Zealand Conservation Council
Assessment Report 51	*Environmental Assessment Report (Number 51)* Assessment of the initial McArthur River Mine Open Cut Project proposal based on the EIS
ARI	Average Recurrence Interval flood event.
AUSRIVAS	Australian River Assessment System: AusRivAS Physical Assessment Protocol
As	Arsenic
Cd	Cadmium
CRG	Community Reference Group
CSIP	MRM's Corporate Social Involvement Program
Cu	Copper
dmt	Dry metric tonnes
dmt/y	Dry metric tonnes per year
draft EIS	*Draft Environmental Impact Statement* for the McArthur River Mine Open Cut Project (submitted August 2005) (Referenced as URS (2005a))
COAG	Council of Australian Governments
DBERD	Department of Business, Economic & Regional Development, NT Government
DEH	Australian Department of Environment and Heritage
DPIFM	Department of Primary Industry, Fisheries & Mines, NT Government
EAA	*Environmental Assessment Act (1982)*, NT Government.
EIS	*Environmental Impact Statement* (*draft* and *Supplement*) for the McArthur River Mine Open Cut Project, August 2005.
EIS/PER	EIS and PER documents for the McArthur River Mine Open Cut Project
EPA Program	Environment Protection Agency Program of the Northern Territory Government
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
Fe	Iron
Guidelines	*Guidelines for Preparation of a Public Environmental Report, McArthur River Mine Expansion.* May 2006
Gulf	Gulf of Carpentaria of Northern Australia, including the Sir Edward Pellew Islands offshore of the McArthur River Mouth, and Bing Bong Port ~25 km to the NW.
Ha	Hectares
HABSCORE	A Rapid Bioassessment Protocol developed by the United States Environmental Protection Agency (USEPA)
HCS	Heritage Conservation Services
HMTV	Hardness modified trigger value
(ISQG-High)	Probable-effects concentrations below which biological effects would possibly occur. Concentrations at or above the ISQG-High represent a probable-effects range within which effects would be expected to frequently occur.
ISQG-Low	Interim Sediment Quality Guidelines-Low. Probable effects concentrations below which biological effects would rarely occur.
kL	Kilolitres (1,000 litres)

IUCN	International Union for the Conservation of Nature
km	Kilometre
MAWA	Mawurli and Wirriwangkuma Aboriginal Association
m	Metre
M	Million
m^3	Cubic metres
the Minister	Minister for Natural Resources, Environment and Heritage (NT)
Mn	Manganese
Mt	Million tonnes
Mt/y	Million tonnes per year
MMP	Mining Management Plan
MRM	McArthur River Mine Joint Venture
MRM1, MRM2	Recognised archaeological sites
MRM4	Archaeological site excised from the eastern aspect of the OEF footprint.
NAF	Non Acid Forming
NEPC	National Environment Protection Council
NLC	Northern Land Council
NRETA	Department of Natural Resources, Environment & the Arts , NT Government
NRM	Natural Resource Management section of NRETA
NT	Northern Territory
OEF	Overburden Emplacement Facility
Over burden	Non ore-bearing material overlying the ore
PAF	Potentially Acid Forming
Pb	Lead
PER	*Public Environment Report* for the McArthur River Mine Open Cut Project (submitted July 2006)(Referenced as URS (2006))
proponent	McArthur River Mining Pty Ltd (MRM), wholly owned by Xstrata
Responsible Minister	Minister for Mines and Energy (NT)
s	Section
Supplement	*Supplement* to the *draft Environmental Impact Statement* for the McArthur River Mine Open Cut Project (submitted December 2005)(Referenced as URS (2005b))
Tailings	Fine wastes from the processing operations
Zn	Zinc

Introduction

1 Environmental Assessment Act and Administrative Procedures

The NT *Environmental Assessment Act (1982) (EAA)* governs the assessment of the environmental effects of development proposals and provides for the protection of the environment, where environment is defined in section 3 as "all aspects of the surroundings of man including the physical, biological, economic, cultural and social aspects".

Section 4 establishes the object of the Act which put simply, is to ensure that each matter capable of having a significant effect of the environment is fully examined and taken into account in making decisions and recommendations (among other matters) to the greatest extent practicable.

Section 7 of the EAA provides for the gazettal of Administrative Procedures which govern the process for undertaking assessment. The section envisages that the Administrative Procedures will enable the Minister responsible for the EAA to direct the preparation of an Environmental Impact Statement (EIS) or Public Environmental Report (PER) [section 7(2)(b)]; to determine the matters to be dealt with in the impact assessment [section 7(2)(c)]; and to have the information provided in the EIS/PER examined and comments, suggestions and recommendations about the information to be made [section 7(2)(g)].

These procedures are further elaborated in the Administrative Procedures. Having made a determination under clause 8(2) that the proponent should prepare an EIS/PER, clause 8(3) requires the Minister to describe in writing the matters that need to be addressed in the report (EIS/PER guidelines).

Clause 11 of the Administrative Procedures establishes the timeframes and process for examining a PER, and enables the Minister to direct the proponent to provide additional information to assist with the assessment.

The purpose of this report is to assist the Minister to meet the obligations of clause 11(3)(a) and (b) of the Administrative Procedures ie to make any comments, suggestions or recommendations concerning the proposed action as the Minister thinks fit for the protection of the environment and to provide these to the responsible Minister (the Minister responsible for determining if a proposed development should proceed, and if so under what conditions).

The development of this report was informed by:

- The EIS process and Assessment Report for the previous project proposal;
- the principles of the ecologically sustainable development, as articulated in the 1992 COAG Intergovernmental Agreement on the Environment (COAG 1992);
- the approach to risk management established in AS/NZS4360:2004 *Risk Management*;
- relevant Government policies and statements; and
- expert advice in relation to industry best practice for managing contaminants.

2 Project Description

This report examines the environmental impact of a proposal by McArthur River Mining Pty Ltd (MRM) (the proponent), a wholly owned subsidiary of Xstrata, to change the mining method for the existing McArthur River zinc/lead/silver mining and processing operation from underground to open cut. The operation is located approximately 45 km south-west of the township of Borroloola and 740 km south-east of Darwin, in the Gulf Region of the Northern Territory (NT).

The current operation was established in 1995. Prior to 2005 mining took place underground. Subsequently MRM has been mining from a 'test pit' and more recently, an extension to that test pit. Mined ore is converted into bulk concentrate in a processing plant on the site. The concentrate is trucked from the mine to the port of Bing Bong where it is conveyed by barge to ships for export to refineries around the world to be made into zinc and lead metal and alloys.

The open cut project would enable the mine production to increase from 1.6 million tonnes per year (Mt/y) of zinc/lead/silver ore to 1.8 Mt/y. The proposal also improves the efficiency of the existing processing plant which converts the ore into a bulk zinc/lead/silver concentrate. The existing concentrate storage and transportation systems have sufficient capacity for the open cut project. The rate of concentrate production from the processing plant reduces from 333,000 dry metric tonnes per year (dmt/y) to 320,000 dmt/y due to a lower grade ore from the open cut operation.

This Environmental Assessment Report is based on: the findings of Assessment Report 51; the Public Environment Report (PER) of the amended proposal; comments received from the public and NT Government agencies and commissioned experts; and the additional information requested by the Minister for Natural Resources, Environment and Heritage provided by the proponent on 14 August 2006.

3 Environmental Impact Assessment History

The proposed expansion of the McArthur River mine by MRM has previously been assessed under the *Environmental Assessment Act* at the level of an EIS. The Minister for Natural Resources, Environment and Heritage (the Minister) recommended to the responsible minister (the Minister for Mines and Energy) that the proposal as outlined in the EIS (the draft EIS and its Supplement) should not proceed. Assessment Report 51 outlined the issues of concern.

As a consequence, the Minister for Mines and Energy informed the proponent that these outstanding environmental issues needed to be resolved to the satisfaction of the Minister for Natural Resources, Environment and Heritage before he could consider whether or not the mine should be authorised to expand to open cut.

The proponent formally notified the Minister and the Responsible Minister of their intention to amend the proposal under clause 14A of the Environmental Assessment Administrative Procedures to address the concerns raised in Assessment Report 51. The Minister determined that the amended proposal would be formally assessed at the level of a Public Environmental Report (PER).

Draft Guidelines covering issues to be addressed in the PER were subject to a statutory 14 day public review period in April 2006. Guidelines for the PER were finalised in May 2006, taking into account submissions and comments from various members of the public, non-government groups and NT Government agencies. The Minister directed the proponent to prepare the PER addressing matters set out in the final guidelines.

In summary the final guidelines (see Appendix 4 of this report) issued for the PER for the amended proposal direct the proponent to:

- demonstrate that the findings of the Assessment Report 51 have been examined and addressed by the proponent ;
- identify and describe the proposed alteration(s) to the expansion proposal including changes to the nature and extent of proposed works and the change in environmental significance of the proposal by virtue of the alterations. An explanation of the objectives, benefits, costs and justifications for the alterations to the project should also be included;

- discuss alternative proposals, which may still allow the objectives of the project to be met, detailing reasons for the selection and rejection of particular options. The short, medium and long-term potential beneficial and adverse impacts of each of the options should be considered; and
- discuss specific aspects of the diversion of the McArthur River and Barney Creek, waste management, the tailings storage facility, surface and ground water, biology, heritage and social impact in some detail.

The PER for the proposed expansion underwent a statutory public exhibition period of 28 days from Tuesday 4 July to Monday 31 July 2006. During the public exhibition period the PER was also circulated to NT Government advisory bodies for review and comment. Five submissions were received from government advisory bodies and more than 200 from the public (including five submissions from non-government organisations and 148 form letters in support of the project from Territory businesses).

To assist in the assessment of the proposed expansion specialist consultants were commissioned to advise on the geomorphological aspects of the proposal and the proposed design and operations of the Tailings Storage Facility. This was done in accordance with clause 11(2b) of the Environmental Assessment Administrative Procedures. The findings of the respective consultants can be found at Appendixes 1, 2 and 3.

On 31 July 2006 the Minister requested MRM provide further information on the operations of the Tailings Storage Facility for completion of the assessment of the project. This information was received on 14 August 2006.

Following the review of the findings of Assessment Report 51, the PER and additional information provided plus all submissions received during the PER processes, this Assessment Report was prepared to report on the outcomes of the environmental assessment process for consideration by the Minister.

Once the Minister has considered the findings of this Assessment Report, she will provide comments, suggestions or recommendations to the Minister for Mines and Energy for consideration under the *Mining Management Act.*

4 <u>Regulatory Framework</u>

The proposed MRM open cut project is located wholly within the land borders of the NT. The NT Government has jurisdiction over environmental and other legislation relating to the siting, construction and operation of the proposal. Approval for mining operations is governed by the Northern Territory *Mining Management Act (2001).* Under the provisions of the *Northern Territory Environmental Assessment Act (1982)*, the Minister for Natural Resources, Environment and Heritage will inform the Minister for Mines and Energy of the findings of the review and assessment of the environmental aspects of the proposed action. The Minister for Mines and Energy will then make a determination as to whether or not a revised 'Authorisation to Operate' will be issued to MRM under the *Mining Management Act.*

The Australian Government administers the *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act). The initial MRM open cut expansion proposal was referred to the Commonwealth under the EPBC Act and was deemed to have the potential to have a significant impact on threatened species and migratory species listed under that Act.

The assessment of the EIS was done in accordance with the bilateral agreement between the Northern Territory and Australian Governments. At the completion of the Minister's assessment of the EIS, Assessment Report 51 was forwarded to the Commonwealth Department of Environment and Heritage with a section 130(1B) (b) notice. The Department of Environment and Heritage determined that further information was required to assist in its Minister's consideration on whether to issue approval under the EPBC Act.

The additional information sought by the Australian Government has been included in the PER, however the assessment of the PER is not subject to the bilateral agreement. This is because the environmental assessment of the proposal is complete for the purposes of the Australian Government and it is now considering whether to grant approval to the proposal under Part 9 s133 of the EPBC Act (the request for additional information was made in accordance with the approval process outlined in Part 9 s132 of the EPBC Act). The approval process under Part 9 of the EPBC Act is not subject to the bilateral agreement.

As the proposal is deemed a controlled action under the EPBC Act, approval will be required from the Australian Government Minister for the Environment and Heritage (or his delegate).

5 Policy Framework

The proposed proposal has been assessed within the policy environment as described in this section.

Intergovernmental Agreement on the Environment (COAG 1992)

The Intergovernmental Agreement on the Environment (IGAE) was signed by first ministers from all Australian jurisdictions in 1992 and includes the agreed recognition "that the concept of ecologically sustainable development including proper resource accounting provides potential for the integration of environmental and economic considerations in decision making and for balancing the interest of current and future generations".

This includes the following principles:

- the precautionary principle – where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- intergenerational equity – the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- conservation of biological diversity and ecological integrity – conservation of biological diversity and ecological integrity should be a fundamental consideration.
- improved valuation, pricing and incentive mechanisms – environmental factors should be included in the valuation of assets and services; polluter pays (those who generate pollution and waste should bear the cost of containment, avoidance, or abatement); the users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes; and, environmental goals, having been established should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/ or minimise costs to develop their own solutions and responses to environmental problems.

The IGAE is given formal legislative status as a schedule to the *National Environment Protection Council (NT) Act.*

AS/NZS 4360:2004 – Risk Management

Risk management is an iterative process of continual improvement which can be applied at all levels of management, including managing natural systems and the cultural, social and heritage issues linked to them. This report is informed by the risk management approach identified in the Australian Standard and New Zealand Standard: *Risk Management* (AS/NZS 4360: 2004). The objective of the Standard is to provide a basis for:

- a more confident and rigorous basis for decision-making and planning;
- better identification of opportunities and threats;
- gaining value from uncertainty and variability;
- pro-active rather than re-active management;
- more effective allocation and use of resources;
- improved incident management and reduction in loss and the cost of risk, including commercial insurance premiums;
- improved stakeholder confidence and trust;
- improved compliance with relevant legislation; and
- better corporate governance.

The main elements, consisting of integrated risk assessment and risk management components (AS/NZS 4360:2004: pp. 7-8) are to:

- establish the context;
- identify risks;
- analyse risks in terms of consequence and likelihood;
- evaluate risks so as to identify priorities;
- treat risks by developing management plans for high-priority risks;
- monitor and review at all stages of the process; and
- communicate and consult throughout all stages.

Land Clearing Guidelines (NRETA 2006a)

The Land Clearing Guidelines are established under the Planning Act and are designed to assist landholders and the consent authority decide which areas are suited to development and those that should be left in their natural state to help protect the environment and maintain biodiversity. Clearing on mining leases is guided primarily through the application of environmental management plans provided under the *Mining Management Act.* As such they do not apply directly to this project but nonetheless provide guidance as to the general standards applicable in the Northern Territory.

There is a clear link between the retention of native vegetation and the protection of biodiversity. To reduce the impacts of clearing, it is important to protect the plants, animals and/or ecosystems which may be a particularly important component of biodiversity. This includes:

- sensitive or significant plant and animal species including rare, endangered or threatened species;
- sensitive or significant plant communities, such as mangroves, rainforests, vine thickets and those along waterways; and other plant communities which provide corridors for wildlife movement between habitats.

The retention and maintenance of buffer zones around such areas is also recommended.

The Guidelines state that native vegetation must be retained adjacent to water ways and require a buffer of 250 metres be retained when clearing is proposed in the vicinity of large waterways such as rivers. Retention of riverine (riparian vegetation) is required to maintain bank stability and prevent erosion, maintain water quality and the health of aquatic ecosystems, and to provide habitat for wildlife and corridors for their movement throughout the country.

Best Practice/ Best Practice Environmental Management

The *Waste Management and Pollution Control Act* defines Best Practice Environmental Management as meaning "the management of an activity or premises in a cost-effective manner that, having regard to national or international practices for management of activities or premises of the same kind, ensure the continued minimisation of the actual or potential environmental impact of the activity or premises"

In accordance with the above definition the EPA Program sought information on what was considered best practice environmental management both within industry and by regulatory standards set by other jurisdictions.

TEAM NT: Technologies for the Environmental Advancement of Mining

In 2003-2004, AusIndustry awarded an Innovation Access Program grant to the Northern Territory Minerals Council Inc. for a project to be known as TEAM NT: Technologies for the Environmental Advancement of Mining (TEAM NT 2004). The aim of AusIndustry's Innovation Access Program was:
"to promote innovation and competitiveness by improving Australian access to global, leading edge research and technologies and facilitate their uptake by Australian firms, particularly small to medium enterprises (SMEs) and researchers".

In awarding the grant, AusIndustry commented that:
"the competitiveness of much of Australia's mining sector is influenced by its effectiveness in managing mine sites and mining wastes so that these do not impose long term economic, environmental or health costs on the industry and ensure that the industry continues to have public support and access to future mining resources".

During the life of the project, a series of internationally recognised specialists were brought to Darwin to:

- participate in workshops on SME mine sites;
- provide technical material on their speciality areas;
- present public seminars; and
- meet members of the mining industry and associated industries and government on a one-to-one basis.

The project was managed by the technical team of Northern Territory Government Mining and Petroleum Management Division. A copy of the report can be found at:
http://ntminerals.org.au/VisionEdit/files/TEAMNT.pdf (Referenced as TEAM NT 2004).

ANCOLD standards for *Tailings Dam Design, Construction and Operation* (1999)

The Australian National Committee on Large Dams (ANCOLD) is an incorporated voluntary association of organisations and individual professionals with an interest in dams in Australia. It is affiliated with the International Commission on Large Dams (ICOLD). Both ANCOLD and ICOLD produce guidelines and recommendations relating to dam issues such as: Environmental Management; Risk Assessment; Safety Management; Acceptable flood capacities; and Earthquake ratings. ANCOLD produces legally binding requirements on dam owners relating specifically to the safety of dams.

In the MRM proposal, ANCOLD guidelines have been incorporated into the designs of the TSF embankments and the Flood Protection Bund. The Flood Protection Bund has been engineered to standards of a water storage dam, and the TSF to ANCOLD standards for a high hazard dam. ANCOLD guidelines have been quoted in the PER in relation to engineered remediation measures and safety standards.

6 The Amended Proposal

The major components of the proposed MRM open cut project proposal discussed in the EIS have been carried over into the amended proposal ie an open pit protected by a flood bund, diversion of Barney Creek and the McArthur River and the location and methods of managing the tailings storage and overburden emplacement facilities. MRM has undertaken further studies and consultation in an effort to improve the design and environmental performance of these components.

Section 2 of Assessment Report 51 provides a brief description of the major components of the MRM open cut project proposal. A comparison of the proposal as outlined in the Environmental Impact Statement and the proposal as amended in the Public Environmental Report has been summarised by the EPA Program and is provided in Table 1 of this report.

Table 1: Summary comparison of previous EIS proposal with current PER proposal components

Component	EIS proposal	Amended/modified PER proposal
McArthur River and Barney Creek realignments	Channel surface irregularity encouraged to trap snags and strategic placement of large woody debris into the new channel.	Incorporation of large woody debris in the river and creek diversion channels with defined spacing, and orientation.
	In sections where main channel banks are in alluvial materials, coarse rockfill armouring will be placed in banks. Rock armouring in alluvial materials is intended to provide a stable growing substrate for re-establishment of riparian bank vegetation. Voids in the coarse armouring will be filled with topsoil.	Provision of rock placement on the banks of the alluvial sections of the new channel. Grading of rock placement on the alluvial banks with soil media placed within voids between rocks, for improved plant establishment. In areas of dispersive soils, geotextile will be placed under the rock layer which will be increased to a minimum depth of 1.5 m to allow for restricted root growth through the underlying geotextile.
	Surface irregularities of the channel bed will be maximised.	Incorporation of (6) riffle features along the beds of the diverted McArthur River and (7) into the Barney Creek diversion channel in the alluvial sections to reduce stream power and flow velocities.
		Revised planting specification with respect to species, seed sources, planting densities, vertical zonation of species etc.
	Stabilisation of the banks but not stream beds. Timber groynes included as a stabilisation method for banks.	Incorporation of stream bed stabilisation strategies such as timber piling (groynes) in critical areas.
	Little information provided on Barney Creek/Surprise Creek geomorphology or the realignment proposal.	Modification to the alignment, section and grade of the Barney Creek diversion to improve stability and to better replicate the hydraulic performance of the existing creek.
	Low level culvert for haul road crossing of Barney Creek diversion.	Bridge for haul road crossing of Barney Creek diversion.
NAF drainage issue	Free drainage from flood bund wall and TSF outer walls. Sediment ponds on NAF side of OEF.	Provision of contoured drainage to sediment ponds around the base of the flood protection bund and the tailings storage facility. Monitoring of runoff water and sediment in sediment ponds.

Component	EIS proposal	Amended/modified PER proposal
Monitoring program	Monitoring similar to underground mining environmental monitoring program?	Significant expansion of the environmental monitoring program.
Archaeological site MRM4	Overburden facility proposed to cover the identified significant archaeological site MRM4.	Reshaping of the overburden emplacement facility (OEF) so that it does not disturb the identified significant archaeological site MRM4.
Social impact		Implementation of a 25 year community engagement strategy.
		Support for the socio-economic sustainability of the Borroloola region.
Flood bund design	NAF rock may be dumped on inside and outside batters to achieve a final slope where available. Inner batter of bund flattened with sandy material to prepare for rehabilitation.	External and internal walls protected with rock armour. Sandy alluvium will be placed as a weighting zone for added stability on downstream (mine) side of bund. Embankments to be graded to a shallow slope, covered with topsoil and (re-) vegetated.
	Crest level allows for 0.9m freeboard in 1 in 500year ARI flood event.	Initial crest level gives 0.9m freeboard. Crest level of final bund wall arrangement (by 2009) allows for 2m freeboard in a 1 in 500 year ARI flood.
	Clay-filled cut-off trench under bund wall in areas where permeable materials are located.	Key trench filled with clayey earth-fill under the full length of the embankment intersecting underlying low-permeability material.
	No information on wall breaching contingencies that would reduce environmental impacts in floods greater than 1 in 500 year ARI.	'Fuse plug spillway' to ensure any overtopping occurs at predetermined section of bund, eroded material moves into the pit and water level is quickly balanced on both sides of the bund.
Tailings Storage Facility	Recovery bores used to control seepage in expanded TSF.	Additional seepage control in the expanded TSF include the use of a geopolymer barrier underneath the cut-offs of the eastern embankments of Cells 1 and 2.

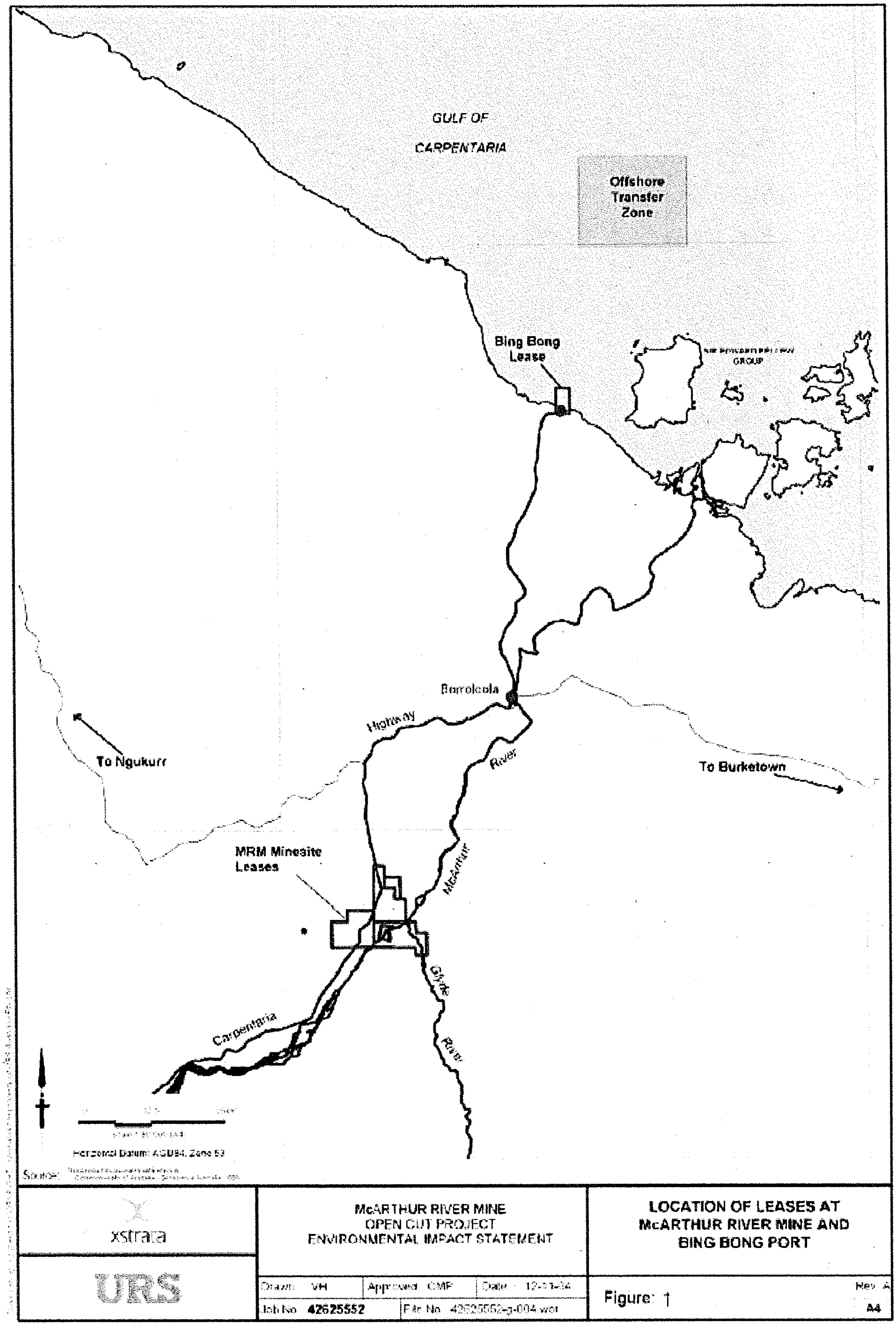

Figure 1: Location of Leases at McArthur River Mine and Bing Bong Port

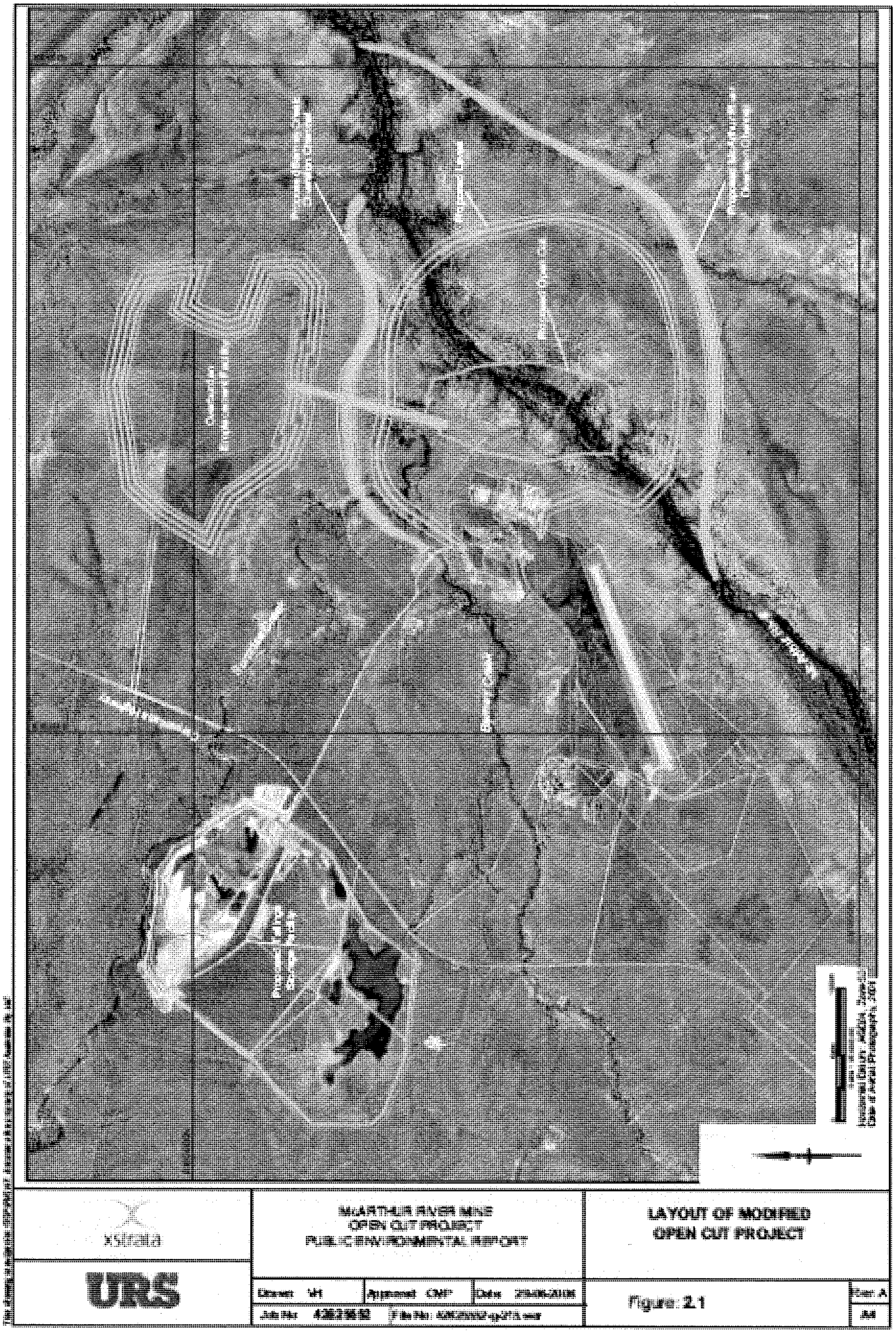

Figure 2: Open Cut Mine Footprint

Assessment of Response from the Proponent as outlined in the PER

7 Overview

What should environmental impact assessment do?

