



REPORT NO.

210015

**INDEPENDENT MONITOR AUDIT REPORT –
ENVIRONMENTAL PERFORMANCE OF THE MCARTHUR
RIVER MINE – 2009 OPERATIONAL PERIOD**

**ENVIRONMENTAL EARTH SCIENCES VIC
REPORT TO THE DEPARTMENT OF RESOURCES**

AUGUST 2010





EXECUTIVE SUMMARY

Environmental Earth Sciences was appointed by the (then) Northern Territory Department of Primary Industry, Fisheries & Mines, now the Department of Resources, in December 2007 to act as the Independent Monitor for the McArthur River Mine. The role of the Independent Monitor is to annually assess the environmental performance of the McArthur River Mine operations. This assessment is undertaken through a review of environmental monitoring undertaken by McArthur River Mining (MRM), and the procedures by which the Northern Territory Department of Resources monitors and regulates the Mine.

Outcomes

Compliance assessment of MRM

McArthur River Mining has demonstrated an adequate level of procedural compliance with environmental commitments and conditions of the 2008/2009 Mining Management Plan. However, associated observations have been made by the Independent Monitor to recommend improvement measures.

Four procedural non-conformances were noted by the Independent Monitor; these related to MRM's commitment to undertake:

- monitoring of a potential sedimentation zone in the McArthur River downstream to the Bukalara Range;
- the installation of lysimeters in the Overburden Emplacement Facility at various stages to monitor water infiltration;
- water quality and sediment monitoring at the Overburden Emplacement Facility dams; and
- kinetic leach testing on-site and within laboratory columns.

Two other commitments could not be confirmed due to a lack of documentation provided to the Independent Monitor.

Procedural assessment of the Department of Resources

The Department of Resources displayed marked improvement in the amount and detail of information provided to the Independent Monitor compared with previous audits. The Department of Resources demonstrated thorough administrative procedures that are carried out by the Department of Resources in their assessment of mining management documentations. The Independent Monitor, however, recommended that a capability and organisational structure chart be developed for the Department to improve resourcing and ensure mining assessments and reviews are matched with appropriately-skilled personnel.

Technical review - significant issues

No issues were identified as requiring urgent investigation this audit; however, the following issues are considered significant and require corrective action to improve MRM's environmental performance:

- excess water storage within the Tailings Storage Facility, which poses the risk of overflowing and embankment failure due to spillways being under-designed for a flood event;



- seepage migration from the Tailings Storage Facility to Surprise Creek and the hazard classification of tailings in Cell 1 and Cell 2;
- fugitive dust emissions from the ROM (Run of Mine) Pad and mine site crushing facilities;
- further reduction of fugitive dust emissions from the Bing Bong concentrate storage shed;
- detail and quality of reporting of the dust, soil and sediments monitoring program (inclusion of long term trends and base studies.);
- weed management along river diversion channels and the mine site; and
- structural integrity of the Bing Bong dredge spoil ponds; and testing of the Tailings Storage Facility Cell 1 clay cap to ensure it meets design specifications.

Technical review - minor issues

Minor issues that are considered to require medium-term rectification relate to:

- inadequate analysis of the accuracy, reproducibility and precision of routine monitoring results collected by MRM;
- rapid maintenance of fencing (damaged by annual floods), or relocation of fence line, to keep cattle away; and
- procedures and results for in-place testing of the clay liner of the Overburden Emplacement Facility.

Other issues

The Independent Monitor identified the following requirements to improve environmental performance:

- improved technical interpretation to evaluate trends in monitoring data (both spatially and with time);
- provision of “as-built” construction reports for the Tailings Storage Facility Cell 1 and Overburden Emplacement Facility;
- increase the amount of fallen timber within the river diversions for habitat creation; and
- undertake immediate and medium-term studies and rectification works in relation to:
 - weed management at the Mine site;
 - stability of the Bing Bong dredge spoil; and
 - the rate and quality of leachate migration and geochemical testing at the Tailings Storage Facility.

Concluding comments

MRM have continued to improve their environmental performance this audit, particularly regarding the management of urgent significant issues identified by the Independent Monitor during the last audit. Whilst, the need for improved environmental performance is ongoing, we recognise that MRM have recently advised of their intent to address many of the abovementioned issues.

Both MRM and the Department of Resources are advised to consider all recommendations provided by the Independent Monitor within this report. Further improvements from these recommendations will be assessed as part of subsequent Independent Monitor audits.



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TABLE OF CONTENTS

1	INTRODUCTION.....	1
1.1	REGULATORY AND OTHER REQUIREMENTS OF THIS AUDIT	1
1.2	OBJECTIVES	4
1.3	AUDIT SCOPE AND CONSTRAINTS	4
2	BACKGROUND.....	5
2.1	RELEVANT LEGISLATION AND GUIDELINES	5
2.2	PREVIOUS INDEPENDENT MONITOR AUDITS	6
2.2.1	2007 Operational Period Audit	6
2.2.2	2008 Operational Period Audit	7
2.3	MRM SHUTDOWN PERIOD 2008/2009	8
3	METHOD OF AUDIT.....	9
3.1	SITE INSPECTION	10
3.2	PERSONNEL INTERVIEWED	10
4	RISK ASSESSMENT.....	11
4.1	PURPOSE, OBJECTIVES AND SCOPE OF RISK ASSESSMENT	11
4.2	STAKEHOLDERS	12
4.3	METHODOLOGY	12
4.3.1	Risk identification and analysis	12
4.3.2	Risk evaluation	13
4.4	OUTCOMES OF RISK ASSESSMENT	13
4.4.1	Update from previous risk assessment	13
4.4.2	Recommendations from risk assessment	15
5	GAP ANALYSIS.....	15
5.1	INTRODUCTION	15
5.1.1	Gap identification and assessment	15
5.1.2	Gap evaluation	16
5.2	OUTCOMES OF GAP ANALYSIS	16
5.2.1	Recommended actions	17
6	OUTCOMES OF PROCEDURAL AUDIT.....	17
6.1	REVIEW OF THE DEPARTMENT OF RESOURCES' ASSESSMENT PROCEDURES	17
6.1.1	Method of review	18
6.1.2	Results of procedural review	18
6.2	PROCEDURAL AUDIT OF MRM COMMITMENTS	19
7	UPDATE ON ISSUES REQUIRING FURTHER INVESTIGATION AND REPORTING LAST AUDIT.....	20
7.1	UPDATE ON ISSUES REQUIRING URGENT INVESTIGATION AND REPORTING	20
7.1.1	Update on Seepage rectification works at the Tailings Storage Facility Cell 1	21



TABLE OF CONTENTS (CONTINUED)

7.1.2	Update on saline discharge through Bing Bong Dredge Spoil Pond walls	23
7.2	UPDATE ON ISSUES RAISED BY THE COMMUNITY	25
8	OUTCOMES OF TECHNICAL AUDIT	30
8.1	INTRODUCTION	30
8.1.1	Update on reporting requirements	30
8.2	REVIEW OF SURFACE WATER AND ARTIFICIAL WATER MONITORING	30
8.2.1	Surface and artificial water monitoring program observations	31
8.2.2	Surface and artificial water monitoring recommendations	31
8.3	REVIEW OF GROUNDWATER MONITORING	34
8.3.1	Overview of groundwater monitoring program	34
8.3.2	Groundwater monitoring program recommendations	35
8.4	REVIEW OF DUST, SOIL AND SEDIMENT MONITORING PROGRAMS	38
8.4.1	Site observations relating to dust, soil and sediments	38
8.4.2	Review of dust monitoring program	41
8.4.3	Review of soil monitoring	45
8.4.4	Review of fluvial sediment monitoring	47
8.4.5	Other matters	49
8.5	REVIEW OF MARINE MONITORING	49
8.5.1	Review of seawater quality monitoring	49
8.5.2	Marine sediment monitoring – swing basin and shipping channel	53
8.6	REVIEW OF FLORA AND FAUNA MONITORING	54
8.6.1	Mine site flora monitoring (terrestrial revegetation)	54
8.6.2	Mine site fauna monitoring	57
8.6.3	Bing Bong Port flora monitoring	60
8.6.4	Bing Bong Port fauna monitoring	63
8.7	REVIEW OF CIVIL WORKS MONITORING	64
8.7.1	Review of Overburden Emplacement Facility monitoring	64
8.7.2	Review of Tailings Storage Facility monitoring	67
8.7.3	Review of Bing Bong Spoil Dump monitoring	76
8.7.4	Geotechnical monitoring of river diversions	79
8.7.5	Sump area at toe of ROM Pad	81
8.7.6	Review of general documentation and geotechnical management	82
8.8	REVIEW OF RIVER DIVERSION HYDRAULICS	84
8.8.1	Review of Mining Management Plan 2008/2009 report (sediment and erosion)	84
8.8.2	Review of 2009 Water Management Plan (surface water)	87
8.8.3	Review of differences between September 2007 and March 2009 water balance/OPSIM modelling reports	89
8.8.4	Diversions construction report review	91
8.8.5	McArthur River diversion channel observations	94
8.8.6	Barney Creek diversion channel observations	101



TABLE OF CONTENTS (CONTINUED)

8.9	OTHER MATTERS	103
	8.9.1 White material at Burketown Crossing, Borroloola	103
9	CONCLUSIONS AND RECOMMENDATIONS	103
9.1	IMPROVEMENTS SINCE THE PREVIOUS AUDIT	103
9.2	RECOMMENDATIONS	104
10	LIMITATIONS	112
11	REFERENCES	113
12	GLOSSARY OF TERMS	114

APPENDICES

A	RISK MATRIX AND RISK RATING TABLE
B	UPDATED RISK REGISTER
C	GAP ANALYSIS PROCESS FLOW CHART
D	UPDATED MONITORING GAP REGISTER
E	LIST OF DOCUMENTS PROVIDED FOR REVIEWED
F	MRM COMPLIANCE AUDIT TABLE



1 INTRODUCTION

The McArthur River Mine is operated by McArthur River Mining Pty Ltd (MRM), which is 100% owned by Xstrata PLC. The McArthur River Mine is located in the Gulf Region, Northern Territory, approximately 740 kilometres south-east of Darwin and 45 kilometres south-west of the township of Borroloola (Figure 1)

The McArthur River Mine is developing one of the largest known zinc-lead-silver deposits in the world. The ore bodies that make up the deposit have been mined since 1995 through underground operations. In 2006, MRM was granted permission to operate as an open-cut mine. The mine site layout is provided in Figure 2.

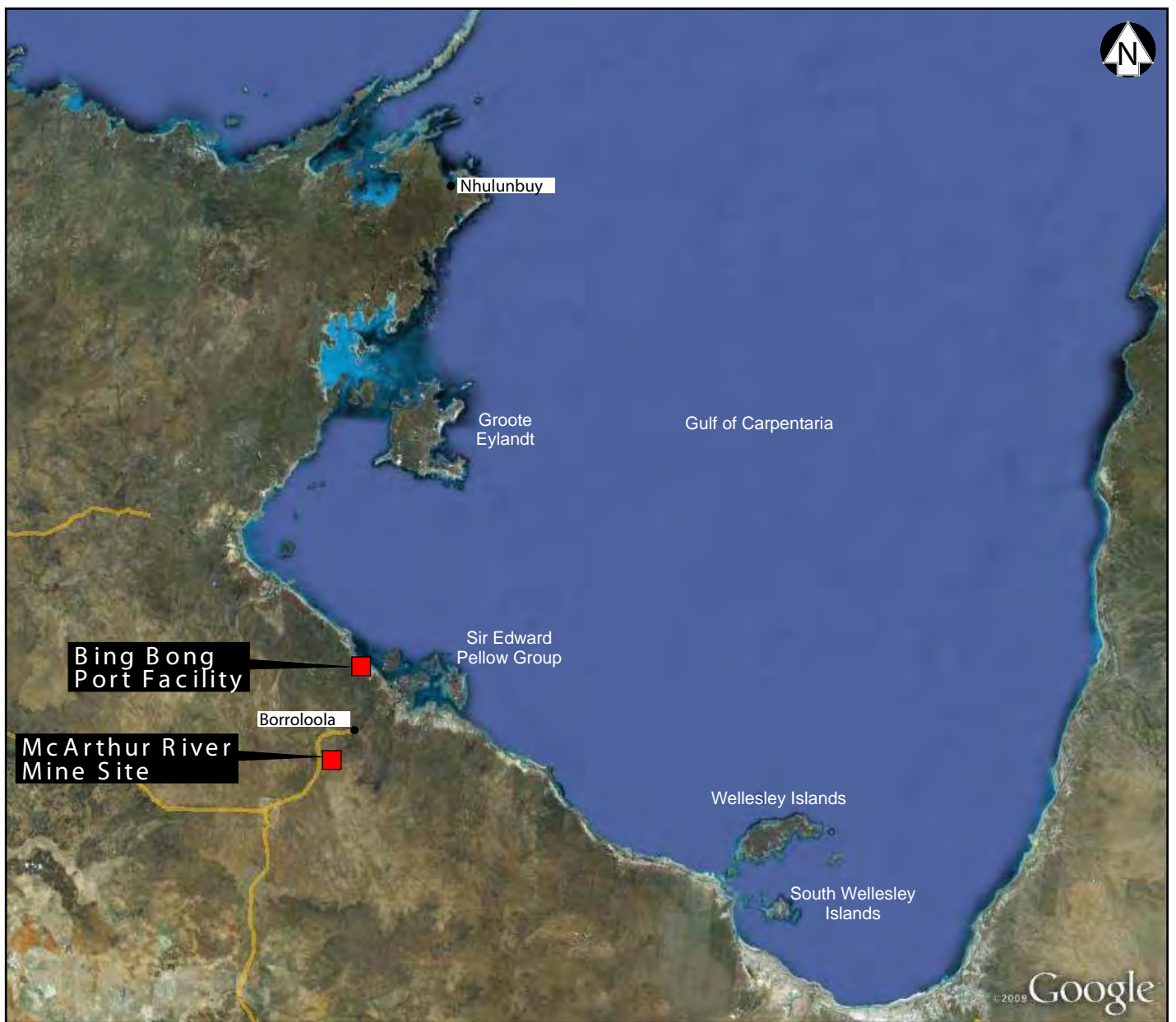
1.1 Regulatory and other requirements of this audit

As part of the approval for open-cut mining operations, a variation was made to the Conditions of Authorisation No 0059-02 for mining leases MLN1121, MLN1122, MLN1123, MLN1124, MLN1125, MLN1126 and MLN582, pursuant to Section 38(2) of the NT *Mining Management Act*. This variation included the provision of an Independent Environmental Monitor under Schedule 2 of the Authorisation 0059-02. The Independent Monitor is required to:

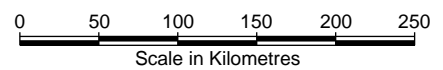
- monitor the environmental performance of the mine by reviewing:
 - environmental assessments and monitoring activities undertaken by the Operator;
 - environmental assessments and monitoring activities undertaken by the Department of Resources (the Department); and
- report to the Operator (MRM) and the Department any urgent issues requiring investigation and reporting.

It is the role of the Independent Monitor to consider key indicators of environmental performance including (but not limited to) the following:

- adherence to statutory commitments;
- effectiveness of environmental risk management systems;
- appropriate and effective monitoring procedures, including air, water, waste, structural, biological and sediment monitoring;
- spatial data management including GIS management, manipulation, representation and presentation of data;
- water management, including: surface water and groundwater modelling; solute transport models; discharge conditions; catchment water balance modelling; water quality, and water treatment technologies and options;
- hydrologic and engineering assessments relating to the river diversions;
- geochemistry, geomorphology and structural integrity design and reports for major infrastructure such as the river diversions, Tailings Storage Facility, Overburden Emplacement Facility, Run of Mine Pad, and Bing Bong Port dredge spoil; and
- closure criteria, progressive rehabilitation planning and costing, and ecological reconstruction assessments including the implementation, monitoring and management of rehabilitated landforms and the river creek diversions.



Source: Google Image 2009




Source: Google Maps Australia

	Title: Locality Map	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor		Job No: 210015
Project Man: GM	Scale: As shown	Figure 1
Drawn By: CM	Date: July 2010	



Source: MRM, 2009b

	Title: McArthur River Mine site layout	
	Location: McArthur River Mine Northern Territory	
Client: McArthur River Mine Independent Monitor	Job No: 210015	
Drawn by: GM	Scale: As shown	Source: Google Earth
Proj Man: CM	Date: July 2010	Figure 2



The Independent Monitor was not required to review mine safety or social issues arising from the operation of the Mine in the McArthur River Region.

The timeframe of the audit was focussed on the period from October 2008 to September 2009, which is referred to herein as the '2009 Operational Period'. It must be noted however, that the audit has also taken into account limited information, data and observations that fall outside of the 2009 Operational Period.

This review reflects the information and documentation received prior to June 11 2010 that relates to the 2009 Operational Period.

1.2 Objectives

The objectives of the Independent Monitor audit are to:

1. review the environmental monitoring and assessment practices undertaken by MRM and the Department;
2. identify and report urgent issues requiring investigation; and
3. provide an annual audit report to the Minister for Primary Industry, Fisheries and Resources that:
 - assesses the environmental performance of MRM operations; and
 - recommends improvement measures to increase environmental performance.

1.3 Audit scope and constraints

The scope of works required to complete the audit comprised the following components:

- update the preceding year's formal risk assessment;
- update the preceding year's gap analysis;
- review of management systems, monitoring and assessments undertaken by MRM during the 2009 Operational Period via:
 - statutory compliance assessment;
 - technical review of data and procedures;
 - interviews with personnel; and
 - site inspections;
- review of management systems, environmental monitoring and assessments undertaken by the Department pertaining to the 2009 Operational Period;
- community consultation; and
- prepare and provide an annual report to the Minister for Primary Industry Fisheries and Resources regarding the environmental performance of MRM operations.

The following assumptions have been applied throughout the audit process:

- the Independent Monitor will not collect additional data to that provided by MRM or the Department of Resources;



- the intention of this audit is to identify and discuss issues that the Independent Monitor considers to be of significant environmental risk, or represent a significant inadequacy in environmental performance; and
- issues of lower environmental risk may be assessed and discussed within subsequent audits periods.

Various focus areas were selected by the Independent Monitor to undergo technical review. Many of these focus areas represent recommendations for improvement from the previous Audit. These focus areas include:

- seepage monitoring at the Tailings Storage Facility;
- management of the Bing Bong dredge spoil;
- success of revegetation along the river diversions;
- weed management along river diversion channels and the mine site;
- hydraulic performance of river diversions;
- geochemical and geophysical testing of waste rock and clay lining as part of the expansion of the Overburden Emplacement Facility;
- evaluation of fugitive dust emission sources at the Bing Bong load-out facility; and
- the generation of dust from the Run of Mine Pad towards Barney Creek and its tributary;
- the design and potential recurrence of failure of the drain sump at the base of the Run of Mine Pad;
- the poor condition of asphalted and paved surfaces at the Bing Bong load-out facility;
- inadequate analysis of the accuracy, reproducibility and precision of routine monitoring results collected by MRM. This includes checking field measurements against laboratory results and expected objectives and using a data quality sign-off sheet for quality assurance; and
- rapid maintenance of fencing (damaged by annual floods) to improve rehabilitation works.

2 BACKGROUND

2.1 Relevant Legislation and Guidelines

The Department of Resources is the Territory Government agency responsible for mining approvals and compliance. It is the responsibility of the Department of Resources to administer the requirements of the *Mining Management Act* and Regulations.

The Mine operates under a range of relevant Commonwealth and Territory legislation as listed below:

Commonwealth statutory requirements

- *Aboriginal Land Rights (NT) Act*;
- *Native Title Act*;



- *Aboriginal and Torres Strait Islander Heritage Act;*
- *Environment Protection and Biodiversity Conservation Act; and*
- *National Environmental Protection Measures.*

Northern Territory Statutory requirements

- *Environment Assessment Act*
- *Environment Assessment Act;*
- *Aboriginal Sacred Sites Act;*
- *Weeds Management Act;*
- *Water Act;*
- *Heritage Conservation Act;*
- *Pastoral Land Act;*
- *Waste Management and Pollution Control Act;*
- *NT Lands Act;*
- *Bushfires Act;*
- *Petroleum Act;*
- *Native Title Act;*
- *Public Health Act;*
- *Territory Parks and Wildlife Conservation Act;*
- *Soil Conservation and Land Utilisation Act;*
- *Energy Pipelines Act; and*
- *Traffic Act.*

Commonwealth and Territory Government Audits

The Independent Monitor understands that two audits of the McArthur River Mine operation were undertaken in 2010, both by the Commonwealth government (Department of Heritage and the Northern Territory Department of Resources). The reports for these audits were not available to the Independent Monitor at the time this report was being prepared, but will be reviewed as part of next year's audit.

2.2 Previous Independent Monitor audits

The Independent Monitor has completed audits of MRM's environmental performance for the 2007 and 2008 Operational Periods. This audit report is the third audit undertaken by the Independent Monitor. The key findings of the two previous Independent Monitor audit reports are provided in the following sections.

2.2.1 2007 Operational Period Audit

The first Independent Monitor Audit was undertaken in 2008, which focussed on the Mine's environmental performance for the 2007 Operational Period. The audit involved a technical review of environmental management and monitoring practices, and a compliance audit against operating conditions.



Results of the audit indicated a high level of procedural conformance with statutory commitments and conditions, although one non-conformance was observed in that larval mosquito monitoring breeding sites rectification programs had not been undertaken. The Independent Monitor also noted a number of incomplete conformances.

The Independent Monitor found considerable data gaps through the technical review or MRM's monitoring and reporting for the review period, as well as a general inadequacy of interpretation of monitoring results both by MRM, and external consultants.

Several monitoring programs were recommended for improvement or rectification over the subsequent 3-5 years. These were:

- improved monitoring and improved technical review and interpretation of all water monitoring data around the mine, in particular the assessment of seepage from the Tailings Storage Facility into Surprise Creek;
- improved management and subsequent reduction of fugitive dust emissions at the Bing Bong load-out facility;
- improvement of dust management practices, particularly at the Tailing Storage Facility;
- improved management and rehabilitation of the dredge spoil dump at the Bing Bong facility; and
- adjustments in analytical suites for the surface water and groundwater monitoring programs.

The Independent Monitor's audit of the check monitoring systems and procedures utilised by the Department of Resources revealed that although the sampling techniques used in the field were satisfactory, the procedural documentation for undertaking this work, i.e. sampling manuals, training procedures and checking competency of staff, were not evident or inadequate at the time of the Audit.

The Independent Monitor identified that the check-monitoring can be improved, principally by ensuring that the results of the Department of Resources' monitoring are assessed internally against the results provided by MRM (for the commensurate monitoring event).

2.2.2 2008 Operational Period Audit

In 2009, the Independent Monitor completed an audit of the Mine's environmental performance over the 2008 Operational Period.

During this audit, improvements were noted from the 2007 Operational Period audit, including (but not limited to):

- practices relating to dust emissions from the Tailings Storage Facility Cell 1 had improved;
- improvements in water monitoring reporting; and
- efforts to begin a mosquito monitoring program were undertaken.

However, two urgent significant issues were identified by the Independent monitor, which required immediate investigation and reporting. These issues were:

- tailings leachate migration from Tailings Storage Facility Cell 1 into Surprise Creek; and
- saline leachate from the Bing Bong Dredge spoil.



MRM have since taken action to bring these issues under control, as reported in Section 7.1 of this report.

Other less urgent but significant issues identified included:

- fugitive dust emissions at the Bing Bong load-out facility; and
- weed management along river diversion channels and the mine site.

The Independent monitor has since viewed evidence that these issues are being addressed, however significant improvements have not yet been observed. Updates on these issues are reported in Sections 8.4.2 and 8.6.1 respectively.

Minor issues that were considered to require medium-term rectification related to:

- the generation of dust from the ROM (Run of Mine) Pad towards Barney Creek and its tributary;
- the design and potential recurrence of failure of the drain sump at the base of the ROM Pad;
- the poor condition of asphalted and paved surfaces at the Bing Bong load-out facility;
- inadequate analysis of the accuracy, reproducibility and precision of routine monitoring results collected by MRM. This includes checking field measurements against laboratory results and expected objectives and using a data quality sign-off sheet for quality assurance;
- rapid maintenance of fencing (damaged by annual floods) to improve rehabilitation works; and
- in-place testing of the clay liner of the Overburden Emplacement Facility as part of future Overburden Emplacement Facility expansions.

Dust generation from the ROM Pad, the construction of the sump at the base of the ROM Pad, and the condition of asphalted surfaces at Bing Bong have improved since the previous audit. However, the inadequacy of the accuracy, reproducibility and precision of routine monitoring results, and the need for rapid fence maintenance still remain to be issues. Planned improvement measures have been sighted/discussed as part of the current audit.

Further, whilst in-place testing of the Overburden Emplacement Facility clay liner is now undertaken, the Independent Monitor needs to review associated procedures and results to confirm the adequacy of the testing.

2.3 MRM shutdown period 2008/2009

Last audit, the Independent Monitor reported that on 17 December 2008, the Federal Court ruled that the Federal Government had overlooked environmental concerns in its approval of the MRM open cut expansion. Consequently, MRM were ordered to cease all civil works while the Federal Minister for the Environment Heritage and the Arts re-made his decision as to whether or not to approve the Mine's expansion, having due consideration for all required information.

After a two-month closure period, on the 20th of February 2009, the (then) Minister for the Environment Heritage and Arts, the Hon. Peter Garrett authorised MRM to construct and operate the open-cut lead, zinc and silver mine, under the condition that listed threatened



species, communities and migratory birds be managed appropriately. As such MRM submitted a revised:

- Freshwater Sawfish Management Plan;
- Migratory Wader Monitoring Plan, and a
- Commonwealth Environmental Monitoring Plan.

These revised plans were subsequently accepted by the Environmental Assessment branch of the Department of Environment, Water, Heritage and the Arts on the 1st of October 2009, and have been reviewed by the Independent Monitor as part of this year's audit (see Sections 8.6.2, 8.6.4). Although MRM continued much of its environmental works throughout the shut-down period, the Independent Monitor has considered the potential effect of the shut-down period on MRM's environmental performance.

3 METHOD OF AUDIT

The Audit was conducted in accordance with the Independent Monitoring Assessment Conditions (IMACs) (2006) and the Scope of Services for the Independent Monitor's contract of engagement, as agreed between the Independent Monitor and the Department of Resources.

The full list of documents reviewed this audit period for the Department of Resources and MRM are provided within Appendix E.

TABLE 1 INDEPENDENT MONITOR TEAM

Name	Company	Position title	Audit focus	Years of experience
Philip Mulvey	Environmental Earth Sciences	Senior Principal Scientist (Independent Monitor team leader)	Geochemistry , hydrogeology, soils and dust	29
Theo Gerritsen	Environmental Earth Sciences	Senior Mining Engineer	Tailings management	12
Geordie McMillan	Environmental Earth Sciences	Senior Hydrogeologist	Groundwater, geochemistry	9
Don Still	Bewsher Consulting	Principal Hydrologist	River diversion and surface water hydrology	34
Mike Shackleton	Mining One	Geotechnical Engineer	Geotechnical issues	8
Dr. Bill Low	Low Ecological Services	Principal Ecologist	Flora and fauna	50
Angela Stewart	Low Ecological Services	Ecologist	Flora and fauna	5
Laura Boland	Environmental Earth Sciences	Environmental Scientist (Project Administrator)	Environmental Management	3
Jorge Alcaino	Environmental Earth Sciences	Environmental Scientist	Environmental Scientist Soil and dust	3



3.1 Site inspection

The Independent Monitor team undertook a mine site inspection on 17 – 18 May 2010. As part of the inspection, the Independent Monitor team inspected the following areas of the Mine operation:

- Tailings Storage Facility;
- Bing Bong Dredge Spoil and Port Facility;
- Overburden Emplacement Facility;
- analogue native vegetation sites upstream of the McArthur River diversion;
- riparian bird monitoring sites along the McArthur River;
- sawfish monitoring sites within the McArthur River;
- Barney Creek and McArthur River diversion channels and rehabilitation efforts;
- ROM Pad and PACRIM yard (crushing plant); and
- contaminated and putrescible waste dumps.

