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

for

NT Environment Protection Agency Program (NRETA)

by

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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).

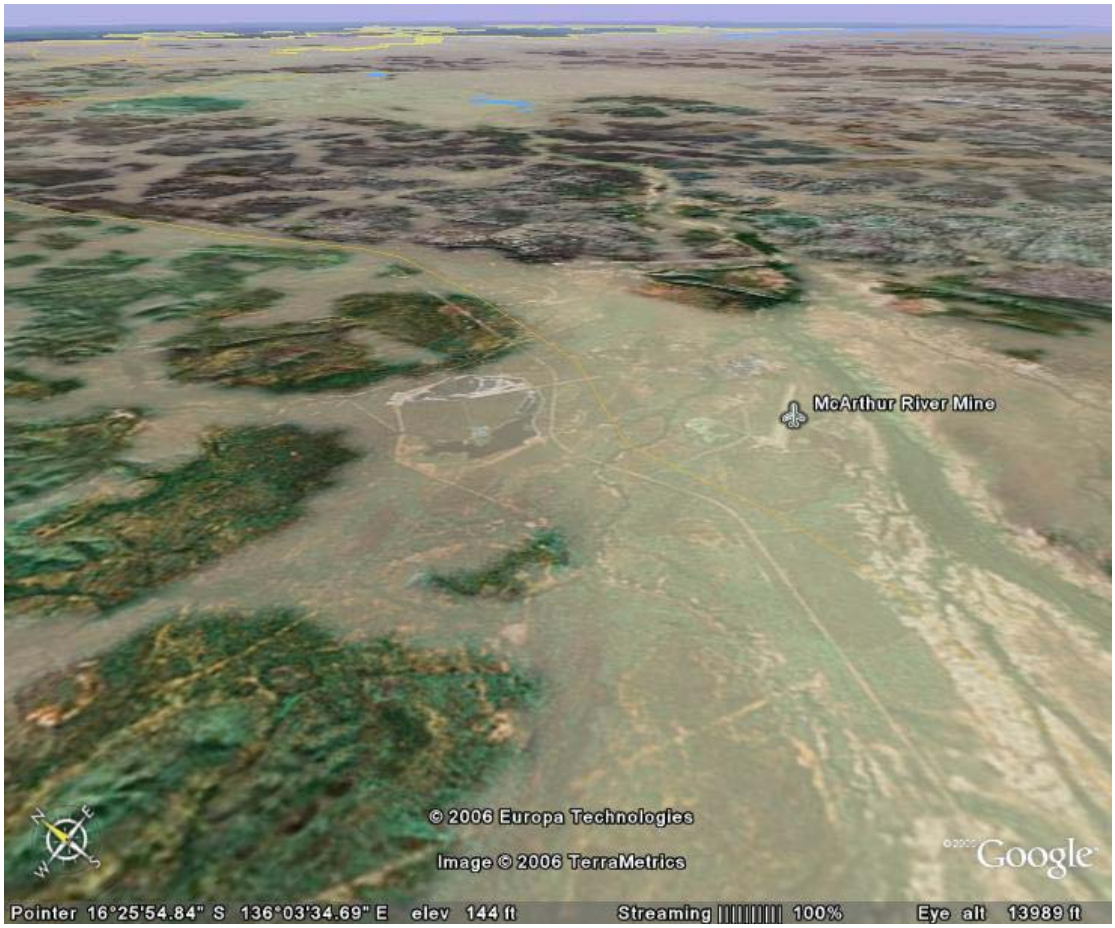

Figure 1 Valley bottom extent indicating alluvial landforms

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.

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5 REFERENCES

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