- identify potential risks/impact on the environment (where environment is defined broadly according to the *Environmental Assessment Act*);
- proponent needs to demonstrate that these risks/impacts can be satisfactorily managed i.e. will not result in long term environmental detriment;
- proponent needs to demonstrate effectiveness/feasibility of management measures in a precautionary/risk management framework; and
- are the potential risks associated with the development "acceptable"? ie there is an element of judgment based on an understanding of the risks involved.

Assessment is also about the proper consideration of values and risks; about estimating the likelihood of success or preventative and remedial measures; and about the validity and comprehensiveness of programs established to provide ongoing measures of the environmental consequences of the proposed development. This assessment considers that risks can be more reliably evaluated where there is a substantial baseline of relevant information and where there is a clear demonstration of the efficacy of proposed management measures. Where this information is limited or not available, risk assessment is inevitably constrained and far less precise, and it is appropriate to use prudence in the evaluation of possible impacts.

In presenting the amended proposal in the Public Environmental Report (PER) the proponent has adopted a similar approach to that taken in the previous Environmental Impact Statement (EIS) and Supplement. That is, rather than taking action to minimize longer term environmental impacts of operations, it proposes to wait to see if impacts occur and then take remedial action. This is not best practice risk management as defined by AS/NZS4360: 2004 – *Risk Management*, nor does it meet the principles underpinning ecologically sustainable development as set out in the Intergovernmental Agreement on the Environment (COAG 1992).

It is recognized that taking a precautionary and best practice risk management approach will potentially raise the level of capital investment required to commence operations. Information contained in the PER as well as discussions with representatives of the company indicated that the proponent places a high value on avoiding/deferring such expenditure.

For example, the company proposes to use reactive management techniques for dealing with seepage from the waste rock disposal areas (ie seepage collection and disposal), rather than eliminating seepage issues through effective characterization, isolation and encapsulation of problematic material. Similarly, the company proposes to manage its tailing storage facility by allowing seepage directly to the natural ground water system and relying on monitoring and collecting seepage both during and post-operations to deal with impact, rather than by taking active steps to prevent it reaching the ground water system.

The approach adopted by the company requires a heavy reliance on rigorous monitoring, and a clear and agreed understanding of trigger points for action (which in turn requires a good understanding of ecological implications of any impacts of the mining operation). The PER does not demonstrate that this approach is backed up with appropriate levels of knowledge and understanding. The approach also potentially requires a significant regulatory and audit function by Government to provide backing if disputes arise. Monitoring and analysis and active intervention will need to continue long after mining operations are over.

This approach depends on adequate resources being made available to treat problems if and when they emerge. This could be achieved by setting and maintaining a significant security bond well into the future. Such a bond would need to cover all aspects of remediation including the need for expert advice, long term monitoring and active intervention, as well as remediation. There is likely to be a significant regulatory cost for Government to ensure that the on-going performance of post-operations systems is adequate. The proponent's approach of remediating environmental issues if and when they arise rather than investing in comprehensive preventative measures has the potential to shift the risk associated with dealing with any long term environmental damage from the proponent to Government.

Conclusions

- the diversion channel for the McArthur River has been re-engineered with a view to withstanding up to 1-in- 500 year flood events (the previous design was estimated to have a 20-50% chance of failing in any year) and the velocity of streamflows will approximate the unmodified river.

- approximately 5 km of the natural riverine (riparian) vegetation along both banks of the McArthur River will be removed and a diversion channel created. This will create a barrier to movement of wildlife and a highly visible scar on the landscape. There is a significant risk that it will not be possible to revegetate the diversion to mitigate these effects.

- there is a significant risk that contaminated seepage from mining and milling operations will enter regional ground water. The approach proposed by the company relies on reactive rather than preventative management strategies. This is not considered to be industry best practice and there is an increased risk of contaminants reaching the river.

- the indigenous population of Borroloola remains strongly opposed to the river diversion, even if they favour the continuation of mining, despite commitments by the company to invest in community infrastructure.

8 <u>Alternatives</u>

The Guidelines to the PER required the proponent to discuss alternate proposals, which may still allow the objectives of the project to be met, detailing reasons for the selection and rejection of particular options. The short, medium and long-term potential beneficial and adverse impacts of each of the options were to be considered.

Various alternative strategies to open-pit mining were examined by the proponent. Beneficial and adverse impacts of each were briefly presented, followed by analysis of the viability of each strategy.

Alternatives considered included:
- continuation of underground mining;
- open pit mining;
- mining without affecting the McArthur River – East Pit;
- mining without affecting the McArthur River – West Pit;
- out-of-pit overburden disposal;
- in-pit overburden disposal;
- re-alignment of flood protection bund closer to proposed Open Cut Project outline;
- re-alignment of McArthur River diversion channel closer to the bund;
- altered sinuosity of alignment of Barney Creek diversion between bund and Overburden Emplacement Facility (OEF); and

- no project option.

In response to the request for additional information the proponent also considered:

- options for limiting tailings seepage:
  - network dewatering bores;
  - claylining of TSF footprint;
  - installation of deep low-permeability cut-off barrier; and
  - installation of a geomembrane over the TSF footprint.
- Options for tailings storage facility:
  - in-pit disposal; and
  - off the floodplain.

The Guidelines requested short, medium and long-term impacts of each of the options be considered, but this analysis was not provided. It is noted that in the detail discussions of alternatives consideration was principally given to economics, technical viability, ore-body recovery and safety, rather than a comparison of potential environmental impacts/ benefits.

The analysis provided by the proponent dismisses other options than that presented in the EIS/PER largely on the associated technical viability and cost of their implementation.

Based on the comparative analysis of the options the proponent concluded that open pit mining to be the safest, most economically productive option, which maximised resource extraction. The proponent has not discussed how their preferred option compares with other options from an environmental and social/ cultural perspective.

9 Physical impacts

9.1 Diversion of the McArthur River and Barney Creek

9.1.1 Summary of Risk

The risks to the environment from the diversion of the McArthur River and Surprise and Barney Creeks include:

- the geometry and dimensions of the diversion channel not being maintained in the short, medium or long-term, leading to the diversion channel being destroyed and subsequent impact to river morphology and riverine and aquatic ecological habitat and value;
- contaminants and sedimentation entering the McArthur River resulting from erosion of the diversion channel;
- the short, medium and long-term fragmentation of riverine vegetation and the subsequent impact on riparian habitats; and
- loss of/ compromised aquatic ecological value of the river system, including its habitat values and its role in providing fish passage.

9.1.2 Stability of the Diversion Channels

The amended proposal retains the realignment of the McArthur River within the design due to the location of the ore body. During the EIS assessment an independent geomorphologist was contracted by the EPA Program to review and report on the realignment proposal. The report found major information gaps relating to the hydrology of Barney / Surprise Creeks and key flaws in the hydrological modelling that was undertaken for the EIS. The report predicted impacts of the diversion channel on up- and downstream channel morphology, including:

- progressive degradation of the upstream McArthur River channel due to drawdown immediately upstream of the river diversion and the consequent, very high shear stresses that would occur. Under these conditions, it was likely that for the 2 and 5 year ARI flood, planted vegetation would not survive, and the geometry and dimensions of the diversion channel could not be maintained, leading to the diversion channel being destroyed;

- conversion of the channel into a sand slug (that is creating a long section of sand aggradation downstream of the diversion channel) due to deposition downstream from high upstream sediment supply. This would have buried aquatic habitats, riparian plants; and
- continuing erosion of the diversion channel banks until a time when dense riparian vegetation is established, which according to the proponent's estimation would have taken longer than 10 years.

On the basis of findings from the report the EPA Program recommended that the proposal as outlined not proceed.

Amendments made to the design of the river realignment are included in Table 1. The proponent has also undertaken additional hydrological modelling and biological surveys, and sought input from rehabilitation and tropical ecology specialists.

Improvements in the engineering design of the diversion channels have been made to reduce the likelihood of the diversion failing.

Modifications made to the McArthur River diversion design reduce the potential for impacts to the McArthur River system both upstream and downstream of the diversion channel, and for impacts on the diversion channel itself. While the diversion channel's cross-sectional geometry has not changed from that presented in the draft EIS, changes made include:

- reducing the longitudinal grades of the upstream reach and rock sections of the diversion channel;
- incorporating six rock riffles (i.e. riffle-pool sequences) in the diversion channel at select chainages;
- increasing the density of large woody debris in the diversion channel at irregularly spaced intervals;
- modifying the flood protection bund around the open cut to provide additional floodplain width for less frequent storm events; and
- incorporating a stepped energy dissipation structure at the confluence of Bull Creek and the McArthur River diversion channel.

The shortcomings in the information related to the design of the river diversion contained in the Draft EIS and Supplement for the McArthur River Mine Open Cut Project have been addressed in the PER. In particular:

- hydrological information is now presented for Barney and Surprise creeks;
- the errors in ground elevation for the photogrammetrically determined cross sections have been discussed along with how these are translated into uncertainty in the calculated water surface levels and hydraulic parameters in HEC-RAS;
- the adopted roughness coefficients have been changed so that they are spatially variable to cover the range of site conditions. The recalibrated flood model for the January 2003 flood, as a result, has a much better fit to the known flood profile;
- the very high shear stresses and specific stream powers in the current channel of the McArthur River have been shown to coincide with extensive bedrock outcrops; and
- meaningful river reach analysis has now been completed for the McArthur River and for Barney and Surprise creeks and has been used in the redesign of the two diversion channels. The types of channel units or aquatic habitats have also been documented and included in the redesign of the river diversions.

Additional geomorphological work has shown that the McArthur River is generally stable, except for some minor pockets of bank erosion. Surprise Creek and Barney Creek downstream of its junction with Surprise Creek are unstable.

Improvements in the engineering design of the river diversions include:
- inclusion of artificial rock riffles in the diversion channels;
- incorporation of large wood loadings, spacing, orientation and accumulations in the diversion channel design that mimic the current channel. However, large wood must be appropriately sourced and such sources have not been discussed; and
- meaningful discussion of sediment erodibility for the material used to form the banks of the diversion channel has been provided and the measures taken to decrease erodibility have been outlined.

The PER presented modelling of the diversion designs for stability of the river and Surprise and Barney Creeks in up to 1-in-500 year flood events.

Advice presented by Professor Erskine is included in Appendix 3 to this report. The modified designs for the diversion channels should be stable but would need to be monitored at least annually until riparian vegetation is re-established. The EPA Program is satisfied that the design modifications provided should be sufficient to provide for relatively stable realigned channel for the McArthur River.

9.1.3 Erosion

In the EIS, riparian vegetation was being heavily relied upon to stabilize channel walls and prevent erosion. However, erosion was predicted to undermine any success of the revegetation.

In the PER, additional geomorphological design refinement and modelling has shown that the McArthur River is generally stable, except for some minor pockets of bank erosion. The banks of the diversion channel will be rock-lined to control erosion until protective riparian vegetation can be established. This reestablishment is predicted to take more than 10 years (Erskine July 2006).

Immediately following construction, sediment plumes will be heavy downstream of the diversion channel. First flush flows and bank-full events will send large quantities of unsecured topsoil, construction mud and silt downstream, as well as any contaminants exposed from freshly mined fascia rocks. Low stream volumes early in the first wet season will concentrate first-flow contaminants, adding stress to downstream ecosystems. Heavy erosion is likely of topsoil superficially applied to the rocky embankments, and bank-full floodwaters will threaten newly planted seedlings above the diversion channel and wash away unsecured seeds.

Sediment management strategies during the construction and early operation of the realigned river channels are an important aspect of the design of these structures and to minimise construction based impacts on the river ecosystem. The early detection of contaminated sediments generated during construction is also crucial to the success of the river realignment project (refer section 9.6).

This could be mitigated by the temporary installation of sediment traps to collect the first low-flow flushes of the river to capture topsoil, mud and rubbish mobilised from the newly constructed diversion channel.

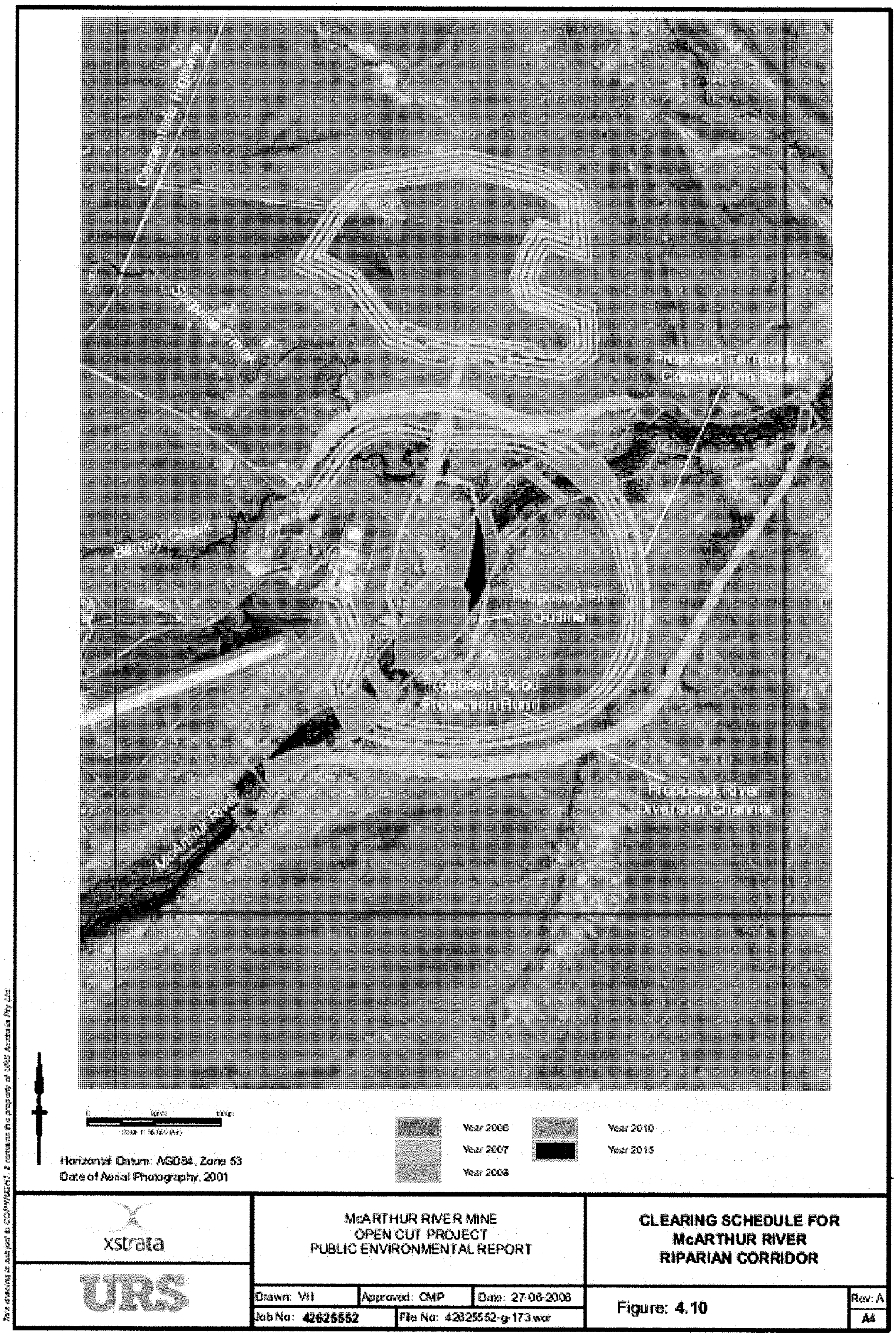

Figure 3: Clearing Schedule for McArthur River Riparian Corridor (PER s4.7.3)

9.1.4 Habitat Loss and Fragmentation

Assessment Report 51 found that the information provided in the EIS was not able to demonstrate that the loss of riparian corridors associated with the diversion would not cause fragmentation of fauna populations in the short- and longer-terms. A critical requirement of the revegetation strategy outlined in the EIS was the need to quickly establish a new riparian and riverine corridor that simulates the existing habitat. However, at the time of the EIS, no trials, seed collections or preparations had been carried out in the prior three years of planning to convey how the proponent proposed to achieve that outcome. In the EIS, riparian vegetation was being heavily relied upon to stabilize channel walls and prevent erosion, yet prediction was made in Assessment Report 51 that the erosion itself would prevent successful creation of the riparian vegetation.

Riparian (riverside) systems are widely recognised as of special significance for biodiversity conservation and ecological functioning. In part, this significance is due to their linear connectivity, allowing dispersal for many species through otherwise generally unfavourable landscapes. The McArthur River at the proposed development site includes a range of well-developed riparian vegetation, in generally good condition.

This riparian vegetation supports a characteristic bird community featuring two riparian bird specialists, the white-browed robin and purple-crowned fairy-wren. Although these species may occur in isolated patches of habitat, their dispersal ability is probably generally limited and both would usually depend upon maintenance of connected corridors of suitable vegetation.

The proposed development will sever and destroy the existing riparian system on both banks over a distance of 4 km of the McArthur River and 2.1 km of Barney and Surprise Creeks. It is proposed that this natural system be replaced by a 5.2km diversion channel, along which planted vegetation will develop. Channel conditions are such that Professor Erskine has predicted that revegetation of riparian vegetation would take at least 10 years.

The PER acknowledges that there may be some formidable obstacles with the development of riparian vegetation alongside the diversion channel, with particular problems due to flood-scouring of inadequately rooted plants and difficulty of plants developing root systems in rocky locations. It proposes (pp. 4-54 – 4-56) a range of management and site mitigation measures to enhance the potential for germination, growth and persistence in riparian plants. To date, these measures remain untested. The rehabilitation plan for the diversion channel provided in Appendix I of the PER indicates that the anticipated growth rate of plants of 1 metre per year is *'unsubstantiated'* and the percentage that survive following a wet season is *'in the lap of the gods'*.

The PER notes (pp. 4-56 – 4.57) a set of 10 woody plant species and two grass/sedge species that characterise the riparian plant community at this site, and commits to use of this set for (re-)vegetation. It is notable that since the findings of Assessment Report 51 local seed stock has been collected to date for only three of these species, that no tube stock is apparently yet available (PER p. 4-58), and that there have been no germination trials to date in the project situation for any of these species.

The PER notes (e.g. p. 11-5) that the habitat quality of aquatic systems may be associated partly with shading derived from a relatively dense cover of bankside vegetation, particularly *Barringtonia acutangula*. That is, the riparian vegetation is not only an important habitat in its own right, but also provides necessary features for its adjacent aquatic system.

The PER recognises the significance of maintenance of riparian connectivity, and asserts (s. 4-7) that the impact of the project proposal will be minimised by the staged series of cuts

(Fig.3) made in that connectivity, and the incremental development of riparian vegetation in the diversion channel over this period.

The proposed development will clear about 39ha of riparian vegetation along the McArthur River and its tributaries, and hence substantially fragment this system. Connectivity is a critical feature of the conservation value and ecological function of riparian systems, and hence this impact is a substantial detriment.

Clearing of riparian vegetation within 250 metres of a high order stream such as the McArthur River is not consistent with the NT Land Clearing Guidelines which state that native vegetation must be retained adjacent to waterways and provide a sliding scale for the retention of buffers depending on the stream size (order).

The current open cut proposal is considered as a one off proposal for the NT. Any subsequent proposals involving the re-engineering of a river received in the absence of overarching policy will also be assessed on their individual merits. A decision made on this proposal does not necessarily reflect future NT policy on the management and conservation of its tropical rivers.

In terms of assessment of this impact, it could be considered more acceptable if there established precedents in similar environments where rehabilitation procedures were shown to have adequately rebuilt riparian systems or the proponent had adequately demonstrated that riparian vegetation could be successfully established along the length of the diversion channel. Criteria for such success include:

- all plant species listed as characteristic of the natural riparian vegetation community (PER p 4-56 and 4-57) are successfully established;
- plant height averages are at least 50% of that of existing riparian communities, for each species;
- the artificial riparian vegetation has withstood at least two wet seasons, with losses no more than 20% greater than natural riparian vegetation;
- cover of the artificial riparian vegetation being at least 80% of that of the existing natural riparian vegetation; and
- the width of the artificial riparian vegetation strip being at least 80% of that of the existing natural riparian vegetation.

Any monitoring of the success of the revegetation of the diversion channel should recognise that the bird species, white-browed robin and purple-crowned fairy-wren, are good indicators of the health of riparian ecological systems. These should be used as foci for any monitoring program and study. A monitoring program should be sufficiently robust to ensure that it can be 90% confident of detecting a 10% decline in the pre-existing population of these two species in riparian vegetation within 20 km of the proposed development. A clear chain of management responses would be required to ensure that such decline is reversed within 2 years of detection.

9.1.5 Aquatic Environments

Concerns were raised in Assessment Report 51 at the potential isolation of upstream and downstream aquatic environments, and the alteration of river flows associated with the proposed river diversion. It was argued that a lack of information in the EIS precluded an informed assessment of the potential long-term impacts of the channel realignments on the aquatic environments upstream and downstream of the mine. The EIS lacked detailed characterisation of in-stream habitats of the existing river channel and detailed biological design specifications proposed for the realigned channel.

Since the EIS various studies have been carried out, monitoring programs have been proposed and surveys undertaken. These are presented in the PER:

- in stream habitats have been characterised in the PER according to standard AUSRIVAS and USEPA 'HABSCORE' index methodology (PER s4.4 and PER App.E):
- a survey of freshwater fishes particularly targeting the Freshwater Sawfish was undertaken in May 2006 (late wet season) in the McArthur River to provide additional data on the distribution and abundance of this species. The survey sampled the three permanent waterholes upstream of McArthur River mine (Djirrinmini, Eight Mile and Bessie Springs), and tidal and non-tidal reaches of the river downstream;
- annual dry season monitoring programs of seasonal pools have been proposed. Sampling would include macroinvertebrate surveys according to AUSRIVAS protocols and seine netting or electrofishing for fish studies are planned;
- fish passage surveys are planned following channel construction, although program details are still to be finalised. Options include a tag-and-release program, above and below the diversion;
- groundwater dynamics of Djirrinmini waterhole were discussed, and monitoring / mitigation programs for groundwater impacts are proposed; and
- ecology data for some McArthur River fish species have been presented in PER App.K and discussion of the ecology of the freshwater sawfish in PER App.L.

The McArthur River (and its tributaries) is a relatively large river in generally intact healthy condition. Studies for the EIS and PER, among others, demonstrate that it supports a reasonably diverse fish community of at least 43 species (PER App.L). The aquatic invertebrate fauna is far less well known. The EIS asserts that this river system and its biota is no richer than, and not unusual relative to, other systems in the region: and that, indeed, its mid- and upper- reaches are notably more simple than comparable rivers flowing to the Gulf.

The proposed development will directly affect this river system. This will be because of:

- severance and destruction of some 5 km of its current course (and its replacement with a proposed diversion channel);
- drawdown of groundwater around the mine site; and
- possible reduction in water quality and flow regimes.

Connectivity is an important feature of river systems, providing for many fish species that must disperse for essential components of their life cycle. This is discussed in part for the threatened freshwater sawfish, but is a factor general for many freshwater fish (and probably other aquatic fauna). The proposed development will interrupt this dispersal through severance of the natural river path, and its replacement with a diversion channel. The PER describes substantial modifications from the previous EIS in the design of the diversion river channel, mostly to create an aquatic environment that provides a more suitable set of features for aquatic biota than that originally designed. These modifications are recognised here to be substantial improvements, and may provide a river system that will be an adequate mimic of the current natural system. However, this has not yet been demonstrated.

The proposed development will destroy about 6.5 km of a largely intact natural river system (McArthur River and Barney Creek), with consequential direct substantial impact on the aquatic biota in that area, and potential consequential impacts more broadly across the river system because of loss of or reduction in the natural dispersal routes required by many aquatic species.

The proposal aims to ameliorate these impacts through creation of a replacement diversion channel that has features comparable to that of the natural system. There are no close precedents for this substitution, and the proponents have not trialled examples of the methodology.

Uncertainties associated with the severing of the natural river system would have been reduced if the proponent had demonstrated the efficacy and suitability of their design for the diversion channel by trialling the proposed methodology. Criteria for the success of such trials would include the diversion channel:

- maintaining its designed habitat features over the course of at least two wet seasons;
- supporting an aquatic biota with at least 80% of the richness of, and 80% similarity in composition to, that of the natural system; and
- supporting at least 80% of the dispersal movements of that of the natural system.

9.2 Overburden Emplacement Facility

9.2.1 Summary of Risk

Contaminants entering Barney Creek and McArthur River resulting from:-

- its location on the floodplain;
- the permeability of the OEF cover, walls and base;
- insufficient categorisation of the waste material;
- NAF/ PAF surface water drainage overflowing during flood periods;
- metal mobilisation in surface drainage; and
- reactive management of NAF sediment ponds.

On the basis of the information provided in the EIS, Assessment Report 51 concluded that it was not possible to confirm that contaminants mobilised from the OEF would not enter the McArthur River. The potential for metal mobilisation to occur from non-acid forming material had not been adequately investigated nor a risk management strategy prepared with detailed contingencies in the event that non-acidic drainage was found to be a significant source of contaminants.

The change made to the OEF presented in the PER was to its configuration in order to protect archaeological site MRM4 (section 11.1).

9.2.2 OEF Location

Concerns were raised during both the EIS and PER processes regarding placement of the OEF in a drainage line, and flood plain, where regular wet season inundation of 5m depth occurs (draft EIS 12.3.2). The location in the floodplain increases the potential for contaminated water (acid and non-acid rock drainage) to enter Barney Creek and the McArthur River particularly during recessional flows after flood events. This means there needs to be a greater emphasis placed on the characterisation of waste material, OEF design and management of discharge,

Smaller OEF emplacements are planned for inside the flood bund and (later) in the open pit, however evaluation of alternative management strategies that would put the main OEF out of the flood zone have not been presented. Best practice in the NT recommends '*catchment isolation by bunding or by location of waste containment structures at the head of catchments'...which also represents... 'the lowest cost method for minimising capture of water in a mine water system*' TEAM NT (2004).

The proponent argues that the proximity of a water course does not necessarily exclude an area as a potential OEF site, as alternative drainage arrangements can be implemented, such as new drainage channels or diversions. The proponent proposes to manage the OEF so that there will be no significant impact on the nearby watercourses.

Except for the clay lined PAF cell, the design of the OEF would not prevent infiltration by floodwaters. No clay is incorporated into outer walls of the OEF. Runoff and infiltration is directed through the pile itself to drain at ground level directly downhill or along the OEF fringes to the PAF pond in the west, or to the sediment ponds on the southern corner. Floodwaters appear to have the potential to inundate the base of the OEF, in particular the southern corner, including the NAF sediment ponds. Receding floodwaters would mobilise sediments and contaminants from within the first lift of the OEF, back to the river.

9.2.3 NAF Characterisation

Concerns have been raised in comments on the EIS and PER, that waste rock will be insufficiently characterised, and material being classed as NAF may retain the potential to create acid or non-acid contamination of drainage with metal species and salts. Drainage may be via rainfall runoff and floodwater infiltration resulting in erosion and/or acidic drainage. Groundwater seepage pathways are likely to enter Barney or Surprise Creek and the McArthur River.