3.2 Personnel Interviewed

McArthur River Mining personnel were interviewed during the mine site inspection. Gary Taylor, Health Safety and Environment Manager, was the primary point of contact for the Independent Monitor during the Audit. Other MRM personnel interviewed during the site inspection included:

- Jeremy Barnett – Environmental Superintendent;
- Sam Strohmayer – Metallurgical Manager;
- Chris McCleave – Mining Manager;
- Dave Henderson – Processing Plant; and
- Chris Williams – Bing Bong Port Manager.

The Independent Monitor met with the following personnel from the Department of Resources on 20 May to discuss the Department's processes and procedures used for the assessment of the McArthur River Mine operation:

- Peter Zeroni – Strategic and Policy Advisor;
- Brett Steele – Team Leader, Mining Compliance;
- Cyrus Edwards – Senior Project Officer, Mining Evaluations;
- Russell Ball – Director Mining Performance; and
- Alister Trier – Executive Director Minerals and Energy.



4 RISK ASSESSMENT

4.1 Purpose, objectives and scope of risk assessment

The Independent Monitor undertook a formal risk assessment as part of the previous audit of the 2008 Operational Period. This risk assessment has been updated this audit, based on observations made during the May 2010 mine site visit, and the technical review of monitoring data from the 2009 Operational Period.

The purpose of the risk assessment was to evaluate environmental risks associated with the monitoring and assessment of the MRM operations. This risk assessment focussed on risks that the Independent Monitor considered to be significant.

This risk assessment was undertaken to fulfil a requirement set out within the Independent Monitor Scope of Services.

The objectives of the risk assessment were to:

1. identify significant environmental risks associated with MRM operations; and
2. evaluate whether environmental monitoring and assessment practices undertaken by MRM are adequate and appropriate to mitigate the risk of potential environmental impacts.

The scope of the risk assessment is intended to be in line with the scope of the technical audit report in that a focus is placed on issues that the Independent Monitor considers to be of high-level risk. Lower level risk issues will be examined within subsequent audit reports and will be included within updated annual Independent Monitor risk registers.

This risk assessment examined the potential environmental impacts resulting from the mine site and Bing Bong Port operations, including potential environmental impacts associated with the following:

- tailings storage facility;
- river diversions;
- the management of surface water and artificial waters;
- groundwater;
- the Overburden Emplacement Facility;
- Bing Bong dredge spoil;
- Bing Bong Port facility fugitive dust emissions;
- the tailings pipeline; and
- flora and fauna monitoring and management.

Risks associated with the above assets were evaluated based on the adequacy and effectiveness of MRM's environmental monitoring systems, and their effectiveness in monitoring these issues.



Scope of information input

The scope of information input was generally limited to the 2009 Operational Period; however, observations made during the May 2010 site inspection, and more recent additional information were also considered during the risk assessment. As such, the scope of the risk assessment comprised all information provided to the Independent Monitor by 11 June 2010, but interpreted primarily in relation to the 2009 Operational Period.

Temporal and spatial scope of impacts

Both short-term and long term potential environmental impacts were assessed throughout the risk assessment. Similarly, the spatial scope of the risk assessment encompassed potential environmental impacts both within and outside of the mining lease area.

4.2 Stakeholders

The following stakeholders were considered to be affected by the potential environmental impacts associated with MRM operations:

- the community of Borroloola;
- future generations;
- McArthur River Mining Pty Ltd; and
- the Department of Resources.

4.3 Methodology

The risk assessment was undertaken in general accordance with the methodology advised within AS/NZS 4360:2004 – *Risk Management* (Standards Australia, 2004).

Assumptions and exclusions as discussed in Section 1.3 apply to the risk assessment methodology.

4.3.1 Risk identification and analysis

Independent Monitor team members utilised the following information resources along with their own expert knowledge and experience, to identify potential environmental risks:

- documentation requested by the Independent Monitor and provided by MRM;
- documentation requested by the Independent Monitor and provided by the Department of Resources;
- site inspections undertaken by the Independent Monitor during 2008 and 2009; and
- interviews with MRM and the Department of Resources personnel during site inspections.

Each team member identified and systematically listed environmental risks relating to their area of expertise (e.g. flora and fauna) within the risk register (Appendix B). Other aspects considered and recorded within the risk register include:

- potential duration of impact (see table in Appendix A);
- location of impact (see table in Appendix A);
- causes; and
- existing controls, monitoring or assessment undertaken.



4.3.2 Risk evaluation

Risk evaluation was conducted on a residual risk basis with known controls in place. As such, the risk rating derived refers to the risk level based upon the information sources provided to the Independent Monitor by MRM.

Risk evaluation was undertaken via qualitative analysis, which was supported by data and other information provided by MRM and the Department of Resources. The risk associated with each potential impact was determined using a matrix of likelihood and potential consequence whereby:

$$\text{Risk} = \text{Consequence} + \text{Likelihood}$$

Consequence was determined based on the maximum reasonable consequence the impact may have upon the natural environment if existing monitoring and assessment controls are inadequate or inappropriate. Consequence was considered in light of the both the location and duration of the impact (see table in Appendix A).

The reasonable consequence and likelihood of occurrence was considered for each impact in terms of the scales provided within the risk matrix (Appendix A).

Risk matrix results were correlated with an associated risk rating scale as provided in Appendix A. The results of the risk assessment are recorded within the Risk Register, which is provided Appendix B.

4.4 Outcomes of risk assessment

This section summarises the results of the risk assessment, which are provided within the Risk Register located in Appendix B.

4.4.1 Update from previous risk assessment

Extreme risks

Three “extreme” risk issues were identified through the risk assessment undertaken as part of the Independent Monitor’s previous audit of the 2008 Operational Period. Two of these risk issues related to the Bing Bond Dredge Spoil, both in terms of dam wall failure, and the damaging impact of saline seepage on vegetation surrounding the dredge spoil. The third extreme risk issue related to the classification of waste rock as “non-acid forming” (NAF) prior to placement at the Overburden Emplacement Facility.

Significant improvements have since been made to the drainage system at the Bing Bong Dredge Spoil (See Section 7.1.2). As such, the two extreme risks associated with this asset have been decreased from “extreme” to “high”. However, further monitoring of vegetation and geotechnical stability monitoring is still required. The extreme risk associated with the classification and potential miss-placement of waste rock, has also been downgraded to a “high” risk, as procedures for rock classification still require updating.

The Independent Monitor commends MRM for taking action to reduce the risk of these issues.

There are currently no extreme risks identified by the Independent Monitor this audit.

High risks

The previous risk assessment identified a total of 14 “high” risk issues were identified. One of these risks, relating to a potential decrease in Freshwater Sawfish numbers within the McArthur River due to decreased water quality and habitat loss, has been reduced to a



“moderate” risk rating, based on the Independent Monitor’s observations this audit. All other high risks identified last audit have not changed significantly and still carry a “high” risk rating.

An additional four “high” risks have been identified by the Independent Monitor this year, that were not evident last year. These relate to a risk of:

- Tailings Storage Facility Cell 2 embankment failure due to stability failure;
- Tailings Storage Facility Cell 2 embankment failure due to scouring at toe of embankment;
- failure of spillway on Cell 2 leading to failure of embankment; and
- failure to establish desired vegetation corridor along the McArthur River Diversion.

There are currently 26 “high” risks identified by the Independent Monitor. This includes seven risks that have been upgraded or downgraded to a “high risk” since the last risk assessment. These are provided within the Risk Register in Appendix B.

Moderate risks

As part of the last risk assessment 25 “moderate” risks were identified. Six of these moderate risks have been upgraded to “high”, including:

- over-flow of Tailings Storage facility Cell 1 due to inadequate spillway;
- overtopping of TSF Cells leading to embankment failure;
- failure of water Management Dam due to overtopping of spillway;
- river diversion channel erosion and poor water quality causes changes to the riparian community species;
- erosion and stock damage to revegetated areas along river diversions; and
- flood waters cause erosion at toe of mine levee wall and along unplanned overland flow path from the old McArthur River Channel into diversion channel.

A total of 21 “moderate” risks have not changed since the previous assessment.

A further five “moderate” risks were identified this audit that were not evident during the previous risk assessment. These include:

- potential failure of dredge spoil revegetation/rehabilitation;
- failure of Tailings Storage Facility rehabilitation due to topsoil contamination ;
- risks to groundwater dependent ecosystems due to lowering of groundwater table;
- risk of mosquitoes breeding in stagnant water within the Bing Bong dredge ponds; and
- bioaccumulation of metals in seawater, sediments and biota in vicinity of the Sir Edward Pellew Islands and the McArthur River estuary.

A total of 27 “moderate” risks are currently Identified by the Independent Monitor. These risks are detailed within Appendix B.

Low risks

One low risk was identified during the previous assessment, which related to the risk of sudden and significant flood-induced channel bank erosion/collapse leading to an unexpected increase in flood level. This risk has remained “low” as part of this year’s assessment.



Four additional “low” risk issues were identified this year including:

- fugitive dust migration to Sir Edward Pellew Islands from Bing Bong Port;
- stockpiled topsoil not available for rehabilitation of tailings dam or waste dumps;
- habitat alteration due to weed infestations on dredge spoil/rehabilitated areas at Bing Bong; and
- failure of pump within ROM Pad sump area during heavy rainfall event causes sump water to flow towards Barney Creek.

4.4.2 Recommendations from risk assessment

McArthur River Mining is commended for taking actions following the previous risk assessment to eliminate “extreme” risks. However, the 27 existing “high” risk issues require immediate attention in order to reduce or mitigate the associated environmental risk level. We recommend that the Independent Monitor’s comments and recommendations provided within the Risk Register (Appendix B) be considered.

Particular attention is also recommended to be given to risk issues that have been upgraded to a higher risk rating since the previous audit, to ensure that the risk ratings associated with these issues do not increase further.

This risk assessment will be reviewed and updated by the Independent Monitor again as part of the next audit in 2011.

5 GAP ANALYSIS

5.1 Introduction

The purpose of this gap analysis is to identify gaps in environmental monitoring and assessment undertaken for MRM operations that require improvement.

This gap analysis was undertaken as a requirement of the Independent Monitor Scope of Services. Assumptions and exclusions as provided in Section 1.3 apply to the gap analysis.

The gap analysis included a comparison of the environmental performance of MRM against:

- best practice industry standards;
- expert assessment and recommendations; and
- MRM statutory obligations.

The gap analysis was undertaken by members of the Independent Monitor team. Each team member separately identified monitoring and assessment gaps within their field of expertise.

5.1.1 Gap identification and assessment

For the purpose of this gap analysis, a gap is defined as ‘a discrepancy between the monitoring program that is taking place, and the monitoring program that should be taking place if MRM’s environmental performance is to be maintained at industry best practice standards’.



Identified gaps were listed within the Gap Register, a copy of which is provided within Appendix D.

5.1.2 Gap evaluation

To maintain a consistent and systematic methodology between Independent Monitor team consultants, each identified gap was evaluated in accordance with the Gap Analysis Process Flow Chart developed by Environmental Earth Sciences, provided in Appendix C. This flow chart guided the categorisation of identified gaps into one of the gap categories as described in Table 2.

TABLE 2 GAP EVALUATION CATEGORIES

Gap Category	Description
Category 1	Monitoring is not undertaken to mitigate potential associated environmental risk.
Category 2	Monitoring is undertaken, but is not sufficient in design (i.e.: frequency, location, type etc) to identify or quantify potential environmental risk.
Category 3	Monitoring is undertaken and is appropriate in design, however, data/output information is not adequately assessed, interpreted or managed to appropriately mitigate potential environmental risk.

All Gap Categories are considered to have equal weighting; for example, not undertaking appropriate assessment of monitoring data or undertaking appropriate mitigation measures (Category 3 Gap) may have the same adverse impact as not monitoring at all (Category 1 Gap).

5.2 Outcomes of gap analysis

In our opinion, MRM have not undertaken sufficient corrective measures to remove gaps identified as part of the last gap analysis, with the exception of a Category 1 gap regarding mosquito monitoring.

The outcomes of the gap analysis are provided in the Gap Register within Appendix D. This register has been updated from that presented in the Independent Monitor's previous audit report.

The gap analysis identified a total of 13 'Category 1' Gaps. These gaps related to a lack of monitoring in the following categories:

- hydraulic assessment of as-built diversion channels;
- as-built drawings of Overburden Emplacement Facility foundations;
- design and construction of Tailings Storage Facility and Water Management Dam;
- lack of a dam emergency response plan for the Tailings Storage Facility;
- quantified geotechnical monitoring of the Tailings Storage Facility and Bing Bong Dredge spoils;
- water quality and vegetation monitoring in the vicinity of the Bing Bong dredge spoil;
- threatened species monitoring; and



- monitoring of Wallaby populations at Bing Bong in response to community concerns.

A total of 15 'Category 2' and five 'Category 3' gaps were identified. These gaps are detailed within the Gap Register in Appendix D.

5.2.1 Recommended actions

The Independent Monitor recommends that the monitoring or reporting measures suggested by the Independent Monitor within the Gap Register be actioned by MRM, and/or relevant reporting be provided to the Independent Monitor within the next Audit period to demonstrate how identified gaps will be addressed or have been 'closed'.

The gap register will be reviewed and updated in light of the corrective measures undertaken by MRM as part of the next audit.

6 OUTCOMES OF PROCEDURAL AUDIT

6.1 Review of the Department of Resources' assessment procedures

Department of Resources is responsible for undertaking audits and checking the environmental performance of the McArthur River Mine operation in accordance with the *Mining Management Act*.

The Independent Monitor requested the following documentation in order to assess the procedures undertaken by the Department of Resources to monitor the Mine operation:

- reports of all assessments and audits undertaken by the Department to evaluate the environmental performance of the McArthur River Mine during the review period;
- written procedures for undertaking audits and assessments of the environmental performance of the McArthur River Mine;
- procedures for assessing/accepting water management plans;
- procedures for sampling and analysis used by the Department to undertake check-monitoring/environmental sampling, including written procedures for:
 - sampling method (if updated since the last audit);
 - sampling location and analyte rationale;
 - quality assurance and quality control; and
 - assessing the significance of monitoring results;
- the Department's check-monitoring reports and data-sets pertaining to the period from October 2008 to December 2009; and
- documents and procedures relating to all received environmental complaints, and serious or critical environmental incidents relating to the McArthur River Mine.

The list of documents provided by the Department of Resources is provided in Appendix E.



6.1.1 Method of review

The documents provided by the Department of Resources were reviewed and assessed through:

- gap identification; and
- correlation with the requirements of the *Mining Management Act* and *Mining Management Regulations*.

6.1.2 Results of procedural review

The Independent Monitor noted an improvement in the amount and detail of information provided by the Department of Resources compared with previous years. The procedural documents provided thorough administrative procedures that are carried out by the Department of Resources in their assessment of mining management documentations.

The interview by the Independent Monitor on 20 May 2010 was conducted by Theo Gerritsen and Geordie McMillan, and the Department of Resources interviewees and attendees including: Brett Anderson-Steele (since left Department of Resources); Peter Zeroni; Cyrus Edwards; Alister Trier; and Russell Ball.

The interview focussed on clarifying the roles, responsibilities and actions undertaken by the Department of Resources during their assessments of the McArthur River Mine. Specifically, the Independent Monitor requested clarification regarding:

- the timing and detail of the Department of Resources' audit of the MRM operation in 2010; and
- the differences in the methodology of the 2010 audit compared to the previous audit undertaken by the Department of Resources (2007).

Representatives from the Department of Resources stated that the audit undertaken by the Department of Resources of MRM is the same process as that undertaken at other mines throughout the Northern Territory.

Due to resourcing constraints and the number of, and distance between mines in the Northern Territory, an audit by the Department of Resources of MRM (and other Northern Territory mines) is generally undertaken every 2-3 years. Representatives of the Department of Resources stated that gaps and issues identified in their previous audit of MRM will be followed up in the 2010 audit, particularly as part of the site inspection. Department of Resources advised that relevant staff undergo training for systems management under International Standard ISO14001, and that the Department of Resources Evaluations section is employing more staff with expertise in geochemistry, ecology and auditing.

The Department of Resources Document Review Procedure (January 2010) was queried by the Independent Monitor. Representatives of the Department of Resources advised that this document has been 'flagged' for revision in 2010. The Department stated that the competency of staff within the Department of Resources to undertake all or part of the assessments and audits of MRM is determined based on personnel that are available at the time. It was reiterated to the Independent Monitor at the interview that the Department of Resources are currently employing more staff to improve their capacity to address general and specific needs for the assessment and evaluation of MRM (in addition to other mines in the NT).

Following this, the Independent Monitor recommended that a capability and organisational structure chart of the Department of Resources be developed that clearly outlines the



competencies and areas of expertise of staff within the Department, which will improve the resourcing and capacity of the Department to review and assess the MRM operation.

The March 2010 annotated review of the MRM MMP by the Department of Resources was queried by the Independent Monitor. This query was directed at the comments made by the Department of Resources representatives within the document, and if the outstanding comments and questions had been addressed, and if not, when they would be.

Brett Anderson-Steele advised that the Department of Resources were waiting on replies to these comments by MRM at the time of the interview. The Independent Monitor considers that if there is a considerable time delay in finalising a document such as the MMP for the operational year for which it is intended, i.e. 2010, this is unsatisfactory and the disputed parts of the document should be finalised swiftly. If necessary, issues such as securities disputes and the documenting of additional tenements, as understood to be contentious in this instance, should be resolved separately if need be in order for a critical document such as the MMP to be valid for the operational period.

Department of Resources representatives advised that comments and queries made during the evaluation and assessment process are rated according to their significance.

6.2 Procedural audit of MRM commitments

The procedural audit of MRM comprised an evaluation of compliance against the commitments stated within the 2008-2009 Mining Management Plan (MRM, 2008a). Not all commitments in the Mining Management Plan were evaluated by the Independent Monitor in this assessment; only those that were considered to be directly related to environmental performance for the monitoring period. A list of the relevant commitments and compliance assessment is provided within the Table in Appendix F.

McArthur River Mine provided evidence to show a high-level of compliance with Mining Management Plan commitments for the 2009 Operational Period; however four non-conformances were noted. Namely, no evidence or insufficient evidence was provided for:

- the monitoring of a potential sedimentation zone in the McArthur River downstream to the Bukalara Range;
- the installation of lysimeters in the Overburden Emplacement Facility at various stages to monitor water infiltration;
- water quality and sediment monitoring at the Overburden Emplacement Facility dams; and
- undertaking kinetic leach testing on-site and laboratory columns.

In addition, even though general compliance was observed for the following items, the Independent Monitor makes the following observations:

- non-conformances with Australian Standards were noted on occasions with regard to MRM dust monitoring program;
- the Independent Monitor has not seen evidence of the existence of groundwater monitoring bores at the Bing Bong Facility. Shallow groundwater monitoring may be required in the vicinity of the Dredge Spoil Ponds;
- further fence maintenance/fence relocation is required to prevent erosion and vegetation damage by cattle;



- waste management is generally appropriate, however, wastes should be separated as per MRM procedures;
- Tailings Storage Facility Cell 1 clay capping has been partially undertaken; however, the capping needs to be completed as soon as possible to avoid dust generation from exposed tailings;
- structural surveillance of the Tailings Storage Facility and associated infrastructure is conducted regularly, in accordance with site procedure MET-GEN-GDL-2800-0001 (MRM, 2010a); however complete documentation of the monitoring was not provided to the Independent Monitor;
- seed collection for revegetation of the McArthur River diversion has been undertaken; However, the species selected are considered to be common species that provide only a limited habitat or foraging value;
- the Independent Monitor has not sighted any documents regarding the design of Tailings Storage Facility Cell 2 (for assessment against ANCOLD Guidelines); and
- no documentation or 'as built' reports have been provided regarding the PAF (Potentially Acid Forming) runoff dams at the Overburden Emplacement Facilities, so that the dam design commitments can be confirmed.

It should be noted that this procedural audit reviewed evidence of compliance with MRM's environmental commitments for the 2009 Operational Period. As such, this procedural audit does not address all environmental monitoring measures that the Independent Monitor deems necessary for good environmental performance. A technical review of MRM's environmental monitoring and performance is provided in Section 8, including the Independent Monitor's recommendations for improved environmental performance.

The Independent Monitor notes that a detailed site inspection was undertaken by the Department of Resources during May 2010. The report for the Department's inspection was not available to the Independent Monitor this audit, but will be reviewed as part of next year's audit.

7 UPDATE ON ISSUES REQUIRING FURTHER INVESTIGATION AND REPORTING LAST AUDIT

7.1 Update on Issues requiring urgent investigation and reporting

Following the Independent Monitor's June 2009 site inspection and data review, the Independent Monitor considered two issues to warrant reporting under Independent Monitoring Assessment Conditions (IMACs), Section 6.4. This Section outlines the process for dealing with issues that the Independent Monitor considers to require urgent investigation and reporting.

The two issues, which were included in the previous audit report, were:

1. seepage from the tailings storage Facility into Surprise Creek; and
2. saline discharge through the dredge spoil dam walls at Bing Bong Port.



The Independent Monitor provided detailed recommendations for further investigation into these matters within a letter *McArthur River Mine Independent Monitor – notification of investigation under Section 6.4 of the IMAC* to General Manager McArthur River Mining (cc: Department of Resources) dated 6 July 2009.

The following sections provide an update on the rectification or investigatory works undertaken by MRM to address these two issues since they were identified by the Independent Monitor last year.

7.1.1 Update on Seepage rectification works at the Tailings Storage Facility Cell 1

Cell 1 of the Tailings Storage Facility is unlined and in close proximity to Surprise Creek. In June 2009, the Independent Monitor observed leachate migrating from the base of Tailings Storage Facility towards Surprise Creek. The presence of alluvium (sands, sandy-clays and silts) and also potential 'paleochannels' (conductive discrete zones of sands and gravels) is a contributing factor to this leachate migration from the Tailings Storage Facility to the creek, which was known to have occurred within 2 years of commencement of tailings deposition (c. 1997). The potential for migration through the underlying fractured dolomite siltstone is unresolved.

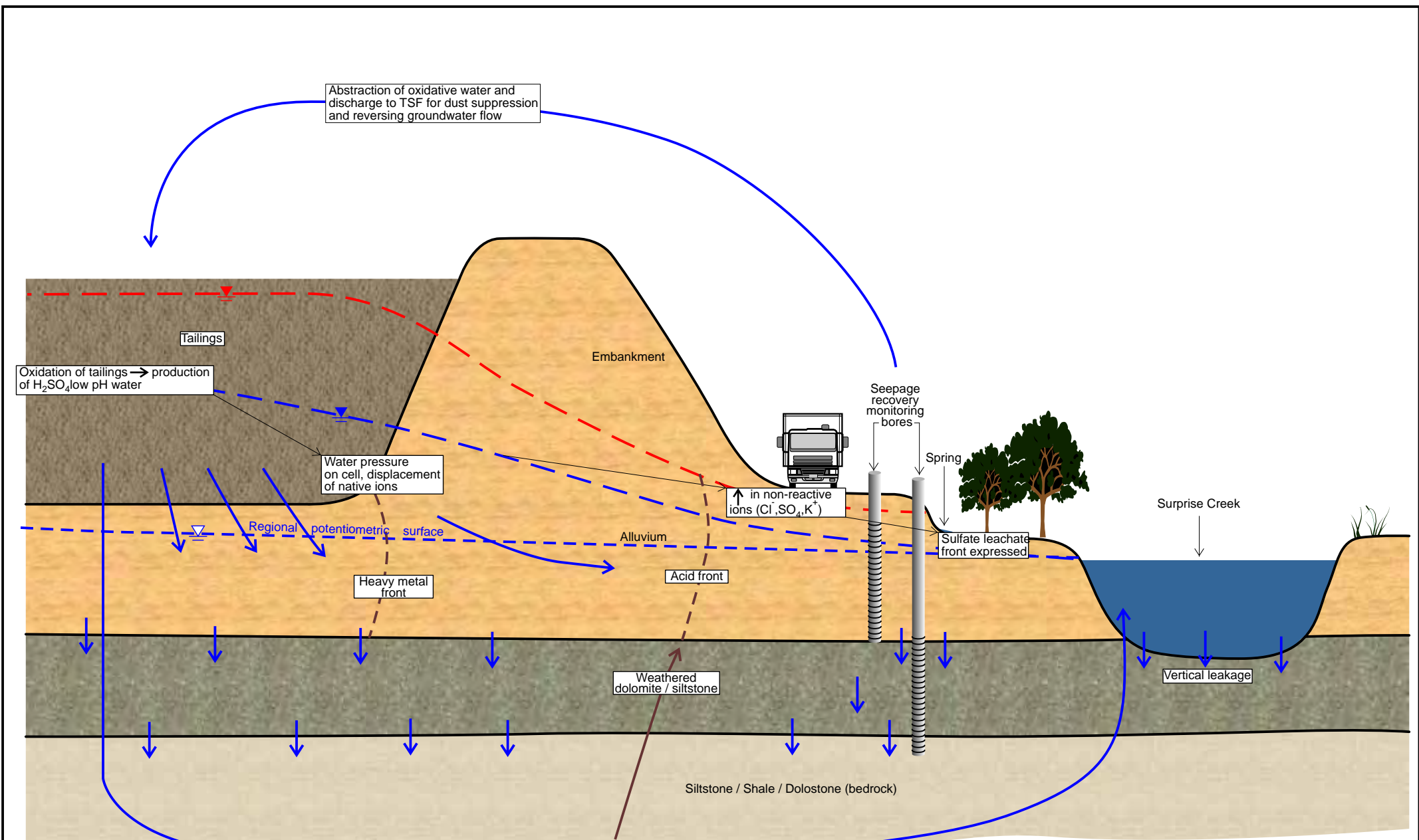
A conceptual model of seepage migration is presented in Figure 3.

As part of the approval of the open cut operation, a 'geopolymer' barrier system was put in place in 2005 to prevent migration to the creek, which was also designed to augment the existing recovery bores, located at approximate 50 m intervals, which were installed in the preceding year.

Seepage in the colluviums was evident in the 2008 and 2009 Independent Monitor inspections.