The contaminated drainage could increase salinities in dry season pools and become incorporated into sediments. The sediments if subject to wetting and drying action, and biological activity, have increasing likelihood of releasing soluble metal species into the river system, potentially adversely impacting on aquatic habitats and bio-accumulating into food chains.

For example, in the Hanging Wall Overburden Material of the Upper Pyritic Shale, sulfur content was up to almost 5%. Leach tests in Table H3 of the PER show that pH is still acidic and some metals are in solution at significant levels. Comment was made that these rocks should therefore be managed as if PAF, not NAF.

Leach column testing and revised block modelling should be undertaken during mining activities to continually assess the overburden material for potential acid generation characteristics. Correlation of test work with waste rock placement in the OEF would also need to be undertaken throughout the operational life of the mine.

Problems with Upper Pyritic Shale have been recognised by the proponent, and its use has been excluded from external bund walls around the pit. However, no commitment is made in the PER that it will be reclassified and stored as PAF, and encased in clay. Any rock type showing potentially contaminated leachate should be stored in a manner which will prevent seepage.

9.2.4 Leachate Management

Concern exists that the full potential for the generation of acid leachate has not been taken into account and therefore management measures proposed may not be sufficient.

For example, the NT Department of Primary Industry, Fisheries and Mines (DPIFM) commented that in kinetic leach testing the first acidic, higher metal load flush should not be ignored, as it may indicate that over time this is what the leachate will trend towards. The first flush may be due to oxidation on the surface of the material and be easily removed in the first flush of water. As material oxidises over time the leachate may again become acidic.

Similarly, the NLC commented that acid consuming rock may not act as expected. The coarse size of the dumped rock works in favour of the escape of acidic drainage products due to the rapidity of acid generating reactions. Acid leachate may bypass neutralizing surfaces by eroding passages through voids. Formation of coatings of oxidation on otherwise useful neutralizing surfaces could reduce the effective neutralization capacity of acid consuming rock. Case studies exist from Australia where waste rock dumps with high theoretical net acid neutralising capability have become sources of acid mine drainage due to the actual kinetics of the reaction not conforming with the simple acid production versus consumption calculation (TEAM NT (2004)).

Continued long term and field kinetic leach testing of all material destined for the OEF would be required to minimise contaminated drainage. Thorough characterisation of overburden is unlikely to fully remove the risk of acid drainage occurring from rock classed as NAF. NAF drainage of metal contaminants even without the presence of PAF/acid seepage can still exist due to characteristics of the local geology.

In the event that leachate from the eastern OEF (leachate from the NAF material entering the sedimentation ponds) becomes acidic, this would create a more significant problem as some metals would be released in soluble form. This is discussed in Section 9.4.5. The proponent makes the statement, '*should there be an emergency discharge in an extreme storm event, the massive dilution would not result in measurable impact on contaminant concentrations downstream*'.

9.2.5 Management of Surface Flows and Seepage

The EIS and PER outline the proposed capture and management measures for drainage from both PAF and NAF components of the OEF – this includes a pond capturing drainage from PAF material where it is then pumped to the water management dam at the TSF, and sediment ponds capturing drainage from the NAF material where it is discharged to Barney Creek. These measures rely on the capture and subsequent management of contaminated drainage rather than its prevention.

For example, it is proposed to establish trigger levels for sediment pond discharges. If a monitoring trigger level is exceeded, the relative impact of sediment pond metals load on downstream aquatic ecosystems is proposed to be determined and if a potential adverse risk were assessed, corrective actions could include:

- increasing the capacity of the NAF sediment pond to reduce quantity of pond discharge and increase effectiveness of sediment settling rates; or
- pumping water from the NAF sediment pond to the water management dam at the TSF, to minimise the probability of discharge, and re-evaluating the site water balance modelling to quantify the impact on overflow risk of the TSF. If necessary the capacity of the TSF would be increased to maintain its design criterion of 1 in 500-year overflow risk.

It should be noted that the proponent has conceded that monitoring may not be able to occur at all times of the year due to poor access to the NAF sediment ponds during floods – the sediment pond monitoring program is therefore likely to be inoperable at the time it is most needed. The stated contingency of increasing pond capacity (sediment ponds or water management dams) is also unlikely to be available until the following dry season.

9.2.6 Summary of findings

There is concern about the proponent's use of reactive management techniques for dealing with potential acid drainage from waste rock. The proponent's management approach involves the collection of seepage and disposal to the tailings dam, rather than isolation and encapsulation of all problematic material including NAF material.

In assessing the hierarchy of controls, a more risk averse management approach would be to choose the technique of seepage collection monitoring and containment only after elimination and substitution options are discounted.

In the case of waste rock management, elimination of seepage issues through effective characterisation, isolation and encapsulation of all NAF/PAF problematic material would require assessment. By relying on seepage management and monitoring techniques the final closure of the waste dump may be uncertain or problematic as active intervention may still be required as part of the closure options.

9.3 Tailings Storage Facility

9.3.1 Summary of risk

Assessment Report 51 raised concerns regarding the operation of the tailings storage facility and its ongoing potential to impact on the receiving environment due to seepage. Ongoing seepage would entail present and long term maintenance and monitoring requirements with remedial actions such as operation of recovery bores long after mine closure. As a response to seepage into Surprise Creek from existing operations and also if further seepage were detected, establishment of a recovery bore network around the existing tailings storage facility (TSF) was proposed by the proponent.

Concerns have continued to be raised regarding seepage and impacts upon river and groundwater systems from the TSF both within the mine's life, and in the long and very long term. To date the TSF has expressed high sulfate seepage into Surprise Creek and created an estimated groundwater plume 400m to 2.5km long, moving toward the McArthur River and underground workings.

To assist in assessing the PER, a consultant hydrogeologist and a soil scientist were commissioned to undertake analysis of the existing and proposed TSF with particular focus on seepage and erosion issues respectively. The consultants' reports are included in Appendix 1 and 2 of this assessment report.

9.3.2 TSF Seepage

9.3.2.1 TSF Design

The designs of both the existing and proposed TSF contain no seepage limiting /containment layer beneath the facility, to create higher tailings consolidation and densities. This permits a smaller footprint, higher tailings structure to be built, and reduces initial capital and ongoing construction costs. However, the approach permits much greater seepage from the tailings to underlying aquifers and hence groundwater contamination.

The lack of a seepage limiting layer relies on actual and expected discharge of contaminated waters to groundwater aquifers. To capture seepage in future the design relies on the establishment of a seepage recovery bore network to capture all groundwater below the TSF. This groundwater is to be pumped to the water management dam during mining operations and to the open-pit after mining ceases.

The lack of a seepage limiting layer minimises initial capital costs but maximises post-closure operational costs, where liability for costs and risk is more likely to be borne by the NT government. This is not considered 'best practice' and does not meet ANCOLD (1999) guidelines relating to integrated life-cycle management of tailings-storage facilities, nor would meet standards of Victoria or Queensland.

9.3.2.2 Contaminated Groundwater Plume from Existing TSF

The PER indicates that there is a plume of contaminated water extending from the existing TSF, however its full extent has not yet been measured. The PER indicates an easterly flow of groundwater from high elevations near the TSF (up to RL 42 m) to lower elevations near the McArthur River (down to RL 20 m). The draft EIS describes groundwater quality with salinity levels and sulfate concentrations greater than those recommended in relevant

ANZECC (2000) guidelines. Some metal concentrations (Cd, Cu, Fe, Mn, Pb and Zn) in seepage/groundwater were stated as greater than ANZECC (2000) water quality guidelines criteria for fresh water ecosystems. According to URS (2006), groundwater quality data indicate that the pH of groundwater at the existing TSF is near neutral.

Trends in sulfate concentrations for groundwater at the TSF (Figure 4.4 URS, 2006), show that sulfate concentrations for all groundwater bores were less than or equal to the livestock guideline value of 2,000 mg/L in late 1997/early 1998. By mid 2005, sulfate concentrations were all above the guideline value except for groundwater at GW7.

Groundwater monitoring data are limited and are mostly located near the perimeter of the existing TSF. The locations of existing plumes beyond the TSF are not known, particularly north of Surprise Creek. The fate of these plumes and the long-term impacts to downstream water quality has not been predicted, i.e. modelled. The current extent of groundwater contamination downstream of the TSF is not well understood because these plumes have yet to be modelled and monitoring appears to be inadequate.

9.3.2.3 Predictive Modelling

Solute transport modelling is generally undertaken to predict changes to downstream water quality as a result of seepage from tailings storage facilities. In this case, impacts to downstream water quality were inferred by the proponent on the basis of the changes to groundwater levels downstream of the TSF. Given the limited groundwater level data used during calibration and the karstic nature of the rocks, it is considered that the modelling results incorporate significant uncertainty.

Predictions of seepage recovery vary significantly from the draft EIS to the additional information provided by the proponent (URS (2006).

For example the draft EIS predicts a total pumping rate of 200kL/day over 30 years or more. The PER predicts total abstraction of 1,980 kL/day during mine operations and 390 kL/day after 10 years. The additional information suggests 1,846 kL/day during the period of mine operations, 745 kL/day after 5 to 10 yrs and 548 kL/day for 10 to 25 yrs post operation.

This uncertainty makes it impossible to predict the actual life of recovery bore system beyond the end of mining operations. This is further exacerbated by the 'worst case' scenario modelling undertaken for the purposes of the PER which indicate that seepage rates are lower and the time taken to lower the head of water within the TSF is increased. Therefore the period for operating the recovery bores is longer. The basis upon which pumping is ceased (post-operations) is not clear.

9.3.2.4 Operational Period

The proposal to operate seepage recovery bores during the period of mine operations constitutes an "observational approach", which requires ongoing refinement so that new areas of groundwater contamination can be detected, regular re-design of the bore network and regulatory review and management. This approach will result in seepage being an ongoing (major) issue during mine operations.

During mine operations, water is to be pumped from the seepage recovery bores to the proposed water management dam. A water balance for the dam has not been undertaken. It is stated in the PER that if there is insufficient capacity in the dam (for storage of water pumped from seepage recovery bores) that seepage water will be spread as low rate irrigation over the TSF active cell during dry weather, at rates that do not result in runoff or ponding. This could result in a salt build up at the surface of the tailings as a result of evaporation, which will be leached into the tailings mass each wet season. It is therefore likely that the water quality of seepage passing through the base of the tailings dam will deteriorate over time.

Alternatively in the dry season contaminated groundwater from the seepage recovery bores may be pumped back to the TSF. This could cause long-term deterioration of seepage water quality by accumulating salts.

9.3.2.5 Legacy of recovery bores

The long term costs of the recovery bore proposal are the ongoing costs of long term groundwater pumping, interception bore maintenance (and possible installation of more interception bores) and potential environmental impacts from unidentified groundwater plumes. Post mine operation costs and bond requirements would have some levels of uncertainty which would require further modelling before mine operations cease.

Post-closure, the TSF would not be self-sustainable and therefore does not meet ANCOLD (1999) guidelines. These state: '*Decommissioning and aftercare maintenance should be anticipated and adequate provision made to ensure that it can continue for as long as is necessary to ensure that the decommissioning objectives and self sustainability are achieved.*' The need for operation of a seepage recovery system beyond closure means that the TSF cannot achieve any degree of self sustainability. It is further stated that '*Ongoing requirements for the aftercare phase should be within the capability of the post-closure land user or other party responsible for the storage to implement. Therefore, aftercare requirements should be compatible with end-user capabilities and vice versa.*' In this instance, it is considered that likely end users would be ill equipped to manage such a complex seepage management program.

ANZMEC/MCA (2000) states that '*Being able to successfully close a mine is critical to project approval. It is necessary to ensure that closure is technically, economically and socially feasible without incurring long-term liabilities.*' Long-term seepage recovery (post-closure) means that the MRM site is left with a significant environmental liability at the time of closure. In the event that MRM withdrew from the site at this time, the Northern Territory Government would need to utilise available funds held in trust on behalf of MRM or other funds to manage a liability over a period of 30 to 50 years.

According to Qld EPA (1995) in MCMPR/MCA (2003), there are a number of objectives that need to be considered when planning the final land form of a tailings storage facility. These include '*containing/encapsulating tailings to prevent leaching into ground and surface waters*' and '*designing the closure to minimise post-closure maintenance*'. The design of the TSF, including cover design, indicate that the tailings are neither contained or encapsulated to prevent leaching into groundwater and post-closure seepage recovery requirements is indicative of substantial post-closure maintenance.

On the basis of the TEAM NT (2004) guidance '*Each year that a groundwater plume develops can translate to ten years of pump and treat operations to recover the plume and restore groundwater quality.*' This translates to recovery bore operation periods of more than 200 years, based on a 20 year mine life. In addition TEAM NT argues that '*A dollar spent wisely now can save nine dollars later*'. The risks, both economic and environmental, of the future operation of this recovery bore system post mine closure would be borne by the Northern Territory Government in the event that the company or its successor was unable or unwilling to adequately maintain the recovery bore system.

9.3.2.6 TSF Location

No assessment was presented in the EIS/PER of alternative, more appropriate TSF sites that would not contain permeable alluvial soils, that in turn would limit seepage from the TSF and hence reduce environmental risk. This issue was subsequently addressed in further information provided at the request of the Minister.

The existing TSF is located close to Surprise Creek and contains tailings placed in direct contact with highly permeable soils, encouraging direct seepage into groundwater aquifers. According to the Draft EIS, '*Groundwater can occur in open vugs or solution channels, fractures, joints and faults within the fresh bedrock.*' Aquifers are known to exist within the underlying dolomitic siltstone rocks. It is proposed to locate the tailings facility for the expanded operation adjacent to the existing cell.

Further information provided in URS (2006c) analysed the flood risk of the proposed location as having a ground level close to the Q_{50} flood level, with the TSF embankment crest significantly higher than the Q_{500} flood level. Soils were considered to be similarly porous at other alternative locations, although serious analysis of alternative locations was not presented.

Although natural soils may be porous at various alternative locations for the TSF, options of construction of artificial seepage limiting layers beneath the TSF are also available.

9.3.2.7 Summary

In the context of seepage issues, it is concluded that the TSF design is inappropriate and should be revisited for the following reasons:

- the impacts of current seepage from the existing TSF are not fully understood and the legacy issues related to this seepage (future impacts to receiving waters) have not been modelled;
- there has not been an assessment of alternative, more appropriate TSF sites that would not contain permeable alluvial soils, that in turn would limit seepage from the TSF and hence reduce environmental risk;
- based on available guidelines, it seems unlikely that the TSF design would be approved in Queensland or Victoria;
- during the period of mine operations, contaminated groundwater from the seepage recovery bores may be pumped back to the TSF in the dry season. This could cause a long-term deterioration of seepage water quality, thus extending the time for seepage recovery; and
- post-closure, the TSF would not be self-sustainable and therefore does not meet ANCOLD (1999) guidelines.

9.3.3 TSF Erosion

The consultant soil scientist examined the PER to identify the potential for contamination in the longer term (beyond 30 years) resulting from erosion of the tailings storage facility. The report is presented in this report at Appendix 2.

The PER presented TSF embankments designed to withstand up to a 1-in-500 year ARI flood event, although the modelling of this risk setting is based on a relatively short period of rainfall statistics. The risk analysis indicated that the TSF would be in the potential flood impact area.

The consultant concluded that the embankment design for the planned TSF is robust in terms of the design criteria. However, the long-term stability of the wall will depend on the quality of the materials chosen to construct the rock facing. Assurance is also needed that there are sufficient quantities of non-acid forming rock of appropriate hardness and durability to construct the tailings dam embankment design.

The PER states that the TSF water management dam embankments are of a capacity capable of containing water inputs from up to a 1in 500 year rainfall event, before overflowing to Barney Creek. However design specifications for the embankments are not presented, creating uncertainty as to whether the embankments:

- meet ANCOLD design standards or would structurally resist a 1-in-500 year flood event; or
- are elevated to a height sufficient to not be overtopped by such a flood event.

Evaluation of alternative tailings management strategies which would put tailings out of the flood zone, for example, on adjacent high ground or ultimately in the pit, were identified and rejected in URS (2006a). The adequacy of this analysis was questioned and recommendation was made that the proponent further consider alternative locations accounting for long term TSF maintenance costs and management of environmental legacies.

Drainage systems for the TSF embankments and final landforms have been designed to contain a 1-in-100 year ARI rainfall event. The proponent has given an assurance that detailed design and operating procedures would be developed.

Adequate modelling of erosion risk to the TSF has not been presented in the EIS/PER. A quantitative approach to erosion risk assessment using terrain analysis and local erosion and sedimentation measurements would need to be developed to support any closure strategy.

The cover design evaluation and the recommended grass species mix for revegetation give no clear assurance that the TSF landform will support a stable self-sustaining native plant community in the long-term. Any rehabilitation plan needs to consider environmental outcomes and be based on a water balance that demonstrates water to support self-sustaining plant communities.

9.4 Surface Water

9.4.1 River Water-Quality Classification

The Beneficial Use Declarations under the *Water Act* for the McArthur River catchment and estuary including the Sir Edward Pellew Island Group are defined as aquatic ecosystem protection; recreation; water quality and aesthetics. These beneficial uses were declared after mining had commenced, but before the open cut project was first proposed. While such a declaration does not prohibit mining in the catchment, companies undertaking such ventures are obliged to ensure their activities do not compromise those declared values.

It is generally accepted that the waters of McArthur River in the vicinity of the mine site are affected by the complex mineralogy, geochemistry and geology of the area and that surface water quality can be influenced by these factors. This is confirmed by results from water quality monitoring points upstream of the mine where elevated metal levels are occasionally recorded.

The proponent presented an assessment of surface water quality as part of the EIS/ PER. The physico-chemical water quality values of the McArthur River in the area of the mine have been assessed by the EPA Program and are considered to fall into the "slightly modified" classification. This is with respect to the setting of appropriate guideline levels for toxicants, as required under the National Water Quality Management Strategy (NWQMS 2000). This assessment is appropriate given the current mine's location in the McArthur River catchment and the current level of impact.

An assessment of the hardness of the water in the McArthur River, Barney Creek and Surprise Creek was undertaken by the proponent and the median hardness value was used to set a trigger value for potential discharges. After determining the appropriate guideline trigger levels it was determined that the existing water quality met the hardness modified trigger value for filtered copper, lead and zinc, below the mine site. Some waters in the McArthur River catchment above the mine site had elevated levels of zinc, but with in-stream chemical and dilution processes, met the 95% Hardness Modified Trigger Values (HMTV) below the mine.

While the hardness-modified trigger values used by MRM for freshwater in Appendix C are appropriate, the use of livestock water quality values for determining trigger values for runoff derived from NAF and PAF materials is questionable and the rationale behind their use has not been explained. Controls based on trigger values derived from livestock guidelines would permit the company to release excessive amounts and loads of water-soluble contaminants into the McArthur River.

Permitting the use of livestock standards for derivation of trigger values would be inconsistent with the declared beneficial use of 'aquatic ecosystem protection' for the environment downstream of the MRM and would possibly result in the company breaching the *Water Act.*

9.4.2 Non Acid Drainage

The proposal includes a number of components which have the capacity to result in the non-acidic mobilisation of contaminants into surface waters. These include the OEF cover material, the TSF embankments, the excavations of the McArthur River and Barney Creek diversions, and the flood bund constructed around the pit. The proponent intends to construct these components from overburden classed as NAF.

The cladding material of the OEF, the TSF embankments, the flood protection bund and the diverted channels are proposed to comprise competent NAF rock. Continuing kinetic leach testing was presented in the PER with the aim of further refining and limiting the suite of rock types considered suitable for placement on erodible external surfaces of the mine components. Durability of rock types against weathering is concurrently considered by the proponent as a limiting factor. Runoff from the OEF was discussed earlier in section 9.2.3.

Uncertainty surrounding appropriate classification of rocks as NAF, PAF, or acid consuming is a vital step in preventing later contaminated seepage from mine structures. Long-term kinetic leach testing of material would be required to determine the appropriateness of its use in mine site components.

Runoff from the external embankments of the flood protection bund and of the TSF is proposed in the PER to be channelled using contoured drainage to sediment ponds prior to being discharged. Water quality monitoring is proposed for the discharges from the sediment ponds for 2 years, before being reviewed in consultation with the Northern Territory Government, with a view to ceasing the monitoring. However, any review would only be appropriate at mine closure after all rehabilitation / revegetation, and thus mine disturbance, was finalised. Therefore monitoring of discharges should be ongoing for the life of the mine.

Monitoring programs are proposed in the PER for discharges from the OEF NAF, TSF embankment and flood bund sediment dams. Contingency management responses have been proposed for breaches of pre-determined water quality thresholds of the OEF sediment pond (s2.3.7). The EPA Program notes that monitoring is proposed of discharges from the sediment ponds on the flood bund and TSF (for 2 years), but the PER does not mention these contingencies being linked to further management contingencies if thresholds are exceeded.

9.4.3 Flood Protection Bund

Assessment Report 51 considered the extreme event scenario of the pit flooding in a 1-in-500 year flood event (as in Fig 9.3 PER). Concern was expressed that water quality would be compromised if this water was pumped back into the river system creating the possibility of contaminants impacting on the McArthur River aquatic ecosystems either through sedimentation or contaminant transport.

9.4.3.1 Sedimentation risk

The PER outlined the design of the flood bund to demonstrate high levels of embankment integrity and safety. The proposed flood bund design is presented as having a low potential for the flood bund materials to erode creating sedimentation impacts on the river during or after a flood event.

The bund has been designed to include an emergency overflow section which, if overtopping occurs, would erode a 250m wide area into the open cut, as this will be the lowest point in the interior of the bund. The open cut will then become filled with floodwater. As the floodwaters recede, the outflow through the breach will be at a much slower rate than the inflow, and the resistant base and sides to the breach will minimise further erosion. Water levels in the open cut will drop until the top of the eroded breach is reached.

Should erosion of breach materials occur during the outflow, the proponent anticipates that they will be deposited near the outside of the breach, as the breach is located in a relatively quiet backwater of the bund, away from the main flow paths. The proponent does not anticipate that this relatively small volume of material would cause any more contamination of the aquatic environment of the McArthur River than would normally be expected in a flood event with a recurrence interval in excess of 500 years. These assumptions would require ongoing monitoring to determine whether or not the bund is behaving as predicted or whether other erosion controls are required.

As the proponent did not consider that significant sedimentation or contamination of the river environment would occur from a bund breach, no discussion was offered regarding impacts or contingencies to mitigate impacts.

9.4.3.2 Contaminated pit outflow water

The PER guidelines required the proponent to address contaminated water from the pit being returned to the river and any of the potential impacts on aquatic ecosystems. However these issues were not further discussed in the PER.

In the EIS the proponent argued that in relation to mine closure, any contaminated pit water would be diluted by the large volumes of water in the river and floodplain due to the extreme flood conditions. However the proponent did not consider loss of significant dilution as flood waters recede and the pit waters concentrate. If pit water is to be pumped to the river after a breach event, the likelihood is that pumping would not occur until floodwaters had receded. The changing dilution ratio may lead to unacceptable changes in discharge water quality to the river. Water quality issues associated with release of water from the pit remain unresolved.

9.4.4 TSF Water Management Dam

Water management system budgets are not presented in the PER. Budgets presented in the draft EIS (Figs 12.10, 12.11) and the Supplement (Figs 2 and 3) incorporate significant groundwater inputs (1800kL/d) from the proposed TSF recovery bore system.

According to the PER if the TSF water management dam capacity is exceeded then water would overflow into Barney Creek via engineered spillways. The dam capacity is engineered to contain a 1-in-500 year ARI rainfall event, but will reduce in size with each new tailings area brought into commission. Concern was raised that the dam capacity may not account for evolving scenarios, such as the potential requirement to capture drainage from the eastern OEF NAF section, and the TSF recovery bores and surface runoff in a flood year. The proponent argued that if the dam scope is to change then modelling would be revised, and if necessary the dam capacity would be increased to maintain its 1-in -500 year design rating.

The ability to increase the capacity of the water management dam is unlikely to be available at the time it is required resulting in additional contaminant loads to Barney Creek and subsequently to the McArthur River. Alternatives to this reactive approach need to be examined.

9.4.5 OEF Sediment Ponds

The PER states '*The sediment ponds will occasionally overflow clean runoff water into the receiving waters*' (PER s6.4). The EPA Program would need some assurance that sediment pond discharge will be clean and be provided with an indication of how often overflow could be expected to occur in a typical wet season. Monitoring would be required to determine if water was clean but the turnaround for analysis would preclude in many cases the availability of results before discharge.

Considering the likelihood of the base of the OEF flooding (s 9.2.2) and uncertainty as to whether sediment ponds on the OEF, flood bund and TSF embankments would also be flooded, a potential appears to exist for floodwaters to create erosion/sedimentation pathways directly to Barney and Surprise Creeks.

Designing the sediment ponds to contain at least a 1-in-10 year ARI rainfall event with the inclusion of a series of gravity flow or passive pond cells would provide better treatment before discharge.

9.4.6 Water Quality Monitoring

9.4.6.1 River Monitoring Program

During the initial phases of development of the open cut and river realignment more frequent monitoring is likely to be required than is proposed, as this is when the effects of disturbance will be most apparent and a higher level of risk of contamination and transport into the watercourses will occur.

Physico-chemical parameters should be selected as described in NWQMS (2000), and monitored on a daily or weekly basis and then the program reviewed once sufficient information has been collected. Heavy metal monitoring should continue to be carried out on a monthly basis to tie together sediment, marine and biota monitoring programs to develop an integrated environmental monitoring program. Any revised monitoring program should be developed in conjunction with government agencies and relevant stakeholders including the local communities and clan groups, AFANT, environmental groups and the NLC for increased transparency and to maximise public confidence.

9.4.6.2 Monitoring of Heavy Metals in McArthur River Catchment Surface Waters

Baseline water quality data from 2003 to 2005 (PER App.C) provided for McArthur River upstream and downstream, Surprise Creek and Barney Creek focuses only on copper, lead and zinc. It does not address cadmium.

Cadmium is one of the key water quality reporting parameters required by the existing Waste Discharge License #103 (NRETA, 2006). There is significant concern that downstream indigenous food sources including dugongs, turtles and oysters are bio-accumulating heavy metals, especially cadmium, to the point that their consumption represents a health risk to the communities of the gulf. Common advice distributed amongst these communities is not to eat the kidneys or livers of these animals, to reduce this risk. High natural environmental levels of metals due to the geology of the region confound identification of the sources of the heavy metals.

While cadmium is considered to be a low risk to water quality from the activity, because of its significance in the geochemistry of the McArthur River catchment and to food safety for downstream recreational users, cadmium should be included in any monitoring programs for precautionary and food safety due diligence reasons.

9.5 Groundwater

9.5.1 Drawdown impact on Djirrimini Waterhole (sacred site)

There is concern with regard to drawdown in Djirrimini water hole (Fig12.2 in draft EIS) during the dry season. The PER advises that assessment of hydrogeological data shows that the drawdown impact on the waterhole would be in the order of 0.35m, not 0.5 metres as advised in the EIS. The proponent proposes a monitoring program to validate this prediction during mining operations and advised that:

- clean water could be added to the waterhole if levels drop to unacceptable levels;
- the waterhole is not ecologically significant in terms of conservation of fresh water fish species in the river in comparison with the much larger Eight Mile Waterhole further up the river.

In terms of freshwater swordfish migrations, Djirrimini Waterhole was seen by the proponent as a potential resting pool, but not large or deep enough to constitute a pool large enough in which to breed and spend the dry season. This is further discussed in Section 10.1.1.

Djirrimini Waterhole is a registered sacred site and accordingly any potential impact on the waterhole would need to be agreed to in consultation with the Aboriginal Areas Protection Authority (AAPA) and traditional owners.

9.5.2 OEF and Risks of Groundwater Contamination

Concern exists that the OEF which is close to the Barney Ck diversion and the McArthur River and up gradient of the groundwater flow, may contribute contaminants from PAF / NAF drainage to groundwater aquifers expressing into the river system.

The OEF site is situated on a terrain primarily comprising deep clay soils (>2.0 m) with superficial topsoil. Deeper subsoils (>1.2 m) are calcareous and locally gypseous with massive soil structure and very low permeability/hydraulic conductivity. The PER therefore concluded that the soils appear suited to creating a relatively impervious and acid consuming base for the OEF.

Initial treatment of the OEF site would involve vegetation and topsoil removal and stockpiling, then re-profiling of the base to slope east and west from a central crest. The surface (150mm) is to be scarified and compacted to create a low-permeability base layer, with a typical permeability of 10^{-8}m/sec, similar to that of clay in dam walls.

Clay is not fully impervious and the continuity of the clay and gypseous base over the 255Ha span is not described. It is also likely that the base will contain numerous faults and pathways by which OEF seepage may communicate with groundwater aquifers. Seepage to groundwater would be expected, albeit at a reduced rate.

While the proposed OEF is designed to capture lateral seepage, concerns exist that the OEF is not engineered to a conservative level to reduce seepage escape and contaminants through the floor of the repository.

The groundwater drawdown cone created by the open pit dewatering is also likely to attract any groundwater seepage from the OEF over the life of the mine. On completion of mining, it is proposed that the OEF will be capped and revegetated. Transpiration through plantings is expected by the proponent to exceed absorbance of rainfall but the EPA Program considers this unlikely considering the nominal layer of topsoil planned as a final cap over the porous OEF rock. The PER offers no recognition or management of this issue.

9.6 Sediment quality

Assessment Report 51 concluded a lack of sediment data for the freshwater reaches of the McArthur River prevented a complete assessment of the environmental risks posed by the proposal. PER guidelines required the provision of '*Sediment data ... to determine the presence of contaminants from the existing mining activities*' and to '*discuss the fate of metal species derived from the exposure of mine mineralisation in the receiving environment including the long-term impacts to downstream biota*'.

Fluvial soil sediment quality data was presented in the PER at monitoring sites both above and below the mine site. It is of some concern that the PER (s8.5) presented sediment monitoring data in graphical form relative to inappropriately high trigger thresholds that do not represent values for protection of aquatic ecosystems. The proponent used as a trigger Interim Sediment Quality Guidelines-High, (ISQG-High) thresholds, which represent a recognised concentration threshold above which effects would be expected to frequently occur in aquatic ecosystems rather than ISQG-Low thresholds which represent concentrations below which biological effects would possibly occur.

The amount of sediment transport and deposition into the river system will be highest during the wet season and negligible during the dry season. The proposed system of quarterly monitoring has the potential to bias any calculations of sediment and contaminant load towards the lower end of the scale. The sediment load is also expected to be high during periods of construction and earthworks which merits more intense monitoring.

The locations and frequency of the sediment monitoring program should be modified to:
- monitor and rehabilitate any mobilisation of contaminated sediments during the revegetation and settlement first years of the realigned rivers;
- tie the program into the marine monitoring program;
- provide a more realistic assessment of impacts; and
- to include community in its development and implementation.

Charles Darwin University has surveyed the heavy metal status of marine sediment at the mouth of the McArthur River. Investigators found that McArthur River Mine ore-derived lead does not contribute to the lead contained in these sediments, and makes only a minor contribution to lead levels in sea grasses around the McArthur River mouth. Metal concentrations in oysters at the McArthur River mouth were all well below food standards and too low to determine lead isotope ratios.

Assessment Report 51 reported a study undertaken in 2002, taking in Bing Bong Port, the Bing Bong Trans-shipment area as well as the McArthur River mouth, measuring metal concentrations in sediments and biota including oysters and sea grass. Annual reporting for the Bing Bong area in the vicinity of MRM port loading facilities indicated that the swing basin and dredged channel, including some biota, have been contaminated with lead-zinc concentrate since port activities began.

The PER stated that the Bing Bong environmental monitoring program running since 1998 had identified levels of lead and zinc elevated above background in surface sediments on the beach and mangrove area immediately west of Bing Bong. Investigations of the lead isotope ratios have shown that the elevated levels are attributed to the McArthur River Mine concentrate.

The proponent has proposed an expansion of the existing monitoring program at Bing Bong to further investigate some of the findings from the existing program. Extra monitoring is to include:

- species abundance and feeding habits of seabirds, waders and shorebirds;
- the extent of the elevated metal levels in surface sediments to the west of the channel, together with depth profiles from cores, historical deposition profiles; and
- dispersion patterns of metals out of the swing-basin into the water column.

Comments were submitted on the PER detailing chronic low level escape of mined concentrate to the sea during offshore loading operations. The escape was reported as dust and occasional spills, especially during rough weather. Areas involved were indicated to be the offshore loading sites, traverse routes and the Bing Bong Port.

A perception exists in some sectors of the local community that the proposed open cut project will pose a risk to these areas. To counter this, the proponent has proposed additional monitoring of the McArthur River estuary and the Sir Edward Pellew Islands. Expansion of the monitoring program is to include further sampling of water quality, sediment, seagrass and oysters for heavy metals in the McArthur River from Borroloola to the river mouth on an annual basis, and a transect across the delta of the mouth of the McArthur River.

A need for further expansion of regular the sediment and biotic monitoring program is evident to characterise the affects of concentrate inputs at offshore loading sites. A review of loading equipment and barge wash-down procedures is required to minimise future concentrate losses to the marine environment.

The PER proposes that if the sampling within the river and the additional transects show no impact during the two years following commencement of the open cut project, the transect sampling should cease, and monitoring focus on the river. However given that any contamination is likely to build up slowly over time, monitoring should continue for the life of potential impacts, i.e. for a period extending well beyond mine operations.

In addition, the proposed marine monitoring program will be expanded to include the Sir Edward Pellew Islands. The program will be developed in consultation with members of the local community members, and their advice will be sought on suggested monitoring locations and targets.

It is anticipated that this monitoring will include metals analysis for water, sediment and a range of biota including seagrass, molluscs and fish. Traditional food types used by the local community will be included. In addition, marine animals that are brought to McArthur River Mine showing potential signs of abnormality or stress will be analysed for metals content.
McArthur River Mine has committed to fund the appointment of a mutually agreed scientific specialist to review the scope and results of the monitoring program. This specialist would be able to report separately to the community.

The NLC recommended that limited annual monitoring occur at locations further around the coast to the east to establish current and future impacts on traditional foods that may be collected from those areas and provide a more complete overview of the open cut's regional impact on traditional owners living towards the east of the McArthur River estuary.

9.7 Greenhouse Gas Emissions

During the assessment of the EIS, it was identified that the mine activity would contribute approximately 120,000tCO_2-e of greenhouse gas emissions (GHG), which represents 0.7% of total NT emissions (based on 2002 data from the Australian Greenhouse Office (AGO)) and 2% of total emissions for the NT's energy sector, a significant contribution. The proponent made a number of commitments relating to GHG in the EIS but considered that offset strategies were not warranted and had not been planned for at that time.

The proponent should identify opportunities for offsetting GHG emissions from its operations. The proponent would also be expected to undertake annual reporting of GHG emissions to the Northern Territory Government, initially through the Mining Management Plan process, noting that the Council of Australian Governments (COAG) has committed to developing a mandatory, public emission reporting scheme for major industry to be implemented as soon as possible. At a minimum, reporting should detail total annual GHG emissions, provide a breakdown of emissions by gas and source, and the emissions intensity of production.

10 Biodiversity

The proposed development occurs in a region with generally intact natural values.

In common with most other regions in the Northern Territory, and northern Australia generally, the biodiversity and ecological functioning of the project area remains imperfectly known, notwithstanding some biological survey effort undertaken for this proposed project and previous developments in this region. These constraints on the information base hamper assessment of the biodiversity valuation of the project area relative to other areas in the region, hamper understanding of the ecological relationships which link this site to the environments of the broader region, and hamper prediction of the responses of biodiversity to any development pressure.

In this particular case, such uncertainty is heightened by the substantial and novel development proposed. There are no close precedents for considering how biodiversity may be affected when a substantial section of a large seasonal river is diverted, nor close precedents for considering how an artificial water channel may be built in such a way that it can provide a reasonable and adequate environmental substitute for that river system.

10.1 Threatened Species

The EIS and PER noted the occurrence of four threatened species in the project area:

- Freshwater sawfish *Pristis microdon*, listed as Vulnerable in Australia under the EPBC Act, Vulnerable in the Northern Territory under the *Territory Parks and Wildlife Conservation Act*, and Critically Endangered in the IUCN Red List 2006;
- Red Goshawk *Erythrotriorchis radiatus*, listed as Vulnerable in Australia under the EPBC Act, and Vulnerable in the Northern Territory under the *Territory Parks and Wildlife Conservation Act*;

- Northern Quoll *Dasyurus hallucatus*, listed as Endangered in Australia under the EPBC Act, and Vulnerable in the Northern Territory under the *Territory Parks and Wildlife Conservation Act*; and
- Australian Bustard *Ardeotis australis*, listed as Vulnerable in the Northern Territory under the *Territory Parks and Wildlife Conservation Act.*

Note that the guidelines for the project's PER (see Appendix 4) included a specification to assess the impact on '*the threatened white-browed robin*', although it is recognised here that this species is not listed as threatened under Territory or national legislation. It is listed as 'migratory' under the EPBC Act.

Of the four listed species, only the freshwater sawfish is considered as significantly vulnerable to potential impacts from the mine proposal.

10.1.1 Freshwater Sawfish

The freshwater sawfish (*Pristis microdon)* is one of a set of sawfishes that have undergone widespread decline across most of their range, due largely to incidental by-catch in fishing operations, deliberate take and/or reduction in water quality. Many aspects of the life history, ecology, distribution and abundance of the freshwater sawfish are poorly-known. It probably occurs, but usually uncommonly, in many of the river systems of northern Australia (and across a broader range around the tropical Indian Ocean, South-east Asia and New Guinea); and probably undertakes a regular or irregular seasonal movement from estuarine and marine areas to upstream freshwater pools (with freshwater areas being particularly important as nurseries for juveniles). It is a relatively large (to 7m) predator of other fish, and may require large (refugial) pools and/or relatively rich aquatic systems in order to provide sufficient resources to survive through the dry season.

Assessment of the value to freshwater sawfish of the McArthur River relative to that of other river systems in northern Australia is hampered by the lack of intensive, comprehensive quantitative survey across these rivers. The EIS noted some previous confirmed and anecdotal records of the freshwater sawfish in the McArthur River; and the PER described a systematic sampling undertaken in May 2006 (late wet season).

From this study (PER App. L), the PER:
- confirmed the occurrence of freshwater sawfish upstream (in Eight Mile Waterhole) of the proposed development [hence accepting that this species would normally disperse along the McArthur River through the section proposed for development];
- asserted that the section of the river proposed for development had limited suitability for freshwater sawfish (other than as a transitory conduit for dispersal);
- asserted that Djirrnmini Waterhole was unlikely to be a significant dry season refuge for this species (although recognised that it may be an important resting pool for migratory sawfish);
- asserted that '*the upper reaches of the McArthur River may be described as marginal habitat for P. Microdon in comparison to other Gulf Rivers*'; and
- speculated that the more complex tidal delta of the lower McArthur River may hold higher numbers of freshwater sawfish.

The 2006 survey is considered to be adequate to provide a relative evaluation of the significance of the mid and upper reaches of the McArthur River; and the conclusion that these do not represent national strongholds is accepted. Hence, the proposed development will not have a significant adverse impact on the national status of this species.

However, the 2006 survey confirms that freshwater sawfish at least transit through the proposed project area. This transit, to upstream dry season refugial pools, may be necessary for the long-term maintenance of the local population of sawfish in the McArthur River, and hence it is important that the proposed development does not result in impedance of this movement. Should the proposed development proceed, dispersal of freshwater sawfish (and other fish species) along the river will be dependent upon the development of a suitable diversion channel and the timing of this development relative to the loss of the natural channel.

Although largely unproven in this environment, the revised modifications described in the PER to make the diversion channel more suitable for aquatic biota should allow, eventually, for the maintenance of continuing upstream (and downstream) dispersal by freshwater sawfish. However, there remains some uncertainty about the extent to which the designed rock riffles at the upstream portion of the diversion channel may act as a barrier to sawfish dispersal; and some uncertainty about the feasibility and timing of construction of a suitable diversion channel relative to the proposed timing of severing of the natural river channel. It is difficult to be more precise in the assessment of dispersal patterns, and the likelihood that development will affect these patterns, because there has been no baseline study of dispersal of freshwater sawfish in this river system. This is a notable limitation in the material presented.

A study of the timing, extent, numbers and requirements of dispersal of freshwater sawfish in this waterway including assessment of the use (if any) of Djirrinmini Waterhole during the dry season by freshwater sawfish would have reduced the uncertainty of the potential impact of the diversion channel on sawfish habitat and movements. Such a study could be used to further refine the design of the diversion channel, and serve as a quantitative baseline against which use of the channel can be monitored.

Monitoring of the use of the diversion channel by freshwater sawfish would need to be sufficiently robust to detect, with at least 90% confidence, a reduction in dispersal numbers of 10% or more of the natural (pre-disturbance) dispersal. If this reduction is exceeded, it is required that management intervention be provided in a timely manner to ensure that this loss is not sustained for a period of more than 2 years.

Other aspects of the proposed development pose risks to this local population of freshwater sawfish. The PER notes that aquifer drawdown will reduce the volume of water maintained in Djirrinminni Waterhole, particularly during the late dry season. The PER asserts that this waterhole is suboptimal as a dry season refuge for freshwater sawfish, but this assessment is based largely on a single wet season sampling, supported by generalisations about its presumed resource requirements. The proposed development will reduce habitat quality at this site, one of the few persistent pools in the mid- to upper-reaches of the McArthur River.

The PER also notes that the lower McArthur River (notably the estuarine delta) may support more substantial populations of freshwater sawfish, at least during some times of year. There may be some risks to this potentially important population associated with either catastrophic release of contaminants from the mine or low-level chronic reductions in water quality.

The 2006 survey does not represent a particularly comprehensive nor substantial baseline for the ongoing assessment of impacts upon freshwater sawfish; and does not provide any detail on dispersal patterns.

The limited survey data demonstrate that the freshwater sawfish currently disperses (presumably as an essential component of its life history) along the McArthur River through the project area. Characteristics of this dispersal pattern remain unknown. There is substantial risk that this dispersal will be detrimentally affected by the proposed development.

Despite this uncertainty, the proposed development will not have a significant national impact on the freshwater sawfish, because the population of this species in the mid- and upper-reaches of the McArthur River is unlikely to represent a significant proportion of the total national population.

10.1.2 Migratory Species: Wetlands, Marine and Offshore Areas, Shorebirds and Seabirds

The EPBC Act recognises migratory species to be of particular importance; and the Department of Environment and Heritage maintains a listing of all recognised migratory species. This mostly includes shorebirds and seabirds. Quixotically it also includes some non-migratory species, such as white-browed robin (note that this species is considered here in section 10.1).

The PER (App.M) lists 58 recognised migratory species as occurring, or presumed to occur, from the broad project area. Most of these records are from the wetlands of the lower McArthur, and coastal and marine areas of the Gulf of Carpentaria, including the area around the existing loading facility at Bing Bong. The immediate project area (mine site) is accepted to hold little or no significance for migratory species.

Wetlands around Borroloola and on the lower McArthur are recognised as nationally important (as "Borroloola bluebush swamps" and "Port McArthur Tidal Wetlands system" respectively). In describing the latter system, Chatto and Whitehead (1996) noted that it included:

- *the only substantial area of mangrove swamp and the widest and largest area of intertidal mudflats, in the south-west of the Gulf*;
- *at least two substantial waterbird breeding rookeries supporting a total of more than 3000 adult birds*;
- *at least 24 seabird breeding rookeries supporting a total of more than 300,000 adult birds*; and
- *the most important section (for shorebirds) of coastal flat in the south-west of the Gulf of Carpentaria.*

However, the PER notes (p.11-12) that '*compared with the inter-tidal mudflats along much of the coast, the extensive saline flats and mangroves around the McArthur River estuary do not support large numbers of shorebirds (Chatto 2003). Generally, the Bing Bong/McArthur River mouth area supports lower concentrations of shorebirds than the south-east and far south-west of the Gulf.*'

The section of the Gulf of Carpentaria around the mouth of the McArthur River includes important feeding sites for dugongs and marine turtles, and the nearby islands (notably including the Sir Edward Pellew group) include many sites of significance for breeding marine turtles and seabirds; and the islands themselves support significant populations of declining and threatened terrestrial wildlife. While most of these values are reasonably remote from sites of disturbance associated with this proposal, two seabird sites (colonies S066 and S082: Chatto 2001(in the PER)) merit particular consideration. These are recognised (Chatto 2001) as of national significance, each supporting 100-500 breeding little terns. Site S066 is 15 km from the Bing Bong facility and site 082 is 35 km from that facility (PER p. 11-12): the former site is 6 km south of Rocky Reef (CDU monitoring site 109), '*where elevated levels of copper have been detected in oysters, and it is possible that birds from this colony feed in that area*' (PER p.11-15). To date, there has been no monitoring of the possible impacts of such contamination on migratory birds.

It is recognised here that there are important biodiversity values in the lower McArthur wetlands, along the adjacent coast, in the nearby waters of the Gulf of Carpentaria, and the islands offshore. However, these sites are generally remote from direct impacts of this mining proposal, and the assessment of the proposed project's risks to these substantial values is complex and uncertain. As with some assessment for the freshwater sawfish (described in section 10.1.1), the risks are associated either with a very low probability of largely unpredictable catastrophe (notably a single episode of major spillage of contaminants) or low-level chronic changes in water quality. The EIS and PER recognise that there may be some instance of the latter associated with the Bing Bong loading area, notably in the increased contamination levels of sampled marine invertebrates:

'*concentrations of zinc, cadmium and lead in surface sediments from the beach immediately west of the channel have shown elevated levels since 1996 ... copper from Rocky Reef, west of Bing Bong had an unexplained increase in 2005. Heavy metals in the two mollusc species from the beach west of the load-out facility have remained elevated, and lead isotope ratios indicate an uptake of core-concentrate derived lead dispersed from the load-out facility towards the west*' (PER p.11-13).

The coastal and marine environments around the lower McArthur River (extending to the Bing Bong area) contain biodiversity values of national significance. There is some risk that the proposed project may detrimentally affect those values, although this risk is difficult to predict or quantify. Evidence presented in the EIS and PER indicates that there has been (and probably still is) at least some localised contamination of marine systems associated with the loading facility at Bing Bong.

Because of the uncertainty about possible risks to significant biodiversity values, the proposed project should include a substantially enhanced monitoring program, linked specifically to rapid intervention and management and regulatory responses.

Any monitoring program must be sufficiently robust to detect with 90% confidence a 10% decline (from baseline levels) in the abundance of listed migratory species in the nationally significant wetlands of the lower McArthur and within 20 km of the Bing Bong facility (with particular attention to the significant colony S066 of little terns). Where any such decline is detected, there must be a clear chain of management responses to ensure that such decline is reversed within 2 years of detection.

10.2 Aquatic Systems

The proposed development will directly affect the McArthur River system. This will be because of

- severance and destruction of some 5 km of its current course (and its replacement with a proposed diversion channel) (discussed section 9.1.4);
- drawdown of groundwater around the mine site (discussed section 9.5.1); and
- possible reduction in water quality and flow regimes.

The PER recognises that groundwater use for the proposed development will result in reduced water availability near the mine site, including for Djirrinmini waterhole, one of the few large waterholes in this river system that persist through the dry season. The PER models that this will cause a reduction in depth of this waterhole by 0.35 m, and hence reduce its value as a dry season refuge for aquatic biota, and as a water source for water-dependent vegetation and water-dependent terrestrial animals. The PER asserts that this reduction will be inconsequential for freshwater sawfish, because Djirrinmini waterhole is currently not sufficiently large to sustain this species through the dry season.

Groundwater use for the proposed development will reduce the dry-season water levels in Djirrinmini Waterhole, one of the few permanent pools in the mid- and upper- reaches of the

McArthur River. This will reduce the value of that waterhole as a dry-season refuge for aquatic and water-dependent biota. While this impact is probably not significant for the threatened freshwater sawfish, it may be locally detrimental for many other species. The proponents should ensure that alternative sources of appropriate water are provided to this waterhole, such that any reduction does not exceed 10% of the average dry-season pre-disturbance volume.

The proposed development may affect downstream aquatic values through changes in water quality, either because of unpredictable catastrophic failure or because of more chronic low-level changes in chemical or physical features. The PER asserts that neither of these is likely.

Given the level of uncertainty about such risks and impacts, a BACI (Before-After-Control-Impact) monitoring program for aquatic biota should be developed that is sufficiently robust to be able to detect with 90% confidence a 10% reduction in species richness, a 10% reduction in the abundance of key species, and/or a 10% change in species composition. Where any such decline or change is detected, there must be a clear chain of management responses to ensure that such decline or change is reversed within 2 years of detection.

10.3 Biological Monitoring

The EIS and PER for this proposed development suggest a number of monitoring programs that may or may not be developed for various aspects of biodiversity. In most cases, these monitoring programs are indicative only, based on currently very limited (or no) baseline information, have had no assessment of statistical power (the effectiveness with which change can be detected), and no clearly developed linkage with management or regulatory response.

In an insufficiently known environment, where development poses a number of predictable and unpredictable risks, monitoring is an essential mechanism for insurance. Such a monitoring program should be capable of:

- detecting unexpected environmental costs, in a timely fashion;
- being sufficiently sensitive to detect whether environmental impacts stay within the accepted pre-defined bounds;
- being sufficiently intensive to provide quantitative measurement of environmental impact, with acceptable levels of precision and power;
- being sufficiently well designed to allow for measurement of remedial and other management options and responses; and
- being sufficiently quantitative and well designed to match impact levels to clearly articulated and justified triggers, thresholds and responses.

Public confidence will be enhanced when local communities and other stakeholders are closely involved in the development and implementation of monitoring programs.

10.4 Biodiversity Offsets

One mechanism for mitigating project impacts is through biodiversity offsets, and the EIS for this project provided some preliminary indications that such offsets may be initiated. However, to date these considerations are insufficiently detailed and without commitment. These would need to be further developed and a binding agreement entered into in the event approval is given for the mine to proceed.

10.5 Weeds

Assessment Report 51 noted that the draft vegetation management plan presented in the EIS focused on monitoring, early detection and control of weed infestations. The proponent provided inadequate details in the EIS of preventative measures that would be implemented during construction and operation to minimise the introduction and spread of weeds around the site. These measures were considered important as they would act as the first line of defence in tackling weed management issues.

The PER indicates weed management of the open cut project will be incorporated into the proponent's existing weed management plan for the mine site and surrounding areas. This plan is to be prepared and implemented with the assistance of the district weeds officer from the NT Government. The plan sets long term and annual strategies, and incorporates programs at both the mine site and Bing Bong. The plan is reviewed annually.

The proponent must include a commitment to preventative weed management measures in any weed management strategy. Any weed management strategies would need to be developed and implemented to the satisfaction of the Department of Natural Resources, Environment and the Arts.

The current NT Declared Weed Species list is being reviewed, and may impact on some weed species (including exotic pasture species) and their legislative responsibility to be controlled in the future.

11 Cultural heritage

11.1 Archaeological heritage

Archaeological surveys of the open cut project area were undertaken as part of the EIS process. Assessment Report 51 reported three archaeological sites of moderate to high significance and 42 background scatters likely to be disturbed by the project in its current form. Of the sites, one site MRM4 was considered to be of major significance.

The footprint shape of the northern OEF has been altered in the PER to excise and avoid disturbance of the archaeological site MRM4. A setback of 50 m from the toe of the OEF embankment, and diversion of OEF surface water runoff away from MRM4 have been incorporated into the proposal. Heritage Conservation Services (HCS) of the Department of Natural Resources, Environment and the Arts support these modifications. HCS also approve of the plans to construct a fence around the boundary of MRM4 and the provision of appropriate signage to prevent construction activities disturbing the site.

The proponent has acknowledged in the PER that despite the modification to the OEF and the preservation of the archaeological site MRM4, permission will still be required from the Minister for Natural Resources, Environment and Heritage to disturb or destroy any other archaeological sites that may be located within the area proposed for the Open Cut Pit, such as MRM1 and MRM2 (stone artefact scatters of moderate to high significance), along with any sites considered to be of low archaeological significance. The proponent has also acknowledged that MRM1 and MRM2 will be subjected to a detailed surface analysis and excavation by a qualified archaeologist prior to any disturbance. Upon completion of the excavation and surface analysis, a copy of any report will be forwarded to HCS.

11.2 Indigenous Heritage

The proponents are relying on an Authority Certificate issued by the Aboriginal Areas Protection Authority (AAPA) in accordance with the *NT Aboriginal Sacred Sites Act 1989* for direction on where mine infrastructure may be constructed so as to avoid damage to or interference with sacred sites. It is noted that the statutory term "sacred site" is common to both the *Aboriginal Land Rights (NT) Act 1976* and relevant Northern Territory laws and widely defines "sacred site " to include any *'...site of significance according to Aboriginal tradition'*. The proponent is entitled to regard the issuing of this Certificate as evidence that the project as proposed will not adversely affect sacred sites (as so defined).

The NLC states that:
'the radical alteration of the river and surrounding landscape will have a profound cultural impact" [and] "threatens the environment from a spiritual and physical perspective" [and] "may bring about retribution in some form from the creative powers that formed the land and the sacred sites ... not predicted by western science'.

These statements stop short of asserting that the mine will cause damage to or interference with specific sacred sites but rather indicate a more generalised apprehension about the effect of the project. The NLC also stop short of asserting that the mine will adversely affect *'areas of cultural significance'* within the meaning of the *Native Title Act* and judgements under that Act.

The nature of the anticipated "cultural impact" is not specified or quantified. The basis (and extent) of the belief that the "creative powers" will exact "some form" of "retribution" is not documented. There is no suggestion that the McArthur River area in the vicinity of the mine is significant because of traditions prohibiting generalised disturbance[1]of the landscape.

The Minister may be satisfied that as long as MRM construct and operate the mine in accordance with the conditions in the Certificate issued by AAPA then no sacred sites on or in the vicinity of the proposed works, will be damaged or interfered with.

12 Economic impact

As noted in Assessment Report 51, the benefits of this proposal to the Northern Territory were stated in the EIS as significant and include the contribution of $175 million to the Gross State Product of the Territory, the creation of an average 290 jobs during construction and 610 during operation (including flow-on effects). Additionally, the proponent estimates that it will contribute $329 million annually to the economic output of all industries in the NT (including flow-on effects).

A 2004 study undertaken by ACIL Tasman (prepared for the then Office of Territory Development) found that MRM directly impacts on the economy via its production, employment and investment and through its demand for a range of goods and services it indirectly generates additional output, value added (the building block of Gross State Product) and employment in the Territory. General equilibrium modelling of these direct and indirect impacts indicated that if MRM were to close at the end of 2005 the Northern Territory economy would experience a decline in GSP and employment. Estimates for the twelve month period after mine closure indicated that:-

- GSP would be 0.96% lower;
- employment would be 0.57% lower; and
- wages and salaries paid to Territorian's would be 1.18% lower.

These direct and indirect impacts highlight that the proponent was (in 2004) contributing some $84.1m to the Territory's GSP (direct and indirect contributions). The majority of the proponent's direct contribution is via wages and salaries as the operation was not profitable and was not paying royalties or state taxes.

[1] Traditions prohibiting disturbance of comparatively wide areas of the landscape have been documented in several areas in the NT and are well known to the NLC. The most well publicised of these are the "sickness country" traditions of the upper South Alligator Rivers region.

During the PER process, approximately 150 Territory businesses wrote to the Minister for Natural Resources, Environment and Heritage indicating their strong support for the expansion of the mine and arguing that MRM spent $60 million with NT companies in 2005; 415 NT companies have provided products or services to MRM and that an estimated 1430 jobs in the NT are supported by contracts with MRM.

The PER provided further information about proposed local and regional investment proposals. It states that as part of its group policy, Xstrata sets aside 1% of Group profit to fund social involvement, primarily to support communities associated with its operations. In the case of MRM, an initial investment of $1.6 million over three years has been committed. A further $5 million has been allocated for investment over up to eight years. Table 13.11 summarises the initiatives agreed through consultation with MAWA. Other Corporate Social Involvement initiatives under development include a pastoral training program (MRM is supporting the initial intake with personal protective equipment) and a school dormitory project.

In addition to the economic and social benefits package approved under the MRM/ MAWA Corporate Social Involvement Program Agreement, the proponent has stated it will also:-

- use local businesses where they are technically capable and commercially competitive.
- undertake discussions with local industry regarding contractual opportunities and Aboriginal employment during the construction phase of the project.
- ensure that local people (both Aboriginal and non-Aboriginal) will have an equal opportunity to apply for positions and traineeships which arise in fields associated with the operations phase of the project. A target of 20% of the workforce has been set for Aboriginal representation.
- continue its involvement in programs designed to encourage school and tertiary students to progress to employment opportunities; participate in a work experience program, a school based apprenticeship program and a tertiary scholarship program.
- continue its involvement in employment based development; implement the traineeship program, offer a formal program for apprenticeships, provide support through a personal development program and the development of a workplace English language and literacy program.

PER Table 13.2 sets out examples of enterprise development opportunities which would become available under a program currently under discussion with community and government representatives.