The following works have been undertaken by MRM to mitigate and investigate leachate seepage from the Tailings Storage Facility (Figure 3):

- a leachate collection sump has been installed between Tailings Storage Facility Cell 1 and Surprise Creek (see photo plate Plate 1 -) ;
- electromagnetic survey of the Tailings Storage Facility was conducted by URS in November 2009. The results of this survey confirmed increased conductivity in the areas of known or likely leachate seepage at the north east and south of the Tailings Storage Facility;
- URS completed a site inspection in February 2010 and report (dated 29 March 2010) (URS, 2010a), aimed at providing final solutions to seepage issues. URS reported that the primary issue concerning the Tailings Storage Facility is the excess amount of liquor being stored at the surface of the Tailings Storage Facility, which is likely to be causing saturation of the dam walls. URS note that the Tailings Storage Facility was not designed to be a water retention dam. URS recommended that the volume of water in the Tailings Storage Facility be reduced to remove the source of infiltration, and leachate should be prevented from reaching Surprise Creek. Recommendations for such mitigation includes:



	Title: Conceptual Geochemical Model of Seepage Migration	
	Location: McArthur River Mine Northern Territory	

Project: McArthur River Mine Independent Monitor		Job No: 210015
Project Man: GM	Scale: Not to Scale	Figure 3
Drawn By: CM	Date: July 2010	



- installation of additional interceptor wells;
- construction of a cut-off drain; and
- the construction of a barrier wall;
- continued monitoring of recovery bores including flow-meter readings; and
- monitoring of water quality within Surprise Creek even during periods of no-flow, which has occurs on a monthly basis.

MRM are engaged in ongoing consultation with URS regarding additional means of leachate investigation and mitigation. Further discussion on the Independent Monitor's recommendations regarding this issue is provided in Section 8.7.2.



Plate 1 - Sump installed between Tailings Storage Facility Cell1 and Surprise Creek to collect leachate.

7.1.2 Update on saline discharge through Bing Bong Dredge Spoil Pond walls

The Independent Monitor observed significant vegetation die-back immediately outside of the Bing Bong Dredge Spoil Ponds during the 2009 site inspection. Saline discharge seeping from the spoil material through the pond walls was considered to be the cause of the die-back. The Dredge Spoil Ponds are located to the east of the Bing Bong Load-out Facility, and are also outside the Mining Lease (Figure 4). They were constructed in the mid 1990s by scraping the existing shelly-sand to form bunds. As such the pond walls are constructed of permeable shelly-sand that is subject to tunnelling erosion.

Figure 4 shows the Bing Bong Port facility location.

McArthur River Mining is commended for undertaking the following rectification and investigatory works to mitigate this issue:

- MRM completed remediation works prior to the dredging event, including:



- construction of an outer spoon drain to divert saline seepage out to sea (see Plate 2 - Figure 6). Although saline leachate is still visibly leaking through the spoil pond walls (Plate 3 -), the spoon drain appears to be effective in draining this seepage to sea; and
- remediation of dredge spoil walls to repair areas affected by gully and tunnel erosion;
- continuation of annual aerial photographs of Bing Bong (Figures 5 -6);
- one round of soil sampling (June 2009) surrounding the spoil ponds, with analysis for electrical conductivity and total dissolvable salts (Figure 7). This analysis will continue on an annual basis;
- turbidity monitoring of surface water within the dredge spoil spoon drain; and
- development of the *Bing Bong MLN1126 Hydrology Plan* (URS, 2010b), which details ongoing monitoring including groundwater and surface water assessments and water balance modelling. This plan will be implemented once approved by the Northern Territory Department of Natural Resources, Environment, the Arts and Sport (NRETAS).

The details of the rectification works are detailed within MRM report *Dredge Spoil Report* (MRM, 2010b). The Independent Monitor considered the urgency of ongoing salt discharge to adjoining land has been brought under control through the rectification works, and is no longer considered an urgent issue, though potential regional historic impacts are still being evaluated. Further discussion and recommendations regarding the Bing Bong Dredge Spoil is provided in Sections 8.6.3 and 8.7.3.



Plate 2 - Remediated Bing Bong Dredge Spoil Pond wall (centre) with newly-constructed outer spoon drain (right) and recently deposited dredge material (Left).



Plate 3 - Saline leachate seeping from Bing Bong Spoil pond wall towards the spoon drain.

7.2 Update on issues raised by the community

Two primary issues were raised by the community during the Independent Monitor's June 2009 site visit. These were: the apparent depletion of the 'ink berry' (*Carissa lanceolata*) (or 'Jubardirri' in one of the local languages); and the observed reduction in populations of the once-abundant Agile Wallaby (*Macropus agilis*) and Short-eared Rock Wallaby (*Petrogale brachyotis*) in the Bing Bong Port Area.

The Independent Monitor concluded last audit that the depletion of the 'ink berry' was due to climatic factors. The Independent Monitor's ongoing investigation into the reduction in wallaby numbers is provided in Section 8.6.4.



Gulf of Carpentaria

Bing Bong Facility

McArthur River Delta

Source: Northern Territory Department of Infrastructure and Planning



Title: Bing Bong Facility
Regional Aerial Photograph - 1995

Location: McArthur River Mine
Northern Territory

Project: McArthur River Mine Independent Monitor

Job No: 210015

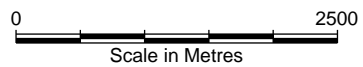
Project Man: GM

Scale: As shown

Drawn By: CM

Date: July 2010

Figure 4



Scale in Metres

1995



0 100 200 300 400 500
Scale in meters


[Source: Northern Territory Department of Infrastructure and Planning]

2005



0 200 400 600 800 1000
Scale in meters

[Source: Google Earth 2005]

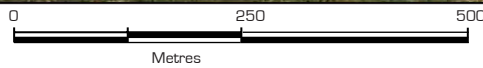
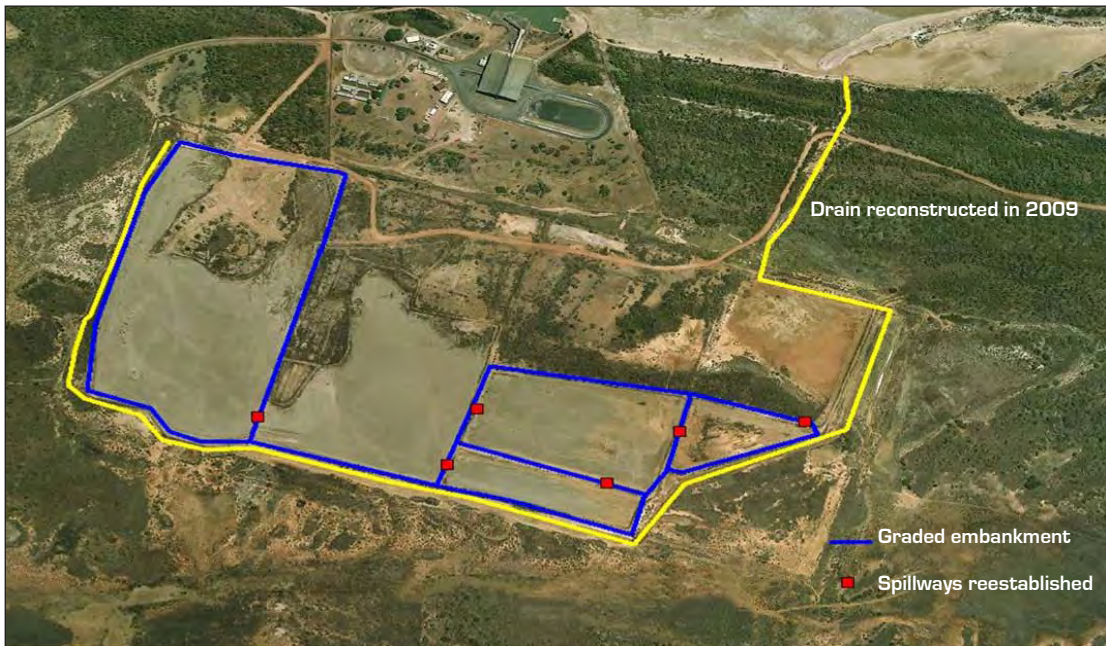
	Title: Bing Bong Facility Aerial Photographs	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor	Scale: As shown	Job No: 210015
Project Manager: GM	Date: July 2010	Source: Google Earth
Drawn: CM		Figure 5

2008



[Source: MRM, 2010b]

2009 (Pre-dredging Works)

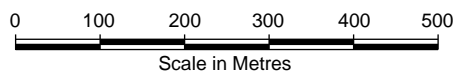



[Source: MRM, 2010b]

	Title: Bing Bong Facility Aerial Photographs	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor	Scale: As shown	Job No: 210015
Project Manager: GM	Date: July 2010	Source: Google Earth
Drawn: CM		Figure 6



Source: Figure provided to Independent Monitor by MRM in 2009



	Title: Bing Bong Spoil/Soil Sampling Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor		Job No: 210015
Project Man: GM	Scale: As shown	Figure 7
Drawn By: CM	Date: July 2010	



8 OUTCOMES OF TECHNICAL AUDIT

8.1 Introduction

A number of focus areas were selected by the Independent Monitor to form part of the technical review of environmental monitoring. These focus areas were those that the Independent Monitor considered to be of greatest environmental significance this audit period. The Independent Monitor's technical review of monitoring data (generally pertaining to the 2009 Operational Period) is presented for each focus area within the following sections.

The Independent Monitor considers that reviewing the environmental performance of MRM operations requires an evaluation of the technical data, and interpretation thereof to fully assess the environmental performance of MRM operations. Although a mine operator may have excellent systems and procedures in place, if the method of data collection, analysis and technical interpretation is unsuitable or requires improvement, then this undermines the evaluation of the environmental performance.

One of the key indicators of environmental performance the audit has to consider is spatial data management including GIS management, manipulation, representation and presentation of data. In the opinion of the Independent Monitor, substantial improvement can still be made in these areas.

8.1.1 Update on reporting requirements

As part of continued improvements in administering the *Mining Management Act*, the Department of Resources introduced the requirement for MRM (and other mining operations who manage significant water risks) to provide an annual Water Management Plan (WMP). As such, an Annual Environmental Report (AER) was not produced for the 2009 Operational Period as this document is no longer a requirement.

The WMP prepared in November 2009, has significantly improved the layout and presentation of MRMs water monitoring and management. Further, contingency planning and mitigation measures considered to be lacking in previous audit periods have improved significantly as part of the introduction of the WMP 2009 (MRM, 2009a). However, other non-water related aspects of environmental monitoring that were previously reported in the AER (e.g. soil and dust) were only reported within the Mining Management Plan (MMP) 2009/2010 (MRM, 2009b). This level and detail of reporting such monitoring in the MMP is considerably lower when compared to the 2008 AER for most monitoring programs.

8.2 Review of surface water and artificial water monitoring

The surface water monitoring program aims to assess potential impacts that the Mine site operations may have on surrounding and downstream water quality. The artificial water monitoring program assesses the condition of potentially contaminated waters in order to determine potential uses, and assess the risks of contaminant migration.

In order to achieve the above objectives, sampling is undertaken at several locations within the Mine site. Surface water and artificial surface water sampling locations are shown in Figures 8 and 9 respectively.



The Independent Monitor commends MRM for continuing to demonstrate improvements in the presentation and evaluation of the surface water and artificial water monitoring programs, as documented through the Water Management Plan. In order to further improve these programs, the Independent Monitor has made the following observations and recommendations.

8.2.1 Surface and artificial water monitoring program observations

The Independent Monitor is in general agreement with the discussion of natural surface and artificial water monitoring results provided in the 2009 Water Management Plan (MRM, 2009a), which is significantly improved from the 2005-2008 Annual Environment report (MRM, 2008b) provided during the previous audit. However, some of the Independent Monitor's criticisms from the previous monitoring period report still remain. These include the following:

- quality assurance and quality control (QA/QC) interpretation of results are not provided in the 2009 Water Management Plan or supporting documentation. The Independent Monitor acknowledges that due to the large volume of monitoring data generated, this information could perhaps be provided as a DVD attachment to the report however, a QA/QC discussion will improve the robustness and validity of the data obtained; and
- there are gaps in the chemicals of concern discussed. Monitoring commitments provided in the WMP have either not been adhered to or not discussed/tabulated, with scant mention of the monitoring of total suspended solids, hardness (as calcium carbonate), nitrogen, phosphorus, and chlorophyll. Improvements have been noted in the discussion of dissolved heavy metal and ionic species.


8.2.2 Surface and artificial water monitoring recommendations

The Independent Monitor provides the following recommendations for improving the environmental performance of the Mine with respect to the monitoring and management of surface and artificial waters:

- interpretation and discussion of quality assurance and quality control (QA/QC) procedures should be provided in the Water Management Plan (MRM, 2009a). This can be as an appendix and also incorporates QA/QC discussions for other monitoring including groundwater, soil and sediments;
- greater detail of the contingency planning and mitigation measures described in Section 4.5 of the Water Management Plan is required. For example, if a trigger level is exceeded, a description of the investigation process that follows the revelation of the trigger level exceedence should be provided (at the least, a cross-reference to this process in a related MRM document, if relevant);
although good detail regarding the nature of "no flow" and "cease to flow" conditions were provided in Section 6.1 of the 2009 Water Management Plan, laboratory and field results for monitoring during these conditions should still be included in the data sets presented. Despite these conditions, little to no-flow surface water systems are still accessible to humans, flora and fauna, and as such are beneficial uses that require protection; and
- where there are gaps in the data-set due to sampling locations being dry, inaccessible, unsuitable to sample or if no sampling was undertaken, explanations for these gaps should be provided as part of the 2009 Water Management Plan. This can be either in the text of the document or tabulated as an appendix, and is an essential component of ensuring compliance with the stated monitoring frequency and analysis commitments.



(Source: MRM, 2009b)

	Title: Surface Water and Fluvial Sediment Sampling Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent	Job No: 210015	
Project Man: GM	Scale: As shown	Figure 8
Drawn: CM	Date: July 2010	



[Source: MRM, 2009a]

Legend

WMD	Water Management Dam	APP	Anti-Pollution Pond
ID	Interceptor Drain	PS	Pit Sump
TDBP	Tailings Dam Borrow Pit	RPS	Rom Pad Sump
CRP	Concentrator Runoff Pond	VDD	Van Dunk Dam

	Title: Artificial Surface Water Sampling Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor	Scale: As shown	Job No: 210015
Project Man: GM	Date: July 2010	Figure 9
Drawn: CM		



Similar to the Independent Monitor's findings last audit, statistical analysis of surface water and groundwater monitoring data is considered by the Independent Monitor to be an insensitive tool to detect changes in water quality; particularly with respect to detecting changes within the background range. A change from host rock dependent water quality to early detection of mine seepage influence requires an understanding of solute transport and attenuation. Such an event is best detected by a technical determination of groundwater chemistry against a seepage model. Statistical evaluation will only detect the plume once the main contamination front has passed.

8.3 Review of groundwater monitoring

According to the *Technical Manual for Environmental Monitoring* (MRM, 2010c), groundwater monitoring is conducted to assess the potential impact of the operation on local groundwater. This monitoring is mainly focused around the Tailings Storage Facility due to the greater potential for groundwater contamination through seepage, with the large volume of material and contaminated water creating additional pressures. Locations of groundwater monitoring are provided in Figure 10.

As stated in Section 5.2 of the Water Management Plan 2009 (MRM, 2009a), the objectives of MRM's groundwater management program are to:

- monitor the impacts of groundwater abstraction;
- determine the extent of any contaminants in shallow aquifers;
- assess the effectiveness of Tailings Storage Facility seepage control systems; and
- assess potential impact of the establishment of the north Overburden Emplacement Facility.

8.3.1 Overview of groundwater monitoring program

The objectives of groundwater monitoring are consistent with those stated in the 2005-2008 AER (MRM, 2008b) reviewed as part of previous Independent Monitor audits.

The presentation and interpretation of the groundwater monitoring and management at MRM has (similar to the surface and artificial water monitoring) improved significantly compared to the information received by the Independent Monitor for the 2008 Operational Period. Furthermore, significant supporting information has been provided that improves the robustness of the interpretation of the monitoring results.

Groundwater monitoring locations are shown in Figure 10. The Independent Monitor's observations and recommendations regarding groundwater monitoring and management at MRM are described below. It is noted that some of these correspond to observations and recommendations that have not been acted upon since the 2006-2007 monitoring period report prepared by the Independent Monitor in 2008:

- laboratory transcripts, chain of custody forms and quality assurance/control interpretation of results are not provided in the Water Management Plan (MRM, 2009a) or supporting documentation. This is particularly important in validating the precision, accuracy and reproducibility of results;
- no individual groundwater potentiometric contours for the mine site, Tailings Storage Facility and dewatering/ borefield locations have been developed. Groundwater contours for the entire mine site are not suitable; we recommend the development of separate contours for each of these areas, as they all have separate issues that need to be addressed. These are essential in determining changes in groundwater



levels over time, inferred flow direction and also to assess the impact of mine dewatering, borefield operations and the potential for seepage migration from the Tailings Storage Facility to Surprise Creek. At a minimum, potentiometric contours should be developed for the Tailings Storage Facility and mine site bi-annually;

- no supporting documentation and few figures demonstrating the robustness of the updated pit and mine dewatering model (URS, 2009a) have been provided. As part of any groundwater modelling process, calibration and verification of the model is essential, and is often reviewed by an independent third party. The updated groundwater model for the MRM operation should demonstrate this calibration and verification process, particularly through update groundwater drawdown contour figures (projected and actual);
- at the Tailings Storage Facility, the electromagnetic survey undertaken by URS (March 2010) (URS, 2010c) appears to concur with the high variation in the alluvium and known areas of seepage breakthrough. However, an electromagnetic survey is considered insufficient in addressing the hydrogeochemical model and risks to beneficial uses, and should not be considered as a 'stand-alone' form of investigation;
- groundwater chemistry at bores between Tailings Storage Facility Cell 1 and Surprise Creek indicates increasing salinity and a (magnesium/calcium-sodium)-(chloride-sulfate) signature with increasing sulphate, which is likely due to localised mounding of water within Cell 2 of the Tailings Storage Facility and continued seepage;
- spatial and temporal hydrogeochemical trends within bores both at the mine and particularly at the Tailings Storage Facility need to be presented and discussed in far greater detail than currently provided. As Cell 1 of the Tailings Storage Facility is known to have leaked for over 10 years, this is overdue;
- the statistical data presented in the 2009 Water Management Plan is unsuitable. Individual or paired chemical concentrations for only a few bores should not be plotted as the entire dataset needs to be considered for an accurate assessment;
- due to variation in the shallow aquifer stratigraphy, particularly at Tailings Storage Facility, detailed geochemical signature analysis of each bore should be tabulated. As no geochemical retardation, degradation, attenuation, dispersion or diffusion was accounted for in the URS seepage modelling study (URS, 2006), this is required; and
- Page 46 in Section 5 of 2009 Water Management Plan describes new groundwater model calculations, but no data or figures of note were provided in either the Water Management Plan or URS report (2009a). The URS 2006 modelling report needs to be updated to reflect the model calibration and verification.

8.3.2 Groundwater monitoring program recommendations

The Independent Monitor provides the following recommendations for improving the environmental performance of the Mine with respect to the monitoring and management of groundwater:

- monitoring and abstraction bores that have been decommissioned, destroyed or not considered to suitable for on-going monitoring should be decommissioned in accordance with Minimum Construction Requirements for Water Bores in Australia (Land and Water Biodiversity Committee, 2003) to mitigate potential contamination of aquifers;
- updated figures should be provided in each annual Water Management Plan, that show the current and used monitoring and abstraction bores, including seepage recovery bores at the Tailings Storage Facility;



- critical evaluation of the performance of the seepage recovery system at the Tailings Storage Facility and the numerical model developed for the dewatering of the regional aquifer as part of the Mine expansion should be provided annually. The Independent Monitor has inspected exported data from the Tailings Storage Facility recovery bores and an example of the Recovery Bore Monitoring Sheet;
- where there are gaps in the data-set due to sampling locations being dry, inaccessible, unsuitable to sample or if no sampling was undertaken, MRM should continue to provide explanations for these gaps as part of the 2009 Water Management Plan. This can be either in the text of the document or tabulated as an appendix, as this is an essential component of ensuring compliance with the stated monitoring frequency and analysis commitments; and
- groundwater monitoring should include analysis for pH and Total Dissolved Salts (TDS) (for comparison against field measurements), cations (sodium, calcium, magnesium, potassium, ammonium), anions (chloride, bicarbonate (may be as calcium carbonate)), sulfate, nitrate) and dissolved heavy metals (aluminium, arsenic, iron, manganese, lead, nickel, zinc).

As discussed in our previous Audit Report of the 2008 Operational Period, the decommissioning of Tailings Storage Facility Cell 1 will only reduce the rate of seepage migration to Surprise Creek in the short term if it is undertaken in conjunction with further hydrogeological investigations of mitigation measures. These may include:

- further drilling along the main salt breakthrough pathway to determine the degree of fracturing in the underlying rock (dolomite/shale);
- understanding of the weathering behaviour of the tailings;
- installation of a leachate collection trench/cut-off wall; and
- infilling of the geopolymer barrier.

A preliminary conceptual geochemical and hydrogeological model of potential and actual seepage migration from Cell 1 of the Tailings Storage Facility to Surprise Creek is presented in Figure 3.

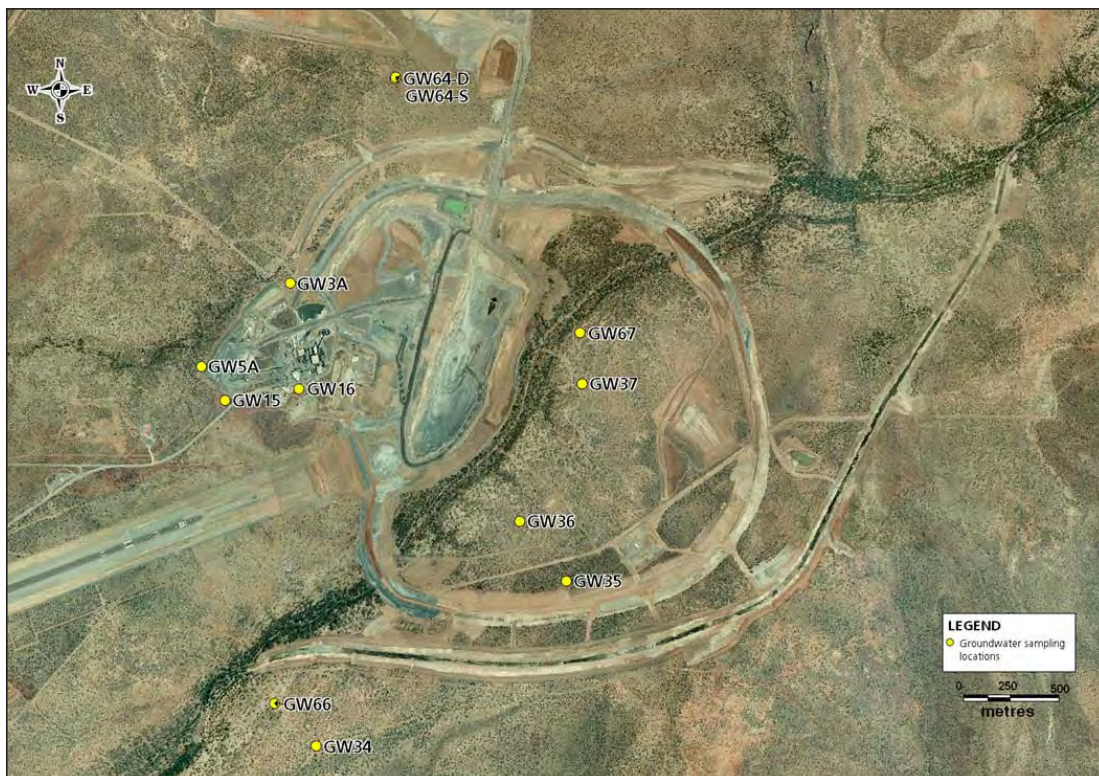
During our previous site inspection in June 2009, the Independent Monitor observed examples of completed field observation records, measurements and chain of custody forms for the dispatch and specification of analytical requirements of collected samples.

Tailings Storage Facility (TSF)




[Source: MRM, 2009a]

Mine Site



[Source: MRM, 2009a]

	Title: TSF and Mine Site Groundwater Sampling Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor	Job No: 210015	
Project Manager: GM	Scale: As shown	Source: Google Earth
Drawn: CM	Date: July 2010	Figure 10



8.4 Review of dust, soil and sediment monitoring programs

These monitoring programs aim to quantify and assess any impacts of mining operations on dust, soil and fluvial sediments that could potentially pose a human health or environmental concern. These monitoring programs also complement the water monitoring programs as they all can be inter-related and provide an overview of environmental performance.

Evidence of the dust, soil and sediment monitoring program undertaken by MRM was received by the Independent Monitor in the form of several documents including: MMP 2008-2009; MMP 2009-2010; 2009 Water Management Plan, Technical Manual for Environmental Monitoring (MRM, 2010c), reports by the Australian Institute of Marine Science (AIMS, 2009; AIMS, 2010a) and several laboratory transcripts detailing the analyses undertaken along with QA/QC documentation.

The locations of dust and soil monitoring sites are provided in Figure 11.

8.4.1 Site observations relating to dust, soil and sediments

The following sections provide observations made with regard to specific areas and assets at the mine site. These observations were made during the Independent Monitor's site inspection in May 2010.

Mine site

- the Independent Monitor observed that approximately 60% of the Tailings Storage Facility Cell 1 had been capped with clay as part of the staged rehabilitation of the facility. During the 2009 inspection MRM were pumping reclaimed tailings seepage back on top of Cell 1 as a means of tailings dust suppression. However, this has since ceased due to water balance and geochemical issues within Cell 1. As such, the remaining uncapped area of Cell 1 is a potential source of dust generation, which is currently not suppressed. It is recommended that the capping of Cell 1 (Plate 4 -) be finalised as soon as possible to limit dust generated from the uncapped area;
- crushing plant in the Pacrim yard at the mine site has recently been upgraded with double-lipped rubber liners, (Plate 5 -) which aim to reduce the volume of dust lost from the sides of the plant's conveyors. Water sprays are also used across the plant to suppress dust (See Plate 5 -Plate 6 -). Further upgrades to the crushing plant are planned, and the independent monitor noted an improvement on dust emanating from this facility compared to last year. This observation will be compared to actual dust monitoring results as part of the next audit; and
- concentrate-bearing dust was observed on soil and vegetation on the banks of a tributary of Barney Creek within an area undergoing rehabilitation during the 2009 Independent Monitor site inspection. The Independent Monitor also notes that the presence of "grey dust" is also recorded in the dust chain of custody documents near monitoring location D24 on the June and September 2009 sampling events. The same grey dust was not noted during the May 2010 inspection.

Since the Independent Monitor's site visit, MRM have advised that additional dust mitigation strategies to be implemented include: purchase of a street sweeper for use in the Mill, Barney Creek Bridge and access roads near the Pacrim yard. A vegetation barrier between the ROM Pad and main road at the mine site is also planned. The Independent Monitor will review these strategies in 2011.

Mine Site



[Source: MRM, 2009b]

Bing Bong



[Source: MRM, 2009b]


	Title: Mine Site and Bing Bong Dust/ Soil Monitoring Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor	Job No: 210015	
Project Manager: GM	Scale: As shown	Source: Google Earth
Drawn: CM	Date: July 2010	Figure 11



Plate 4 - TSF Cell 1 with incomplete clay capping.



Plate 5 - Pacrim conveyor with double-lipped lining (circled) to aid dust suppression.



Plate 6 - Water sprays applied to ore within crushing machinery for dust suppression.

Bing Bong Port Facility

The roller doors of the concentrate storage shed at Bing Bong remain open at all times due to potential sulfate gas build-up within the shed. This practice increases the opportunity for dust to escape from the shed and contaminate surrounding soil, sediments and seawater.

Existing dust mitigation practices were in place during the May 2010 inspection. These included the following:

- an enclosed conveyor system to minimise escape of concentrate during barge load-out. It is estimated that only approximately one small wheelbarrow of dust (sic.) is generated per loading cycle (Gary Taylor, pers. comm.);
- sprinklers used across the ground surface of the port facility and;
- wheel sprays are installed along the dumping bridge and platform used by trucks within the storage shed; and
- the Arburri barge is equipped with sprays for dust suppression during load out.

We understand that MRM are considering installing a gas vapour extraction system within the storage shed to allow the roller doors to remain shut, and or/ keeping the roller doors shut during concentrate dumping.

8.4.2 Review of dust monitoring program

According to the Mining Management Plan 2009/2010 (MRM, 2010b) the dust monitoring program comprises twenty five depositional gauges located at both the mine site and the Bing Bong Loading Facility. Twenty of the monitoring gauges are located at the mine site and five in the vicinity of the loading facility. These gauges (see Plate 8 -).are to remain in place for a period of 30 ± 2 days (as per AS/NZS 3580.10.1:2003) (Standards Australia, 2003) after which they are analysed for Total Insoluble Matter (TIM), lead and zinc.



Plate 7 - Enclosed load-out conveyor at Bing Bong Port.



Plate 8 - An Independent Monitor team member inspecting a dust sampling gauge at the Bing Bong Port facility.



After reviewing all the documentation received, the Independent Monitor is of the opinion that the environmental program for monitoring dust emissions is generally appropriate; however several issues were noted as follows:

- although there are several monitoring locations in the vicinity of the Bing Bong loading facility, the Independent Monitor believes that the monitoring of dust fallout in this area should be improved as there are currently no sampling gauges located within the swing basin or on the beach down-wind of the facility;
- there are currently no dust monitoring locations in the vicinity of the Overburden Emplacement Facility or the southern side of the McArthur River channel;
- dust monitoring results were not received for many locations: D15 in May 2009, due to samples not received from lab; D19 in November 2009, as bottle was broken; D21 for July 2009 onwards, as sampler was destroyed and not replaced until January 2010). Furthermore, inconsistencies and issues were noted within the analytical process. These include:
 - QA/QC documentation was not provided to the Independent Monitor for dust analyses undertaken by MIM Analytical Laboratories (however QA/QC was provided analyses undertaken by ALS);
 - it is noted that on the Chain of Custody documents (COCs) that Total Solids (TS) and Total Insoluble Matter (TIM) analyses are requested by MRM (on some occasions only TS is requested). However, MIM Analytical Laboratories invariably reports only one set of values for 'particulates'. Since data reported in the MMP 2009-2010 (MRM, 2010b) refers to TIM, it is assumed that MIM Laboratories are reporting this parameter; however, this is not made clear;
 - MRM advised that some of the bottles used for dust collection overflowed due to the high amount of rainfall during the wet season. It has to be noted that if bottles overflow then soluble matter cannot be determined and, hence, the TS value will be erroneous; moreover, in this situation TIM values are also prone to be underestimated; and
 - it was noted on several occasions that sampling gauges were not left for the number of days (30 ± 2) required by Australian Standard AS 3580.1990-1991 (Standards Australia, 2003). Further, samples were either left longer than, or collected before their due date. This non-compliance with Australian Standards may potentially affect the validity of the results.

The Independent Monitor is in general agreement with the discussion of dust monitoring results provided in Section 4.2.9 of the MMP 2009-2010 and thus, also believes that:

- there is little if any correlation between lead and zinc and Total Insoluble Matter;
- higher dust levels at specific monitoring locations are related to the prevailing north-west wind direction (spatial trend); and
- there are generally increases in dust levels in drier months at all locations (temporal trend).

The Independent Monitor notes, however, that there are several information gaps regarding the reporting of dust data within the MMP 2009-2010. These are:

- no discussion is provided in terms of spatial or temporal trends in regard to lead and zinc concentrations at any of the areas monitored (Bing Bong, ROM pad and Tailings Storage Facility) with the exception of Table 4.1 detailing simple statistics for each



monitoring location over the reporting period (i.e. mean, standard deviation of the mean, min, max and number of samples);

- total insoluble matter results are only presented within the MMP 2009-2010 for dust monitoring locations adjacent to the ROM pad/Pacrim yard. No analysis on spatial or temporal trends is provided for monitoring locations at the Tailings Storage Facility (D3, D5, D6, D12, D13, D15, D17, D19, D20 and D26) or the Bing Bong Load-out Facility (locations BB1 to BB5);
- the location for gauges D1 and D5 is not provided on the latest MMP 2009-2010. It is not made clear if monitoring location D5 is the same as monitoring location D4. From the Technical Manual for Environmental Monitoring (MRM, 2010c) it is inferred that monitoring location D4 is situated within a few metres of D5; and
- no long term dust level trends (i.e. over one year or several years to compare long term seasonal data sets) are presented for any of the areas of concern (Bing Bong, ROM pad and Tailings Storage Facility), and hence no analysis is made on whether dust emissions are actually decreasing over time. This prevents MRM from evaluating the performance of dust mitigation practices.

The effectiveness of the observed dust mitigation practices cannot be assessed solely over a one year period as correctly identified by MRM, as fluctuations in total insoluble matter, lead and zinc levels are mostly due to seasonal environmental factors (i.e. rainfall and wind). Since long term trends are not reported in the MMP 2009-2010, the Independent Monitor has reviewed and compared data provided in the MMP 2009-2010 with previous data contained within the 2005-2008 AER (MRM, 2008b). Our main findings are as follow:

- the mean total insoluble matter levels have increased in ten monitoring locations out of the eighteen that have been consistently monitored since 2008;
- the mean lead level in dust samples has increased by 2 to 5 times when compared to the 2008 Operational Period mean value at all monitoring locations, with the exception of monitoring location D8 where lead levels have slightly decreased; and
- mean zinc levels in dust have increased by 5 to 7 times when compared to the 2008 Operational Period mean value at all monitoring locations, with the exception of monitoring location D8 where zinc levels have slightly decreased.

Recommendations

The Independent Monitor reiterates the following recommendations for improving the dust monitoring program at MRM:

- there are no baseline pre-mining dust levels for the mine site, Tailings Storage Facility or Bing Bong load-out facility for comparison against current levels. This renders the development of site and contaminant-specific guidelines for dust as problematic; however temporal and spatial trends can still be evaluated, which also account for the effects of the wet and dry seasons. The Independent Monitor recommends that MRM install dust gauges outside the mine-site perimeter and Bing Bong load-out facility in order to gain information as to the potential (pre-mining) background dust levels;
- monitoring at the Bing Bong Loading Facility area should be improved by locating at least one dust gauge within the swing basin north of monitoring location BB2 in order to quantify dust fallout in the estuary to assess its relationship to heavy metal concentrations in marine sediment, and one on the beach to the west of the swing basin. It is proposed that dust monitoring be undertaken on a monthly basis (as per AS 3580.1990-1991) however, the Independent Monitor understands that this may not be possible at occasions due to environmental conditions;



- MRM should remain consistent in whether to monitor dust as Total Insoluble Matter or Total Solids, as inconsistency was observed between monitoring events. It was noted that Total Solids and Total Insoluble Matter are different parameters, with Total Insoluble Matter referring solely to insoluble material while Total Solids is the sum of insoluble and soluble material. MRM have advised that this was due to changing laboratories and should not occur again;
- the COC's should be completed in a consistent manner and only include the parameters required (be either Total Solids, Total Insoluble Matter, lead and zinc). Ideally, the laboratory should provide results in g/m²/month for Total Insoluble Matter or Total Solids and in mg/mg for metals;
- MRM have indicated that a vacuum extraction system is being considered for the concentrate storage shed at Bing Bong. This system would allow for the shed doors to remain shut and thus limit fugitive dust emissions without causing a build-up of corrosive sulfate gas inside the shed. The Independent Monitor believes this to be desirable and encourages MRM to implement this system as soon as practicable;
- the reporting of dust monitoring should include a discussion of results within each area of concern noting spatial and temporal trends (long and short term) for all parameters analysed;
- we understand that MRM are investigating the implementation of hi-flow dust samplers that are not affected by heavy rainfall. The independent Monitor agrees with this investigation; and
- MRM should consider upgrading the dust monitoring program to include new monitoring locations at the Overburden Emplacement Facility and the southern side of the McArthur River channel.

Overall, Total Insoluble Matter, lead and zinc levels recorded for the 2009 period (when compared to 2008) suggest that dust mitigation measures in place over that period were insufficient, and indicate the need to appropriately control dust emissions at all areas of concern (Tailings Storage Facility, Bing Bong and ROM pad/Pacrim). Current monitoring would suggest that dust is increasing and appeared to be sourced from mine operations.

The Independent Monitor commends MRM for the dust mitigation improvements observed during the May 2010 inspection; however it is likely that the effectiveness of these improvements will only be evident through an assessment of monitoring data for the 2010 Operational Period, which will be undertaken as part of the Independent Monitor's next audit in 2011. The Independent Monitor will continue to closely scrutinise the dust mitigation and management methods and results to ensure the environmental performance of the MRM operation continues to improve.

8.4.3 Review of soil monitoring

According to the MMP 2009-2010 (MRM, 2010b), a soil monitoring program is conducted annually at the Mine Site and Bing Bong Port Facility. Surface soil samples (0 - 0.05mBGL) are collected next to each dust monitoring gauge immediately prior to the wet season, and then submitted for heavy metals/metalloids (arsenic, cadmium, copper, iron, manganese, lead and zinc), ions (calcium, potassium, magnesium and sodium), pH, Electrical Conductivity (EC) and Particle Size Analysis (PSA) analyses.

After reviewing all the documentation received, the Independent Monitor is of the opinion that the soil monitoring program undertaken by MRM is generally appropriate. However, the following observations are made:



- the number of current soil monitoring locations (25) could be considered insufficient given the large extension of the mining lease area. This prevents an accurate assessment of the soil physico-chemical characteristics of the soil at the mining lease areas and thus accurately quantifying the impact of mining operations;
- no soil monitoring locations exist currently in the vicinity of the Overburden Emplacement Facility or the southern side of the McArthur River channel; and
- the Independent Monitor commends MRM for providing complete laboratory transcripts with quality assurance/control documentation and accompanying chain of custody forms. It is noted that there are no breaches to quality assurance/control in the sampling or analysis process.

After reviewing soil monitoring data provided by MRM, the Independent Monitor is in general agreement with the discussion of soil monitoring results provided in Section 4.2.9 of the MMP 2009-2010, which concludes:

- the highest lead and zinc concentrations were recorded in the vicinity of the ROM Pad/Pacrim yard, with monitoring locations S24 and S28 above NEPM's health investigation level for industrial/commercial land use (termed 'HIL-F') (National Environment Protection Council, 1999); and
- the highest concentrations for Bing Bong were recorded north west of the concentrate shed monitoring location BB2; however lead and zinc concentrations were below NEPM HIL-F.

However the Independent Monitor makes the following additional comments:

- the Independent Monitor does not agree with MRM in that "...contamination was confined to the soil in the immediate vicinity of the ROM pad/Pacrim..." (MRM, 2009b:70). Although two monitoring (S24 and S28) locations near the ROM pad/Pacrim had the highest concentrations, elevated levels of lead and zinc (>1000 mg/kg) were also found near Barney Creek (monitoring location S05) and north of the Tailings Storage Facility (monitoring location S15). The MMP 2009-2010 acknowledges that elevated concentrations were recorded at monitoring location S05 (Figure 11), and suggests that heavy metal input has a non Mine Site source. The Independent Monitor believes this conclusion to be incorrect as both corresponding dust monitoring location D05, and Barney Creek nearby sediment sampling location FS04 have also recorded high lead and zinc concentrations and thus suggest a Mine Site source for elevated soil levels. With regard to elevated concentrations at monitoring location S15, the Independent Monitor believes these to be due to dust blown from the Tailings Storage Facility which is located nearby;
- there is also no analysis of long-term temporal trends (i.e. comparing data from different years). The Independent Monitor has reviewed and compared soil concentrations recorded on the 2008 Operational Period with data from the 2009 Operational Period and has noted that Pb and Zn concentrations have slightly increased at all locations;
- there is no discussion on the rest of the parameters analysed (i.e. soil pH, electrolytic conductivity, particle size distribution, major cations (sodium, calcium, magnesium and potassium) within the MMP 2009-2010; and
- the NEPM criteria are not designed to be used as permission to pollute to this level. Temporal monitoring should be undertaken to evaluate whether pollution is occurring over time. As indicated above, pollution via dust deposition appears to be occurring.



Soil monitoring recommendations

The Independent Monitor makes the following recommendations for improving the soil monitoring program at MRM:

- MRM are advised to consider increasing the number of soil and dust sampling locations at the Mine Site and Bing Bong Facility. A larger dataset would allow for a better spatial determination of mining impacts on nearby soil;
- It is recommended that a complete soil landscape study of the mine lease areas be undertaken within the next two to five years to update the study already undertaken as part of the draft Environmental Impact Statement (EIS) prepared for the Mine's open-cut expansion in 2007;
- the Independent Monitor notes that MRM has not undertaken an investigation into heavy metal background levels in soil although this was recommended in the previous audit. This can be undertaken using two methods:
 - using the methodology described by Hamon *et. al.*, (2004) - Geochemical indices allow estimation of heavy metal background concentrations in soils. Global Biogeochemical Cycles, Vol 18, GB1014; or
 - collecting a number of surface samples of soils at locations sufficiently distant from the Mine Site so that heavy metal concentrations are not influenced by mining activities. Background concentrations are then calculated averaging concentrations for soils of similar physicochemical characteristics (i.e. cations, pH, electrolytic conductivity, etc);
- MRM are not advised to monitor soil against NEPM HIL-F as this was developed for the protection of human health (under specific conditions) and may not be conservative enough to protect biota inhabiting the region. It is acknowledged that there are currently no set ecological soil trigger levels and thus it is highly recommended that MRM undertakes a comprehensive human health and ecological risk assessment using the methodology described in NEPM 's "Schedule B(5): Ecological Risk Assessment - Dec 1999" and "Schedule B(4): Health Risk Assessment Methodology - Dec 1999" to determine no effect soil concentrations (National Environment Protection Council, 1999);
- MRM should provide a discussion on the analysis of soil pH, electrolytic conductivity, particle size distribution, and major cations (sodium, calcium, magnesium and potassium). This information could also aid in the development of ecological trigger levels;
- MRM should consider analysing samples using reagents that mimic the uptake of humans and biota (for example PBET and EDTA) in order to gain information as to the bioavailable fraction of metals. This information should also be part of the Risk Assessment investigations recommended above; and
- minimise dust so as to reduce airborne deposition of metals.

8.4.4 Review of fluvial sediment monitoring

According to the 2009 Water Management Plan (MRM, 2009a), a fluvial sediment monitoring program is conducted biannually at all natural surface water sampling locations as well as within the Overburden Emplacement Facility sediment dams. Sediments are analysed for heavy metals/metalloids (arsenic, cadmium, copper, iron, magnesium, manganese, lead and zinc), ions (calcium, potassium, magnesium and sulfate), pH, Electrical Conductivity (EC) and Particle Size Analysis (PSA).

The fluvial sediment monitoring sampling locations are presented in Figure 8.



After reviewing all the documentation received, the Independent Monitor is of the opinion that the fluvial sediment monitoring program undertaken by MRM is generally appropriate. However the Independent Monitor notes the following:

- Although the number of monitoring locations is considered appropriate for the Mine-Site, the Independent Monitor notes that there are no sediment sampling locations in the tributary south east of the Bing Bong Facility. While the wind has a north-west direction, it is still possible that concentrate bearing dust is transported to the creek by either surface runoff or occasional changing wind pattern; and
- it is acknowledged that MRM have increased the number of monitoring locations at the mine site, and now include the collection of a sample at the Southern Potentially Acid Forming (PAF) dam. The Independent Monitor approves this measure as it will provide additional information regarding any potential effects of Mining Activities in local streams.

The Independent Monitor commends MRM for providing complete laboratory transcripts with quality assurance/control documentation and accompanying chain of custodies forms for fluvial monitoring. It is noted that there are no breaches to quality assurance/quality control in the sampling or analysis process.

After reviewing fluvial sediment monitoring data provided by MRM, the Independent Monitor is in general agreement with the discussion of monitoring results provided in Section 6.1.9 of the 2009 Water Management Plan (MRM, 2009a), and thus also believes that data shows greater heavy metal impact at downstream locations for all monitored streams (McArthur River and Barney and Surprise creeks). However the Independent Monitor makes the following additional observations. This is consistent with observations and measurements of dust from the ROMP Pad onto the nearby floodplain of Barney Creek:

- the entire extension of Barney Creek that passes through the MRM mine lease area appears to have suffered a great impact from mining activities as is evidenced by lead concentrations exceeding ISQG-High triggers for samples collected along its entire extension during the 2009 Operational Period;
- with respect to the above point, the Independent Monitor does not agree with the statement that Barney Creek has “naturally high lead concentrations” (MRM, 2009a) and believes these to be sourced from mining activities based on the following evidence:
 - neighbouring dust monitoring location D6 consistently recorded high lead concentrations (up to 10,600 mg/kg); and
 - no background sediment lead concentrations have been determined for Barney Creek. It has to be noted that upstream monitoring location FS4 is not appropriate for determining background heavy metal concentrations due to its proximity to the location at which Savannah Way crosses Barney Creek. As such, this area is prone to receiving concentrate-bearing dust dislodged from the road pavement by passing vehicles.
- no data has been provided regarding the results interpreted for the analysis of sediment pH, electrolytic conductivity, particle size distribution, major cations (sodium, calcium, magnesium, and potassium) and arsenic. With regard to arsenic, MRM state in the 2009 Water Management Plan (MRM, 2009a) that this element was only analysed on “one sampling occasion”; however, the Independent Monitor acknowledges the receipt of laboratory transcripts for arsenic analysis for all sampling rounds, hence this observation appears incorrect;



- MRM consider heavy metal concentrations at upstream monitoring locations to represent background levels (having not established windblown dust will not reach this location), although the justification for this approach is not completely clear within the MMP 2009-2010. While this approach may indeed be correct, the Independent Monitor proposes a different approach for the determination of metal background concentrations in sediment, which is outlined in the recommendations below.

Fluvial sediment recommendations

- MRM should not arbitrarily consider upstream monitoring locations to represent background metal concentrations. Instead the following methodology is proposed:
 - collecting an undisturbed streambed sediment core of at least 1 m length; and
 - subsequently analyse discrete samples in 10cm intervals. If background levels were reached these would be noted as a sharp decrease in metal concentrations, however, if no sharp decrease is noted then it is likely that background concentrations were not reached and thus the core needs to be collected again at a greater depth. In addition to providing background concentrations, this methodology may also provide useful information regarding sedimentation; and
- MRM are advised to consider collecting samples at the McArthur River Delta east of Bing Bong to assess whether any mining impacts are taking place within sediments.

8.4.5 Other matters

The Independent Monitor acknowledges the receipt of the Bing Bong Dust Audit and commends MRM for undertaking this investigation. However, since this document was provided to the Independent Monitor after the closing date for the receipt of documents, it will undergo a technical review in the next audit. A preliminary review of this document indicates that MRM collected daily data regarding airborne metal levels at the Bing Bong Facility.

MRM indicated to the Independent Monitor that the Department of Resources officials undertook an inspection of the Bing Bong Port Loading Facility in response to media claims of concentrate being spilled in the swing basin during barge load-out. The Independent Monitor will review and comment on the reports regarding this official inspection as part of the next Independent Monitor report. However, the Independent Monitor understands that the Department was satisfied that the concentrate loading procedures were appropriate and not resulting in gross contamination of the swing basin, as reported by recent media.

8.5 Review of marine monitoring

The Marine monitoring program aims to assess and quantifying whether activities undertaken at the Bing Bong Port facility are having a significant influence on sediment and seawater, which could subsequently impact on marine biota within the estuary and/or Sir Edward Pellew Islands.

Bing Bong Port and Sir Edward Pellew Islands seawater and marine sediment sampling locations are provided in Figure 12 and Figure 13 respectively.

8.5.1 Review of seawater quality monitoring

According to the 2009 Water Management Plan seawater samples are collected on a monthly basis in the area around the Bing Bong Port Facility. Sampling locations include two sites in the swing basin, three in the navigation channel and three control sites located between West Island and the shipping channel. Samples are analysed for heavy



metals/metalloids (arsenic, cadmium, copper, iron, lead, zinc), pH, electrolytic conductivity, Total Suspended Solids and turbidity.

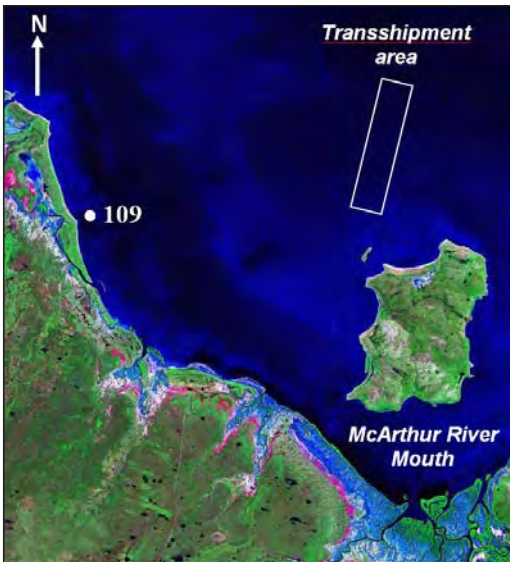
After reviewing all the documentation received, the Independent Monitor is of the opinion that the environmental program for seawater quality monitoring is appropriate and well-conducted. The Independent Monitor makes the following additional observations:

- MRM is commended for the scientific approach of the monitoring program, namely for establishing background concentrations (control sites) and statistically assessing differences in metal concentrations between sites. It is also noted that MRM assess whether long term trends exist for metal concentrations. This approach is lacking for dust, soils and sediments (see section 8.4).
- the Independent Monitor also agrees with MRM in setting the target for metal concentrations in seawater to the most conservative value (protection of the 99% of the species) in the ANZECC (2000) due to the relatively pristine environment where the operations take place. It is however noted that the ANZECC (2000) target for copper has been set to 95% protection of the species. While the Independent Monitor agrees with this approach (seawater in the area is naturally high in copper as is evidenced by concentrations at control sites), this needs to be made clear in future Water Management Plans;
- it is noted that MRM did not provide the official laboratory transcripts and accompanying documentation for seawater quality to the Independent Monitor (CoC's and QA/QC);
- the Independent Monitor is in agreement with the discussion and conclusions provided in the 2009 Water Management Plan and the 2009 Annual Marine Monitoring Program (AIMS, 2010a). This investigation indicated that even though exceedances of the ANZECC (2000) trigger levels were recorded, there is no major impact of mining operations on seawater conditions. The Independent Monitor reviewed the data provided by MRM and notes that a comparison of November and December 2008 versus 2009 data reveals that metal concentrations have not generally increased. However, it should be noted that monitoring locations MSW07 and MSW08 record the highest lead and zinc concentrations, indicating a potential impact of port operations on seawater chemistry. We do note that these could also be false positive results(see following bullet point)
- it was noted that the investigation undertaken by AIMS (2009) analysed samples for aluminium concentrations while monitoring undertaken by MRM did not. The Independent Monitor recommends that consistency should be maintained across monitoring programs. Further, regarding aluminium, the Independent Monitor notes the following:
 - aluminium cannot substantially exist in the dissolved phase above water pH of 5.5 (seawater pH is generally above 7.5). Given that laboratory results recorded aluminium concentrations in the samples this could only be due to sediment passing through the filter (0.45µm mesh); and
 - the fact that aluminium was recorded in the samples may indicate that all other elements recorded were in fact within the solid phase (sediment) and not in the dissolved phase (seawater). As such, these concentrations may represent false positives;
- the Independent Monitor also noted that turbidity data was not available. This issue has been recognised by MRM; and

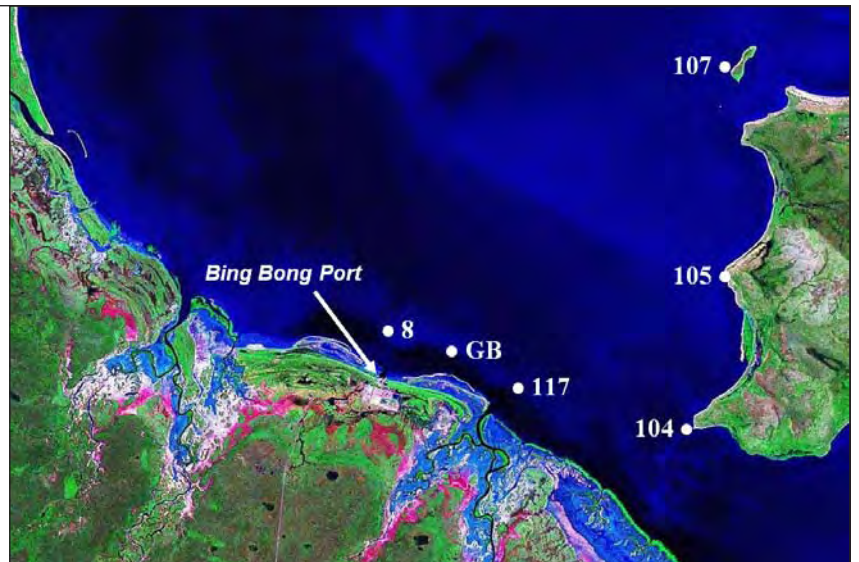


Source: MRM 2009a

	Title: Bing Bong Seawater and Marine Sediment Sampling Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor		Job No: 210015
Project Man: GM	Scale: As shown	Figure 12
Drawn By: CM	Date: July 2010	



0 10
kilometres



0 10
Kilometres

(Source: AIMS, 2009a)

Sir Edward Pellow Islands (SEPI)



0 10
Kilometres

Eye alt: 67.86 km
(Source: Google Earth)

	Title: Australian Institute of Marine Sciences (AIMS) Marine Program Monitoring Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor	Job No: 210015	
Project Manager: GM	Scale: As shown	Source: Google Earth
Drawn: CM	Date: July 2010	Figure 13



- metal analysis (including isotopic lead analysis) of suspended sediments at the McArthur River delta was not undertaken. It is recommended that this continue.

Seawater monitoring program recommendations

The Independent Monitor makes the following recommendations based on the review of the seawater quality:

- the results of investigations by MRM and external consultants such as AIMS should be combined and presented in one report (such as the Water Management Plan) in order to gain a clearer picture of actual seawater conditions;
- ensure that the filtering of samples is undertaken with a filter of at least (0.22µm) to avoid the presence of colloids and thus false positives;
- ensure that laboratory transcripts, chain of custody forms and quality assurance/control interpretation of results are provided in future Water Management Plans or supporting documentation;
- ensure that all monitoring commitments, including sampling locations, frequency and analysis, are adhered to and reported in subsequent Water Management Plans; and
- lead isotope ratios of suspended sediments in the McArthur River delta and at Bing Bong should be continued.

8.5.2 Marine sediment monitoring – swing basin and shipping channel

According to the 2009 Water Management Plan, marine sediment samples are collected at seven locations in the vicinity of the Bing Bong Port (Figure 12). These sites include a control site midway between West Island and the shipping channel, along with three transects located in the swing basin. In addition, AIMS (2010a) have also collected sediment samples from estuary areas near Bing Bong and Sir Edward Pellew Islands as part of the marine sediment monitoring program. All samples were analysed for particle size distribution (PSA), lead isotope ratios, major cations (copper, magnesium, sodium and potassium), and heavy metals/metalloids (arsenic, cadmium, copper, iron, lead, zinc) for the total and 63µm fraction.