The Department of Business, Economic and Regional Development has advised that the PER incorporates and deals with the socio-economic issues effectively. The NLC commends the spirit of the employment and training initiatives outlined in the PER however they raise concerns about the lack of specificity in the policies, and the fact that they are not legally binding. The NLC also argues that Aboriginal representation in the workforce should increase, considering the percentage of Aboriginal representation in the population of the Borroloola region.

The NLC also raises concerns about the lack of framework or strategy on how the target of 20% Aboriginal representation will be achieved and states that MRM has been operating for over ten years and '*yet currently employs/ contracts only 26 Aboriginal people out of a total workforce of 438 (a proportion of only 5.9%), only 15 of whom are local (a proportion of 3.4%)…*'. Accordingly NLC expresses doubt on whether the target of 20% can be treated as a genuine and credible without a sound and detailed framework for achieving it.

NLC also commends MRM for providing funding for practical social benefits for the community however expresses concern about the term of the agreement, the ability for the MAWA projects funding committee to administer and provide specialist support skills to ensure the proposed initiatives can be implemented, and the engagement with only MAWA rather than the indigenous community as a whose. The NLC advises that '*traditional owners do not consider that the agreement with MAWA is an agreement with traditional owners as no consultation has taken place with the broader group of traditional owners in relation to their desires for the community.*' MAWA was established as a vehicle for indigenous business enterprise and has entered into a number of commercial arrangements with MRM. It does not purport to represent the traditional owners.

In this respect MRM has indicated its willingness to enter into an agreement with the Northern Territory Government reflecting the commitments it has made within the PER.

13 Social Impact

13.1 Community Engagement

Section 4.1 of Assessment Report 51 provides some discussion on the community perception of the proposed mine expansion and outlines concern expressed from some residents about community engagement and consultation by MRM with the local indigenous people and their organisations. Assessment Report 51 states that it is the EPA Program's expectation that '*any future consultation will be undertaken through the most appropriate mechanisms to maximise transparency and accountability to stakeholders*' and that any further discussions should be conducted '*in accordance with a community engagement strategy outlining the appropriate mechanisms that will not isolate the various groups...*'. These findings were reflected in the Guidelines to the PER to be addressed by the proponent.

The PER describes MRM's policy position when undertaking community engagement and outlines the contribution it has made to date in this regard and summarises both the challenges and opportunities when undertaking this work. MRM has acknowledged the criticism that some consultation methods have been divisive and states that opportunity exists to address the criticism by '*communicating the engagement strategy to all stakeholders to ensure openness and transparency in discussions*' and '*reporting to all stakeholders on the outcomes of all engagement activities*'.

The PER states that MRM's approach to community engagement is founded on policies upheld by MRM and its parent company, Xstrata. Xstrata's Corporate Social Involvement Policy states '*We work together and with others: We are committed to co-operating with employees, local communities and other stakeholders*' (www.Xstrata.com). Xstrata states '*Our Corporate Social Involvement policy will be consistent with the highest standards of our industry and will reflect international best practice.*'

MRM has presented its Community Engagement Strategy in the PER which it proposes to be in place for the life of the mine (25 years). The Community Engagement Strategy is based on three key elements (linking these to the NT Government Consultation Strategy): information giving; consultation; and, active participation. The methodology for community engagement is illustrated at Chart 13.1 of the PER and includes the establishment of a Community Reference Group. The CRG was established in 2006 and to date it has met twice. Terms of Reference for the CRG are included in Appendix O of the PER.

Section 13.2.6 of the PER states that the CRG '*will be an important facilitator in building relationships as a body representative of the community.*' However, a number of the submissions received on the PER have expressed their concern about the CRG and accordingly its ability to be the vehicle in which to engage with the community. Specific concerns include:-

- representation within the CRG. The TOR states that the CRG is designed to represent a cross-section of community, business, council and NT Government interests. Members were appointed by invitation and are able to nominate one alternate to act for them if they are going to be absent from meetings. Membership includes the General Manager MRM. A MRM appointed facilitator/ secretariat is to attend each meeting together with other MRM staff as appropriate. The preferred number is 10; however this is at the discretion of the MRM General Manager and the appointed Chairman.

  Shortly after the establishment of the CRG, a letter was sent to the Chief Minister informing her about the establishment by the Borroloola Traditional Owners Group (BTOG) of the MRM Liaison and Advisory Committee which represented all four clan groups from the Borroloola Region. The Committee's role was to develop a draft terms of reference that would facilitate open discussion between the key representative groups, MRM, the Aboriginal and non Aboriginal community, Northern Territory Government, MAWA and the NLC. Concern was being expressed that MRM did not recognise the Committee, instead stating that it was better placed to organise a liaison committee. It is noted that the stakeholder list included in section 13.2.4 of the PER does not include the BTOG nor their established MRM Liaison and Advisory Committee. The Northern Land Council is also absent from the list of stakeholders and was not invited to be a member of the CRG. The BTOG accordingly question whether Aboriginal concerns can be adequately expressed by the CRG.

- the Role of CRG Members. According to the TOR community members of the CRG are to identify concerns or questions from the local community and provide feedback to the CRG and similarly give feedback from the meetings to the wider community. Members do not receive remuneration for this work as the TOR state that the CRG is to be an independent, voluntary, advisory Committee.

  The NLC states that the direct appointment of members to the CRG is inconsistent with the customary Aboriginal law of the Gurdanji, Yanyuwa, Mara and Garawa people, since the person who are appointed by the mine may not have the right to speak for their clans. The NLC states that traditional owners have indicated that in their view, community members attending meetings of the CRG would be expressing their own views and not the views of the traditional owners as a whole.

- MRM's role with the CRG. The Terms of Reference (TOR) for the CRG explicitly state that "the General Manager, McArthur River Mining retains ultimate responsibility for the direction, purpose and conduct of the MRM CRG. While the MRM CRG may provide advice or make recommendations regarding action by the mine, it is noted that the MRM CRG is advisory only in nature, and the General Management, McArthur River Mining may accept or reject these recommendations."

  The TOR also state that any changes to them may only be made by the General Manager MRM at their absolute discretion.
  MRM is also responsible for appointing the Chairman to the CRG (it was not done by consensus with CRG members). The BTOG recognise that the Chairman has traditional affiliations in the area but state he has little real understanding and experience of living in Borroloola.

The EPA Program recognises that MRM has attempted to take on board the concerns raised in Assessment Report 51 by establishing the CRG, however it seems apparent from the correspondence and submissions received that it is currently not successful in facilitating effective and consultative engagement with the community.

The proponent has failed to capitalise on the opportunity that exists when working within a community where a cooperative relationship based on trust is established. MRM have operated at Borroloola for over 10 years and there appears to be little trust within some parts of the local community. An opportunity was presented to start working with a component of the community through respecting and using the communication channel presented by the BTOG. However the proponent put in place its own CRG of which the key operative element is information provision, rather than true consultation.

Xstrata has not presented a social impact analysis, assessment or plan in either the EIS or the PER, even though the PER states that a key activity of the MRM Community Relations Team (none of which are identified members of the CRG) is the development of social impact management plans – '*detailed plans of impact of the mine and its community (employees, contractors, movement of products etc) in or on the local community and actions to minimise or mitigate the potential impacts.*'

The EPA Program questions whether any management or strategy that is put in place without the appropriate upfront analysis, assessment and consultation will meet the intent of Xstrata's Corporate Social Involvement Policy.

Another key concern is the apparent separation that exists between the mechanism established for consultation (ie the CRG) and the mechanism in which to implement MRM's Corporate Social Involvement Program (CSIP) – MAWA. Table 13.11 of the PER summarises the economic and social benefits package approved under MRM/ MAWA Corporate Social Involvement Program Agreement of which some fall within the program negotiated with MAWA. A further agreement has been entered with MAWA for an independent review of the annual marine environment monitoring commissioned by MRM and conducted by scientists from the Charles Darwin University.

It should be noted that Assessment Report 51 states '*There is still a perception that inappropriate consultation is still occurring as the proponent prefers to undertake its consultation through the MAWA business enterprise, an organisation that directly benefits from the mine and does not necessarily speak for all the people of the Region.*' This situation has not been rectified by the establishment of the CRG.

A social impact analysis and assessment undertaken by an independent consultant is needed to:

- identify the issues and concerns of the community with respect to the mine proposal;
- determine the most appropriate forum and methodology in which to engage with all relevant sectors of the community;
- facilitate community engagement with the mine to work towards meaningful solutions or management strategies for those issues of concern; and
- facilitate engagement with the community for at least the first 10 years of its operations.

Reports on progress and outcomes need to be made regularly to Government.

14 <u>Rehabilitation and Closure</u>

14.1 Mine Pit Closure

Assessment Report 51 described the proponent's preferred closure strategy, which has the open pit maintaining the McArthur River in the realigned river channel but with the flood protection bund breached to the extent that 2 year ARI flood flows can enter the pit. In this scenario, the pit is expected to initially fill with river water relatively quickly. Assessment Report 51 considered the risk of possible contamination of river water during successive flood flows into the flood-bunded pit void, and concluded that overflows of the pit void should not result in the transport of contaminants above background levels into the McArthur River.

Successive inputs to the pit-lake during flood flows were predicted in the EIS to create sufficient periodic dilution to maintain pit water contamination levels within acceptable thresholds. However, the lack of hydrological information for the Barney Creek diversion and inadequate modelling for the McArthur River realignment gave a high level of uncertainty regarding the possibility of a major environmental incident occurring as a result of the proposal.

The closure plan for the existing operation requires that the overburden be returned to the 'test pit'. The costs and benefits of opting for a similar closure strategy for the open cut operation were briefly analysed in the PER, but did not fully examine the environmental costs and benefits of this option.

Further examination of such options is required before a decision could be made about the most environmentally appropriate closure option. The emphasis should be on the minimisation of legacy issues such as ongoing contaminant releases and alignment with world best practice.

14.2 Tailings Storage Facility

14.2.1 Seepage Legacy

Assessment Report 51 criticised the EIS for not modelling the proposed tailings storage facility to account for best and worst-case scenarios into the long term (>30 years). Determination was lacking of the risk of these worst-case scenarios occurring, or their predicted environmental impacts. Management options were not presented to mitigate those impacts. Refer Section 9.3 for detail.

The PER provides a management proposal for the TSF which relies heavily upon a bank of recovery bores operating continuously for many decades. A best-case scenario would see TSF seepage reduce in volume and improve in water quality within a decade of mine closure, allowing cessation of pumping and mine closure. A worst case scenario includes ongoing seepage and pollution of groundwater aquifers preventing closure or cessation of recovery bore operation. The worst-case scenario has been predicted in comments as a not-unlikely scenario. The level of risk of this worst case scenario has not been well established. Discussion of this issue is presented in Appendix 1.

The proponent has argued via models that once the hydraulic head within the TSF is removed within 30 to 50 years of mine closure, no further seepage will be generated and no further pumping of the recovery bores will be needed. However the PER states (s7.5.3) that 8% of incident rainfall will penetrate the proposed two metre cover through tree root penetration and erosion, potentially creating an ongoing seepage issue.

Comments received predicted a delayed pollution pulse from the TSF to the groundwater after the recovery bores cease operation. Once pumping ceases, the water content of the tailings is predicted to build due to infiltration and eventually contact a raised hydraulic head, caused by the mass of the TSF. The first post-pumping contact of water within the tailings facility with the hydraulic head is predicted to transmit the high level of accumulated reactants, and resume contamination of groundwater aquifers.

14.2.2 TSF Cover

The change in tailings deposition from middle to peripheral may result in the finer slimes fraction being deposited in the middle of the TSF, which will result in greater consolidation over time and require a thicker cover in this area to accommodate this consolidation so that the final design is still water shedding.

Results from worldwide monitoring and modelling of covers have shown that a protective growth layer of at least 2m is needed to prevent a clay layer from failing. Clay needs to be maintained at greater than 85% saturation to be an effective oxygen barrier. Capping should be designed to cope with the extremes of the climate experienced at the mine site.

In considering the use of grasses in the TSF and OEF rehabilitation, exotic grasses have the potential to become pests when not in their natural environment and inhibit the establishment of native vegetation. Use of grasses will also form large fuel loads for fires, which could damage the emerging native trees and lead to the failure of the revegetation. Rock mulch could be used in conjunction with revegetation to help provide erosion protection on batters, particularly in light of extreme rainfall events which have high erosion capability.

These issues would need to be addressed in any mine closure plan.

14.3 Overburden Emplacement Facility (OEF)

The OEF design as proposed in the PER has not been significantly altered since the EIS, except in shape to avoid archaeological site MRM4. Improved rock characterisation will potentially improve the long term water quality from seepage and surface runoff from the OEF.

Water inputs to the OEF would generally be limited to wet season rain and flooding of the OEF base level. Adequate engineering and revegetation of an OEF cap is likely to significantly reduce seepage from rain water infiltration.

Limited detail has been provided of rehabilitation plans for the completed OEF. The rehabilitation is proposed to be progressive, as sections reach their fill capacities. Outer exposed layers of NAF rock are to be layered into terraces/rises and contoured to disperse drainage yet minimise erosive flows. The contoured surface is to be covered by a ‘nominal’ 50cm of topsoil and oversown with grasses, while sloped embankment walls will be left exposed. A post rehabilitation monitoring plan is planned to address any developing erosion sites.

Concerns exist that if the seepage / runoff from the OEF NAF section is found to be acidic or contaminating, then the proposed 0.5m topsoil cap would need to be redesigned. The current design allows significant water infiltration and would perpetuate seepage. Concern exists as to whether the proposed 0.5m thick topsoil cap could support vegetation any more substantial than seasonal grasses and weeds, before washing away.

The design of the OEF is discussed in Sections 9.2.6 and 9.5.2.

14.4 Security

Current Northern Territory Government policy requires mining companies to lodge a security equivalent to 100% of the estimated cost of rehabilitating their disturbance. The calculations underpinning these estimations focus on remediation of physical disturbance.

The MRM operation is situated in the immediate flood plain of a major river and relatively close to a thriving estuarine environment which supports a range of fishing and other food gathering activities. Contaminants have a relatively short pathway from the mining operation to the river and downstream environments. The security held by Government for the underground and test pit operations does not take into account potential remediation associated with seepage from the existing tailings storage facility – the company is currently actively working to address this problem.

The MRM parent company XStrata has a reputation of taking hard economic decisions, including closing operations earlier than scheduled where these are determined to be unsustainable. In recognition that this is a reality in the increasingly globalised mining industry, the 2004 Western Australian parliamentary *Inquiry into Vanadium Resources in Windimurra* (a XStrata controlled operation) made a series of recommendations aimed at increasing the state's capacity to protect its interests (LAPWA 2004).

The Commonwealth Government holds approximately $61 million in security for the Ranger Uranium Mine, which is similarly situated on a major flood plain. This is imposed in a situation where the company and governments each also spend many millions of dollars every year to undertake environmental protection measures and to investigate, monitor and report on their effectiveness. In addition, Ranger has a statutory obligation to implement best practicable technology, and to report on its operations and impacts publicly. These are all measures aimed at increasing public confidence in the operation by reducing the risk of long term environmental impacts and minimising on-going liabilities for government and the public purse.

Similar arrangements have not been proposed for the MRM expansion. In the event that the company or its successors are unable or unwilling to fix a problem, there is the potential for long term liability for environmental issues being shifted to Government. Security for any expanded activities should take these risks into account in setting the amount.

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15 Appendix 1: TSF Seepage Review

McArthur River Open Cut Mine Expansion: Public Environmental Report – Review of seepage issues related to the Tailings Storage Facility MBMB

Prepared for: NT Environment Protection Agency Program (NRETA)
Prepared by: EWL Sciences Pty Ltd

Author: A Puhalovich

Date: August 2006

McArthur River Open Cut Mine Expansion: Public Environmental Report - Review of seepage issues related to the Tailings Storage Facility

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Prepared by: EWL Sciences Pty Ltd

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McArthur River Open Cut Mine Expansion: Public Environmental Report –

Review of seepage issues related to the Tailings Storage Facility

for

NT Environment Protection Agency Program (NRETA)

by

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EXECUTIVE SUMMARY

Project Focus

EWL Sciences has been commissioned to provide a critical evaluation of the adequacy of information included in the Public Environmental Report (PER) for the McArthur River Mine Open Cut Project with respect to the proposed tailings storage facility, including the adequacy of proposed management and mitigation options. The evaluation focussed on the critical issue of potential for contamination in the longer term (>30 years) and impacts to the environment.

Approach

The approach followed in the review was to assess the adequacy of information presented in the context of historic seepages that have occurred from the existing TSF, the methods used to select the preferred seepage management/mitigation option and predictive modelling. The information was then 'benchmarked' against available guidelines to determine whether the TSF design (in terms of the seepage management strategy) is appropriate.

Conclusions

1. The impacts of historic and current seepage from the existing TSF are not fully understood and the legacy issues related to this seepage (future impacts to receiving waters) have not been modelled;
2. There has not been an assessment of alternative, more appropriate TSF sites that would not contain permeable alluvial soils, that in turn would limit seepage from the TSF and hence reduce environmental risk;
3. It is unlikely that the TSF design would be approved in other states, based on available guidelines.
4. During the period of mine operations, contaminated groundwater from the seepage recovery bores may be pumped back to the TSF in the dry season. This could cause a long-term deterioration of seepage water quality, thus extending the time for seepage recovery
5. Post-closure, the TSF would not be self-sustainable and therefore does not meet ANCOLD (1999) guidelines.
6. In the unlikely event that MRM were placed into receivership before or at the end of mine operations, the NT Government would be left with a very substantial environmental liability that would require ongoing, costly management for a period of decades.

Recommendations

It is recommended that other designs for the TSF are developed and assessed with the prime objectives of limiting seepages to the underlying groundwater system (in the first place) and achieving compliance with relevant guidelines and standards for the operational and post-closure management of TSFs.

1. TERMS OF REFERENCE

The terms of reference for this review are listed below.

1. Critically evaluate the adequacy of information included in the Public Environmental Report for the McArthur River Mine Open Cut Project with respect to the proposed tailings storage facility, including the adequacy of proposed management and mitigation options presented in the Public Environmental Report (PER).

2. Critical evaluation should focus specifically on the potential for contamination in the longer term (>30 years) resulting from seepage from the Tailings facility. The proponent was asked to undertake modelling for the proposed tailings storage facility to account for best- and worst-case scenarios into the long term (>30 years) to determine the risk of these scenarios occurring and the predicted probable environmental impact. Management options were requested to be presented in the PER to minimise the risk of these adverse environmental impacts occurring.

3. Assist in the development of recommendations for inclusion in the final Assessment Report (the presentation of the findings of the assessment undertaken by the EPA Program) on the acceptability of predicted impacts, proposed management measures and proposed monitoring and mitigation programs outlined in the PER.

2. ADEQUACY OF INFORMATION ON THE TSF

The adequacy of the information in the PER was initially assessed in terms of the description of risks, identification of seepage management options and ultimately selection of the preferred management and seepage mitigation strategy.

A request for additional information, to assist with assessment of the above, was provided NRETA/EPA on 26 July 2006. This request was subsequently passed on to MRM on 31 July 2006 in a letter from the Minister for Natural Resources, Environment and Heritage to the General Manager - MRM. (Appendix A).

A response to the request for additional information was issued on 14 August 2006 (URS, 2006).

2.1 GUIDANCE

In the context of seepage issues related to the TSF, the PER Guidelines provided the following direction to environmental reporting, Section 4.7.2 in Assessment Report 51:

"EIS respondents recommended that the impact of various future scenarios, for a time period greater than 30 years (best to worse) should be modelled and asked that the risk of these scenarios occurring and the resultant environmental impacts associated with these scenarios be predicted. Further, management options for minimisation of the risk of these adverse environmental impacts occurring were requested by NRETA. The proponent has undertaken modelling for best- and worst-case scenarios for the TSF to 25 years, that is, during the expected mine life. No further modelling into the longer term has been presented except to estimate how long the recovery bore network may need to operate to ensure no further surface expression of seepage water would occur. ***The EIS should have provided modelling of the proposed tailings storage facility to account for best-and worst-case scenarios into the long term (>30 years) to determine the risk of these scenarios***

occurring and the predicted probable environmental impact. Management options for minimization of the risks of these adverse environmental impacts occurring should have been presented."

2.2 ENVIRONMENTAL REPORTING

The approach to the review of seepage issues associated with the TSF component of the MacArthur River PER was made with reference to key standards for long-term environmental management and closure planning at mine sites.

The responses in the PER that relate to our guidance (Section 0) are listed below.

PER July 2006 Volume 1 Main Report	
Section 7 Tailings Storage Facility	TSF information
Section 10 Groundwater	
PER July 2006 Volume 2 Appendices	
Appendix A Government Requirements	compliance
Appendix N Tailings Storage Facility Seepage Modelling Report	environmental risk/impact assessment
URS (2006) McArthur River Mine Open Cut Project PER: Response to Further Information Request (14 August 2006)	

2.3 HISTORIC PERFORMANCE OF EXISTING TSF

2.3.1 *Geological & Hydrogeological Conditions*

The existing TSF (Cell 1) contains tailings placed in direct contact with floodplain soils (shallow colluvial outwash fan deposits and alluvium). The majority of the upper sediments (soils) contain a mix of silt, sand and gravel, with the basal few metres containing permeable sand and gravel deposits. According to the Draft EIS, *"...the footprint of TSF contained significant areas where the surface soils comprised "permeable sands and gravels"*. The Draft EIS reports that the upper silts, clays and fine-grained sands have permeabilities of 2 m/day, while the lower coarse-grained sands, gravels and cobbles/boulders have permeabilities of 50 m/day. Aquifers exist in the alluvial soils.

The soils overlie weathered, dolomitic siltstone rocks. According to the Draft EIS, *"Groundwater can occur in open vugs or solution channels, fractures, joints and faults within the fresh bedrock."* It also states that *"...Furthermore, in situ testing within the underlying weathered dolomitic siltstone indicated that the siltstone was relatively permeable and contain karst features"*. Aquifers are known to exist within the dolomitic siltstone rocks.

Groundwater levels indicate easterly flow of groundwater from higher elevations near the TSF (up to RL 42 m) to lower elevations near the McArthur River (down to RL 20 m).

2.3.2 *Seepage Issues*

A seepage limiting layer (containment) underlying the tailings, such as a low permeability compacted clay or synthetic liner, is not utilised. Seepage from the existing TSF has been much greater than expected, with seepage of contaminated waters to Surprise Creek observed in June 1997. A geopolymer barrier to limit seepages to the creek was constructed along the wall (around the perimeter of Cell 1 fronting Surprise Creek) in 2005.

The Draft EIS states that salinity levels and sulfate concentrations are greater than those recommended in relevant ANZECC (2000a) guidelines. Some metal concentrations (Cd, Cu, Fe, Mn, Pb and Zn) in seepage/groundwater can be greater than ANZECC (2000a) water quality guideline criteria for fresh water ecosystems. According to URS (2006), groundwater quality data indicate that the pH of groundwater at the existing TSF is near neutral. Interestingly, comparisons of the above parameters were made against criteria for fresh water ecosystems in the Draft EIS, whereas URS (2006) compares data against livestock water quality criteria which are less stringent.

Trends in sulfate concentrations, for groundwater at the TSF (Figure 4.4 URS, 2006), show that sulfate concentrations for all groundwater bores were less than or equal to the livestock guideline value of 2,000 mg/L in late 1997/early 1998. By mid 2005, sulfate concentrations were all above the guideline value except for groundwater at GW7.

Groundwater monitoring data are limited and are mostly located near the perimeter of the existing TSF. The locations of existing plumes beyond the TSF are not known, particularly north of Surprise Creek. The fate of these plumes and the long-term impacts to downstream water quality has not been predicted, i.e. modelled.

The current extent of groundwater contamination downstream of the TSF is not well understood because these plumes have yet to be modelled and monitoring appears to be inadequate.

There has not been an assessment of historic and current seepages on the beneficial uses of groundwater over the long-term and (related) future liabilities.

3. ALTERNATE TAILINGS DISPOSAL OPTIONS

URS (2006) ranked the following two options according to *technical performance, seepage performance, residual environmental risk* and *cost* (final scores are shown in brackets):

1. Rehabilitation of Above Ground Storage (62)
2. Disposal of Tailings to Post Pit Mining (49)

The rationale for the scoring and results of the assessment seem appropriate, based on issues related to seepage.

The following options were also compared:

1. Optimise Existing TSF cells (62)
2. New TSF Area Outside Floodplain (57)

The scores for the above are close.

Given that the final scores for the two options (shown in brackets) are close, and the significant issues related to historic seepage via aquifers within shallow alluvial sediments, consideration of other TSF sites is warranted.

4. ANALYSIS OF SEEPAGE MANAGEMENT OPTIONS

The assessment of seepage management options for the TSF was undertaken by MRM/URS using a multi-criteria selection/assessment approach as well as predictive modelling.

4.1 DEVELOPMENT OF MULTI-CRITERIA SELECTION MATRICES

URS (2006) ranked the following four options according to *technical performance, seepage performance, residual environmental risk* and *cost* (final scores are shown in brackets):

1. Clay Liner to TSF (47)
2. Deep Low-Permeability Cut-off (51)
3. Dewatering Bores (70)
4. Geomembrane Liner (64)

A sensitivity analysis was undertaken by URS (2006) to see if the final ranking of options is altered by placing different weightings on the four criteria. The results of the analysis indicated that Option 3. still remains the preferred option. Despite this, a concern exists that a number of assumptions underpinning the scoring are not appropriate, and so an independent scoring of the options was undertaken. The results, including comments for scores that are different to those made by URS (2006), are contained in Appendix B. In summary, the 'dewatering bores' option received the lowest score.

A discussion of alternatives considered during the design phase is contained in Section 2.2.2 in URS (2006). Three options are presented and discussed:

1. Clay Lining of the TSF Footprint
2. Deep Low-Permeability Cut-off
3. Geomembrane Liner

A number of construction/performance issues and difficulties were identified for each option. It is considered that these difficulties can be readily overcome with the development of robust and appropriate designs. For example, Options 1. and 3. (above) could, with other design components (eg base drains, cut-off drains), be utilised to substantially restrict the hydraulic connection between the tailings and the underlying soils and hence substantially limit seepage to underlying aquifers.

It is considered that the basis for selecting seepage recovery bores as the key element of the seepage management strategy cannot be justified using the selection criteria applied.

4.2 PREDICTIVE MODELLING

Solute transport modelling is generally undertaken to predict changes to downstream water quality as a consequence of seepage from tailings storage facilities. In this case, impacts to downstream water quality were inferred on the basis of the changes to groundwater levels downstream of the TSF. Given the limited groundwater level data used during calibration and the karstic nature of the rocks, it is considered that the modelling results incorporate significant uncertainty which has not been appropriately quantified. This conclusion is supported by the fact that the model (forward) predictions of seepage recovery vary significantly from the Draft EIS to URS (2006), supporting the above comment.

The Draft EIS assumes seepage recovery bores were positioned on the southern side of the TSF spaced at 50 m centres to depths of approximately 11 m. Recovery bores would need to be operated for 30 years or longer after decommissioning to avoid surface expression of seepage waters. Solar or wind powered pumps would be used after closure. The total pumping rate would be 200 kL/day.

The PER assumes 32 seepage recovery bores are required pumping at 60 kL/day over 10 years, for up to 40 to 50 yrs after closure. Despite claims of their effectiveness, seepages are not fully recovered, as evidenced by contours of 'level change' extending to distances of at least 2 to 3 km south-west of Cell 1. Sensitivity analysis was carried out to assess a 'worst case' scenario where the base rock had a lower permeability. Results of this 'worst case' scenario are of serious concern, because they indicate that seepage rates are lower and the time taken to lower the head of water within the TSF is increased. During mine operations, it is estimated the seepage to water table ranges from 580 to 1,130 kL/day, equivalent to 100 to 200 mm/year. Total abstraction equals 1,980 kL/day during mine operations and is predicted to be 390 kL/day after 10 years.

In URS (2006), it was assumed that a total of 59 bores are required, pumping at a total rate of 1,846 kL/day during the period of mine operations, 745 kL/day after 5 to 10 yrs and 548 kL/day for 10 to 25 yrs post operation.

The basis upon which pumping is ceased (post-closure) is not clear.

5. DISCUSSION OF TSF SEEPAGE MANAGEMENT STRATEGY

5.1 DESIGN PHILOSOPHY

The proposed TSF will comprise three cells, the existing TSF (83 ha), Cell 1 (56 ha) and Cell 2 (62 ha). The total tailings volume is 23 Mm^3. Settled density is assumed to be 1.3 t/m^3. The tailings bleed water and stormwater runoff flow down the beached tailings to decant groynes, and may flow to the dirty water dam. It is not known whether there are seepage issues associated with the dirty water dam.

The PER states that the overall strategy to manage the risk of environmental impact from the TSF comprises a "multiple lines of defence" strategy, that has been developed for the three key stages of the life of the TSF. Key elements to manage seepage from the TSF (taken from Table 7.1 in PER) include:

- embankment to have clay core with cut-off key;
- ponded water in TSF to be kept away from perimeter embankment;
- geopolymer barrier to be installed around eastern embankment;
- network of recovery bores to be installed around entire TSF perimeter;

- TSF to be capped with low permeability layer, to prevent ongoing entry of water at closure; and
- maintain recover bores post closure, until seepage head in TSF reaches design level.

An "observational approach" will guide the operation of the seepage recovery bores (the key element of seepage minimisation), with additional bores assumed to be the contingency measure.

5.2 DESIGN CONSIDERATIONS & ASSUMPTIONS

Despite historic problems with tailings seepage, investigations of alternative sites for the TSF, that contain less permeable soils/rocks that would result in much less seepage from the TSF, were not undertaken. The new TSF will adjoin the existing TSF and will be constructed without seepage containment (i.e. a seepage limiting layer). The principal difference in design between the existing and new TSF is the establishment of a seepage recovery network to collect seepage during the period of mine operations and for 30 to 50 years after mine closure.

MRM considers initial capital costs as an "issue of critical importance", whereas operational costs, closure capital costs and post closure operational costs are (individually) seen to be an "issue of average importance" (URS, 2006). It could be implied that inadequate seepage containment measures were included in the TSF design to minimise initial capital costs with operational/post-closure costs not adequately considered. This is not considered to be *best practise* and does not meet the ANCOLD (1999) guidelines relating to integrated life-cycle management of tailings storage facilities[1]. Indeed, the design would not be approved in Victoria (DPI, 2004), where storage of contaminated tailings has a minimum level of containment mandated "*...the standard level of containment should be at least equivalent to 0.6 metre of clay, with permeability no greater than 10^{-8} m/sec.*" Similarly, guidelines prepared by EPA QLD (2002) would also not be met because the design does not meet 'Design Principle (f)' which states that "*Seepage through or beneath external embankments should be minimised as far as practicable*".

5.3 PERFORMANCE OF SEEPAGE CONTROL MEASURES

5.3.1 *Operational Period*

The absence of a seepage limiting layer provides operational benefits because it results in higher rates of tailings consolidation and settlement and higher tailings densities, thus permitting construction of a smaller TSF and resulting in lower initial capital and ongoing construction costs. But, it permits much greater seepage from the tailings to underlying aquifers and hence groundwater contamination.

MRM operation of the seepage recovery bores during the period of mine operations requires an "observational approach", an ongoing refinement that implies that new areas of groundwater contamination will be detected, requiring regular re-design of the bore network and regulatory review and management. Seepage will be an ongoing (major) issue for assessment by EPA and/or DPIFM during mine operations, and will rely heavily on appropriate data being made available by MRM for assessment.

[1] ANCOLD (1999) Section 9.3 states that *"Decommissioning, closure and aftercare are more effective, efficient and economic if the storage has been planned, operated and managed with closure in mind."*

During mine operations, water will be pumped from the seepage recovery bores to the Proposed Water Management Dam. A water balance for the Dam has not been undertaken. It is stated that if there is insufficient capacity in the Dam (for storage of water pumped from seepage recovery bores) that seepage water will be spread as low rate irrigation over the TSF active cell during dry weather, at rates that do not result in runoff or ponding. This could result in a salt build up at the surface of the tailings as a result of evaporation, which will be leached into the tailings mass each wet season. It is concluded that the water quality of seepage passing through the base of the tailings dam will deteriorate over time.

5.3.2 Post-Closure Period

A conceptual cover design has been developed to minimise infiltration to the TSF. There is a concern that groundwater model used may not be well calibrated because average rainfall recharge rates across the model are assumed to be 10 to 20 mm/yr and yet the cover will permit 65 mm of infiltration each year. The conceptual cover design is therefore likely to be inappropriate because it does not appear to limit infiltration to the TSF to rates that are less than 'natural' rainfall-recharge.

The TSF design does not meet the requirements of relevant tailings management guidelines in terms of decommissioning. ANCOLD (1999) states that *"Decommissioning and aftercare maintenance should be anticipated and adequate provision made to ensure that it can continue for as long as is necessary to ensure that the decommissioning objectives and self sustainability are achieved."* The need for operation of a seepage recovery system beyond closure means that the TSF cannot achieve any degree of self sustainability. It is further stated that *"Ongoing requirements for the aftercare phase should be within the capability of the post-closure land user or other party responsible for the storage to implement. Therefore, aftercare requirements should be compatible with end-user capabilities and vice versa."* In this instance, it is considered that likely end users would be ill equipped to manage such a complex seepage management program. The design does not meet other guidelines[2].

The TSF design does not satisfy guidelines in the context of its post-closure performance and requirement for ongoing management.

[2] According to EPA (1995) in MCMPR/MCA (2003), there are a number of objectives that need to be considered when planning the final land form of a tailings storage facility. These include *"containing/encapsulating tailings to prevent leaching into ground and surface waters"* and *"designing the closure to minimise post-closure maintenance"*. The design of the TSF, including cover design, indicate that the tailings are neither contained or encapsulated to prevent leaching into groundwater and post-closure seepage recovery requirements is indicative of substantial post-closure maintenance.

ANZMEC/MCA (2000) states that *"Being able to successfully close a mine is critical to project approval. It is necessary to ensure that closure is technically, economically and socially feasible without incurring long-term liabilities."* Long-term seepage recovery (post-closure) means that the MRM site is left with a significant environmental liability at the time of closure. In the event that MRM withdrew from the site at this time, the Northern Territory government would need to utilise available funds held in trust on behalf of MRM or other funds to manage a liability over a period of 30 to 50 years.

6. OTHER ISSUES

There are a number of inconsistencies in statements contained in URS (2006) that are not supported by the results of the studies (particularly modelling) and should be of concern to NRETA/EPA. For example:

pES-1: *"The assessment concluded that the network of recovery bores was the preferred option. The clays available on site have a long-term permeability similar to the tailings, and so offer no advantage. ....The use of a geomembrane liner would inhibit consolidation of the tailings and provide a long-term environmental risk"*. The statements misrepresent the benefits that both options could provide in limiting seepage from the TSF; in effect clay is not sufficiently impermeable but a geomembrane liner is too impermeable?

p.ES-2: *"During operations and for the post-closure period during which the recovery bores are operating, there will be no TSF seepage reporting to the underlying groundwater..."* Barriers or liners separating the tailings from the underlying aquifers are not planned to be installed, so the statement that there will be no TSF seepage reporting to the underlying groundwater is factually incorrect.

p. ES-2: *"Thus any groundwater seepage from the TSF that does not express at Surprise or Barney Creeks eventually reports to the underground mine, which is a regional sink in the groundwater flow system."* The comment that seepage will ultimately enter the underground mine cannot be support by the information available, given that there is inadequate groundwater monitoring and the fact that solute transport modelling has not been undertaken.

p. 5-6: *"Some contamination of groundwater could occur at depth if the recovery bores are ineffective. However an assessment of the results of the current groundwater monitoring program that has included the effects of seepage from the existing TSF shows that the quality of the groundwater will still meet the ANZECC guidelines for livestock water quality (Section 4.2.3). Therefore the risk of deteriorating groundwater quality is not significant."* Groundwater at TSF mostly does not meet the livestock guideline value (for sulfate), and based on historic trends continuing, seems unlikely to meet the guideline value in the future.

7. CONCLUSIONS

1. The impacts of historic and current seepage from the existing TSF are not fully understood and the legacy issues related to this seepage (future impacts to receiving waters) have not been modelled and assessed;

2. There has not been an assessment of alternative, more appropriate TSF sites that would not contain permeable alluvial soils, that in turn would limit seepage from the TSF and hence reduce environmental risk;

3. It is unlikely that the TSF design would be approved in other states, based on available guidelines.

4. During the period of mine operations, contaminated groundwater from the seepage recovery bores may be pumped back to the TSF in the dry season. This could cause a long-term deterioration of seepage water quality, thus extending the time for seepage recovery

5. Post-closure, the TSF would not be self-sustainable and therefore does not meet ANCOLD (1999) guidelines.

6. In the unlikely event that MRM were placed into receivership before or at the end of mine operations, the NT Government would be left with a very substantial environmental liability that would require ongoing, costly management for a period of decades.

8. RECOMMENDATIONS

It is recommended that other designs for the TSF are developed and assessed with the prime objectives of limiting seepages to the underlying groundwater system (in the first place) and achieving compliance with relevant guidelines and standards for the operational and post-closure management of TSFs.

9. REFERENCES

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APPENDIX A - COPY OF LETTER FROM THE MINISTER FOR NATURAL RESOURCES, ENVIRONMENT AND HERITAGE TO THE GENERAL MANAGER - MRM (31 JULY 2006)

Fax sent by : 31/07/06 10:58 Pg: 2/3

MINISTER FOR NATURAL RESOURCES,
ENVIRONMENT AND HERITAGE

PARLIAMENT HOUSE
STATE SQUARE
DARWIN NT 0800
minister.scrymgour@nt.gov.au

GPO BOX 3146
DARWIN NT 0801
TELEPHONE: (08) 8901 4102
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Mr Brian Hearne
General Manager
McArthur River Mining Pty Ltd
PO Box 36821
WINNELLIE NT 0821

Dear Mr Hearne

The Public Environmental Report for the amended proposal to expand the McArthur River Mine is on public exhibition until 31 July 2006. I consider that the information set out in Attachment A is necessary to facilitate examination of the report.

In accordance with clause 11(2)(a) of the *Administrative Procedures of the Environmental Assessment Act*, I direct the project proponent to provide the necessary information set out in Attachment A.

My decision under clause 11 will be made within fourteen (14) days after I am satisfied that the necessary information has been received.

In the first instance, any questions of clarification in relation to this matter should be directed to Ms Lyn Allen, Executive Director, Environment and Heritage on telephone (08) 8924 4135.

Yours sincerely

MARION SCRYMGOUR
31 JUL 2006

Northern Territory Government

31/07/06 18:58 Pg: 3/3

tx sent by :

ATTACHMENT A

Tailings Storage Facility

Background

1. The modelling of seepage from the **Tailings Storage Facility** (TSF) is semi-conceptual, with two-dimensional modelling (in the draft Environmental Impact Statement (EIS)) used to select "a network of recovery bores at the downstream toe of the perimeter embankment" as the preferred (seepage) mitigation measure, over the use of a "1m thick compacted clay layer below the tailings". Only two seepage mitigation measures were modelled in the draft EIS. A further two options were modelled in the Public Environmental Report.

   There does not seem to have been a thorough identification and assessment of seepage limiting options; it is considered that other 'passive' seepage limiting options could / should have been considered and modelled, eg geosynthetic liner to seal base of tailings with use of underblanket drain to collect tailings water before it enters the groundwater system, return of tailings to the pits (to reduce the need for long-term operation of an 'active' seepage recovery system).

2. The criteria for successful seepage mitigation is "to avoid surface expression of the seepage" in Surprise Creek. It is implicit that some degree of groundwater contamination is possible elsewhere (e.g. elevated groundwater levels are predicted to the south of the TSF). The impacts to groundwater quality (and hence beneficial uses) and surface water quality in other creeks / rivers was not modelled or discussed. It seems highly unusual that modelling focuses on groundwater 'mounding', and yet no attempt has been made to predict the fate and transport of seepage and impacts on downstream surface water or groundwater quality (during operations and post-closure).

Further Information request

- Provide thorough identification, modelling and assessment of further seepage limiting options, including 'passive' options (see above).
- Discuss the feasibility, costs / benefits and potential hydrological / environmental impacts in the short and long term of further tailings disposal options, including in-pit disposal of tailings, and shifting the TSF to adjacent higher ground (above the floodplain).
- Provide any recent report(s) that describe existing TSF monitoring and the fate / impacts of historical seepage, particularly in relation to seepage that may have bypassed Surprise Creek or may be occurring in other areas. Describe historical TSF seepage in terms of hydrogeological destinations.
- Discuss in detail future TSF seepage and model impacts to groundwater quality and surface water quality in creeks / rivers other than Surprise Creek. Predict the fate and transport of future seepage and impacts on downstream surface water or groundwater quality (during operations and post-closure).

APPENDIX B - EWL SCIENCES SCORING OF SEEPAGE LIMITING OPTIONS

MRM Open Cut Project - Seepage Control

Option Selection Criteria

Project Objective (KRA)	KRA Group Weighting	Key Per I	KPI Individual Weighting	Clay Liner to TSF Raw Score	Clay Liner to TSF Weighted Score	Deep Low Permeability Cutoff Raw Score	Deep Low Permeability Cutoff Weighted Score	Dewatering Bores Raw Score	Dewatering Bores Weighted Score	Geosynthetic Liner Raw Score	Geosynthetic Liner Weighted Score	Comments
				Ranking Scores								
[redacted]	25%	Improved tailings placement - (density achieved)	2	3	6	3	6	3	6	2	4	
		Provide stable landforms	4	3	12	3	12	3	12	3	12	
		Emissions to the environment (erosion, dust)	4	3	12	3	12	3	12	3	12	
		Disturbed area/footprint	2	2	4	3	6	3	6	2	4	
		Storage efficiency - (incl upstream lifts)	1	3	3	3	3	3	3	2	2	
		Maximu[redacted]										
Seepage Performance	25%	No surface expression of seepage	4	3	12	3	12	4	16	5	20	1. Impact on receiving waters for dewatering bores from 4 to 2 because contaminated waters are constantly pumped from depth to the surface; high risk of pump or pipe failure leading to ongoing spills, leaks and untracked losses to creeks or contamination of other groundwater bodies 2. Beneficial uses of surface and groundwater for dewatering bores from 4 to 2 for same reason as 1. 3.Clay liner on TSF for all criteria from 1 to 3 because no information presented to suggest that clay not available or likely to be ineffective (particularly given that clay available for TSF walls) 3.Deep low permeability cutoff for all criteria from 1 to 3 because no information presented to suggest that clay not available or likely to be ineffective (particularly given that clay available for TSF walls)
		Impact on receiving waters	4	3	12	3	12	2	8	5	20	
		Beneficial uses of surface and groundwater	4	3	12	3	12	2	8	5	20	
		Maximum KPI weighted score	60	Σ	36	Σ	36	Σ	32	Σ	60	
		KRA Group Weighted Sub-Total		15%		15%		13%		25%		
Seepage Performance	25%	Established precedent	2	3	6	3	6	3	6	3	6	1. Potential for seepage legacy from dewatering bores from 5 to 1 because mounding extends beyond bores & risks associated with pump equipment failure, human error, pumping of seepage water back to TSF thus increasing recycling salts and resulting poorer quality seepage from TSF over time 2. Potential for seepage legacy from geosynthetic liner from 2 to 4 because liner limits impacts to groundwater system in the first instance so legacy issues likely to be lower in the long-term 3. Ability to augment/implement contingencies for all options likely to be the same for all options, so all options given scores of 3
		Construction risks	1	3	3	3	3	4	4	3	3	
		Ability to augment/implement contingencies	3	3	9	3	9	3	9	3	9	
		Reliance on post closure attendance	4	4	16	4	16	2	8	5	20	
		Potential for seepage "legacy"	3	3	9	3	9	1	3	4	12	
		Maximum KPI weighted score	65	Σ	43	Σ	43	Σ	30	Σ	50	
		KRA Group Weighted Sub-Total		17%		17%		12%		19%		
[redacted]	25%	Initial capital costs	4	2	8	3	12	4	16	1	4	1. Individual weightings for 'closure capital costs' and 'post closure operational costs' increased because less certainty of finance at times where no cash flow 2. Closure capital costs for geo liner from 1 to 3 because costs for option overstated; cover should limit infiltration irrespective of liner presence 3. Closure capital costs from 5 to 4 for dewatering bores because non-power issue requires substantial refit 4. Post-closure operational costs from 2 to 1 will be unacceptable 4. Post-closure operational costs from 2 to 3 for cutoff and clay liner
		Operational costs	2	3	6	3	6	2	4	3	6	
		Closure capital costs	3	3	9	3	9	4	12	3	9	
		Post closure operational costs	4	3	12	2	8	1	4	4	16	
		Maximu[redacted]										
				63%		64%		58%		75%		

16 <u>Appendix 2- TSF Erosion Review</u>

REVIEW OF EROSION ISSUES RELATED TO MRM'S TAILINGS STORAGE FACILITY

Prepared for: NT Environment Protection Agency Program (NRETA)
Prepared by: EWL Sciences Pty Ltd

Author: Ian Hollingsworth

Date: August 2006

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earth | water | life

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REVIEW OF EROSION ISSUES RELATED TO MRM'S TAILINGS STORAGE FACILITY

for

NT Environment Protection Agency Program (NRETA)

by

EWL Sciences Pty Ltd

Author: Ian Hollingsworth

Date: August 2006

Project Manager: ____________________
Ian Hollingsworth

Reviewer: ____________________
Alan Puhalovich

General Manager: ____________________
Dr A R Milnes

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EXEXCUTIVE SUMMARY

Project Focus

EWL Sciences has been asked to provide a critical evaluation of the adequacy of information included in the Public Environmental Report (PER) for the McArthur River Mine Open Cut Project with respect to the proposed tailings storage facility, including the adequacy of proposed management and mitigation options presented in the Public Environmental Report. The critical evaluation focussed on the potential for contamination in the longer term (>30 years) resulting from erosion of the Tailings facility. Assessment included determination of the need or otherwise for modelling to account for best- and worst-case scenarios to assess the risk of these scenarios occurring and the predicted probable environmental impact into the long term.

Also, EWL Sciences was required to provide assistance in the development of recommendations for inclusion in the final Assessment Report (the presentation of the findings of the assessment undertaken by the EPA Program) on the acceptability of predicted impacts, proposed management measures and proposed monitoring and mitigation programs outlined in the PER.

Methodology

EWL Sciences evaluated the stability management and mitigation options presented in the Public Environmental Report (PER) tailings storage facility design with respect to embankment design, cover design, revegetation, surface water management, and geomorphic context in the natural landscape.

Recommendations

- The tailings dam revegetation plan should be further developed to carefully consider environmental outcomes, based on a water balance that demonstrates sufficient plant available water in the cover to support self-sustaining plant communities.

- The tailings dam remediation plan should be further developed during the life of the mine to incorporate quantitative erosion risk assessment using digital terrain analysis and/or erosion modelling methods based on local erosion and sedimentation measurements to support the closure surface water management design.

- Visualisation of the surface drainage system would clarify design issues.

- Assurance that the Water Management Dam embankment is not affected by flooding, or if it is, it is designed to withstand flood waters is needed.

- Assurance that sufficient quantities of non-acid forming rock of appropriate hardness and durability to construct the tailings dam embankment design is needed.

- While alternative tailings management strategies that would put tailings out of the flood zone, thus eliminating the main hazard to tailings containment were identified and discarded, these strategies should be kept in mind during the life of mining, and revisited in response to stakeholder consultation and environmental issues as they arise.

1 TERMS OF REFERENCE

The terms of reference for this review are listed below.

1. Provide a critical evaluation of the adequacy of information included in the Public Environmental Report (PER) for the McArthur River Mine Open Cut Project with respect to the proposed tailings storage facility, including the adequacy of proposed management and mitigation options presented in the Public Environmental Report.

2. The critical evaluation should focus specifically on the potential for contamination in the longer term (>30 years) resulting from erosion of the Tailings facility. Assessment should include determination of the need or otherwise for modelling to account for best- and worst-case scenarios to assess the risk of these scenarios occurring and the predicted probable environmental impact into the long term.

3. Provide assistance in the development of recommendations for inclusion in the final Assessment Report (the presentation of the findings of the assessment undertaken by the EPA Program) on the acceptability of predicted impacts, proposed management measures and proposed monitoring and mitigation programs outlined in the PER.

2 ADEQUACY OF INFORMATION ON THE TSF

The adequacy of the information in the PER was assessed in terms of:

- the description of risk;
- the presentation of management and mitigation options; and
- the description of the management and mitigation options that were selected.

2.1 GUIDANCE

In the context of erosion issues related to the TSF, the PER Guidelines provided the following direction to environmental reporting

Sections 4.3.2 and 4.7.2, Assessment Report 51:

The proponent is to provide details of the proposed design, and operational and management strategies of the tailings storage facility (TSF), including ongoing maintenance and monitoring requirements (beyond mine life), to demonstrate that it will not impact on the receiving environment.

The proponent is to undertake modelling of the proposed tailings storage facility to account for best- and worst-case scenarios into the long term (>30 years) to determine the risk of these scenarios occurring and the predicted probable environmental impact. Management options for minimization of the risks of any adverse environmental impacts occurring should be presented.

2.2 ENVIRONMENTAL REPORTING

Our approach to the review of erosion issues associated with the Tailings Dam component of the MacArthur River PER was made with reference to environmental impact assessments (URS 2005, URS 2006, URS 2006a) and standards for long-term environmental management and closure planning at mine sites (ANCOLD 1999, ANZMECC 2000, MCMPR 2006).

The responses in the PER that relate to our guidance (Section 2.1) are listed below.

Table 1 Reviewed documents

PER July 2006 Volume 1 Main Report	
Section 7 Tailings Storage Facility	TSF information
Section 8.2 Transport of Metals p8-6,7	Environmental risk
Section 8.3, Fate of Metal Species	Environmental risk
Section 8.5 Sediment Monitoring Program	Monitoring strategy
Section 8.6 TSF Discharge Regime	
PER July 2006 Volume 2 Appendices	
Appendix A Government Requirements	compliance
Appendix G Tailings Storage Facility Stability Assessment	Environmental risk
Appendix B Project Execution Plan	
• Design Basis Report	Management strategy
• Hydraulic Designs and Flooding Investigation	Environmental risk
Draft Report McArthur River Mine Open Cut Prorject PER Response to Further Information Request	Seepage information
Draft EIS supplement	
Section 6 Alternatives	
Section 6.8.2	Tailings Management
Section 7 Waste Management	
Section 7.3	Tailings Existing Operations
Section 7.4	Tailings Open Cut Operations
Section 12 Surface	
Section 19 Risk Management	
Section 20 Rehabilitation & Closure	

2.3 RISK ANALYSIS

Flood frequency has been used to assess Environmental risk and a very conservative setting of 1:500 year events (estimated from Australian Rainfall and Runoff 2001) has been used for embankment design. This risk setting may not be accurate because of the relatively short period of rainfall statistics on which it is based. However, the design setting that it subsequently requires creates a high level of confidence that a catastrophic failure will be avoided.

The risk analysis based on the 1:500 year flood event indicated that the TSF would be in the potential flood impact area. We checked this using a terrain analysis index MrVBF (Gallant and Dowling (2003) which is interpreted as an index of deposition, based on the assumption that flat valley bottoms are flat because they are filled with sediment. The index separates upland terrain dominated by erosional processes from lowland depositional terrain. The MrVBF index is available from the ASRIS web site (). This indicates the extent of alluvial landforms and associated drainage systems in low relief terrain at the site (Figure 1).

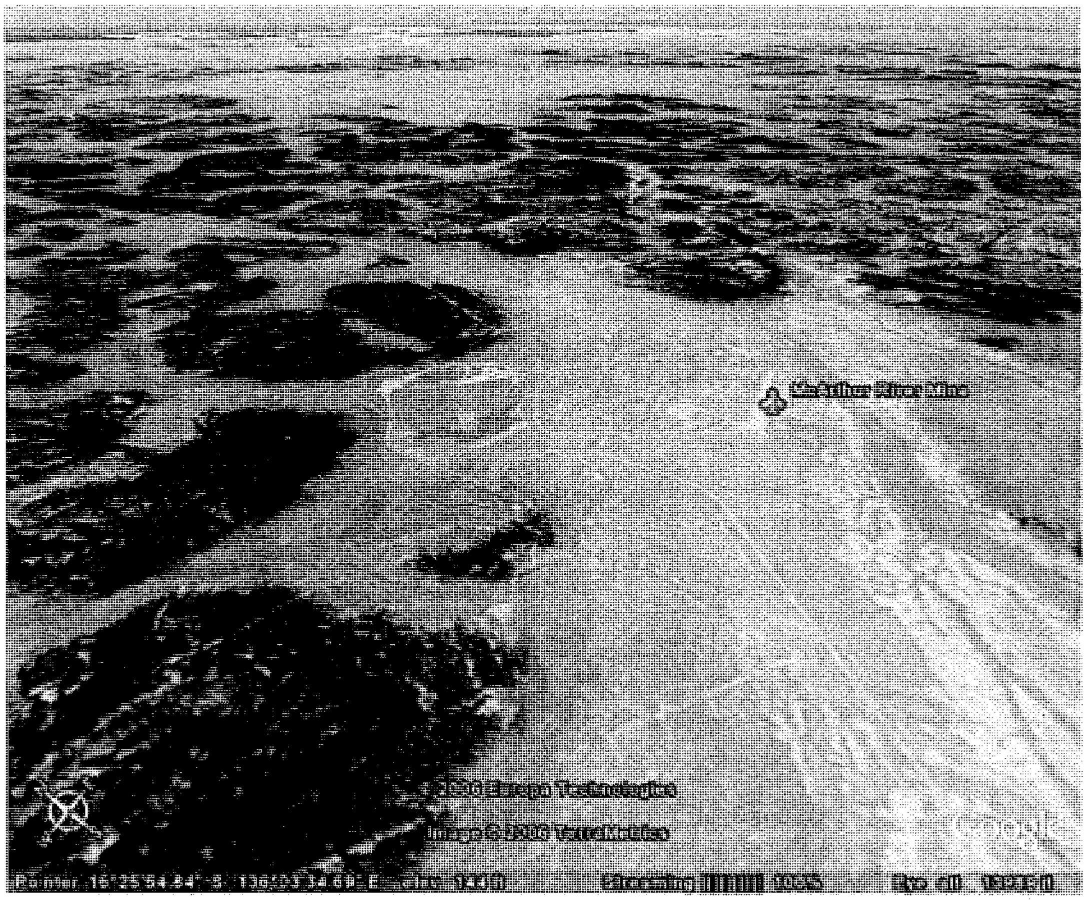

Figure 1 Valley bottom extent indicating alluvial landforms

Figure 1, combined with the flood risk analysis in the PER identifies the TSF footprint with a flood plain environment. Consequently, the risk setting used for design of the embankment appears to be appropriate.

2.4 TSF RISK MANAGEMENT STRATEGY

The approach to managing risk was presented in Table 7-1 of the PER main report. This table describes mitigation, monitoring and contingency strategies for reducing risk of failure of the TSF facility.

On the basis of steady state (General Limit Equilibrium) modelling, slope stability analysis was applied to the embankment design. Risk mitigation was achieved by designing the tailings dam embankment to meet conservative (high risk) design settings. The detailed report given in Appendix G demonstrated that this had been achieved.

However, while the risk environment is accurately described, different options for managing tailings to reduce the risk of release to the external environment have not been assessed. Other options which address flood risk should be identified and assessed to provide confidence that the approach presented in the PER is optimal in terms of cost and environmental protection.

Evaluation of alternative tailings management strategies that would put tailings out of the flood zone, eg. on adjacent high ground or ultimately in the pit, is needed to demonstrate that the proposed management and mitigation option is optimal.

2.5 MITIGATION OPTIONS

Mitigation has been achieved by carefully considered tailings water management and a conservative design approach to the embankment wall.

2.5.1 *Embankment design*

The existing TSF cell is not designed to the standard described in the PER. There is a history of seepage from this cell (Section 7.2.1) and its close proximity to Surprise Creek increases implies higher water velocities and a higher risk of failure that associated with the development plan.

The embankment design for the planned TSF has been demonstrated to be robust in terms of the design criteria. The long-term stability of the wall will depend on the quality of the materials chosen to construct the rock facing.

Assurance that sufficient quantities of non-acid forming rock of appropriate hardness and durability to construct the tailings dam embankment design is needed.

2.5.2 *Surface water overflow*

The mitigation options presented included perimeter placement of tailings and decanting water from the centre of the dam to the water management dam. This will reduce the risk of embankment failure. Upstream lifts and an associated water management system are broadly described. This is understandable at the planning stage. The design risk setting of 1:100 year rainfall intensity for the drainage system is conservative. Assurances are given that detailed design and operating procedures will be developed. However the description of the contour drainage system is obscure and the final effect is difficult to visualise.

Visualisation of the surface drainage system would clarify design issues.