The following observations have been made regarding the marine sediment monitoring program:

- the Independent Monitor agrees with the design and procedure of the marine sediment monitoring program undertaken and commends MRM for the inclusion of extra sites as advised by AIMS (2010a), as well as the establishment of background control sites;
- complete laboratory transcripts with quality assurance/quality control documentation and accompanying chain of custody forms were provided for the monitoring program undertaken by MRM. However, no documentation was provided for the analytical program conducted by AIMS. No breaches to quality assurance/quality control in the sampling or analysis process were noted where documentation was provided;
- the Independent Monitor is in general agreement with the discussion of marine sediment monitoring results provided in Section 4.2.9 of the MMP 2009-2010 and thus, agrees that heavy metal concentrations (lead and zinc) increase towards the Bing Bong Port, and are generally higher within the swing basin; and
- an anomalous pattern was observed with regard to the heavy metal concentrations results recorded on the October 2009 monitoring round. It is understood, as per supporting documentation, that this was also noted by MRM. The Independent Monitor is of the opinion that these anomalous results occurred due to the mislabelling of samples. If this is the case, MRM should review their sampling procedures.



Marine sediment monitoring recommendations

The following recommendations have been made with regard to the Independent Monitor's review of marine sediment monitoring:

- MRM has not provided a long-term trend analysis within the 2009 Water Management Plan. This is an essential tool to assess the effectiveness of contamination mitigation measures adopted at Bing Bong Port;
- the results of investigations undertaken by MRM and external consultants should be combined and reported in one document, such as within future Water Management Plans;
- monitoring of the McArthur River delta sediments (east of Bing Bong) should be undertaken as the potential for impact exists; and
- sediment samples are recommended to be collected at either side of the transects (outside the swing basin) to assess the lateral extent of the heavy metal impact. It is also recommended that the transect samples are not composited and that these are analysed individually. The Independent Monitor has sighted a proposal for the monitoring of beach sediments in Bing Bong by AIMS, however, no report was provided for review; The Independent Monitor will request to review this report as part of the next audit period; and
- MRM staff should be vigilant and ensure that the labelling of samples is always undertaken appropriately as wrong information could potentially result in the adoption of incorrect and unnecessary measures.

8.6 Review of flora and fauna monitoring

8.6.1 Mine site flora monitoring (terrestrial revegetation)

McArthur River vegetation monitoring

Revegetation of the McArthur River diversion is still in its early stages of regeneration. Although the diversion channel does not yet provide favourable habitat for fauna, positive indications of self seeding, direct seeding, and limited tubestock vegetation growth were observed during the Independent Monitor's May 2010 visit. The rehabilitation of the McArthur River will require ongoing intensive effort before a functioning riparian habitat corridor similar to the original McArthur River can be achieved.

A wide-scale tubestock planting effort of 40,000 plants was scheduled to commence in May/June of 2010 along the McArthur River diversion. In addition, the new irrigation system which uses a water tank on a sled was viewed during the site inspection. The effectiveness of this system will become apparent as the 2010 dry season progresses (See Plate 9 -).

The following observations were made during the Independent Monitor's May 2010 site inspection:

- rapid stream flow preventing deposit of soil and sites for establishment of plants is a cause of concern in the opinion of the Independent Monitor. Back eddies are a feature of the original channels and provide sites for soil deposit, plant growth and migrating and residential fish resting places. These aspects are lacking in the current McArthur River diversion channel;
- the Independent Monitor suggests that monitoring techniques targeting preferred rehabilitation species could be useful over a greater length of the diversion channel. The current monitoring program is thorough within plots; however, there is a large distance between plots. Currently, photographs are taken every year at 250m intervals



as part of the erosion monitoring, which also provides a gross measure of plant establishment. During early growth, species-specific identification as well as distinguishing weed species from desirable species could be challenging using this method; and

- large infestations of Noogoora Burr were observed on the original McArthur River and the diversion channel. The Independent Monitor is aware that these infestations are not entirely due to MRM operations. Control of these weeds is taking place to a degree but MRM are diverting the greatest efforts to the diversion area at this stage.



Plate 9 - New Irrigation system at the upstream section of the McArthur River diversion.

Barney Creek vegetation monitoring

The Barney Creek diversion revegetation/rehabilitation (See Plate 10 -) is progressing well with rapid vegetation growth and good ground cover. Cane grass clumps are present. The dominant species that have prevailed from revegetation is *Eucalyptus camaldulensis* (River Redgum), which is growing rapidly and is able to withstand flooding and cattle disturbance.

The Redgum is proving very useful as an initial rehabilitation species but MRM may need to cull Redgums and introduce more of the original dominant species such as *Casuarina cunninghamiana*, *Lophostemon grandiflorus*, *Terminalia bursarina* and *Excoecaria parvifolia* in the future in order to replicate the original Barney Creek ecosystem.

Recommendations for terrestrial mine site vegetation monitoring

It is acknowledged that rehabilitation efforts by MRM staff are challenged by great seasonal variation and the large scale of the operation. However, MRM must persevere in adhering to its commitments to fully revegetate the diversion channel as a suitable riparian habitat corridor. The following recommendations have been made for consideration:

- specific monitoring targeting preferred rehabilitation species along the McArthur River diversion will indicate whether rehabilitation is developing in the desired direction. The current monitoring program is thorough within plots however plots are considerably distant to each other;



Plate 10 - Revegetation at Barney Creek Diversion Channel.

- The Independent Monitor notes that seed collection has been local but mainly of common species of minimal habitat or foraging value. Species mix has been dictated by seed availability rather than original planned species mix, as acknowledged in the MMP 2009-2010 (MRM, 2009b:183). Whilst the Independent Monitor understands the practical limitations of collecting seed and propagating some species, we recommend that MRM work towards successfully establishing a species mix that closer resembles the successional stages and eventual climax habitats along the original river over the next few years. Particular emphasis should be placed on important or indicator species such as *Melaleuca argentea*, *Casuarina cunninghamii*, *Barringtonia acutangulata*, *Pandanus* and native cane grass. The Independent Monitor did not inspect the nursery during the May 2010 site inspection, but understands that MRM have a reliable planting contractor and relationship with nurseries in Darwin, which should give greater confidence that MRM will be able to fulfil their rehabilitation obligations;
- McArthur River Mine, in conjunction with Charles Darwin University, should undertake an assessment of whether a commitment of 5,000 stems per hectare after the first 12 months (as per the MMP 2009-2010) is appropriate as this would greatly exceed the natural densities;
- in relation to riparian monitoring (Bellairs, 2009), an upstream analogue site located along Surprise Creek is now downstream of identified Tailings Storage Facility seepage issues and thus is potentially impacted by tailings seepage. It would be useful to continue monitoring this site however MRM should include an analogue site on Surprise Creek upstream from the Tailings Storage Facility. It is understood that Glyde Creek was used as a reference site in the Draft Environmental Impact Statement (URS, 2005) baseline study; however this reference site may not be appropriate as is located within a different geological setting. An additional analogue site could also be established upstream along Barney Creek in order to adjust revegetation/rehabilitation targets. It would also be useful for future monitoring to include more comparison to baseline data as revegetation progresses;
- fences are destroyed by annual flooding events. Rapid maintenance of the 17 km perimeter fence surrounding the mine site is required to keep cattle away from areas undergoing revegetation and rehabilitation (See Plate 11 -). Whilst fence repair and



cattle mustering is undertaken by MRM, the Independent Monitor agrees with MRM's plan to move sections of the fence (where possible) away from areas that are repeatedly damaged by floods. The Independent Monitor acknowledges the receipt of feral animal removal register and a fence redesign plan from MRM;

- the Independent Monitor understands that weed monitoring has been carried out along the diversion channels. However, increased weed control efforts may be necessary at other mine lease areas such as Bing Bong Port, and upstream/ downstream from the McArthur River diversion to fulfil commitments made in the 2009 Weed Management Plan (MRM, 2009c);
- further efforts to provide back eddies and sediment deposition locations along the in the McArthur River channel should be regarded as a high priority; and
- future investigations should compare revegetation progress on the McArthur River diversion with baseline data as vegetation becomes established and begins to provide a suitable habitat. This will provide focus on important habitat species.



Plate 11 - Cattle foraging along Barney Creek.

8.6.2 Mine site fauna monitoring

Bird Monitoring

The Independent Monitor is satisfied that the Riparian Bird Monitoring and Macro invertebrate monitoring by EMS (2009a; 2009b; 2009c) have been carried out appropriately.

Riparian bird monitoring of White-browed Robin and Purple Crowned Fairy Wren show that these species were appropriately chosen as indicator species due to their specialist mature riparian habitat selection and territorial behaviour. This theory is supported by the fact that banded birds recaptured through the monitoring program have consistently been White-browed Robin or Purple Crowned Fairy Wrens, with few other species captured. Other species have presumably moved to alternative areas. As such, it is inferred that these species are not utilising the McArthur River Diversion channel as there is no habitat for them to occupy. This indicates that rehabilitation of the diversion requires intense efforts over a number of years to achieve a suitable habitat for these specialist species.

Fish Monitoring

Annual fish surveys were carried during the 2009 Operational Period. The two main issues identified were a lack of shade and absence of sufficient amounts of large woody debris for fish habitat. Subsequent personal communications with the MRM Health Safety and Environment (HSE) Manager have discussed the planned addition of large woody debris and boulders into the channel. The Independent Monitor understands that MRM are working towards revegetating the channel to address the lack of shade issue.

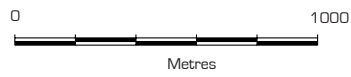
Fish surveys around the mine site, including heavy metal analysis of fish tissue were to be collected and analysed as per the 2008/2009 MM, are reported in Indo-Pacific Environmental reports (2010a; 2010b). Further, sawfish observed as part of the 2010 Fish Monitoring Program (see Plate 12 -) were found to be using the diversion channel to reach upstream waterholes after a large wet season event.



Plate 12 - Tagging of Sawfish forms part of the environmental monitoring program

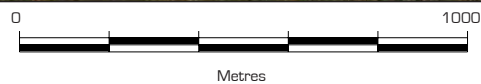
The Independent Monitor noted a lack of information regarding threatened species that have been found in the mine area, which are listed in the 2005 EIS (URS, 2005) and subsequent Mining Management Plans (e.g. Worrell's Turtle and the Northern Quoll). The Independent Monitor needs to be informed as to the current status of these species in the project area, management strategies and/ or reasons why they are not being monitored.

Mine Site Mosquito Monitoring




[Source: MRM, 2009b]

Bing Bong Mosquito Monitoring



[Source: MRM, 2009b]

	Title: Mine Site and Mosquito Monitoring Locations	
	Location: McArthur River Mine Northern Territory	
Project: McArthur River Mine Independent Monitor	Job No: 210015	
Project Manager: GM	Scale: As shown	Source: Google Earth
Drawn: CM	Date: July 2010	Figure 14



Recommendations

The following recommendations are made with regard to mine site fauna monitoring:

- fish monitoring (Sawfish) conducted by Indo-Pacific Environmental has been carried out appropriately, however the Independent Monitor recommends that the next survey includes the analysis of heavy metals in fish tissue from the diversion channel as per the commitment made in the 2009 Commonwealth Environmental Monitoring Plan (MRM, 2009d);
- a discussion on the status of other threatened or endangered species in the project area flagged in the Environmental Impact Statement baseline study (URS, 2005), such as the Northern Quoll and Worrell's Turtle, should be included in the next Mining Management Plan in order to address the importance and relevance of these species, and provide with reasons for not undertaking monitoring for these species; and
- MRM should consider installing cane toad traps around the mine site to show that they are actively trying to reduce the large population present.

Mosquito monitoring

A lack of a mosquito monitoring program was observed as a non-compliance during the past two Independent Monitor audits. The Independent Monitor is satisfied that the Mosquito Monitoring program is being undertaken in a satisfactory manner. Mosquito monitoring locations are provided in Figure 14.

8.6.3 Bing Bong Port flora monitoring

Dredge Spoil Ponds and vegetation dieback

The Independent Monitor's previous audit report highlighted the issue of saline seepage that was observed to be draining from the walls of the dredge spoil ponds and affecting vegetation within the surrounding area. The Independent Monitor inspected rectification works at the dredge spoil ponds in May 2010, which include a spoon drain surrounding the ponds (See Plate 13 -). This drain appears to have been successful at redirecting dredge seepage to sea rather than to the surrounding mud flat. The Independent Monitor is satisfied that this is a positive outcome for flora surrounding the spoil (See Plate 14 - Plate 15 -) and has probably halted further vegetation dieback. Accompanying documentation and photographs were provided to the Independent Monitor in the 2010 Bing Bong Dredge Spoil Report (MRM, 2010d).

The Independent Monitor noted the presence of self-seeded vegetation on the spoil, which indicates that the spoil is likely to be able to support vegetation. The Independent Monitor recommends the continuation of vegetation monitoring on the spoil, but particularly surrounding the spoil ponds outside the spoon drain, to monitor vegetation recovery and to ensure that the revegetation is native in composition rather than weeds.

The revegetation trial to be undertaken by a PhD student on a section of the dredge spoil has been approved to commence. This trial will be carried out over a period of 3.5 years, pending the nomination of a student. The Independent Monitor would like to see the inclusion of reference sites in the proposed vegetation monitoring program, the natural vegetation establishing in the salt seepage areas, and the inclusion of a strategy for managing future dredging operations without impacting rehabilitation commitments.



Plate 13 - Outer spoon drain at the Bing Bong Dredge Spoil to direct saline seepage from the spoil ponds to the sea.



Plate 14 - Vegetation recovery outside of the dredge spoil area.



Plate 15 - Independent Monitor team member inspecting succulent recolonisation between the outer wall of the spoil dump and the outer spoon drain.

The Parkinsonia infestation and biological control trials around the dredge ponds were inspected during the 2010 site visit. The Independent Monitor, MRM and the University of Queensland staff are in agreement that these trials should cease due to the high risk of Parkinsonia spreading in this area and the relative ineffectiveness of the biological control method compared to chemical control.

The Independent Monitor notes that aerial photographic mapping accompanied by ground truthing/field surveys have been carried out in the past (2003, 2005 and 2006) and additional aerial photography was undertaken in 2009 without ground truthing. Aerial photography may sufficiently show the changes resulting from impact of cyclones and the recovery phase. This information could then be incorporated into the annual aerial vegetation mapping program. The Independent Monitor also recommends that mangrove monitoring be undertaken through photographic reference.

Recommendations for vegetation monitoring at Bing Bong

Vegetation monitoring at Bing Bong Dredge Spoil has been generally appropriate, however the Independent Monitor makes the following recommendations for its improvement:

- continuation of aerial photography and ground truthing on an annual basis;
- commencement of Charles Darwin University PhD revegetation studies;
- monitoring of vegetation surrounding the spoil where previous vegetation dieback has occurred with the inclusion of reference sites;
- a plan for managing future dredging spoil storage should be developed. This plan must consider MRM rehabilitation commitments in the area;
- a mangrove monitoring program should be put in place as part of the general vegetation monitoring. This program could be undertaken through the analysis of aerial photography; and
- biological control of Parkinsonia should cease as evidence shows the relative ineffectiveness of the biological control method compared to chemical control.



Seagrass monitoring

The annual seagrass monitoring program was carried out in November 2009 (no survey appears to have been carried out in 2008) (BMT WBM Ltd, 2010). Seagrass helps stabilising beach sediments and is important habitat for Dugongs, prawns and turtles among other marine species.

It appears from the regular seagrass survey by BMT WBM Ltd (2010) and the annual monitoring of heavy metals in seagrass by AIMS (Australian Institute of Marine Science) that seagrass is generally continuing to recover from cyclones that occurred in 2000/2001; however, seagrass in the shipping channel area may also be affected by Bing Bong Port operations. Poor seagrass recolonisation around the shipping channel area and slightly elevated lead isotope ratios in seagrass tissue in this area have been detected. The Independent Monitor agrees that further research and monitoring is required to ensure that observed negative effects are minimised and do not become broad-scale.

Recommendations for seagrass monitoring

The following recommendations are made with regard to seagrass monitoring:

- It is recommended that the annual marine program continues with an aim over the next few years to work towards assessing whether the current trigger levels are satisfactory for a tropical marine environment of significance, and to possibly look into chronic or sub-lethal effects of metal contamination on flora and fauna; and
- seagrass has been monitored by BMT WBM Ltd appropriately; however, further investigation into lack of seagrass recolonisation around the shipping channel is required with possible collaboration from Charles Darwin University who conduct analysis of heavy metals in seagrass annually.

8.6.4 Bing Bong Port fauna monitoring

Migratory Birds monitoring

Migratory Bird surveys by EMS as part of MRM migratory birds monitoring programs have been carried out appropriately to satisfy legislative requirements, however, the Independent Monitor is of the opinion that it would be more useful to focus monitoring efforts on residential shore bird populations while maintaining a reduced migratory birds monitoring program.

Heavy metals in marine biota

Heavy metals in biota have been satisfactorily monitored as part of the Annual Marine Monitoring Program. The December 2008 marine monitoring at Bing Bong found metal concentrations in biota generally below trigger levels, or within previously reported ranges with a few exceptions at various sites (such as elevated arsenic levels in *Telescopium* and *Terebralia*, high cadmium levels in oysters, elevated lead levels in oysters in the western beach area, and elevated lead in seagrass). The Independent Monitor understands that high levels of total arsenic was further investigated and found to be largely from organic non-mine related sources.

The Independent Monitor also recommends that monitoring of heavy metals in fish tissue (particularly Barramundi) is carried out as part of the next marine program in order to fulfil commitments made in the Supplement to the Environmental Impact Statement (URS, 2005) and Public Environmental Report (URS, 2006) among other documents.

Observed decline in wallaby populations

The 1992 Environmental Impact Statement prepared for the Mine states that large numbers of Agile Wallabies were observed inland from the beach. However community concerns have been raised due to a perceived decline in wallaby populations in the Bing Bong port



area issue which has been noted by the Independent Monitor within the 2008 and 2009 audit reports. It is understood that MRM have undertaken an investigations to address this issue with the results of this provided in the *Bing Bong Macropods Final 23 June 2010* report. This report suggests that MRM operations are unlikely to be causing a decline in Agile Wallaby numbers around Bing Bong Port facilities, however since this document was provided outside the submission timeline it will undergo a technical review in the following audit of 2011.

A low level of monitoring of dingoes and wallabies, as reported by MRM in June 2010, provides an indication of dingo and wallaby numbers. MRM are advised to continue this program. The data can be used to assess the change in dingo numbers, which may relate to cessation of dingo baiting at Bing Bong Station. An increase in dingoes may indicate a potential increase in wallaby predation. It is also possible that the dry years have had an impact on wallaby numbers and changes in lawn availability at the Bing Bong facility may also have had an impact.

The dieback in vegetation due to cyclones or salt seepage, particularly small shrubs to the south and south east of the spoil dumps, may also be associated with the presence of wallaby populations in the area.

8.7 Review of civil works monitoring

The Independent Monitor team inspected the following assets to review geotechnical and geochemical monitoring and environmental performance:

- Overburden Emplacement Facility (OEF);
- Tailings Storage Facility;
- Bing Bong Spoil pond area;
- Barney Creek and McArthur River diversion channels; and
- sump area at toe of ROM.

8.7.1 Review of Overburden Emplacement Facility monitoring

Geotechnical monitoring

The placement of the clay liner (Plate 16 -) was observed to be progressing and expected to be completed in the near future. A pad foot roller was observed spreading and compacting the clay liner during the May 2010 inspection.

Based on the information provided by MRM, the quality control with regard to the construction of the Overburden Emplacement Facility clay lining continues to be limited. Even though the URS Overburden Emplacement Facility Design Report (URS, 2008) specifies that the contractor responsible for the placement of the clay liner should prepare a Quality Control/ Quality Assurance Plan (QA/QC), no comprehensive geotechnical reports/ documents regarding the foundation preparation or the placed Overburden Emplacement Facility clay liner have been provided to the Independent Monitor for review.



Plate 16 - Facing north-west towards the clay liner being placed for the Overburden Emplacement Facility.

The Independent Monitor acknowledges that limited material testing has been conducted to confirm whether the clay used meets plasticity and permeability requirements. According to the certificates provided to the Independent Monitor the tests conducted have been:

- 3 x Plasticity/Liquid Limit Tests (Atterburg test);
- 1 x Permeability Test (Falling Head Permeability); and
- 2 x Particle Size Distribution Tests (gradings).

Given the large volume of clay liner placed, the Independent Monitor believes that these tests are insufficient to ensure that the clay being used to construct the clay liner is suitable to meet the design specification. In addition, no evidence of QA/ QC testing upon the placed clay liner has been provided. The Independent Monitor was advised during the May 2010 visit that direct quality assurance was taking place using a densometer and undertaking laboratory compaction testing, however evidence of these tests (density ratio and moisture variation certificates) were not provided for review. Without sufficient evidence of this testing, the Independent Monitor is unable to state whether the Overburden Emplacement Facility design specifications (URS, 2008) have been met without supporting test results.

The following recommendations and were made by the Independent Monitor as part of the last audit. Relevant updates area also listed as follows:

- MRM were recommended to review the previously completed PAF cells and investigate/prove that the clay liner and foundation meets the design intent of the URS final OEF design (URS, 2008). As indicated above, no data has been provided to verify that the clay liner is being placed under a QA plan that ensures compliance with the URS Design Report;
- it was advised that for all future cell construction, ensure that the clay liner is placed under level 1 supervision (or alternatively approach URS to determine a revision to the design to compensate for the situation of no supervision, i.e. overdesign. Work out field indicators that operators can confirm and then complete regular confirmatory testing). No testing data was provided to the audit team for review that indicates that



the clay meets the URS design report (URS, 2008). The use of a Nuclear Densometer to determine the density of placed clay was mentioned during the audit visit, yet no test results have been provided to the audit team; and

- continuation of the PAF and NAF material sampling and confirmation program was recommended to ensure that PAF material is not inadvertently placed incorrectly. This is an ongoing task and testing has been verified as ongoing.

The OEF has been designed by URS and a Quality Control and Assurance Plan is a requirement of this design report. Quality Control with respect to the foundation preparation and clay lining sections appears to be non-existent. This is not in line with current industry practice and by not devising a Quality Control and Assurance Plan, MRM cannot assure the audit team that the design requirements of the clay lining are being met.

The following recommendations are made regarding the Overburden Emplacement Facility:

- implement with a matter of urgency a QA/QC program as per the URS design report, to ensure the Overburden Emplacement Facility clay liner is being constructed in accordance with the design to avoid future potential complications; and
- for all future cell construction, ensure that the clay liner is placed under level 1 supervision, or develop a method specification in conjunction with URS that allows for minimal supervision and testing of the liner construction. Method specifications are developed through the use of trial programs and quantitative testing. Through these trial programs a standardised placement method is developed, that meets the design specifications.

Geochemical monitoring of Overburden Emplacement Facility

The Independent Monitor was provided with updated procedures used by MRM in identifying and classifying waste rock destined for the Overburden Emplacement Facility. These procedures were updated following the Independent Monitor's recommendations in 2009 that the differences between the methods used by the mine geologists and those specified in the previous *Ore Spotting and Grade Control* procedure be reconciled. The procedure now reflects the observations made by the mine geologists in identifying waste rock, for which the Independent Monitor commends MRM.

Examples of PAF/ NAF confirmation sampling undertaken during the 2009 operational period were provided, the results and interpretation of which concurs with the observations made by the Independent Monitor on-site and with previous waste rock characterisation. Examples of waste rock characterisation from the pit and the river channel areas were provided, however no waste rock kinetic monitoring data was provided and interpreted, which is an unmet commitment.

Although conceptual closure plans for the Overburden Emplacement Facility are provided in the 2009/2010 Mining Management Plan (MMP), no contingencies for longer term (> 30 years) acid/ saline leachate generation are provided. The previous MMP stated that lysimeters will be installed in the Overburden Emplacement Facility to monitor water infiltration (and oxygen flux in pore spaces), however no evidence exists in the 2009/2010 MMP. The Independent Monitor supported this commitment in 2009 and recommends that MRM maintain this commitment and also update the closure plan to reflect potential acid/ saline leachate generation management in the long term.

Furthermore, the Independent Monitor recommends that MRM commit to undertaking larger-scale field weathering trials on selected NAF, PAF, acid consuming (AC) and uncertain (UC) classified waste rock to evaluate longer term leachate quality. This recommendation

continues from 2009, and is considered to be important in rehabilitation planning because, as the rate of acid and/or saline leachate production (and geotechnical integrity) is a function of mineralogy, geochemistry and particle size, the results of kinetic column test monitoring should be abandoned or used in conjunction with larger scale field trials.

Another recommendation from the Independent Monitor's 2009 report, being that of developing a conceptual hydrogeological model of the Overburden Emplacement Facility and ensuring that groundwater monitoring bores (and any lysimeters installed) at the Overburden Emplacement Facility be monitored for pH, TDS, cations (sodium, calcium, magnesium, potassium, ammonium), anions (chloride, bicarbonate, sulfate, nitrate) and dissolved heavy metals (aluminium, arsenic, copper, iron, manganese, lead, zinc), be implemented in 2010-2011. This will enable MRM to continually improve their monitoring program by pro-actively identifying potential leachate breakthrough events before it discharges to the environment.

8.7.2 Review of Tailings Storage Facility monitoring

Geotechnical monitoring observations

In May 2010, the following areas of the Tailings Storage Facility were inspected:

- the eastern boundary of Cell One and Surprise Creek;
- the northern boundaries of Cell 1 and Cell 2 and;
- spillways from Cell 2 into the water storage (limited visual inspection from a distance).

Evidence of seepage (see Plate 17 -) and potential piping (see Plate 18 -Plate 19 -) was noticed along the road between Cell 1 and Surprise Creek. Salt deposits were also noted around these locations, which could indicate that seepage is occurring from Cell 1.



Plate 17 - Seepage expressing into Surprise Creek, northern boundary of TSF Cell 1



Plate 18 - Evidence of piping erosion on the northern track edge of TSF Cell 1.



Plate 19 - Plate 7 Erosion Gully taken from reverse angle

A geopolymer “curtain” was installed along the South Eastern Boundary of Cell 1 in 2009. This curtain is a proprietary product injected into the ground in order to create an impermeable boundary at the toe of the Cell 1 embankment. It appears that no means of



quantitative assessment of the effectiveness of these works is possible. Such a program would consist of installing groundwater monitoring bores upstream and downstream of the curtain. Comparisons between water levels and water chemistry between bores on either side of the curtain could be used to determine whether the sub surface curtain is functioning as intended. Ideally, this monitoring program should have been implemented prior to the installation of the geopolymer curtain, so that groundwater conditions before and after the works could have been compared.

Anecdotal evidence in the form of staff monitoring of the water levels within a pit located of the eastern corner of Cell 1 indicates that the water level in the pit “is lower than previously observed.” However, there is no way of corresponding this observation with the installation of the geopolymer curtain.

Cell 1 is currently decommissioned and does not accept any more tailings. The tailings stored within Cell 1 were observed to be dry to the point of desiccation and compact enough to walk upon without sinking into the surface. Drainage ditches within the tailings have been excavated to expedite drainage of the tailings surface.

The placement of a clay cap is currently ongoing and reported to be approximately 60% complete (AWA, 2010). Completion of this clay cap should be set as a priority in order to prevent rain water infiltration into Cell 1. The proposed drainage plan for Cell 1 will also redirect rain water runoff flows into Cell 2.

The condition of Cell 1 embankment was observed to be generally good (see Plate 20 -and) and furthermore, trees had been removed from specific embankment areas for the management of the dam, though regrowth has occurred (Plate 21 -)



Plate 20 - TSF Cell 1, Northern embankment looking west



Plate 21 - Some example of the larger vegetation present on the TSF Cell 1 Embankment

Cell 2 is currently operational and the deposition of tailings occurs from spigots located along the northern, eastern and southern boundaries. Basic deposition principles for the Tailings Storage Facility as adopted by MRM include the development of a beach profile on the northern and eastern embankment (AWA, 2010) (See Plate 22 -)



Plate 22 - TSF Cell 2 western embankment with tailings beach formed against embankment.

Cell 2 was observed to be containing a large amount of standing water of depths indicated to be in the order of 10m and resembling a water dam (See Plate 23 -Plate 24 -). The Independent Monitor did not receive the design report pertaining to the Cell 2 embankment and hence it is not known whether the Tailings Storage Facility Cell 2 is intended to function in that manner. Furthermore, seepage observed through the concrete apron of the spillway



(see Plate 25 -) indicates that the embankment is not performing appropriately as a water storage dam even if that was indeed MRMs intention.



Plate 23 - TSF Cell 2 Western Embankment, showing tailings pipeline and Standing Water against embankment of Cell2.



Plate 24 - TSF Cell 2: Deep body of standing water against the embankment with some erosion of the embankment occurring



Plate 25 - TSF Cell 2 Spillway. Seepage evident through concrete spillway.

During a site flyover in a small aeroplane conducted during the site inspection, it was noticed that a body of standing water was present near the Western corner of the Tailings Storage Facility (Plate 26 -). The impact of this standing water on the dam wall should be assessed to ensure it does not impact on the stability of the Tailings Storage Facility Cell 2 embankment.



Plate 26 - Standing water very evident within TSF Cell 2. Ponded water near toe of embankment (at wing tip) is a cause for concern



Update on geotechnical recommendations from previous audit

The following points provide an update on recommendations made within the Independent Monitor's previous audit in 2009:

- a complete comprehensive Tailings Storage Facility inspection and Dam Safety Review was advised during the last audit. According to the ANCOLD guidelines the Cell 1 embankment was overdue for a comprehensive inspection and dam safety review both in terms of time that the facility has operated and given the major issues with the embankment, both previously and currently. The Dam Safety Review was recommended to include an assessment of: the spillway adequacy for Cell 1; Water Management Dam; the various embankment construction and stability; and the operating procedures (including dam emergency response plan).

A Dam Safety Review was subsequently conducted in 2009 by AWA as reported in the *Dam Safety Review Report* (AWA, 2010);

- MRM were advised to continue to train MRM permanent personnel further in basic geotechnical hazard identification so that the effectiveness of inspections can be further improved. It was not possible to determine whether additional training to identify geotechnical hazards was conducted on site. The daily and monthly Tailings Storage Facility monitoring reports indicate that this may not be the case. However, it is understood that MRM have employed an on-site Geotechnical Engineer in the 2010 year, so an improvement in these areas would be expected in the next audit;
- it was recommended that MRM review and revise the MRM Risk Register so that the assigned hazard ratings reflect the current conditions on site. Following completion of this process, it will be possible for management to re-prioritise its resourcing to ensure that the highest hazards are appropriately managed and monitored. The MRM risk register appears to comprehensively list hazards for most facilities. Worker health and safety appears to be comprehensively covered, although there is no indication of consideration for risks within the Tailings Storage Facility. No tab within the risk register covers the identified risks and controls for embankment failure. Risks identified during the AWA Dam Safety Review should be added to the register;
- MRM were advised to action AWA Tailings Storage Facility key recommendations, including installation of groundwater monitoring boreholes in all embankments (where not present) and installation of survey pins at key locations around the dam perimeter. No groundwater monitoring bores were installed in the Tailings Storage Facility during the 2009 audit period. However, it is understood that these works are expected to be completed in 2010 dry season. No survey pins have been installed, and it is unknown when these are expected to be completed; and
- MRM were advised to increase the monitoring regime in terms of frequency, detail and scope (include review of water levels etc) so that the level of surveillance is more in line with the ANCOLD guidelines for High hazard category dams. At this stage, monitoring of the Tailings Storage Facility remains a qualitative exercise. Daily and monthly Tailings Storage Facility reports more relate to the operational aspects of the dams (volumes of tailings placed, locations etc) rather than information such as survey runs and groundwater levels. However, this level of monitoring can only occur when monitoring bores and survey pins are installed.

Discussion on geotechnical monitoring

The Tailings Storage Facility is composed of variously-aged embankment structures, and is inspected annually by external consultants (currently Allan Watson Associates). More regular, although not systematic, inspections and monitoring completed by MRM personnel.



There does not seem to be a great level of continuity between the MRM's day-to-day understanding of the facility (no real issues identified or reported) and the AWA inspection observations. Within the Mining Management Plan, MRM do indicate a high frequency of inspections in and around the Tailings Storage Facility. However, based on the Independent Monitor's review of documentation, it appears that these inspections are not conducted to a standard routine in order to ensure high risk areas of the dam are being identified and/or regularly visited. Further, the inspections rely solely on visual observations and no quantitative observations are being recorded, such as piezometric levels and survey data.

Given that a number of people complete the inspections, there is a significant risk of hazards remaining unidentified if no quantitative tools are employed to monitor the Tailings Storage Facility condition. The current means of day-to-day monitoring and surveillance is not in accordance with the ANCOLD guidelines for a high hazard category dam.

The AWA Tailings Storage Facility Dam Safety Review for 2009 (AWA, 2010) was provided for review. The following general comments are made regarding the AWA Dam Safety Review:

- the embankments of Cell 1 and Cell 2 appear to be stable;
- seepage expression along the western wall has been observed, and the discharge of tailings along this boundary is recommended to minimise the standing water against the embankment, thereby reducing seepage expression;
- detailed analysis of the emergency spillways is required to ensure they comply with existing design criteria;
- the Tailings Storage Facility should not be used to store water from mine dewatering activities, as this impacts on the tailings densities, available freeboard, seepage and potential for future upstream lift development.
- capping of Cell 1 is recommended to minimise rainfall infiltration into Cell 1;
- routine monitoring of phreatic surfaces within the Tailings Storage Facility embankments is undertaken to identify the potential for embankment instability. Monitoring bores should be commissioned in order to facilitate this monitoring; and
- freeboard within the Tailings Storage Facility is inadequate. Removal of excess water within Cell 2 and/or raising of the Cell 2 spillway is recommended.

Recommendations for geotechnical monitoring

The Independent Monitor recommends the following with regard to geotechnical monitoring at the Tailings Storage Facility:

- continue to action the aforementioned recommendations in the 2009 AWA Dam Safety Review, including the installation of monitoring boreholes in all embankments and the installation of survey pins at key locations around the dam perimeter;
- improve the monitoring regime, in terms of frequency, detail and scope (include review of water levels, piezometric data, survey monuments) so that the level of surveillance is in line with the ANCOLD guidelines for high hazard category dams. MRM should commit to transitioning the monitoring program from a qualitative based assessment to a quantitative one; and
- determine the safe operating limits for the piezometric levels within the embankment and settlement in the embankment crest.



Geochemical monitoring of Tailings Storage Facility

Similar to the 2009 audit period, the Independent Monitor conducted a detailed inspection of the Tailings Storage Facility in 2010, and also reviewed laboratory and field monitoring data provided by McArthur River Mine for the period October 2008 to December 2009.

The laboratory results were on a monthly basis for “final tails” discharged to Cell 2 for pH, total sulfur (S%), acid neutralising capacity (ANC), net acid production potential (NAPP), net acid generation (NAG) at pH 4.5 and 7, and selected heavy metals and ionic species (arsenic, cadmium, chromium, copper, lead, zinc, fluoride, calcium, magnesium, sodium, and potassium).

Monthly field and laboratory results for surface water sampled from Cell 2 were also provided. These results included pH, temperature, EC, oxidation-reduction potential (ORP), total suspended solids (TSS), total dissolved solids (TDS), and selected cations, anions and filtered and total heavy metals.

McArthur River Mine also provided copies of e-mail correspondence with Golder Associates pertaining to the Independent Monitor’s recommendations for further hydrogeological and geochemical investigations of the Tailings Storage Facility, as described in Section 7.1 and 8.8.2 of the 2009 Independent Monitor report. This correspondence took place on 3 and 4 June 2010, and involved MRM requesting Golder Associates provide a proposal to undertake the intrusive, geochemical and modelling works described by the Independent Monitor in 2009.

These works were, and are still considered to be of an urgent nature, which is why they were described in detail to enable MRM to start the works promptly (as part of the Independent Monitor’s notification under Section 6.4 of the IMACs). The delay of over 12 months in initiating these works is of concern to the Independent Monitor and we insist that the studies be undertaken urgently. The lack of a coherent hydrogeochemical model of the Tailings Storage Facility, particularly of Cell 1 and its interaction with Surprise Creek, is essential in determining the current and future risk of seepage from, and potential acid or ‘neutral’ mine drainage generation within the Tailings Storage Facility, and its impact on beneficial uses.

The MMP for 2009-2010, although it details the average geochemical of the ‘final tails’, provides little critical evaluation of the potential acid generating capacity of the tailings, and the changes in the geochemistry of the tailings over time.

The geochemistry results for the review period of the ‘final tails’ indicate relatively consistent levels of sulfur (8.72 to 16.2 % Sulfur), while NAG pH (at 7) are variable. The overall NAPP values are increasing over time, which is likely due to increasing efficiency in removing pyrite from the mill, which in turn is likely due to the modifications in the metallurgical process (see 2009 Independent Monitor report) and process of high sulfide ore zones. Increased pyrite at the expense of sphalerite and galena could well increase the potential of acid drainage depending on the amount and reaction kinetics of the dolomite ANC.

It should be noted that the values provided by MRM are for final tails deposited in Cell 2 of the Tailings Storage Facility, and does not include tailings disposed of in Cell 1 from 1995 to 2007. the Independent Monitor concurs with MRM that tailings are not currently potentially acid forming (PAF) however, the high S%, NAG pH (at 7) and decreasing ANC values, in conjunction with the lack of kinetic monitoring data, underlines the necessity for more detailed evaluation of historic and current tailings.



8.7.3 Review of Bing Bong Spoil Dump monitoring

Geotechnical observations

The Bing Bong Spoil Dump (see Plate 27 -) was inspected and since the previous audit, numerous works have been completed to reduce the environmental impact of the spoil dump on the wider area, including:

- Rehabilitation of the failed embankment (see Plate 28 -)
- Clearing of the drains around the spoil embankments to ensure runoff flows out to the ocean and not into the surrounding area.

The rehabilitation works appear to be effective, in that areas of dieback in vegetation due to increased salinity appear to be recovering.

It is understood that the embankment was reconstructed with compacted sandy dredge material, using bulldozers and excavators. It is not apparent whether this was completed to an engineered design, with factors of safety determined.

Seepage through and under the embankment was witnessed in a number of locations, and some sections of the embankment were witnessed to have piping and longitudinal cracking consistent with embankment instability and localised failure (see Plate 28 -Plate 29 -Plate 30 -). The Spoil Dump is also storing water with no freeboard between the crest of the embankment and the water stored within the spoil dump. This leaves the embankment vulnerable to overtopping during a heavy rainfall event that may lead to a failure of the Spoil Dump embankment due to washout.



Plate 27 - Bing Bong Spoil Dump – Aerial view looking west.



Plate 28 - Bing Bong Spoil Dump. Repaired Section of embankment. Seepage visible on left.



Plate 29 - Bing Bong Spoil Dump. Longitudinal cracking in Eastern Embankment



Plate 30 - Bing Bong Spoil Dump. Piping erosion in Eastern embankment

Update on recommendations from previous audit

The following points provide an update on recommendations made within the Independent Monitor's previous audit in 2009:

- MRM were recommended to review the proposed future use of this facility and then develop an investigation and design program so that the existing structure can be remediated to a state where it can meet its objectives in accordance with generally acceptable industry standards. The Bing Bong Spoil Dump has been remediated during 2009. Drainage channels around the dump have been reinstated to facilitate the flow of dredge spoil seepage out to sea; and
- following dredge spoil pond remediation, MRM were advised to develop a management for its continued operation including inspections, monitoring and usage strategies. No evidence of an inspection or monitoring program has been provided to the Audit team. The Bing Bong Spoil dump requires a standard inspection checklist, with identified issues recorded on a register and prioritised according to risk. It is recommended that identified issues, especially those pertaining to embankment stability are remediated prior to the commencement of every wet season.

Discussion on geotechnical monitoring

The Bing Bong dredge spoil has been remediated since the last audit visit, and vegetation surrounding the site is likely to regenerate due to improved drainage.

No plan or method has been submitted by MRM to manage the risk of future embankment collapses. In the light of recent repairs, it is recommended that MRM devise a program of regular monitoring and recording of the condition of the containment bund to safeguard against future wall collapses. A plan to manage the accumulation of stormwater within the



spoil ponds should be considered to ensure that failure of the bund(s) does not occur due to overtopping or piping.

It is understood that there is no dredging to occur in the Bing Bong location in the near future. If further dredging is required, an assessment of the suitability of the spoil ponds at that time should be conducted.

Geotechnical recommendations

MRM are recommended to:

- establish a monitoring program for the Bing Bong spoil dump. This program should identify potential failure locations and establish a timetable for remediation works;
- develop a method to manage and reduce the stored water within the spoil dump in order to mitigate the risk of overtopping; and
- if further dredging is required, review the suitability of the containment structure.

8.7.4 Geotechnical monitoring of river diversions

Geotechnical observations

The general condition of the diversion appears to be good (see Plate 32 -Plate 33 -Plate 34 -), with limited scouring of the banks. Revegetation of the river diversion banks (see Section 8.6.1) will improve scour protection during the wet season. Attempts to place large boulders and logs within the channels in order to reduce stream velocity and thus help with fauna recolonisation have not been successful, as boulders and logs placed are washed away during high velocity wet season flows. From a geotechnical perspective, bank instability due to wet season erosion within the diversion presents a minor risk. This could change and become an issue of concern if the banks erode to the extent that there is undercutting of the levee surrounding the mine (see Plate 31 -)



Plate 31 - Scour at the toe of the main Mine levee due to overland flows of the McArthur River during 2009/2010 wet season flooding – (see section 8.8.5)



Plate 32 - Looking downstream along the McArthur River diversion channel from the ford.



Plate 33 - Looking upstream along the McArthur River diversion channel, towards the ford.



Plate 34 - View of McArthur River diversion channel from the air.

As part of the last Independent Monitor's audit, MRM were advised to:

- ensure that as-constructed drawings and reports are finalised; and
- identify any areas along the diversion channels where it is critical to maintain the channel crests and ensure that adequate rock armour protection is in place. Continue visual monitoring of the diversion channels with particular focus on any areas identified as being critical to the ongoing performance of the diversion channels.

In response, an as-built report has been provided to the Independent Monitor. Further (as observed in the site visit), the protection of the diversion channels is an ongoing process and rock armour placement needs to be reviewed at the beginning of every dry season, with any remedial works required completed prior to the following wet season.

Overall, from the inspected sections of the river diversions the Independent Monitor considers that there are no major geotechnical issues that could directly impact on the operation of the mine or the wider environment for the short to medium term. The Independent Monitor recommends however that ongoing targeted monitoring be continued on a regular basis and that OH&S risks (falling rocks and soft crests) are also taken into account when undertaking the monitoring.

It is recommended that MRM continue a program to visually monitor the diversion channels to identify any areas along where it is critical to maintain the channel crests and ensure that adequate rock armour protection is in place where required.

8.7.5 Sump area at toe of ROM Pad

An environmental incident occurred during the 2008-2009 wet season at the toe of the ROM area, where a period of prolonged rainfall caused a sump to overtop. Stormwater (runoff from the ROM) discharged over the adjacent access road and into the upper tributary area of Barney Creek. It is understood that at the point of breach the road embankment was mostly washed away.



In response to this incident, the sump has been reconstructed (See Plate 35 -) to withhold a larger capacity and thus if the pump fails (as in the previous incident), there would be a longer period of time to address any issues before overtopping occurs. Although the Independent Monitor visually inspected the reconstructed sump, no design calculations were provided to support the assertion that the capacity will be sufficient.

The Independent Monitor has reviewed a capacity calculation and as-built drawings provided by MRM. If pump failure was to occur, we are satisfied that the capacity of the sump is likely to be sufficient to collect and hold runoff until the pump can be replaced or repaired.

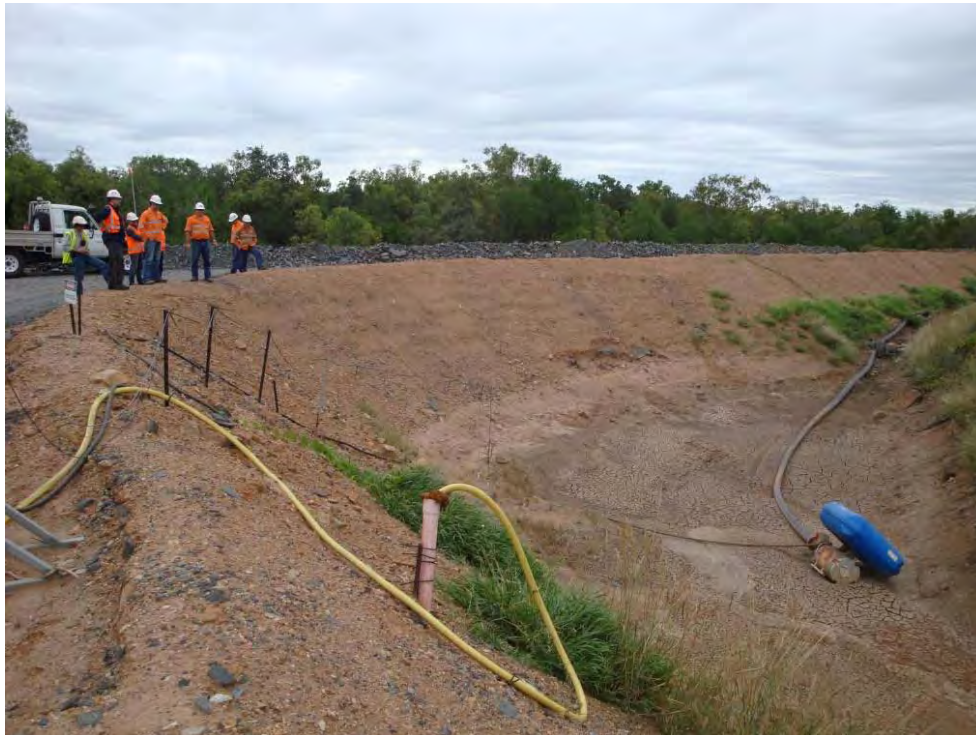


Plate 35 - Reconstructed sump at the west outer corner of the ROM Pad.

8.7.6 Review of general documentation and geotechnical management

In general, the overall management system at MRM, and how it is documented, seems comparable with other Australian mines in that there are overriding reference documents, including:

- Mining Management Plans;
- technical manuals;
- monthly reports;
- routine inspections; and
- for specialist design and construction work, consulting engineers and contractors are engaged to complete packages of work which are generally documented in a series of reports.

Whilst MRM have demonstrated that there is a framework in place for managing environmental risks, it is not apparent whether the system is being employed in such a manner that identified issues are being recorded, prioritised, actioned and closed out.



The main deficiency in MRM's geotechnical management of operations appears to be a lack of specialist understanding of the issues associated with the geotechnical management of their assets, in particular the Tailings Storage Facility (Section 8.7.2) and Overburden Emplacement Facility (Section 8.7.1). Specialist reports have been developed for the construction and management of these assets, yet without the technical knowledge to interpret and implement the recommendations, many have not been addressed. Failing to address these specialist recommendations in a timely fashion may have a direct impact on environmental performance.

The Independent Monitor understands that MRM have recently employed a Geotechnical Engineer. Having an onsite specialist should facilitate a better understanding of specialist Geotechnical Reports and allow MRM to better address the recommendations within these reports.

The MRM 2009 Risk Register was reviewed. It is noted that this was the same spreadsheet that was reviewed by the Independent Monitor as part of the 2008 Audit. Some of the risks are assessed as having likelihoods of "rare" (i.e. once every 100 years) when evidence suggests that these risks have either already occurred or are ongoing events. Examples of such risks are contaminant seepage from the Tailings Storage Facility (ongoing issue), overtopping of the runoff pond at the Bing Bong Facility (this occurred in the 2009/2010 wet season), and failure of the Tailings Storage Facility wall, which is understood to have occurred in the 2003.

Some of the Risks have aggregated causes of hazard scenarios, which may skew the risk ratings. For example, the following hazard scenarios have been assessed for Tailings Wall Failure:

- sabotage;
- poor design;
- adverse weather;
- exceeding operational capacity;
- machinery interaction;
- lack of maintenance; and
- poor communication.

Each of these hazards has a different likelihood, yet the same severity of outcome. Sabotage, for example, would have a likelihood of "rare," whereas failure due to lack of maintenance would be assessed as "likely." The risk of "Tailings Wall Collapse" due to sabotage would be "Medium," whereas the risk due to lack of maintenance would be "Extreme". Therefore, the implementation of controls to prevent wall collapse due to lack of maintenance should be given higher priority than collapse due to sabotage.

It is recommended that MRM review their risk register, and segregate the hazard scenarios for each identified risk.

Recommendations

The following recommendations are aimed at improving the management of the geotechnical aspects of the facilities reviewed that could have a significant adverse environmental impact if not managed appropriately.



- continue to train MRM permanent personnel in geotechnical hazard identification so that the effectiveness of inspections can be further improved;
- complete a full review of the MRM database to ensure all key design, construction, operation and inspection documents are registered and easily accessible to the relevant personnel on site; and
- review and revise the MRM risk register so that assigned hazard ratings reflect the current conditions. Split the hazards up into their component causes to appropriately assess the risk due to each cause.

8.8 Review of river diversion hydraulics

8.8.1 Review of Mining Management Plan 2008/2009 report (sediment and erosion)

Sediment Control Monitoring

Under the MMP 2008/2009 Section 4.2.9, a number of commitments were made with regard to “erosion and sediment control monitoring” including the inspection of sediment traps both “weekly during the wet season and after prolonged rainfall events”. While the Independent Monitor has sighted a series of regular inspection reports (starting in February 2009) for the substantially upgraded sediment trap located behind the ROM Pad, there has been no evidence of regular inspections of other traps apart from a summary of 2008-2009 ‘HSEC’ inspections and several early 2010 ‘Workplace Safety Observations’ reports.

It is noted that the same issues of lack of evidence of inspections and reporting of sediment trap performance were documented in the previous Independent Monitor report.

In June 2010, the Independent Monitor was advised by MRM staff that “the additional silt traps near the Barney Creek bridge will be placed in the same work order system as the ROM Pad sump along with other areas of focus for inspection purposes”. However it is noted that this commitment does not appear to cover all sediment traps.

Diversion Channel Erosion

Section 4.2.9 of the 2008/2009 MMP states a number of commitments - listed under four ‘dot points’, regarding “rechannelling erosion monitoring”. Dot points one and four relate to survey of the diversion works, and while not explicitly stated, it appears from dot point four that the intention was for ground survey to be undertaken to satisfy those two commitments. The following observations are made in relation to these commitments:

- the Independent Monitor has not sighted any “as-constructed survey of the completed McArthur River and Barney Creek re-channelled sections” that was to be done in “early 2009”. However the Independent Monitor has sighted the September 2009 aerial survey-based cross sections which are included in the 2010 Connell Hatch construction report of the channel diversions and these are considered to adequately address the first dot point commitment;
- the Independent Monitor has sighted two sets of 250m interval photographs for Barney Creek (taken in July 2008 & March 2009) and McArthur River (taken in October 2008 & March 2009). While the commitment included repeat photography “after the first three flood events, then annually for a period of three years...” it appears there were no photographs taken after individual floods during the 2008-2009 wet season. MRM have indicated that this is due to inaccessibility during floods. This commitment will be changed in future to aerial photography;



- while aerial photography was undertaken in September 2009, the Independent Monitor has not sighted any post-MMP 2009/2010 report commentary regarding “assessment of potential changes in plan form” as a result of a comparison of the 2008 and 2009 aerial photography; and
- the Independent Monitor has not sighted any subsequent cross section survey at 250m intervals along the re-channelled sections which were/are intended “to facilitate assessment of potential changes in geometry”. While it is recognised that the 2010 Connell Hatch construction report did include a review of design and post-construction channel cross sections, the review of the cross sectional data was not comprehensive. Further, the Independent Monitor has not sighted any evidence for the 2008/2009 period regarding a supplementary survey having been undertaken to determine “as soon as practicable...the extent of erosion damage”.

Downstream River Sediment Monitoring

Also under 2008/2009 MMP Section 4.2.9, a number of commitments - listed under four ‘dot points’ - were made regarding “downstream sediment monitoring”. The dot points refer to monitoring of “a potential sedimentation zone, in the McArthur River, downstream to the Bukalara Range” (a length of approximately two kilometres downstream of the river diversion outlet). The following observations are made regarding these commitments:

- the Independent Monitor has not sighted the results of any “pre-construction survey... of the (downstream) channel cross-sections with +/- 50mm vertical accuracy”;
- the Independent Monitor has sighted a set of 250m interval photographs which were taken in October 2009. The commitment included repeat photography “after the first three flood events, then annually for a period of three years...” While it appears that there were no post-flood photographs taken after any of the floods during the 2008-2009 wet season, it would seem that such photography would not produce meaningful images due to the likely persistence of substantial low flows (as also discussed below);
- while further aerial photography was undertaken in September 2009, the Independent Monitor has not sighted any post MMP 2009/2010 report commentary regarding “assessment of potential changes in plan form” as a result of a comparison of the 2008 and 2009 aerial photography; and
- the Independent Monitor has not sighted the results of any “cross-section surveys at 250m intervals” one year after the completion of the diversion construction works “to facilitate assessment of sedimentation impacts in the natural channels” (where it is implied that this survey would be undertaken in the same manner and level of accuracy as that referred to in the first dot point).

Additional Comments/Recommendations

As highlighted above, the Independent Monitor has not sighted any post MMP 2009/2010 report documentation whereby the 2008 and 2009 aerial photographs have been used to assist in the evaluation of erosion and/or sedimentation trends following the completion of the river and creek diversion works.

While it is agreed that the aerial photographs would provide such assistance, it is considered that the accompanying aerial survey plans (which have been developed from the aerial photographs) would prove to be a very valuable tool for the monitoring of changes along, and downstream of, the re-channelled sections of the McArthur River and Barney Creek. That is, by explicitly comparing the Digital Elevation Model (DEM) surfaces developed from each aerial survey, an ‘impact map’ of ground level changes could be very readily produced. Such an impact map would provide a much more comprehensive picture of changes happening throughout the footprint of the re-channelled sections than the current commitment of either



comparing the photographs themselves or comparing cross sections at 250m spacing's (or at the 100m spacing's as used in the Connell Hatch construction report (2010)).