The decant water from the TSF is placed in the Water Management Dam. It is stated that the Water Management Dam will be above the 1:500 year flood level. However clear evidence to support this statement is not evident in the hydraulic analysis (Appendix B).

Assurance that the Water Management Dam embankment is not affected by flooding, or if it is, it is designed to withstand flood waters is needed.

3 POTENTIAL FOR LONG-TERM TAILINGS CONTAMINATION IN THE RECEIVING ENVIRONMENT

3.1 EROSION & SEDIMENT TRANSPORT MODELLING

No commitment has been made to undertake erosion and sediment transport modelling in order to assess the adequacy of the design approach and risk to the receiving environment. Erosion modelling is incorrectly equated with landform evolution modelling.

There are different approaches to erosion modelling that range from a static demonstration that the erosion risk in the final landform is similar and in context with parts of the local landscape (see Gallant JC 2001 Topographic scaling for the NLWRA sediment project. Technical Report 27/01, CSIRO Land and Water, Canberra, Australia, 2001) to technically demanding mechanistic modelling of erosion and sedimentation over long time periods.

Meaningful landform evaluation using erosion and sediment modelling requires that the closure plan design is well advanced. However, some quantification of the local erosional environment using terrain based indicators would support the design approach that is taken.

A quantitative approach to erosion risk assessment using terrain analysis and local erosion and sedimentation measurements needs to be developed to support the closure strategy which is developed during the life of the mine.

3.2 COVER OPTIONS

Cover performance was assessed on the predicted long-term seepage rates through five different capping options. The selected option included a 2 m cover comprising a number of layers including a capillary break layer to prevent capillary rise of saline pore water from the tailings mass (Section 7.5.2).

No clear account is made of the contribution of re-vegetation to the water balance. Evapotranspiration by the local woodland vegetation uses most of the available water in this environment. Woodland plants extract most of the water they require to survive from the top 3 m of the soil/regolith. The thickness and water retaining capacity of the cover design will have a significant effect on the type of vegetation that will be self-sustaining.

The cover design evaluation and the recommended grass species mix for revegetation give no clear assurance that the TSF landform will support a stable self-sustaining native plant community in the long-term. This creates a level of uncertainty in the outcomes of the rehabilitation program which is not acceptable.

A rehabilitation plan needs to be developed that carefully considers environmental outcomes and is based on a water balance that demonstrates sufficient plant available water to support self-sustaining plant communities.

4 RECOMMENDATIONS

- The tailings dam revegetation plan is further developed to carefully consider environmental outcomes, based on a water balance that demonstrates sufficient plant available water in the cover to support self-sustaining plant communities.

- The tailings dam remediation plan is further developed during the life of the mine to incorporate quantitative erosion risk assessment using digital terrain analysis and/or erosion modelling methods based on local erosion and sedimentation measurements to support the closure surface water management design.

- Visualisation of the surface drainage system would clarify design issues.

- Assurance that the Water Management Dam embankment is not affected by flooding, or if it is, it is designed to withstand flood waters is needed.

- Assurance that sufficient quantities of non-acid forming rock of appropriate hardness and durability to construct the tailings dam embankment design is needed.

- While alternative tailings management strategies that would put tailings out of the flood zone, thus eliminating the main hazard to tailings containment were identified and discarded, these strategies should be kept in mind during the life of mining, and revisited in response to stakeholder consultation and environmental issues as they arise.

5 REFERENCES

Australian National Committee on Large Dams (1999). *Guidelines on Tailings Dam Design, Construction and Operation.* October 1999.

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URS (2006a). McArthur River Mine Open Cut Project, Public Environmental Report, Response to Further Information Request. Report prepared for McArthur River Mining. 4 August 2006.

17 Appendix 3- River Realignment Review

TUNRA

REVIEW OF THE McARTHUR RIVER MINE OPEN CUT PROJECT PUBLIC ENVIRONMENTAL REPORT

By
Professor Wayne D. Erskine
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University of Newcastle – Ourimbah Campus
PO Box 127
Ourimbah NSW 2258

The UNIVERSITY of NEWCASTLE AUSTRALIA

July 2006

TUNRA

REVIEW OF THE McARTHUR RIVER MINE OPEN CUT PROJECT PUBLIC ENVIRONMENTAL REPORT

By
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AUSTRALIA

July 2006

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EXECUTIVE SUMMARY

The shortcomings in the information contained in the Draft EIS and Supplement for the McArthur River Mine Open Cut Project were outlined in my first report (Erskine, 2006) and have been meaningfully addressed in the Public Environmental Report (URS, 2006). In particular,

- Hydrological information is now presented for Barney and Surprise creeks.
- The errors in ground elevation for the photogrammetrically determined cross sections have been discussed along with how these are translated into uncertainty in the calculated water surface levels and hydraulic parameters in HEC-RAS.
- The adopted roughness coefficients have been changed so that they are spatially variable to cover the range of site conditions. The recalibrated flood model for the January 2003 flood, as a result, has a much better fit to the known flood profile.
- The very high shear stresses and specific stream powers in the current channel of the McArthur River coincide with extensive bedrock outcrops.
- Additional geomorphological work has shown that the McArthur River is generally stable, except for some minor pockets of bank erosion. Surprise Creek and Barney Creek downstream of its junction with Surprise Creek are unstable. However, the modified design for the river diversion should improve river stability.
- Meaningful river reach analysis has now been completed for the McArthur River and for Barney and Surprise creeks and has been used in the redesign of the two diversion channels. The types of channel units or aquatic habitats have also be documented and included in the redesign of the river diversions.

Improvements in the design of the river diversions include

- Inclusion of artificial rock riffles in the diversion channels.
- Incorporation of large wood loadings, spacing, orientation and accumulations in the diversion channel design that mimick the current channel. However, large wood must be appropriately sourced and such sources have not been discussed.
- Details of the revegetation proposal have now been outlined.
- Meaningful discussion of sediment erodibility for the material used to form the banks of the diversion channel has been provided and the measures taken to decrease erodibility have been outlined.
- The modified designs for the diversion channels should be stable but need to be monitored at least annually until riparian vegetation is re-established.

The original predicted impacts of the diversion channels on up- and downstream channel morphology were based on the information contained in the Draft EIS and Supplement. The provision of better quality information in the Public Environmental Report has shown that the original predictions were overstated because:

- There are extensive bedrock bars and gravels exposed in the bed of the McArthur River and Barney Creek.
- The redesign of the diversion channels will result in a more stable channel than originally planned.
- Downstream deposition will not be as severe as originally predicted and a sand slug should not form.

- The banks of the diversion channel will be protected by rock-lining until dense riparian vegetation is re-established which will take more than 10 years.

The development of a government policy on river diversions and biodiversity offsets for river diversions would assist future assessment of similar proposals.

INTRODUCTION

This report was commissioned by Ms Juanita Croft and Mr Rod Johnson of Environmental Assessment, Northern Territory Environment Protection Agency, Department of Natural Resources, Environment and the Arts to critically review the new information included in the McArthur River Mine Open Cut Project Public Environmental Report (URS, 2006) for the proposed realignments of the McArthur River and Barney Creek for diversion around the proposed open cut pit.

The alignment of the two proposed diversion channels is shown in Figure 2.1 and a summary of the project modifications is outlined in Table 2.1 of URS (2006). The McArthur River diversion is discussed in Section 4 and the Barney Creek diversion in Section 5 of URS (2006).

The basis of this assessment is all of the following:

- URS' Draft Environmental Impact Statement for the original proposal (URS, 2005a).
- URS' Environmental Impact Statement Supplement for the original proposal (URS, 2005b).
- URS' Public Environmental Report for the modified proposal (URS, 2006).
- Field inspections of the McArthur River catchment in 2002.
- Aerial and on-ground inspections of the McArthur River, Barney Creek and Surprise Creek in the vicinity of the mine site on 18 May 2006 with representatives of URS and Northern Territory Environment Protection Agency.
- Air photograph interpretation of 1:50000 vertical air photographs flown in 1995.
- My earlier report on the original proposal (Erskine, 2006).
- Over 10 years lecturing and research on river restoration and river engineering.
- Previous and current research on channel diversions around open cut mines (for example, Hardie *et al.*, 1994).
- Continuing research on tropical river geomorphology and hydrology, including rivers draining to the Gulf of Carpentaria (for example, Erskine *et al.*, 2005; 2006a; 2006b; Saynor *et al.*, 2004; 2006a; 2006b).
- Continuing research on river rehabilitation (for example, Erskine, 2001; Erskine and Webb, 2003).
- Continuing research on the role of riparian vegetation and large wood in influencing channel morphology (for example, Erskine, 2003; Webb and Erskine, 2003a; 2003b).
- Use of HEC-RAS for the prediction of fish passage (Erskine, 2005a).
- River classification and reach analysis (for example, Erskine, 2005b; Erskine *et al.*, 2001; 2006a).
- Experience as a member of many expert scientific panels relating to rivers (Snowy River, Murrumbidgee River, rivers impacted by Snowy Mountains Hydroelectric Scheme, Coxs River, rivers impacted by Gosford-Wyong Water Supply Scheme, Daly River).

GUIDELINES FOR THE PREPARATION OF THE PUBLIC ENVIRONMENTAL REPORT

The Environment Protection Agency specified in its guidelines for the Public Environmental Report that the issues raised in Section 4.2 of the Environmental Assessment Report (Environment Protection Agency, 2006) and in Erskine (2006) should be addressed. The issues raised by Environment Protection Agency (2006) and not covered by Erskine (2006), included:

- Destruction of 6 km of riparian and riverine corridor.
- Resultant habitat fragmentation and its potential impacts on many species.
- Uncertainties on upstream and downstream aquatic environments.
- Effects on erosion and sedimentation and flow-on effects to other river reaches.
- Contaminant release through ground disturbance and metal mobilisation.
- Creation of a barrier to fish passage for smaller fish species and *Pristis microdon*.
- Establishment of a functioning ecological community on the realigned channel similar to the pre-disturbed McArthur River.
- Impacts on people living downstream.
- Implications for other Northern Territory and Australian rivers.

Erskine (2006) outlined the shortcomings in the information contained in the Draft EIS for the McArthur River Mine Open Cut Project Draft EIS (URS, 2005a) as:

- No hydrological information for Barney and Surprise creeks was provided.
- No errors were cited for the ground elevations for the photogrammetrically determined cross sections nor how these were translated into uncertainty in the calculated water surface levels in HEC-RAS hydrodynamic model.
- The adopted roughness coefficients were high but the HEC-RAS model calibration resulted in a poor fit to a known flood profile. The original roughness coefficients may be incorrect.
- The adopted grain size for McArthur River sediment was very fine and seemed inappropriate.
- There was a marked drawdown in the water surface profile immediately upstream of the diversion channel during the 1:2 and 1:5 year ARI events which produced very high shear stresses and specific stream powers that will cause erosion. This drawdown requires further investigation.
- Additional geomorphological work was required to determine whether the McArthur River and Barney and Surprise creeks are currently stable. No work had been undertaken on Barney and Surprise creeks.
- Meaningful river reach analysis needed to completed for the McArthur River and started for Barney and Surprise creeks to assist in the design of the two diversion channels. In particular, the types of channel units or aquatic habitats present must be documented.

Erskine's (2006) recommended improvements in the design of the diversion channels included:

- Supplying appropriate information for the Barney and Surprise creeks diversion channel.

- Following the methods outlined in the Rehabilitation Manual (Rutherfurd *et al.*, 2000a; 2000b) for the design of the diversion channels.
- Outlining the method used to derive the channel geometry for the McArthur River diversion channel.
- Incorporating the same aquatic habitats as exist in the current channel in the diversion channel design.
- Incorporating large wood loadings, spacing, orientation and accumulations in the diversion channel design that mimick the current channel. Large wood must be appropriately sourced.
- Providing meaningful information on the revegetation proposal, including species, seed source, planting densities, vertical zonation of species, etc.
- Meaningful discussion of sediment erodibility for the material used to form the banks of the diversion channel and what measures will be taken to decrease erodibility.
- Details of the proposed channel monitoring program.
- Offsets for the destruction of 8 km of river channel by the two channel diversions.

The predicted impacts of the diversion channels on up- and downstream channel morphology included:

- No information was provided in the EIS to make any meaningful predictions of the potential impacts of the Barney and Surprise creeks diversion channel.
- Upstream progressing degradation will occur on the McArthur River due to the drawdown immediately upstream of the diversion channel and the consequent very high shear stresses. No information was presented in the EIS to enable an assessment of the likelihood that armouring would reduce the magnitude of bed degradation.
- Downstream deposition will occur on the McArthur River, converting the channel into a sand slug.
- The banks of the McArthur River diversion channel will erode until dense riparian vegetation is re-established which will take more than 10 years.

The following discussion addresses the additional information and analyses contained in the Public Environmental Report and how these impact on the original assessments.

McARTHUR RIVER DIVERSION CHANNEL

Figure 4.4 of URS (2006) shows the proposed alignment of the McArthur River diversion channel and flood protection bund. Figure 4.5 shows the long section of the diversion channel and Figure 4.6 shows typical cross sections.

Hydraulics

Erskine (2006) noted that the use of photogrammetrically-derived cross sections introduced an error in the computed water surface levels for all discharges because the ground levels are usually accurate to only ± 0.1 m or worse. No error term for the heights for such cross sections was mentioned in Appendix K of the Draft EIS (URS, 2005a) or how it translated into uncertainty in the calculated water surface levels. It has now been established by URS (2006) that the photogrammetrically-determined levels are accurate to ± 0.2 m but that they have been supplemented by ground surveys of the channel near the mine, which are accurate to ± 0.05 m. New sensitivity analyses by URS (2006) found that survey errors of ± 0.2 m produce less than a 1 % change in water surface levels for discharges less than the 5 year ARI flood. Therefore, the HEC-RAS results are not sensitive to the known errors in the survey data.

URS (2006) found that the effect of the survey errors on hydraulic parameters was greater than for water surface levels. Nevertheless, the modelled hydraulic outputs are still useful for impact assessment and serve to indicate the likely potential changes due to the river diversion.

Erskine (2006) suggested that the original roughness coefficients used for model calibration of the January 2003 flood were high and noted that no supporting material was presented to justify the adopted values. Detailed work has now been completed in URS (2006) on estimation of the roughness coefficients, which has resulted in the use of spatially variable but appropriate values.

Model calibration of the January 2003 flood heights was relatively poor for the two gauging stations (approximately 0.5 m higher at the MIM gauge and 0.5 m lower at the DIPE gauge) for the original flood model, indicating that further work was still needed to refine the hydraulic model (Erskine, 2006). The use of variable instead of constant roughness coefficients at the cross sections used in HEC-RAS resulted in a much better fit to measured flood levels for the January 2003 flood in URS (2006). The recalibrated model underestimated flood peak heights by only 0.1 to 0.14 m (URS, 2006).

Erskine (2006) suggested that the equation and r^2 for the relationship shown in Figure K.4 of URS (2005a) should be added to the figure. This has now been completed (Chart 4.6 in URS (2006)). The HEC-RAS results for flow velocities plot within the scatter of the data measured at the gauging station, which is an acceptable result.

Erskine (2006) expressed concern at the magnitude of the specific stream power/shear stress on the McArthur River under natural and diverted conditions. Erskine (1999) found that when specific stream power exceeds 35 W/m^2, sand-bed channels usually erode. On the McArthur River, specific stream power often exceeds 80 W/m^2 and hence the channel should be either a very active sand-bed stream with many pockets of rapid bank erosion or contain long sections of channel protected by extensive bedrock bars exposed in the channel boundary. URS (2006) point out that the high specific stream powers calculated under natural conditions occurred where bedrock was exposed in the channel or where some large-scale flow restriction was present. I agree with this assessment following the aerial and on-site inspections of the McArthur River. Figure 1 shows some of the many bedrock bars that are present in the upstream anabranching reach. Figure 2 shows the extensive, steep bedrock rapids at the downstream end of Djurinmini Waterhole. Many trees have had their trunks snapped by the high shear stresses experienced on these rapids and most trees have a marked downstream lean.

While URS (2006) concluded that the channel of the McArthur River was stable upstream of the entrance to the diversion channel in the anabranching reach, there are pockets of bank erosion (Figure 4C). These pockets seem to occur where there are gaps in the riparian vegetation due to flood disturbance and/or grazing damage or where there are channel bifurcations around islands or where there are locally steeper sections over bedrock bars. The channel is not as active as originally expected (Erskine, 2006) because of the often dense riparian vegetation and the multiple bedrock bars. Nevertheless, the channel is also not as stable as suggested in URS (2006).

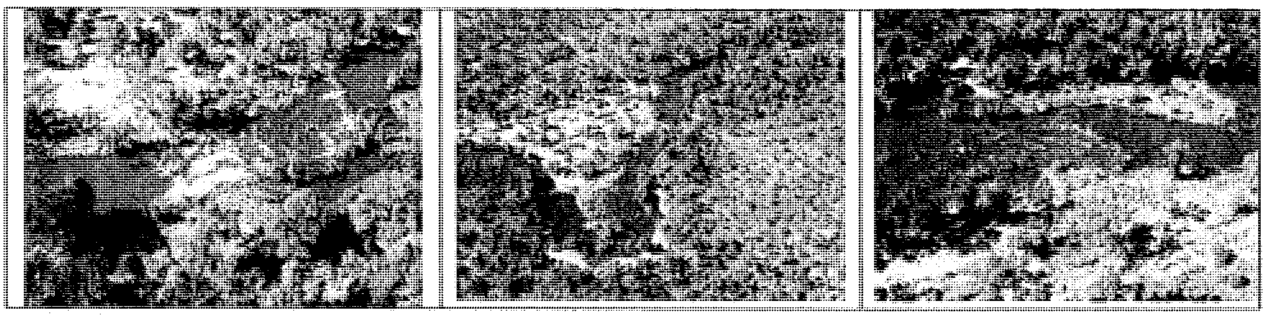

Figure 1. Bedrock exposed in the bed of the main channel in the upstream anabranching reach. (W.D Erskine photographs).

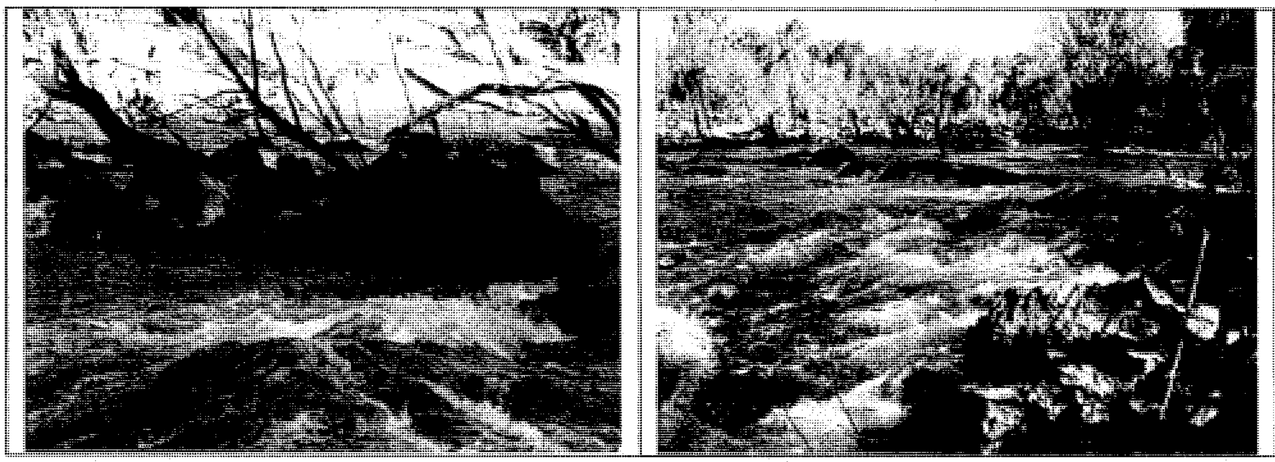

Figure 2. Steep bedrock rapids downstream of Djirinmini Waterhole showing downstream leaning trees and snapped tree trunks. (W.D Erskine photographs).

The design of the diversion channel has been modified so that it now incorporates, among other things (URS, 2006: Table 4.17 and text):

- Reduced slope for the upstream segment of the diversion channel where it is located in alluvium.
- Steeper slope for the section of the diversion channel excavated through bedrock.
- Inclusion of six artificial rock riffles (Newbury and Gaboury, 1993) in the diversion channel.
- Greater density of large woody debris.
- Additional floodplain width by modifying the flood protection bund.
- Stepped energy dissipation structure at the confluence with Bull Creek.
- Use of rock armour to protect alluvial banks from erosion.
- Use of geofabric to protect dispersible soils from erosion.
- A maximum stream power of 65 W/m^2 to enable vegetation to grow on the banks of the diversion channel.

The HEC-RAS results for the proposed modified diversion channel design show that flow velocities are usually kept below 2.2 m/s and that specific stream power is usually kept below 150 W/m^2 for flood events up to the 1:500 year flood. The rock-lining of the alluvial banks and the size of the gravel used in the artificial rock riffles should have been selected to withstand the calculated specific stream powers. While URS (2006) does not indicate that the shear stress procedure of Newbury and Gaboury (1993) was followed, the specific stream power method of Annandale (1995) was certainly used. Erskine (2006) recommended that the erodibility of the material to be exposed/filled on the banks of the diversion channels should be determined. The method of Annandale (1995) was used to quantitatively assess material erodibility in relation to specific stream power by URS (2006). It was found that the silty sand in the diversion channel had the lowest resistance to erosion but could withstand specific stream powers up to 95 W/m^2. This only applies to non-dispersible and/or non-slakeable material, which does not lose coherence on wetting. Dispersible sediment is so highly erodible that it totally and rapidly disaggregates when wet (Emerson, 1967) and will erode at very low specific stream powers. Bedrock in the diversion channel can withstand specific stream power of at least 17000 W/m^2. Unfortunately, sands up to 2 mm in diameter are mobilised by flows with specific stream powers of < 1 W/m^2 (Annandale, 1995: Tables 10 and 11). Such sands are present in the channel in the upstream anabranching reach (Figure 3) and will be transported into the diversion channel. While it is likely that the diversion channel will be stable, it is essential that its condition is assessed every dry season, at least until riparian vegetation has been re-established, which is likely to take at least 10 years.

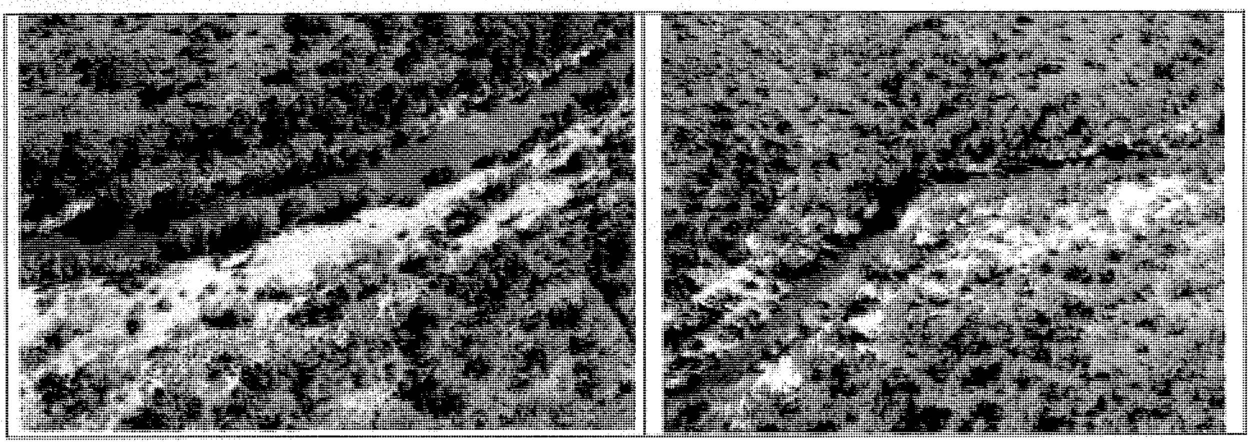

Figure 3. Sand deposits in the channel of the upstream anabranching reach of the McArthur River. (W.D. Erskine photographs).

Geomorphology

Erskine (2006) concluded that Section 12.6 of the Draft EIS was poor and needed revision so that it corrected the erroneous information presented on the fluvial geomorphology of the McArthur River. River reaches have now been defined for the McArthur River in Section 4.3 of URS (2006). Erskine (2006) also noted that channel reaches are the appropriate spatial scale to define specific reach or river types. This has now been done with the description of three reaches, namely the upstream anabranching reach, the low sinuosity mine reach and the Bukalara bedrock-confined reach downstream of the mine (Figure 4). These reaches were discussed on-site with URS personnel and revise the errors in the Draft EIS. The photographs in Figure 5 confirm the data in the Public Environmental Report (URS, 2006).

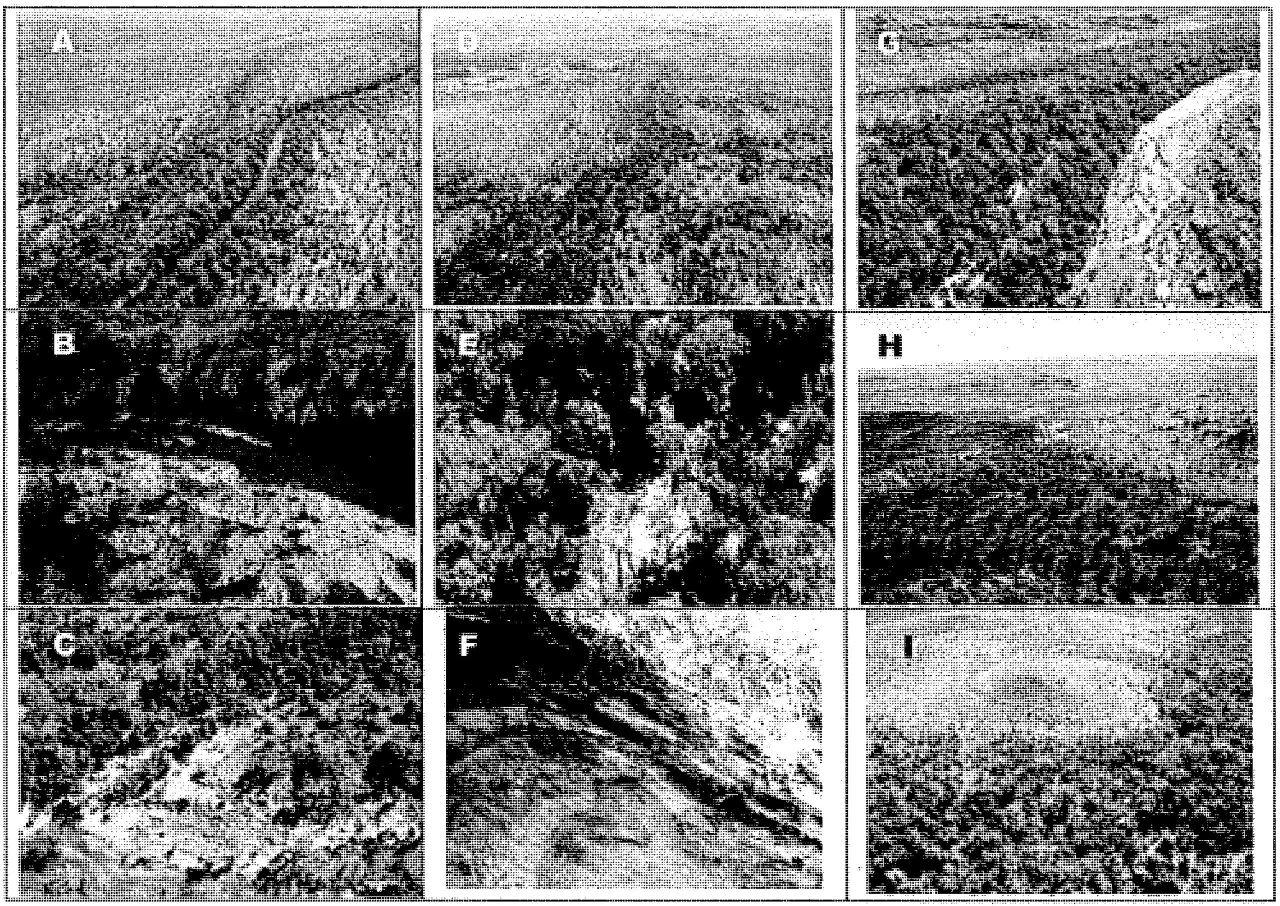

Figure 4. (A) Upstream anabranching reach showing the deep main channel and shallower anabranches on the wide floodplain. (B) One of the numerous bedrock bars in the river bed of the main channel of the anabranching reach, which were not mentioned in the Draft EIS (URS, 2005a). (C) One of the occasional examples of bank erosion present in the anabranching reach, which were not mentioned by URS (2006). (D) The low sinuosity mine reach next to the test pit. (E) Run which is the dominant channel unit in the low sinuosity mine reach. (F) Steeply channel-dipping, intercalated mud and sand units which have been obliquely accreted on the channel banks of the low sinuosity mine reach. (G) Well-vegetated Bukalara bedrock-confined reach downstream of the mine. (H) Another example of a well-vegetated section of the Bukalara bedrock-confined reach (I) Bedrock mound beside the channel in the Bukalara bedrock-confined reach. Such mounds also occur on the floodplain in the upstream anabranching reach (All photographs by W.D. Erskine).