Apart from in areas of ponded or flowing water, the impact map would provide detailed information about changes in ground levels – both in the channel bed and on the batter slopes – related to both erosion and deposition. Furthermore, there is seen to be a current lack of survey data regarding past and present conditions at each of the tributary chutes and the impact map would also provide a detailed picture of changes in those areas.

There might also be merit in using the above described DEM-based 'impact map' to review changes in the river channel conditions downstream of the re-channelling. However this would most likely be subject to a review of the density of the ground level data/points (which are typically related to vegetation cover issues) and the coincident water levels in the river. Obviously if the aerial photography takes place in times of other than very low flow, the results would not be useful for the review. It is also noted (as stated in the 2010 Connell Hatch construction report) that the aerial survey plans have an accuracy of +/- 0.15m and therefore, even given a good coverage of ground level points, the impact map would not be able to reliably define bed level changes of smaller than about 0.3m.

In the 2009 Independent Monitor report, it was recommended that 'opposite bank' photographs be taken to compliment the current series of photographs which are taken from the south bank of the Barney Creek diversion and the west bank of the McArthur River diversion. MRM responded to this recommendation with the comment that the current monitoring photographs "should be acceptable as both sides of the banks can be sighted" . The Independent Monitor does not agree with this assertion since the current 45 degree photographs provide little or no information about near bank conditions.

As part of further justification for not taking opposite bank photographs, MRM staff also advised the Independent Monitor in June 2010 that they considered the annual aerial photographs provided "more accurate/quantitative information than standard digital photographs". In this regard, as noted above, the Independent Monitor has not sighted any evidence that the aerial photographs have in fact been used for this purpose. Nonetheless, it is the Independent Monitor's opinion that sets of 'opposite bank' photographs will complete the picture of how the channel diversion works are performing with regard to erosion, sedimentation trends and rehabilitation.

With regard to the taking of photographs downstream of the river diversion, the Independent Monitor has sighted a second set of photographs which were taken in March 2010 (following the first set taken in October 2009). Due to relatively "high" low-flow water levels at the time the second set were taken, there is only water shown in the bed of the channel. Hence there is no opportunity to compare the two sets of photographs in terms of reporting on potential channel bed changes. Given that March 2010 situation, it is recommended that future photograph series should only be taken at times of very low flow so that potential changes in river bed conditions can be evaluated and reported.

The above comments are focused on the lack of evidence regarding the monitoring and assessment of erosion and sedimentation issues which were detailed in the MMP 2008/2009 report. However, it is reported with some considerable concern that erosion and sedimentation issues (and their associated monitoring) are not even featured in the more recent MMP 2009/ 2010 report.



8.8.2 Review of 2009 Water Management Plan (surface water)

River Flow reporting

Section 2 of the 2009 Water Management Plan includes figures depicting July 2008-July 2009 time series plots of water level and flow for the Upstream and Downstream McArthur River gauging stations and just water levels for the (new) Barney Creek gauging station. The time series patterns for the two McArthur River stations look to be very similar as would be expected (although the 2009 Independent Monitor report noted some discrepancies in previously reported river water level patterns). Although the time series patterns are very similar it is noted that the figures show that the downstream river station flows are about twice the upstream river station flows. This is unexpected given that the catchment area above the downstream river station is only about 30% larger than the area above the upstream river station and warrants further investigation. Also, as belatedly discovered by MRM staff, it is noted that while the river flows, the figures are reported in units of L/s, however the flow unit should in fact read m^3/s .)

The figure depicting Barney Creek water levels suggests that the timing of flood events in Barney Creek differ consistently by one month from the flood events experienced in the McArthur River. Such a trend would be most unusual and therefore it is assumed that there is an error in the presentation of the data.

The 2009 Independent Monitor report recommended that then reported river flow discrepancies should be investigated. The Independent Monitor has since sighted information that the flow rating tables for the various MRM gauging stations are about to be either developed (as in for the Upstream Flood Forecasting station and the Barney Creek station) or reviewed/verified.

Flood Warning System

In Section 2, the 2009 Water Management Plan also describes the current early warning flood system. It is noted with regard to this system that the 2009 Independent Monitor report recommended the upgrading of information from the flood forecasting river station in order to allow early identification of potentially critical flooding at the mine. The Independent Monitor has reviewed the *Early Flood Warning System Procedure* (MRM, 2009e) and notes that the procedure includes the statement that:

“if anyone listed within the callout schedule are notified of a rising river level that has potential to affect the safety of mining personnel, damage mine equipment or impact the surrounding environment they are to notify relevant mining personnel...”

While the Independent Monitor has been briefed on the new, and vastly superior, intranet facility, which provides real-time river water levels recorded at the flood forecasting station, there is still there is no written procedures as to how persons are to assess what constitutes ‘potentially critical river levels’.

The Early Flood Warning System Procedure (MRM, 2009f) also refers to the “Site Emergency Response Plan” regarding the roles of senior site personnel when notified of a rising river level. However, the only part of the Site Emergency Response Plan that deals with potential flooding is Section 5.3, which is solely focused on potential flooding of the open pit.

The concern expressed in the 2009 Independent Monitor report – that the current flood forecasting and response procedures fail to identify the water levels associated with very large (and rare) flood events – remains a concern. While it is recognised that work is currently planned to develop a flow rating table for the flood forecasting station, the



Independent Monitor has not sighted any evidence that the new data will be utilised to improve both the Flood Warning Procedure and the associated Site Emergency Response Plan.

Process Water System

Section 3 of the 2009 Water Management Plan states that “*water contained within the CRP (Concentrator Runoff Pond) can be reused in the processing plant, (and) transferred to the TSF Water Management Dam...*”. This appears to be an error and presumably should rather refer to potential transfer to the Tailings Storage Facility Cell 2 rather than the Water Management Dam.

Water Management Infrastructure

The operation of the Antipollution Pond (APP) is reported in Section 3 of the Water Management Plan. The plan states that “*the second pumping input is from the CRP...*”. This description does not correspond with Table 5.2 of the OPSIM 2009 (Water Solutions Pty Ltd, 2009a) report and therefore presumably “from” should be replaced with “to”.

With regard to the decommissioned underground workings, the report describes the twin pumps as having a total capacity of 6000kL/day. This discharge value does not correspond with the value of 10,020kL/day listed in Table 5.2 of the OPSIM 2009 report.

With regard to the Tailings Storage Facility, the report states “*the WMD may also be used as buffer storage for water transferred from the CRP, which is subsequently pumped back to the CRP in dry periods...*”. This description does not correspond with Figure 5.1 in the OPSIM 2009 report where the connection between the Tailings Storage Facility and the CRP is with Cell 2 rather than the Water Management Dam.

Under ‘Tailings Seepage Management’, the 2009 Water Management Plan states that the new recovery bore network “*became operational in early 2009 and to date 16,755 cubic metres has been recovered and placed in Cell 2*”. The Independent Monitor presumes that this new bore network will be included in the modelling reported in the next OPSIM report.

With regard to the Old McArthur River Channel, the Independent Monitor notes the MRM commitment to “*ongoing monitoring will ... occur in various locations once rainfall starts to fill up the old channel in order to fulfill requirements of a discharge license*”.

Water balance

The 2009 Water Management Plan, Section 3, provides a brief summary of OPSIM modeling. The Independent Monitor notes that there are a substantial number of recommendations made within the OPSIM 2009 report that are not captured or referred to within the Water Management Plan. It is therefore unclear whether MRM has either accepted these recommendations, or is committed to implementing them.

Water abstraction

Section 4 of the 2009 Water Management Plan report describes the system for extracting water from the McArthur River.

The 2009 Independent Monitor report expressed concern about the gaps in the then current procedures for both monitoring/measuring river flows and reporting how much water was being extracted. It is recognised that the water extraction system changed in March 2010 when a new irrigation sled system came into operation. This new irrigation system utilises flows extracted by pump from the river to irrigate the rehabilitation vegetation (rather than being pumped to an intermediate storage dam with subsequent water cart transport, etc).



In June the Independent Monitor was informed that a procedure to regarding the new sled system was in the process of being developed, and that water extraction pump readings were being recorded weekly. While a copy of the weekly readings table has been sighted it is noted that the table does not include allowance for noting the coincident river level/flow rate. Since the license conditions associated with extraction from the river are related to the river flow rate, it is important that the table reporting system also note those details. Furthermore, in order to show that the license conditions are being fully met, it is also important for the table to reflect each occurrence of pumping (along with the concurrent river flow value) rather than just weekly totals.

While the 2009 Water Management Plan report makes reference to the Department's water extraction approval letter (of 11 August 2008), it fails to address the potential environmental impacts identified by the Department associated with extracting some groundwater-fed river flows.

8.8.3 Review of differences between September 2007 and March 2009 water balance/OPSIM modelling reports

The March 2009 Water Balance/OPSIM report prepared by Water Solutions Pty Ltd is the latest in a series of reports prepared by that company regarding the MRM OPSIM water management model.

In terms of model capability this report differs from the previous 'September 2007' report as follows:

- the 'new' Van Duncan Dam (and an accompanying new tailings pipeline from the Van Duncan Dam to the Tailings Storage Facility) is included;
- the 'new' Overburden Emplacement Facility is included;
- the underground operations dewatering is integrated into the overall model;
- flow contributions from the old McArthur River (following completion of the McArthur River diversion and the main mine levee) are included; and
- for the first time, the modelling includes the Bing Bong port facility.

While the latest report details the rainfall and evaporation data sets which have been used in the water balance modelling, it is unclear why some of the data sets differ from that presented in the 'September 2007' report. In their respective Table 3.2 presentations of monthly 'site rainfall versus Data Drill' it would be expected that both reports would quote identical values for their common period of Jan 2007 to July 2007. However, almost all the monthly totals for site rainfall and Data Drill differ and some of the differences are substantial – for example, the site rainfall for March 2007 is listed as 142mm in the 2007 report but only 105mm in the 2009 report – yet the latter report does not provide any explanation for the differences.

There are also differences in the adopted evaporation data sets; the 2007 report quotes an average annual total 'point potential evapotranspiration' value of 3020mm (sourced from the Bureau of Meteorology) while the 2009 report lists three different average annual 'evaporation' rates of 2738mm ('Pan'), 2130mm ('Lake') and 2019mm ('Aerial') which have been sourced from the DNRM's Data Drill service. Not only does the 2009 report not provide an explanation for the adoption of 'new' data sets, it also does not provide any definition of the terms 'pan', 'lake' and 'aerial'. Furthermore, the 2009 report also fails to explain why two of the three accompanying evaporation factors differ markedly from those adopted in the earlier report.



Both reports list average daily flow rates based on MRM metered data. While it is recognised that the 2007 report utilises data based on the period January to July, while the 2009 report utilises data from the whole of 2007, some of the quoted values differ markedly as shown in Table 3.

TABLE 3 DAILY FLOW RATES

Item	Year 2007 value (ref 2007 OPSIM report)	Year 2007 value (ref 2009 OPSIM report)	Comment
Tailings	8683 t/day	4391 t/day	A 49% decrease; a significant difference presumably due to dry tonnage rather than total tonnage being quoted in the 2009 report but this is not clarified in the report
Total Bore Water to Decant	285 kL/day	420 kL/day	A 47% increase
APP to CRP	216 kL/day	1830 kL/day	A 750% increase

Review of March 2009 OPSIM Report

Apart from the differences between the 2007 and 2009 reports, there are also a number of discrepancies in the 2009 report as follows:

- In Section 3.4.3, three MRM measurements of Tailings Storage Facility Cell 2 water levels are presented. While the corresponding Cell 2 contained volume value is also listed, the 26 January 2009 value of 2935ML is at odds with the value (of approximately 2500ML) which can be read from Figure 5.2;
- In Sections 3.5.1 & 3.5.2, differing Tailings moisture contents of 51% and 48% are listed;
- In Table 3.14 the Tailings Storage Facility Cell 3 (Water Management Dam) catchment is described as 100% ‘tailings’ whereas the actual condition is more like a mixture of ‘natural/undisturbed’ and ‘cleared/prestrip’. The implications for the modelling appear to be substantial since Table 3.17 shows that the long term runoff volumes should be somewhere between 14% (‘undisturbed’ value) and 29% (‘cleared’ value) rather than the 45% value associated with ‘tailings’; and
- In Table 5.2 some of the presented flow rates vary from the data presented in Tables 3.5 and 3.10 and other text descriptions. For the Anti Pollution Pond (APP) it is considered to be a significant oversight to make no mention of the pumping regime to the Concentrator Runoff Pond (CRP) which is also listed in Table 3.5.

With very little data concerning fluctuations in the various MRM water storages, the modellers had only three Tailings Storage Facility Cell 2 water levels (recorded in the period April 2008 to February 2009) for the verification of their modelling. The report identifies that while the assessment of Tailings Storage Facility Cell 2 storage is a combination of three “primary sets of data” there is currently only recorded information for the surface water level, and hence the report also concedes that “the current verification is limited in scope”. Given the very limited information available for model verification, the Independent Monitor considers that the reporting of model results would have benefitted from sensitivity testing of the more important modelling assumptions and/or adopted parameters.



The Tailings Storage Facility Cell 2 and Tailings Storage Facility Water Management Dam storage spill frequencies determined from running 121 years of data through the model (reference Table 6.2 of the 2009 report) are flawed. This is because the modelling, as acknowledged in the report, “*has not considered the on-going expected reduction in storage volume resulting from solids accumulation*” (p. 41). Since it is noted at the beginning of the report that “*it is expected that the (MRM) site maintains the water management system to ensure that discharge from (the WMD to Little Barney Creek) is a last resort*”, the Table 6.2 results are potentially seriously underestimating the risk of Water Management Dam – that is, last resort - spill. However it is noted that this flaw has been addressed by the additional analysis detailed in Section 6.6 of the report where, by looking four years ahead, it was concluded that Tailings Storage Facility Cell 2 is likely to be completely filled with solids by September 2012. While it is unclear what rainfall data has been selected for the analysis of the next four years or whether there has been sensitivity testing of the adopted rainfall record, it is noted that the capacity of Tailings Storage Facility Cell 2 has very recently been increased through raising both the spillway and also the lowest portion of the bund wall.

It is also noted that Table 6.2 does not include spill frequency data for the Concentrator Runoff Pond. Nor does the report include a discussion (similar to that for Tailings Storage Facility Cell 2) regarding the impact that the accumulation of solids in the Concentrator Runoff Pond might/would have on its spill frequency (and in this regard it is noted that the solids which had accumulated in the Concentrator Runoff Pond were recently removed to order to restore its storage capacity).

The 2007 report provides details of the “*seven surface water storages which are considered significant in the context of the site water management system*” (p.15) and details of individual stage storage relationships are also provided in the report’s Appendix B. It is considered that the presentation of that data is a very useful component of the OPSIM reporting, but there is no such data presented in the 2009 report. It is therefore recommended that future OPSIM reports should include the storages’ information.

Section 4 of the 2009 report documents the underground inventory assessment. The associated Figure 4.1 shows that for most of the two year modeled period there is a good fit between the OPSIM simulation and the estimated underground inventory storage volumes. However for the remaining period (between April 2008 and December 2008) the OPSIM simulated volume is consistently and noticeably lower than the estimated value. The report includes a discussion as to whether or not the inflows to the underground inventory are rainfall related and recommends the gathering of more data by MRM in order that the underground inventory model might be improved.

The 2009 report concludes with an identification of “a number of items that require further consideration...” (p. 46). Given that within the Water Management Plan 2009 report there no associated MRM response to the OPSIM report’s findings and conclusions, it is unclear to the Independent Monitor whether MRM is committed to addressing the identified items.

8.8.4 Diversions construction report review

MRM staff advised that they had a Public Environmental Report (PER) commitment to produce the following river diversion reports:

- as-built;
- report after 1 year;
- report after three years (i.e. in 2011); and



- report after five years.

The Independent Monitor was provided with a March 2010 Connell Hatch report titled “*Construction Report – Levee & Diversions McArthur River Mine Expansion Project*” (2010). MRM staff also advised that since the ‘as-built report’ was being prepared ‘late’, Connell Hatch had been asked to combine the above first two reports into one.

It is noted the Connell Hatch (2010) report does not distinguish between reporting related to the construction as compared with reporting of conditions some time after construction was completed (e.g. the discussion of the aerial survey data/design cross section plots). As detailed below it is considered the report should have been structuring with:

- clearer analysis of what was built compared with what was required/specified; and
- separate review/reporting of channel conditions a year later.

Given that the river and creek diversions represent very substantial elements of the mine open cut expansion project, it is considered that the performance of those works needs to have been carefully assessed against both the project commitments and the details which were presented in the construction plans (including reference to changes and associated approvals made to those plans during construction).

While the report provides a general description of the Environmental Impact Statement/Public Environmental Report process, the detailed design process, the subsequent design modifications and the actual construction process it fails to provide specific information which would allow the reader to appreciate that the work was completed in accordance with stated commitments and detailed construction plans.

The following observations are made regarding the Connell Hatch documentation of the Barney Creek and McArthur River diversions.

Barney Creek Diversion

- In Section 4.1, the report summarises the list of Environmental Impact Statement (EIS) (URS, 2005) and Public Environmental Report (PER) (2006) commitments, but in so doing does not include reference to specific details such as rock sizes and riffle dimensions (which are listed in the report’s Appendix D). The report also fails to confirm if all the specific commitment requirements have been met;
- In its Table 4.1, the report refers to “Chainage 0 to 815”. This differs from the PER commitment (reference the report’s Appendix D) to “the upstream 890 metres. Under “Chainage 1650 to 3000” the table lists the design D50 rock size as 250mm yet Appendix D lists the size as 200mm for the “downstream reach of the diversion”. It is considered that Table 4.1 should not only have addressed these differences but also to have stated what was constructed in terms of bed widths, side slopes and rock armouring (with as-necessary additional columns to reflect approved design/construction changes);
- in Section 4.2.3, the report details the design process and preparation of detailed plans for the tributary “minor chutes”. It is considered that the report should have included as-built details of the various chutes compared with the detailed design plan information;
- in Section 4.4, the report refers to changes made to “step locations” (and it is assumed that the use of ‘step’ is synonymous with ‘riffle’). It is considered that the report’s Table 4.6 should have included additional columns which list the as-built step crest levels and



heights. The report also refers to “calculated peak water levels...are generally less due to...attenuation of the flow caused by the bridge” but it is unclear what is being implied by this sentence;

- Section 4.5 refers to “sections at 100m spacing” being provided in Appendix J, however plots are not provided for Chainages 1200 to 1500. The report states “a number of these (October 2009) photographs have been compared with June 2008 photographs taken in the same vicinity (Photos K1 to K10)”, yet the results of the comparison are not presented in the report;
- MRM had taken photographs in July 2008 and March 2009 along Barney Creek , however, the Independent Monitor questions whether there any attempts to compare the October 2009 Connell Hatch photographs with the MRM photographs;
- Section 4.5 of the report includes comments on both the 2007-2008 and 2008-2009 wet season flow regimes, and differences revealed in the aerial survey data set/design cross section plots provided in Appendix J. It is considered that the report should have provided more information on the locations where “rock bars left as natural riffles” or “deposited gravel bars” are deemed to account for the higher bed levels seen in the Appendix J plots. It is considered that such interpretative work might have been aided by reference to the construction period tasks undertaken by the MRM project surveyors; and
- in relation to the discussion in Section 4.5, it is considered that the review of Barney Creek channel changes would have substantially benefitted from an explicit comparison of the 3D surfaces associated with:
 - the Digital Elevation Model (DEM) generated from the September 2009 aerial survey; and
 - the diversion channel detailed design ‘12D’ surface. It is noted that such a comparison would assist in the review of not only the main channel itself, but also the tributary chute conditions.

McArthur River Diversion

- Section 5.1 includes a list of design parameters for the diversion. There is no evidence in the report that issues such as fish passage flow velocities, stream power values, Mannings ‘n’ values and rock & soil excavation tolerances have been satisfied as a result of the as-built works. This section of the report also summarises the list of EIS and PER commitments but in so doing does not include reference to specific details such as rock sizes. The report also fails to confirm if all the specific commitment requirements have been met;
- Section 5.2 details the design process and the preparation of detailed plans for the tributary “major” and “minor chutes”. It is considered that the report should have included as-built details of the various chutes compared with the detailed design plan information;
- Section 5.4 identifies the design changes made during construction. For a number of the design changes there is no description of the accompanying approval process;
- Also in Section 5.4, the report includes the comment ...”some flexibility was given in the location of riffles....” but the report does not provide confirmation of how many riffles were constructed or their river chainages. While Section 5.5 includes the statement that “dumped rock riffles in the upper reaches were removed” by the 2008/2009 wet season flows there is no clarification as to how many of the original riffles were washed away;



- In Section 5.5, the report states “a number of these (October 2009) photographs have been compared with June 2008 photographs taken in the same vicinity (Photos K1 to K10)”. However the results of the comparison are not presented in the report;
- MRM had taken photographs in October 2008 and March 2009 along the river but was there any attempt to compare the October 2009 Connell Hatch photographs with the MRM photographs;
- within Section 5.5, the series of key points regarding the comparative cross section plots (in Appendix J) are considered to represent an inadequate/incomplete description of the differences in the plots. That is, the use of statements such as batters being generally very close to the design profile and the batter profile being “slightly higher” downstream of Chainage 4900 masks batter level differences of the order of 2.5 metres at Ch 1000, 3.0 metres at Ch 3000 and 2 metres at Ch 5000. Furthermore the report states that “upstream of Chainage 1800 the toe of batters are flatter possibly resulting from deposition of sand and gravel in this area”. Further clarification re ‘possible’ broad scale deposition is considered necessary since the batter level differences in that area exceed one metre. The key points also fail to address issues such as noticeably smaller cross sectional areas at locations such as Ch 600-1800, Ch 2000, Ch 2600-2800 and Ch 4200-4500;
- in relation to the “key point” discussion in Section 5.5, it is considered that broad comments such as “the surveyed level of the base is higher.... as a result of siltation, gravel bars and ponded water” might have substantially benefitted from referencing definitive post-construction information – e.g. the construction period tasks undertaken by the MRM project surveyors; and
- relating to the discussion in Section 5.5, it is considered that the review of McArthur River channel changes would have substantially benefitted from an explicit comparison of the 3D surfaces associated with (a) the DEM generated from the September 2009 aerial survey and (b) the diversion channel detailed design ‘12D’ surface. It is noted that such a comparison would assist in the review of not only the main channel itself but also the tributary chute conditions.

Additional Flood Modelling

As detailed within the 2009 Independent Monitor report, it is considered that the as-built diversion channel works should be ‘tested’ by inserting as-built channel cross sections into the detailed design (HEC-RAS) hydraulic model. This should include associated reporting as to how the as-built channels compare against the various project commitments and design intents.

The 2009 Independent Monitor report also recommended that the flood flow path between the original McArthur River channel and the new diversion channel be modelled. Given that there was more erosion happening along that flow path in the 2009-2010 wet season compared with the 2008-2009 wet season, the 2009 recommendation is restated. This recommendation could be achieved by modifying the design, or work-as-executed - HEC-RAS model to include the separate flow path.

8.8.5 McArthur River diversion channel observations

Bank Erosion

A number of cases of bank erosion were observed during the Independent Monitor’s site inspection (See Plate 36 -Plate 37 -Plate 38 -).

A significant and very recent bank slump/erosion situation was observed in the natural river reach adjacent to the upstream river station (that is, upstream of the diversion channel).



Given such dynamic bank changes occurring in the natural river reach, it is impractical to expect all cases of diversion channel bank erosion to be rectified. Nonetheless, cases of relatively minor bank erosion should be monitored after each wet season since where there are cases of minor erosion expanding to a much large scale, protective works will need to be considered.



Plate 36 - Example of relatively minor bank erosion in the McArthur River diversion channel.



Plate 37 - Relatively minor bank erosion in the McArthur River diversion channel.



Plate 38 - An example of relatively minor bank erosion in the McArthur River diversion channel.

The bank erosion/slumping shown in Plate 38 - is also explicitly referred to in an MRM internal memo dated 22 April 2010 which scopes work deemed necessary to address various cases of river diversion channel erosion. It is noted that the memo notes that “some areas along the channel also could be seen to be slumping.... in these locations a mixture of clean rock and soil can replace the slumped area”.

Photograph Plate 39 - shows a location where local erosion occurs due to nearby overbank areas sloping away from the diversion channel. Such areas should be inspected after each wet season in order to assess if the erosion is worsening, and if so works should be undertaken to address the erosion. It is noted that this is associated with a concentration of local runoff and/or flood flow returning to the channel. The erosion occurs at this location due to the fact that nearby overbank areas slope away from the top of the channel which means that the returning flow is concentrated at this location since here the overbank area does slope towards the channel.



Plate 39 - Local (foreground) erosion at the top of the McArthur River diversion channel bank.



Photograph Plate 40 - is an example of potentially serious scour occurring at one of the tributary chutes. Each of the tributary chutes should be inspected after each wet season in order to assess the amount of change since the previous dry season inspection. The Independent Monitor recommends taking and reviewing annual photographs, and advises that ground surface along the diversion channel be reviewed through a comparison of the 3D surfaces generated by the annual aerial surveys.



Plate 40 - Evidence of recent scour at one of the tributary chutes. Such locations should be inspected at the end of each wet season to assess the amount of change.

Overland flowpath from remnant McArthur River to diversion channel

In June 2009, the Independent Monitor noted an overland flowpath taken by flood waters during the 2008-2009 wet season. This overland flow-path resulted from flood waters entering the cut-off section of the old McArthur River channel, then flowing over land around the base of the mine levee wall and into the new McArthur River diversion. This flowpath also occurred during the 2009/2010 wet season (Plate 42 -). Erosion from this overland flow was not seen to be significant in 2009

However during the May 2010 Independent Monitor inspection it was clear that significant erosion had occurred during the 2009-2010 wet season as a result of flood waters taking this overland flowpath. This included significant erosion at the toe of the main mine levee (see Plate 31 -), erosion along the flowpath towards the diversion channel, and significant erosion at the actual spill location into the diversion channel (See Plate 41 -).

While the problem is included in a MRM river works memo dated 22 April 2010, the Independent Monitor notes that the memo does not refer to potential further assessments/investigations of the scale of work required to address the problem. This is of some concern since the scale of the problem could be much greater if larger flood events are experienced. It is recommended that the area undergo flood modeling such that the potential scale of the problem can be both appreciated and the results used to inform the process of doing works which will not only effectively address the extent of current problems but also efficiently and effectively limit potential future scour.



Plate 41 - View of ground conditions at the point where the flowpath from the remnant river channel empties into the diversion channel. There is clear evidence of substantial and broad erosion.



Plate 42 - The broad and denuded flowpath (marked by arrows) between the cut-off remnant river channel (left) and the diversion channel (middle of the photograph) (May 2010).

Ford structure

The previous Independent Monitor report expressed some reservations about the impact of the ford at the upstream start of the McArthur River diversion channel, which was inspected



during the June 2009 Independent Monitor mine visit. The same location was inspected during the May 2010 Independent Monitor visit. This time (as shown in Plate 43 -) the ford structure, which had since been reconstructed, was fully submerged due to higher-than-normal water levels.

However, the reconstructed ford appeared to be a lower structure relative to the channel bed, than the ford of the previous year. Despite being overtopped there was no visible draw down effect in the river flow as it passed over the ford. From a river low-flow and channel bed sediment/erosion perspective, the lower ford is a significant improvement from that constructed in 2009.