Pools and riffles have been included in the design of the diversion channel because of the inclusion of artificial rock riffles. Pools and riffles involve morphological complexity in the bed profile that create diverse hydraulic conditions that will assist fish passage through the diversion channel. While the low sinuosity mine reach is characterised by an essentially continuous run, the proposed channel units for the diversion channel are still appropriate.

Erskine (2006) noted that the citation of data for one cross section at the DIPE gauging station in the upstream anabranching reach must be supplemented by additional data to justify calling the existing channel near the mine as stable (see URS, 2005a, Appendix K, p. K-24). The representativeness of a single piece of site specific data is always a concern. By itself, it is not helpful. As noted in URS (2006), aerial inspection of the upstream anabranching reach revealed numerous bedrock bars in the bed of the main channel and occasional sections of bank erosion (Figure 4C). Furthermore, high parts of the floodplain were also eroded by rilling and gullying and appeared to be associated with overgrazing of dispersible/slakeable soils (Figure 5).

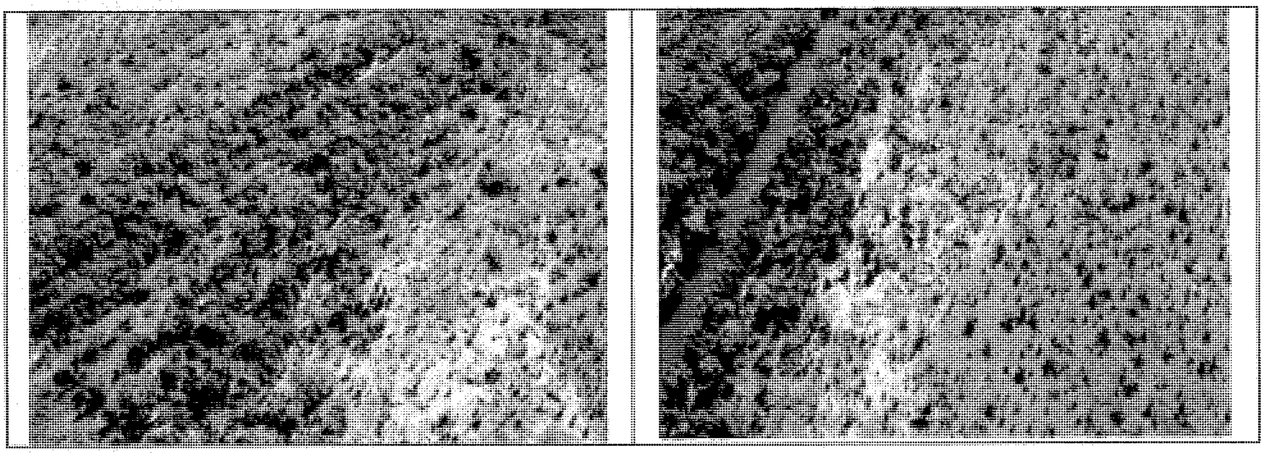

Figure 5. Natural levees in the upstream anabranching reach eroded by rilling and gullying of dispersible/slakeable soils (W.D. Erskine photographs).

Erskine (2006) predicted that upstream progressing degradation will occur upstream of the diversion channel because of the very high specific stream power. The Draft EIS did not discuss whether bedrock was exposed in the channel boundary where the HEC-RAS model indicated that there were very high specific stream powers. Armouring is a natural self-stabilising tendency of rivers which selectively erodes the finer sediment in the bed material and concentrates the coarser sediment on the bed surface. Gravel armour layers produced by bed degradation are monolayers that coat and hence protect the finer underlying sediment from erosion. The Draft EIS did not investigate armour layers. My initial concerns have been reduced because bedrock is exposed in the channel bed at sites of high specific stream power and a significant gravel fraction is present in many sections of channel in the upstream anabranching reach (see above).

Similarly the predicted deposition downstream of the diversion channel on the McArthur River is not as significant an issue as first assessed because upstream sediment supply is unlikely to be as great as initially predicted. Upstream bed degradation and bank erosion of the diversion channel are unlikely to be as great as predicted because of the modifications to the diversion channel design in the Public Environmental Report and the presence of bedrock in the channel boundary. The predicted sand slug should not form, provided the diversion channel performs as predicted in URS (2006).

The banks of the diversion channel have also been redesigned so that they will be protected by a gravel armour layer and the specific stream power of the redesigned diversion channel are now lower than originally designed. The six artificial rock riffles also reduce the slope of the energy grade line.

The time needed for plant establishment will be relatively long in this strongly seasonal climate. Dispersible sediment may also cause major erosion problems. Therefore, it is essential that annual inspections of the diversion channel are conducted at least until riparian vegetation is well established.

Aquatic Habitats

Hawkins *et al.* (1993) defined channel units (or aquatic habitats) as quasi-discrete areas of relatively homogeneous depth and flow that are bounded by sharp physical gradients. Each channel unit exhibits different physical characteristics and can also be associated with habitat-specific fish species assemblages (Petersen and Rabeni, 2001a; 2001b). Erskine (2006) concluded that it is essential to know what aquatic habitats or channel units are present on the channels that will be diverted so that they can be incorporated into the design for the diversion channels. Section 4.4 in the Public Environmental Report (URS, 2006) discusses the results of a field survey of aquatic habitats of the low sinuosity mine reach of the McArthur River which is used as an analogue of the diversion channel. The channel unit that dominates this reach is the run set within well-vegetated, steep-sided banks of a sand-bed, low sinuosity main channel flanked by high natural levees. Living trees and large woody debris are important structural habitats.

Erskine (2006) noted that there were no data on large wood loadings, spacing, orientation and accumulations in the Draft EIS (URS, 2005a). Large wood has now been incorporated into the design of the two diversion channels, based on the characteristics of large wood in the current channel (see Section 4.4 on Aquatic Habitats in URS (2006)). However, appropriate sources of large wood have still not been identified to ensure that existing trees are not removed from river channels and floodplains. Large wood often induces scour that forms a range of pool types that are important aquatic habitats (Webb and Erskine, 2005). Such scour is unlikely in the bedrock sections of the diversion channel but may occur in the alluvial sections.

Revegetation

Erskine (2006) strongly supported the revegetation proposal, but noted that there were no details of the program contained in the Draft EIS (URS, 2005a). A revegetation management plan has been included in the Public Environmental Report (URS, 2006) as part of the rehabilitation works and covers species selection, vertical zonation of species, seed sources, maintenance of genetic integrity, site preparation, planting techniques, etc. Long stem plantings should be trialled because they have proved very effective in surviving without irrigation in southern Australia (Dr Anita Chalmers, 2006, personal communication).

BARNEY CREEK DIVERSION CHANNEL

Figure 4.4 of URS (2006) shows the proposed alignment of the McArthur River diversion channel and flood protection bund. Figure 5.3 shows the long section of the diversion channel and Figure 5.4 shows typical cross sections.

Erskine (2006) noted that little design information on the Barney Creek diversion channel was included in the Draft EIS (URS, 2005a) and that no hydrological data were presented. Furthermore, he also concluded that the fluvial geomorphology and aquatic habitats of Barney and Surprise creeks were not addressed in the Draft EIS (URS, 2005a) and so the diversion channel design could not be assessed as to how well it mimicked the natural channel.

The design of the Barney Creek diversion channel has been modified since the Draft EIS and its Supplement (URS, 2005a; 2005b). The fluvial geomorphology and aquatic habitats of Barney and Surprise creeks are discussed in Sections 5.3 and 5.4, respectively of the Public Environmental Report (URS, 2006). Significantly, field inspections have established that the lower section of Barney Creek is often backwater-affected by the McArthur River, as evidenced by its channel morphology and the perched nature of the channel bed of Barney Creek above the main stream. Furthermore, there are many bedrock outcrops in the channel and gravel lag deposits. Nevertheless, there are extensive areas of bank erosion, pool scour and flood chute development on Surprise Creek (Figure 6). These indicate that Surprise Creek is not as stable as Barney Creek and responds to floods.

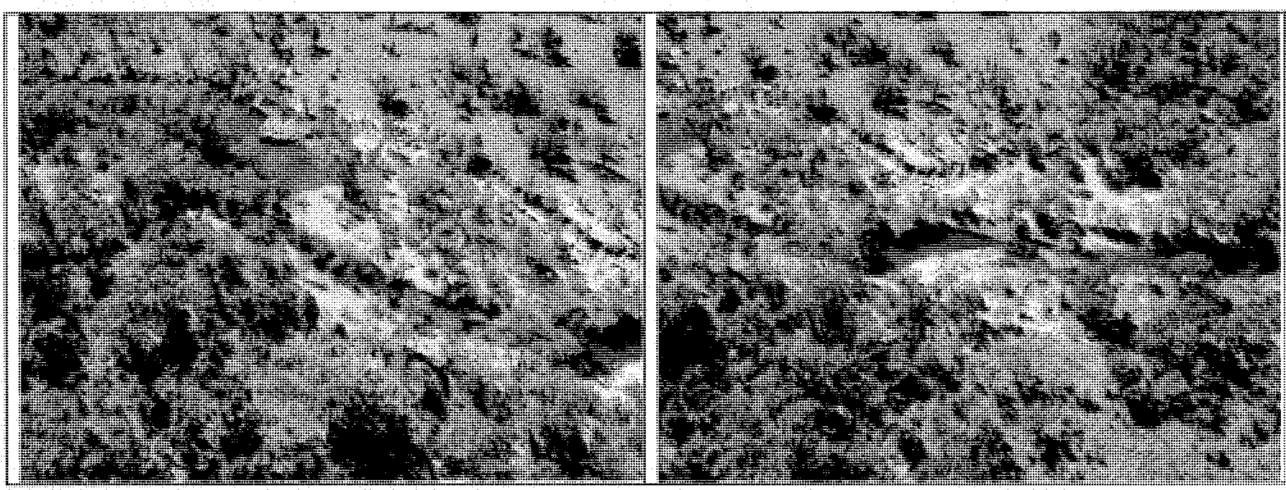

Figure 6. Bank erosion, pool scour and flood chute development on Surprise Creek. (W.D. Erskine photographs).

Design peak flow estimates have now been calculated and are shown in Table 5.2 of the Public Environmental Report (URS, 2006). Furthermore, an extreme storm on Surprise Creek has also been considered in Section 5.5.2.

Following the procedure discussed above for the McArthur River, URS (2006) have evaluated spatially variable roughness coefficients for the HEC-RAS hydraulic model. The adopted values (Tables 5.3 and 5.4 and text in URS (2006)) are appropriate.

For the hydraulic modelling using HEC-RAS, URS (2006) have evaluated the effects of backwater from the McArthur River and no backwater as well as the extreme storm over the Surprise Creek catchment. No backwater from the McArthur River would represent an extreme case scenario. Under existing conditions, very high specific stream powers and shear stresses (>100 N/m^2 and >300 W/m^2, respectively) are experienced on Surprise Creek and Barney Creek downstream of the Surprise Creek junction. These channels are eroding and exhibit flood chutes which have been excavated into the floodplain (Figures 6 and 7). URS (2006) called the chutes on lower Barney Creek, cutoffs, but they are not abandoned channels in former meander loops, as occurs with cutoffs (Erskine and Melville, 1982; Erskine *et al.*, 1992). Instead, they are actively functioning channels that convey flood waters and are eroding the floodplain. They are not currently stable, as stated in the Public Environmental Report (URS, 2006: p. 5-24).

The original design for the Barney Creek diversion channel would have caused erosion because 600 mm diameter rock would have been mobilised (URS, 2005a: p. 5-27). Therefore, the diversion channel design has been modified as outlined in pp. 5-28 to 5-30 in the Public Environmental Report (URS, 2006). Seven artificial rock riffles (Newbury and Gaboury, 1993) have been included along with coarse rock-lining of the bed and/or banks at many locations, among other things. The modifications reduce maximum flow velocities to below those currently experienced in the natural channel. From the HEC-RAS results for the modified diversion channel and the results of an erodibility assessment using Annandale (1995), the modified diversion channel will withstand the shear stresses and specific stream powers, provided all the protection works outlined in the Public Environmental Report (URS, 2006), are implemented.

Figure 7. Flood chute and low flow channel on lower Barney Creek downstream of the Surprise Creek junction. (W.D. Erskine photograph).

The Public Environmental Report (URS, 2006) has largely addressed all of the issues that I raised in my earlier report (Erskine, 2006). To ensure that the Barney Creek diversion channel functions as designed, it is essential that annual inspections of the diversion channel are undertaken until riparian vegetation has been re-established. This will take at least 10 years. The frequency of inspections can be reduced thereafter.

A revegetation management plan has been included in the Public Environmental Report (URS, 2006) for the Barney Creek diversion channel as part of the rehabilitation works and should be implemented.

OTHER ISSUES

The McArthur River Mine Open Cut Project has been assessed in the absence of a government policy for river diversions in the NT. Clearer direction and guidelines to government agencies, developers and interested individuals for any such future proposals would occur if the NT Government was to develop a policy on river diversions.

A diversion channel monitoring program involving geomorphology, hydrology, hydraulics and ecology should be implemented if approval is given to the present proposal.

Biodiversity offsets covering the realigned diversion channels should also be covered by Government policy. Rehabilitation of at least an equivalent length of channel to that destroyed by the two diversions (8 km) should be included in any proposal for a river diversion. There needs to be a strong economic incentive for mining companies to exhaustively consider all alternatives to river diversions and, if a diversion is the only option, its length should be reduced to the shortest possible.

CONCLUSIONS

The shortcomings in the information contained in the Draft EIS and Supplement for the McArthur River Mine Open Cut Project have been meaningfully addressed in the Public Environmental Report (URS, 2006). In particular,

- Hydrological information is now presented for Barney and Surprise creeks.
- The errors in ground elevation for the photogrammetrically determined cross sections have been discussed along with how these are translated into uncertainty in the calculated water surface levels in HEC-RAS.
- The adopted roughness coefficients have been changed so that they are spatially variable to cover the range of site conditions. The calibrated flood model, as a result, has a much better fit to a known flood profile.
- The very high shear stresses and specific stream powers in the current channel of the McArthur River coincide with extensive bedrock outcrops.
- Additional geomorphological work has shown that the McArthur River is generally stable, except for some minor pockets of bank erosion. Surprise Creek and Barney Creek downstream of its junction with Surprise Creek are unstable. However, the modified design for the river diversion should improve river stability.
- Meaningful river reach analysis has now been completed for the McArthur River and for Barney and Surprise creeks and has been used in the redesign of the two diversion channels. The types of channel units or aquatic habitats have also be documented and included in the redesign of the river diversions.

Improvements in the design of the river diversions include

- Inclusion of artificial rock riffles in the diversion channels.
- Incorporating large wood loadings, spacing, orientation and accumulations in the diversion channel design that mimick the current channel. However, large wood must be appropriately sourced.

- Details of the revegetation proposal have now been outlined.
- Meaningful discussion of sediment erodibility for the material used to form the banks of the diversion channel has been provided and the measures taken to decrease erodibility have been outlined.

The original predicted impacts of the diversion channels on up- and downstream channel morphology were based on the information contained in the Draft EIS and Supplement. The provision of better quality information in the Public Environmental Report has shown that the original predictions were overstated because:

- There are extensive bedrock bars and gravels exposed in the bed of the McArthur River and Barney Creek.
- The redesign of the diversion channels will result in a more stable channel than originally predicted.
- Downstream deposition will not be as severe as originally predicted and a sand slug should not form.
- The banks of the diversion channel will be protected by rock-lining until dense riparian vegetation is re-established which will take more than 10 years.

The development of a government policy on river diversions and biodiversity offsets for river diversions would assist future assessment of similar proposals.

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18 Appendix 4 - PER Guidelines

GUIDELINES FOR PREPARATION OF A PUBLIC ENVIRONMENTAL REPORT

McARTHUR RIVER MINE EXPANSION

May 2006

ENVIRONMENT PROTECTION AGENCY PROGRAM

epa northern territory

GUIDELINES FOR PREPARATION OF A PUBLIC ENVIRONMENTAL REPORT

McARTHUR RIVER MINE EXPANSION

May 2006

ENVIRONMENT PROTECTION AGENCY PROGRAM

Northern Territory Government
Department of Natural Resources, Environment and the Arts

1 Purpose & Legislative Requirements

The proposed expansion of the McArthur River Mine by McArthur River Mining Joint Venture (MRM) ("proponent"), which is wholly owned subsidiary of Xstrata, has been assessed under the *Environmental Assessment Act* at the level of an Environmental Impact Statement (EIS). The Minister for Natural Resources, Environment and Heritage (the Minister), under clause 14 of the Environmental Assessment Administrative Procedures of the *Environmental Assessment Act* (the "Administrative Procedures") recommended to the Responsible Minister (the Minister for Mines and Energy) that the proposal as outlined in the EIS (the draft EIS and its Supplement) should not proceed. Assessment Report 51 outlined the findings of the Minister, raising a number of issues of concern, including the proposed engineering of the McArthur River and Barney Creek diversions.

As a consequence, the Minister for Mines and Energy informed the proponent that these outstanding environmental issues needed to be resolved to the satisfaction of the Minister for Natural Resources, Environment and Heritage before he could consider whether or not the mine should be authorised to expand to open cut.

The proponent has formally notified the Minister and the Responsible Minister of their intention to amend the proposal under clause 14A of the Administrative Procedures to address the concerns raised in Assessment Report 51. The Minister has determined that the proposed alterations are to be formally assessed under the *Environmental Assessment Act* at the level of a Public Environmental Report (PER).

These Guidelines have been developed to assist the proponent in preparing a PER for the amendments to the proposed expansion to the McArthur River Mine in accordance with Clause 8 of the Administrative Procedures. The Administrative Procedures state that the Minister will specify the following in the direction to the proponent:

- the matters relating to the environment which the proponent shall deal with in the PER;
- the timeframe for submitting the report to the Minister;
- the number of copies of the report to be provided to the Minister/responsible Minister/other agencies and persons;
- the newspapers in which, and occasions when, the proponent will publish a notice making the PER available for public comment.

2 General

The PER needs to demonstrate that the findings of the Assessment Report 51 have been examined and addressed by the proponent through the collection of further appropriate data, the provision of supporting information, the redesign of the proposal, the preparation and demonstration of appropriate management measures (including plans and strategies), the proposed monitoring plans to be implemented and the formulation of contingency plans (where appropriate).

3 The Proposal

Identify and describe the proposed alteration(s) to the expansion proposal which prompted the clause 14A notification under the *Environmental Assessment Act*. This should include changes to the nature and extent of proposed works and the change in environmental significance of the proposal by virtue of the alterations.

An explanation of the objectives, benefits, costs and justifications for the alterations to the project should also be included.

4 Alternatives

Alternative proposals, which may still allow the objectives of the project to be met, should be discussed, detailing reasons for the selection and rejection of particular options. The short, medium and long-term potential beneficial and adverse impacts of each of the options should be considered.

5 Diversion of the McArthur River and Barney Creek

Section 4.2 and Appendix 1, Assessment Report 51

5.1 McArthur River

Provide details of the design measures and proposed management strategies to demonstrate that downstream and upstream impacts to the McArthur River system, and impacts to the diversion channel, are minimised in any altered diversion design taking into account the issues raised in Appendix 1 of Assessment Report 51. The potential for disturbance to sacred sites must also be taken into account in design changes.

The proponent needs to demonstrate that:-

- The river diversion channel is able to be maintained over the mine life and is self-sustainable at mine closure, requiring no periodic, long term intervention, with specific consideration to bankfull flooding events as well as the larger flooding events (up to 1 in 500 year ARI);
- The river diversion will not impact on other mine components, including the flood protection bund, during flood events;
- River morphology upstream and downstream of the realignment can be maintained during mine life and after mine closure;
- The aquatic habitat integrity can be maintained both downstream (including estuarine, wetland and coastal areas) and upstream through the life of the mine and after mine closure; and
- A functioning aquatic, riparian and riverine system in the diverted river channel is able to be established and sustained within a timeframe that would not cause fragmentation of fauna populations in the medium- to long-terms.

The proponent needs to provide detailed characterisation of the in-stream and riparian habitats of the existing river channel and detailed biological design specifications proposed for the realigned channel.

5.2 Barney and Surprise Creeks

The proponent is to provide details of the proposed diversion of Barney and Surprise Creeks to demonstrate that it will not impact on other mine components, including the flood protection bunds and the overburden emplacement facility (OEF), during flood events. In particular, details of the design for the diversion channels should be outlined.

Provide appropriate information for the Barney and Surprise Creeks diversion channel, including hydrological and geomorphological information to support the proposed diversion. Backwater conditions from the McArthur River are unlikely during tropical cyclones which move from the Gulf across land. All hydraulic modelling should assume no backwater.

6 Waste Management

Section 4.3, Assessment Report 51

The proponent is to describe preventative measures and strategies proposed to ensure that contaminants mobilised from overburden in the overburden emplacement facilities and any other areas where overburden has been used for mine structures or otherwise, will not enter the McArthur River.

Undertake and provide results, if available, of leach testing of any overburden material to be used for construction of mine structures or placed within the OEF to determine the potential for metal mobilisation from the material, including non-acid forming (NAF) waste.

Provide a risk management strategy with detailed contingency options in the event that non-acidic drainage is found to be a potential source of contaminants.

7 Tailings Storage Facility

Sections 4.3.2 and 4.7.2, Assessment Report 51

The proponent is to provide details of the proposed design, and operational and management strategies of the tailings storage facility (TSF), including ongoing maintenance and monitoring requirements (beyond mine life), to demonstrate that it will not impact on the receiving environment..

The proponent is to discuss alternative methods of seepage control from the tailings storage facility and identify the risks associated with the controls. In identifying the preferred management approach, the proponent is to:-

- o demonstrate the feasibility of approach in the long-term (after mine closure), accounting for ongoing costs; and
- o demonstrate that the risk of impacts to the receiving environment will be minimal, including but not limited to the risks to surface water, groundwater and soils of contamination from tailings. If groundwater recovery systems are

to be used, the proponent needs to consider the possible drawdown impacts to surrounding groundwater resources and the potential flow on effects including impacts on biota and environmental flows. The proponent should consider undertaking numerical modelling in addressing these issues.

The proponent is to undertake modelling of the proposed tailings storage facility to account for best- and worst-case scenarios into the long term (>30 years) to determine the risk of these scenarios occurring and the predicted probable environmental impact. Management options for minimization of the risks of any adverse environmental impacts occurring should be presented.

The proponent is to provide details of the proposed disposal of contaminated sludge in the TSF and the medium and long term implications for the receiving environment of this sludge disposal on seepage from the TSF.

8 Surface Water

Section 4.4 Assessment Report 51

The proponent is to demonstrate that the potential for contaminants entering the aquatic environment (including freshwater and saltwater) will be minimal.

8.1 Water and sediment quality

Provide details of the management measures proposed to minimise the potential for contaminants entering the aquatic environment.

- Further investigation is required to determine the potential for ongoing transport of metals into the aquatic environment from material used to construct mine components including the OEF, the TSF embankments, the excavated material from the realignments and the flood protection bund.
- Discuss the fate of metal species derived from the exposure of mine mineralisation in the receiving environment including the long-term impacts to downstream biota.
- Detail the monitoring that would be implemented for any material including NAF products from mine site components and the contingencies in the event that elevated metals or other contamination is identified..
- Sediment data is required from the freshwater reaches of the McArthur River downstream of the mine and from appropriate upstream locations to determine the presence of contaminants from the existing mining activities, to estimate the potential for further contamination of sediments from any proposed open cut mine activities and to inform any future monitoring program.
- Dilution/hydraulic modelling is required to determine appropriate minimum river flow/stage height requirements for a discharge regime to deal with any diluted TSF effluents that may need to be discharged during heavy rainfall events.
- Provide details on the proposed expansion to the monitoring program for the McArthur River estuary and Sir Edward Pellew Islands.

8.2 Flood protection bund

The proponent is to demonstrate that the integrity of the flood protection bund can be maintained in the short- and long-terms during flood events, including the northern wall of the bund that is proposed to protect the mine infrastructure from flooding in the realigned Barney Creek channel.

Detail contingencies in the event that the flood bund is breached. Include potential impacts on, and measures for clean-up and rehabilitation of, the downstream environment should sediment loads from eroded bund material impact the McArthur River or contamination of the aquatic environment occur.

9 Groundwater

Discuss the possible ecological impacts associated with drawdown on Djirrinmini waterhole (a registered sacred site) during a period when it will be most stressed. This information can inform future baseline data collection and a monitoring program.

Discuss the ecological impacts of the extension of the no-flow period in the McArthur River in light of revised hydrological modelling.

10 Biology

A preliminary assessment of the potential for the project to impact on the Freshwater Sawfish *Pristis microdon* must be presented, and management and mitigation measures to minimise these impacts needs to be provided.

An assessment of the potential for the project to impact on the threatened White-browed Robin must be presented and measures to minimise these impacts provided.

Provide information on the potential impacts of the Bing Bong Port operation on migratory bird species and include a program to monitor these impacts.

11 Heritage

Present options for the preservation of archaeological site MRM4. Provide information on the consultations undertaken with the Traditional Owners regarding the possible cultural significance of this site.

12 Social Impact

The proponent should provide a community engagement strategy to be implemented for the life of the mine, outlining appropriate mechanisms for communication with all stakeholders (ensuring effective community and language group representation).

Describe the likely economic and social benefits and contribution of the project to the local region and its communities (including the Sir Edward Pellew Islands) with particular consideration given to opportunities for local industry and Indigenous workforce participation in the construction, future operation and servicing of the mine including outlining how any potential local business and employment opportunities will be identified, communicated and managed. Consideration needs to be given to how economic input to the region's communities is to be managed.

13 EPBC Act matters

The proponent should address the information requirements of the Australian Government Department of the Environment and Heritage within the PER document.

14 Administration

The nominated Action Officer for this project is Mr Rod Johnson from the Environment Protection Agency Program, Department of Natural Resources, Environment and the Arts (NRETA). The contact telephone number is (08) 8924 4139 and facsimile number (08) 8924 4053, e-mail: roderick.johnson@nt.gov.au.

Copies of the final guidelines will be posted on the NRETA website at:

http:// www.nt.gov.au/nreta/environment/assessment/register

Approximately 28 bound copies of the PER will be required for distribution to the Australian and NT Government and advisory bodies. In addition, 8 CD ROM copies (in ADOBE*.pdf format) plus two unsecured Microsoft Word copies should be submitted (to allow placement on the Office's Internet site and to facilitate production of the Assessment Report and Recommendations).

The proponent has the responsibility of advertising the public exhibition of the PER in Territory and National newspapers. The proponent is required to place the PER on public exhibition for a 4 week period. The PER is to be made available for public viewing at the following locations:

- Northern Territory Library, Parliament House, Cnr Bennett and Mitchell Streets, Darwin NT;
- Darwin Public Library, Civic Centre, Harry Chan Avenue, Darwin NT;
- Casuarina Public Library, Bradshaw Terrace, Casuarina, NT;
- Palmerston Public Library, Civic Plaza, Cnr University Avenue and Chung Wah Terrace, Palmerston, NT;
- Commonwealth Department of the Environment and Heritage Library, John Gorton Building, King Edward Terrace, Parkes, ACT;
- Information NT, Palmerston Shopping Centre;
- Department of Planning and Infrastructure, Cavenagh House, Cavenagh Street, Darwin, NT; and
- Locations within the Borroloola township as appropriate.

In accordance with clause 8(6(c)) of the Environmental Assessment Administrative Procedures, the proponent shall also provide a copy of the PER to the following organisations and persons for comment:

- The Environment Centre of the Northern Territory;

- The Northern Land Council;
- Australian Aboriginal Protection Authority;
- Mabunji Aboriginal Resource Association;
- The McArthur River Mining Community Reference Group;
- MAWA;
- The Borroloola Community Government; and
- The Department of the Environment and Heritage (Australian Government).

The proponent should also consider producing at least several copies for direct sale to the public, on request.