Diversion channel bed

During the June 2009 Independent Monitor inspection it could be clearly seen that the river low flow regime was creating a naturally meandering low flow 'channel' along the flattish base of the diversion channel. Due to the higher than normal river flows at the time of the May 2010 inspection similar patterns were unable to be observed. However, the river flow was shallow enough to allow some of the riffle locations to be observed (Plate 44 -).

Irrigation of rehabilitation works

MRM have instigated the use of a water irrigation sled to aid vegetation establishment along the McArthur River diversion channel over the dry season. Drip irrigation systems (as used along the Barney Creek diversion) cannot be used along the McArthur River diversion, due to the damage that would ultimately be caused by the high volume/velocity floods that pass through the area. The irrigation sled can be dragged along the top of bank as required, with each setup feeding water to the requisite 400 metres of plantings (see Plate 45 -)

The incoming extracted river flow passes through a flow meter (which measures the flow in units of cubic metres) which allows MRM personnel to read the progressive total value at any given point in time.



Plate 43 - View of ford (under water), looking east across the river diversion channel (May 2010).



Plate 44 - View of one of the riffle zones in the McArthur River diversion channel



Plate 45 - The new irrigation sled structure which is now used for the irrigation of the river diversion channel rehabilitation works



8.8.6 Barney Creek diversion channel observations

The Barney Creek diversion channel was inspected between its upstream end and the confluence with Surprise Creek.

While the channel conditions were generally seen to be similar to the conditions at the time of the June 2009 Independent Monitor visit, the observed main change was bank erosion of the Barney Creek channel bank, opposite the Surprise Creek confluence (see Plate 46 -). The extent of bank erosion is apparent and MRM's have advised that this area has been rehabilitated with several hundred meters of material since the Independent Monitor's May inspection.

The vegetation density and height, particularly at the top of the channel banks and in the southern overbank area, were noticeably greater than a year earlier. However, we note the the presence of less vegetation in the lower bank batters is likely to be due to flood time erosion of soil material and the presence of young plants (see Plate 47 -Plate 48 -).



Plate 46 - The scale of erosion of the Barney Creek diversion channel's southern bank opposite the Surprise Creek entry point is clearly visible from the air (in May 2010)



Plate 47 - As reported in the previous Independent Monitor audit report (2009) the paucity of vegetation established on the lower parts of the Barney Creek batter slope (here located just upstream of the Surprise Creek confluence) is clearly evident.



Plate 48 - Barney Creek channel, just downstream of the Surprise Creek confluence.



8.9 Other matters

8.9.1 White material at Burketown Crossing, Borroloola

The Independent Monitor acknowledges the receipt of a report regarding the investigation and characterisation of white material found deposited on the rocks and sediment at the Burketown Crossing (AIMS, 2010b). This investigation was undertaken in response to complaints from the community of Borroloola through the Department of Resources on 21 January 2010.

This investigation concluded that the white material deposited on rocks and sediments had the chemical signature of precipitated salts from seawater evaporation, and is not the result of mining operations. The Independent Monitor has reviewed the data presented in the report and agrees with this conclusion however, notes that official laboratory transcripts and documentation were not provided.

The Independent Monitor reiterates that for all investigations official laboratory results and documentation should be provided for review.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Improvements since the previous audit

Many improvements have been made to environmental performance since the last audit. Most notably, as discussed in Section 7.1, improvements implemented by MRM have reduced the risk of urgent issues relating to:

- saline seepage from the Bing Bong Dredge spoil, and
- leachate migration from the Tailings Storage Facility, Cell 1.

Other notable improvements implemented by MRM since the last Independent Monitor audit include, but are not limited to, the following:

- implementation of an irrigation sled to aid McArthur River diversion rehabilitation;
- provision of as-built drawings for the river diversions;
- barney creek has continued to improve in Vegetation growth;
- improvements to the Pacrim crushing facilities to reduce fugitive dust mitigation;
- reconstruction of the ROM Pad sump;
- reconstruction of a lower ford structure across the upstream McArthur River Diversion;
- commencement of mosquito monitoring program;
- demonstration of improvements in the presentation and evaluation of the surface water and artificial water monitoring programs;
- provision of complete laboratory transcripts with quality assurance/control documentation and accompanying chain of custodies forms;
- undertaking a Bing Bong Dust Audit (which will be reviewed as part of the next audit);
- inclusion of additional marine monitoring sites; and



- updating of the Ore Spotting and Grade Control Procedure

9.2 Recommendations

Whilst many improvements have been noted, the following sections provide a summary of the Independent Monitor's recommendations to continue to improve MRMs environmental performance. These recommendations have been summarised from Section 8 – Outcomes of technical audit.

Surface and artificial water monitoring recommendations

- interpretation and discussion of quality assurance and quality control (QA/QC) procedures should be provided in future Water Management Plans;
- greater detail of the contingency planning and mitigation measures should be provided in future Water Management Plans. For example, if a trigger level is exceeded, a description of the investigation process that follows the revelation of the trigger level exceedence should be provided (at the least, a cross-reference to this process in a related MRM document, if relevant);
- although good detail regarding the nature of “no flow” and “cease to flow” conditions were provided in Section 6.1 of the 2009 Water Management Plan, laboratory and field results for monitoring during these conditions should still be included in the data sets presented. Despite these conditions, little to no-flow surface water systems are still accessible to humans, flora and fauna, and as such are beneficial uses that require protection; and
- where there are gaps in the data-set due to sampling locations being dry, inaccessible, unsuitable to sample or if no sampling was undertaken, explanations for these gaps should be provided as part of the 2009 Water Management Plan. This can be either in the text of the document, or tabulated as an appendix, and is an essential component of ensuring compliance with the stated monitoring frequency and analysis commitments.

Groundwater monitoring recommendations

- monitoring and abstraction bores that have been decommissioned, destroyed or not considered to suitable for on-going monitoring should be decommissioned in accordance with Minimum Construction Requirements for Water Bores in Australia (Land and Water Biodiversity Committee, 2003) to mitigate potential contamination of aquifers;
- develop individual groundwater contours for the Tailings Storage Facility, Mine site, and underlying aquifers of the borefield;
- updated figures should be provided in each annual Water Management Plan, that show the current and used monitoring and abstraction bores, including seepage recovery bores at the Tailings Storage Facility;
- critically evaluate the performance of the seepage recovery system at the Tailings Storage Facility and the numerical model developed for the dewatering of the regional aquifer as part of the Mine expansion. This should be done annually;
- where there are gaps in the data-set due to sampling locations being dry, inaccessible, unsuitable to sample or if no sampling was undertaken, MRM should continue to provide explanations for these gaps as part of the 2009 Water Management Plan. This



is an essential component of ensuring compliance with the stated monitoring frequency and analysis commitments;

- groundwater monitoring should include analysis for pH and Total Dissolved Salts (TDS) (for comparison against field measurements), cations (sodium, calcium, magnesium, potassium, ammonium), anions (chloride, bicarbonate (may be as calcium carbonate)), sulfate, nitrate) and dissolved heavy metals (aluminium, arsenic, iron, manganese, lead, nickel, zinc); and
- undertake further hydrogeological investigations regarding leachate mitigation measures at Tailings Storage Facility Cell 1. These may include:
 - further drilling along the main salt breakthrough pathway to determine the degree of fracturing in the underlying rock (dolomite/shale);
 - accelerated leaching of the tailings;
 - installation of a leachate collection trench/cut-off wall; and
 - infilling of the geopolymer barrier.

Dust monitoring and mitigation recommendations

- evaluate temporal and spatial trends and provide a discussion within subsequent MMPs;
- install dust gauges outside the mine-site perimeter and Bing Bong load-out facility in order to gain information as to the potential (pre-mining) background dust levels;
- monitoring at the Bing Bong Loading Facility area could be improved by locating at least one dust gauge within the swing basin north of monitoring location BB2 in order to quantify dust fallout in the estuary and assess its relationship to heavy metal concentrations in marine sediment. It is proposed that dust monitoring be undertaken on a monthly basis (as per AS 3580.1990-1991) however, the Independent Monitor understands that this may not be possible at occasions due to environmental conditions;
- monitor dust as either 'Total Insoluble Matter' or 'Total Solids' consistently between monitoring events in the future;
- the COC's should be completed in a consistent manner and only include the parameters required (be either Total Solids, Total Insoluble Matter, lead and zinc). Ideally, the laboratory should provide results in g/m²/month for Total Insoluble Matter or Total Solids and in mg/mg for metals;
- continue to investigate the efficacy of installing a vacuum extraction system into the Bing Bong concentrate storage shed so that shed doors can be kept closed;
- consider closing the doors of the Bing Bong concentrate shed during truck concentrate dumping to reduce dust;
- MRM are investigating the implementation of hi-flow dust samplers that are not affected by heavy rainfall. The independent Monitor also recommends this;
- consider upgrading the dust monitoring program to include new monitoring locations at the Overburden Emplacement Facility and the southern side of the McArthur River channel; and
- include soil /dust sampling locations swing basin and on the beach down-wind of the facility.



Soil recommendations

- MRM are advised to consider increasing the number of soil and dust sampling locations at the Mine Site and Bing Bong Facility, to allow for a better spatial determination of mining impacts on nearby soil;
- undertake a complete soil landscape study of the mine lease areas within the next two to five years to update the study already undertaken as part of the draft Environmental Impact Statement (EIS) prepared for the Mine's open-cut expansion in 2007;
- undertake an investigation into heavy metal background levels in soil. This could be undertaken using two methods:
 - using the methodology described by Hamon *et. al.*, (2004) - Geochemical indices allow estimation of heavy metal background concentrations in soils. Global Biogeochemical Cycles, Vol 18, GB1014; or
 - collecting a number of surface samples of soils at locations sufficiently distant from the Mine Site so that heavy metal concentrations are not influenced by mining activities. Background concentrations are then calculated averaging concentrations for soils of similar physicochemical characteristics (i.e. cations, pH, electrolytic conductivity, etc);
- cease monitoring soil against NEPM HIL-F as this was developed for the protection of human health (under specific conditions) and may not be conservative enough to protect biota inhabiting the region
- consider undertaking a comprehensive human health and ecological risk assessment using the methodology described in NEPM's "Schedule B (5): Ecological Risk Assessment - Dec 1999" and "Schedule B (4): Health Risk Assessment Methodology - Dec 1999" to determine no-effect soil concentrations. This may include analysing samples using reagents that mimic the uptake of humans and biota (for example PBET and EDTA) in order to gain information as to the bioavailable fraction of metals; and
- provide a discussion on the analysis of soil pH, electrolytic conductivity, particle size distribution, and major cations (sodium, calcium, magnesium and potassium) within future monitoring reports. This information could also aid in the development of ecological trigger levels.

Fluvial sediment recommendations

- MRM should not arbitrarily consider upstream monitoring locations to represent background metal concentrations. Instead the following methodology is proposed:
 - collecting an undisturbed streambed sediment core of at least 1 m length; and
 - subsequently analyse discrete samples in 10cm intervals. If background levels were reached these would be noted as a sharp decrease in metal concentrations, however, if no sharp decrease is noted then it is likely that background concentrations were not reached and thus the core needs to be collected again at a greater depth. In addition to providing background concentrations, this methodology may also provide useful information regarding sedimentation; and
- MRM are advised to consider collecting samples at the McArthur River Delta, south east of Bing Bong to assess whether any mining impacts are taking place within sediments.



Seawater recommendations

- In future, the results of investigations by MRM and external consultants such as AIMS should be combined and presented in one report (such as the Water Management Plan) in order to gain a clearer picture of actual seawater conditions;
- ensure that the filtering of samples is undertaken with a filter of at least (0.22µm) to avoid the presence of colloids and thus false positives;
- ensure that laboratory transcripts, chain of custody forms and quality assurance/control interpretation of results are provided in future Water Management Plans or supporting documentation;
- ensure that all monitoring commitments, including sampling locations, frequency and analysis, are adhered to and reported in subsequent Water Management Plans; and
- metal analysis including lead isotope analysis should resume for annual analysis of suspended sediment in the McArthur River delta region.

Marine Sediment monitoring recommendations

- provide long-term trends analyses within future Water Management Plans. This is an essential tool to assess the effectiveness of contamination mitigation measures adopted at Bing Bong Port;
- the results of investigations undertaken by MRM and external consultants should be combined and reported in one document, such as within future Water Management Plans;
- monitoring of the McArthur River delta sediments (south east of Bing Bong) should be undertaken;
- sediment samples are recommended to be collected at either side of the transects (outside the swing basin) to assess the lateral extent of the heavy metal impact. It is also recommended that the transect samples are not composited and that these are analysed individually; and
- if necessary, update sampling procedures to ensure that the labelling of samples is always undertaken appropriately, as wrong information could potentially result in the adoption of incorrect and unnecessary measures.

Terrestrial vegetation monitoring – Mine site recommendations

- MRM should work towards successfully establishing a species mix for the McArthur River diversion revegetation that closer resembles the successional stages and eventual climax habitats along the original river over the next few years. Particular emphasis should be placed on important or indicator species such as *Melaleuca argentea*, *Casuarina cunninghamii*, *Barringtonia acutangulata*, *Pandanus* and native cane grass;
- in conjunction with Charles Darwin University, MRM should undertake an assessment of whether a commitment of 5,000 stems per hectare after the first 12 months (as per the MMP 2009-2010) is appropriate as this would greatly exceed the natural densities;
- in relation to riparian monitoring (Bellairs, 2009), an upstream analogue site located along Surprise Creek is now downstream of identified Tailings Storage Facility seepage issues and thus is potentially impacted by tailings seepage. It would be useful to continue monitoring this site however MRM should include an analogue site on Surprise Creek upstream from the Tailings Storage Facility. It is understood that Glyde Creek was used as a reference site in the Environmental Impact Statement (REF) baseline study; however this reference site may not be appropriate as is located within



a different geological setting. An additional analogue site could also be established upstream along Barney Creek in order to adjust revegetation/rehabilitation targets. It would also be useful for future monitoring to include more comparison to baseline data as revegetation progresses;

- rapid maintenance of the 17 km perimeter fence surrounding the mine site is required to keep cattle away from areas undergoing revegetation and rehabilitation (See Plate 11 -). Whilst fence repair and cattle mustering is undertaken by MRM, the Independent Monitor agrees with MRM's plan to move sections of the fence (where possible) away from areas that are repeatedly damaged by floods;
- weed control efforts may be necessary at other mine lease areas such as Bing Bong Port, and upstream/ downstream from the McArthur River diversion to fulfil commitments made in the 2009 Weed Management Plan;
- further efforts to provide back eddies and sediment deposition locations along the in the McArthur River channel should be regarded as a high priority; and
- future investigations should compare revegetation progress on the McArthur River diversion with baseline data as vegetation becomes established and begins to provide a suitable habitat. This will provide focus on important habitat species.

Fauna Monitoring – Mine site recommendations

- fish monitoring (Sawfish) conducted by Indo-Pacific Environmental has been carried out appropriately, however the Independent Monitor recommends that the next survey includes the analysis of heavy metals in fish tissue from the diversion channel as per the commitment made in the 2009 Commonwealth Environmental Monitoring Plan;
- a discussion on the status of threatened or endangered species in the project area such as the Northern Quoll and Worrell's Turtle should be made in the next Mining Management Plan in order to address the importance and relevance of these species, and/or provide reasons for not undertaking monitoring for these species; and
- MRM should consider installing cane toad traps around the mine site to show that they are actively trying to reduce the large population present.

Vegetation Monitoring – Bing Bong recommendations

- salt seepage damage may be more widespread than immediately close to the berm walls of the Bing Bong Dredge Spoil. A such, more widespread vegetation monitoring of recovery and die-back should be undertaken;
- continuation of aerial photography and ground truthing on an annual basis;
- commencement of Charles Darwin University PhD spoil revegetation studies;
- monitoring of vegetation surrounding the spoil where previous vegetation dieback has occurred with the inclusion of reference sites;
- a plan for managing future dredging spoil storage should be developed. This plan must consider MRM rehabilitation commitments in the area;
- a mangrove monitoring program should be put in place as part of the general vegetation monitoring. This program could be undertaken through the analysis of aerial photography; and
- biological control of Parkinsonia should cease, as evidence shows the relative ineffectiveness of the biological control method compared to chemical control.



Seagrass monitoring recommendations

- it is recommended that the annual marine program continues with an aim over the next few years to work towards assessing whether the current trigger levels are satisfactory for a tropical marine environment of significance, and to possibly look into chronic or sub-lethal effects of metal contamination on flora and fauna; and
- seagrass has been monitored by BMT WBM Ltd appropriately; however, further investigation into lack of seagrass recolonisation around the shipping channel is required with possible collaboration from Charles Darwin University who conduct analysis of heavy metals in seagrass annually.

Bing Bong Fauna monitoring recommendations

- migratory bird surveys by EMS as part of MRM migratory birds monitoring programs have been carried out appropriately to satisfy legislative requirements, however, the Independent Monitor is of the opinion that it would be more useful to focus monitoring efforts on residential shore bird populations while maintaining a reduced migratory birds monitoring program;
- monitoring of heavy metals in fish tissue (particularly Barramundi) should be carried out as part of the next marine program in order to fulfil commitments made in the Supplement to the Environmental Impact Statement and Public Environmental Report (REF), among other documents; and
- consider monitoring dingo numbers compared with wallaby number to investigate whether the cessation of dingo baiting at Bing Bong is having an effect on wallaby predation.

Overburden Emplacement Facility recommendations

- implement (with a matter of urgency) a QA/QC program as per the URS design report, to ensure the Overburden Emplacement Facility clay liner is being constructed in accordance with the design to avoid future potential complications;
- for all future cell construction, ensure that the clay liner is placed under level 1 supervision, or develop a method specification in conjunction with URS that allows for minimal supervision and testing of the liner construction. Method specifications are developed through the use of trial programs and quantitative testing. Through these trial programs a standardised placement method is developed, that meets the design specifications;
- waste rock kinetic monitoring data should be provided and interpreted as part of the next audit;
- as part of the next audit, MRM should provide evidence of the installation of lysimeters within the Overburden Emplacement Facility to monitor water infiltration (and oxygen flux in pore spaces);
- update the closure plan to reflect potential acid/ saline leachate generation management in the long term;
- MRM commit to undertaking larger-scale field weathering trials on selected NAF, PAF, acid consuming (AC) and uncertain (UC) classified waste rock to evaluate longer term leachate quality. This recommendation continues from 2009, and is considered to be important in rehabilitation planning because, as the rate of acid and/or saline leachate production (and geotechnical integrity) is a function of mineralogy, geochemistry and particle size, the results of kinetic column test monitoring should be abandoned or used in conjunction with larger scale field trials; and



- Develop a conceptual hydrogeological model of the Overburden Emplacement Facility and ensuring that groundwater monitoring bores (and any lysimeters installed) at the Overburden Emplacement Facility be monitored for pH, TDS, cations (sodium, calcium, magnesium, potassium, ammonium), anions (chloride, bicarbonate, sulfate, nitrate) and dissolved heavy metals (aluminium, arsenic, copper, iron, manganese, lead, zinc), be implemented in 2010-2011. This will enable MRM to continually improve their monitoring program by pro-actively identifying potential leachate breakthrough events before it discharges to the environment.

Tailings Storage Facility recommendations

- seepage expression along the western wall of Cell 2 has been observed, and the discharge of tailings along this boundary is recommended to minimise the standing water against the embankment, thereby reducing seepage expression;
- detailed analysis of the emergency spillways is required to ensure they comply with existing design criteria;
- completion of the clay capping of Cell 1 is recommended to be undertaken as soon as possible to minimise rainfall infiltration into Cell 1 - MRM have indicated that this will be completed before the commencement of the 2010/2011 wet season;
- routine monitoring of phreatic surfaces within the Tailings Storage Facility embankments is undertaken to identify the potential for embankment instability. Monitoring bores should be commissioned in order to facilitate this monitoring;
- freeboard within the Tailings Storage Facility is inadequate. Removal of excess water within Cell 2 and/or raising of the Cell 2 spillway is recommended;
- continue to action the recommendations in the 2009 AWA Dam Safety Review, including the installation of monitoring boreholes in all embankments and the installation of survey pins at key locations around the dam perimeter;
- improve the monitoring regime, in terms of frequency, detail and scope (include review of water levels, piezometric data, survey monuments) so that the level of surveillance is in line with the ANCOLD guidelines for high hazard category dams. MRM should commit to transitioning the monitoring program from a qualitative based assessment to a quantitative one;
- determine the safe operating limits for the piezometric levels within the embankment and settlement in the embankment crest;
- undertake intrusive, geochemical and modelling works. These works were recommended last audit and are still considered to be of an urgent nature. The delay of over 12 months in initiating these works is of concern to the Independent Monitor and we insist that the studies be undertaken urgently. The lack of a coherent hydrogeochemical model of the Tailings Storage Facility, particularly of Cell 1 and its interaction with Surprise Creek, is essential in determining the current and future risk of seepage from, and potential acid or 'neutral' mine drainage generation within the Tailings Storage Facility, and its impact on beneficial uses; and
- MRM should provide critical geochemical evaluations of 'final tails' within future MMPs, including evaluations of the potential acid generating capacity of the tailings, and the changes in the geochemistry of the tailings over time.



Bing Bong dredge spoil geotechnical recommendations

- MRM should establish a formal geotechnical monitoring program for the Bing Bong dredge spoil. This program should identify potential failure locations and establish a timetable for remediation works;
- develop a method to manage and reduce the stored water within the spoil dump in order to mitigate the risk of overtopping; and
- if further dredging is required, a review of the suitability of the containment structure should be undertaken.

General geotechnical recommendations

- continue to train MRM permanent personnel in geotechnical hazard identification so that the effectiveness of inspections can be further improved;
- complete a full review of the MRM database to ensure all key design, construction, operation and inspection documents are registered and easily accessible to the relevant personnel on site; and
- review and revise the MRM risk register so that assigned hazard ratings reflect the current conditions. Split the hazards up into their component causes to appropriately assess the risk due to each cause.

River diversion hydraulic recommendations

- the geotechnical protection of the diversion channels is an ongoing process, and rock armour placement needs to be reviewed at the beginning of every dry season, with any remedial works completed prior to the following wet season;
- it is recommended that MRM continue a program to visually monitor the diversion channels to identify any areas where it is critical to maintain the channel crests and ensure that adequate rock armour protection is in place where required;
- aerial photographs should be used to assist in the evaluation of erosion and/or sedimentation trends following the completion of the river and creek diversion works.
- digital elevation models (DEM) developed from aerial surveys could be used to develop an 'impact map' of ground level changes to the diversion channels. Such an impact map would provide a much more comprehensive picture of changes happening throughout the footprint of the re-channelled sections than the current commitment of either comparing the photographs themselves or comparing cross sections at 250m spacings (or at the 100m spacings as used in the 2010 Connell Hatch construction report) (see Section 8.8.1 for further details);
- MRM should reconsider their previous rejection of the Independent Monitors recommendation to include 'opposite bank' erosion monitoring photographs to complement existing photograph, as the current 45 degree angle photographs provide little or no information about near bank conditions;
- With regard to the taking of photographs downstream of the river diversion, it is recommended that future photograph series should only be taken at times of very low flow so that potential changes in river bed conditions can be evaluated and reported; and
- it is concerning that erosion and sedimentation issues (and their associated monitoring) are not featured in the MMP 2009/2010 report. The Independent monitor urges the increase of erosion and sedimentation reporting within subsequent MMPs.



Water balance and flood modelling recommendations

- MRM should provide evidence to the Independent Monitor next audit as to whether MRM has accepted the suggested recommendations within the Water Solutions Pty Ltd OPSIM 2009 report;
- future OPSIM reports should include surface water storages' information;
- as-built river diversion channel works should be 'tested' by inserting as-built channel cross sections into the detailed design (HEC-RAS) hydraulic model. This should include associated reporting as to how the as-built channels compare against the various project commitments and design intents; and
- the overland flow path between the original McArthur River channel and the new diversion channel should be modelled. This recommendation could be achieved by modifying the design, or work-as-executed - HEC-RAS model to include the separate flow path. In this way, the potential scale of the issue can be appreciated, and the results used to inform the process of undertaking works which will not only effectively address the extent of current problems but also efficiently and effectively limit potential future scour.

10 LIMITATIONS

This report has been prepared by Environmental Earth Sciences VIC ABN 13 109 404 024 in response to and subject to the following limitations:

1. The Independent Monitor Assessment Conditions (IMACs);
2. The specific scope of services set out in contract issued by the Department of Resources– Document KO7-0065;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences VIC (which consent may or may not be given at the discretion of Environmental Earth Sciences VIC);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being the McArthur River Mine and Bing Bong Port facilities, Northern Territory (“the site”);
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report; and
8. Our General Limitations set out at the back of the body of this report.



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12 GLOSSARY OF TERMS

The following descriptions are of terms used in the text of this report.

Adsorption attraction and binding of solutes from an (usually) aqueous solution to surfaces of solid or colloidal particles with which it is in contact.



Alluvial describes material deposited by, or in transit in, flowing water.

Aquifer rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Background natural level of a property.

Baseline initial value of a measure.

Bio-availability amount of a substance able to be assimilated during the digestion process of an organism.

Borehole an uncased well drill hole.

Buffer ionic compound, usually a salt of a weak acid or base, added to a solution to resist changes in its acidity or alkalinity and thus stabilise its pH.

Clay Soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay.

Colluvial unconsolidated soil and rock material moved down-slope by gravity.

Composite sample bulking and thorough mixing of soil samples collected from more than one sampling location to form a single soil sample for chemical analysis.

Conductivity (EC) conductivity of water is an expression of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is in turn a function of the total dissolved (ionisable) solids (TDS) concentration. An estimate of TDS in fresh water can be obtained by multiplying EC by 0.65.

Confidence Limits (statistics) an interval so constructed as to have a prescribed probability of containing the true value of an unknown parameter.

Compliance evidence has been provided to the Independent Monitor to indicate that Mining Management Plan commitment has been undertaken.

Confining layer an aquitard or sparingly permeable layer that confines the limits of an aquifer.

Contaminant generally, any chemical species introduced into the soil or water. More particularly relates to those species that render soil or water unfit for beneficial use.

Contamination is considered to have occurred when the concentration of a specific element or compound is established as being greater than the normally expected (or actually quantified) background concentration.

Diffusion process by which species in solution move, driven by concentration gradients (from high to low).

Discrete sample samples collected from different locations and depths that will not be composited but analysed individually.



Dispersion process by which species in solution mix with a second solution, thus reducing in concentration. In particular, relates to the reduction in concentration resulting from the movement of flowing groundwater.

Drawdown lowering of a water table by pumping from one or more wells.

Ephemeral stream a stream that flows only during periods of precipitation and briefly thereafter, or during periods of elevated water-table levels when the stream is in direct hydraulic connection with the underlying unconfined aquifer (i.e. receives base-flow).

Flow path direction in which groundwater is moving.

Fluvial material deposited by, or in transit, in streams or watercourses.

Gradient rate of inclination of a slope. The degree of deviation from the horizontal; also refers to pressure.

Groundwater water held in the pores of an aquifer.

Gully erosion displacement of soil by running water that forms clearly defined, narrow channels that generally carry water only during or after heavy rain.

Heavy Metals all metallic elements whose atomic mass exceeds that of calcium (20) and includes lead (Pb), copper (Cu), Zinc (Zn), cadmium (Cd), and tin (Sn).

Hydraulic conductivity rate of water movement through soil.

Hydraulic continuity water bridge or connection between two or more geological formations.

Hydrocarbon molecule consisting of carbon and hydrogen atoms only, such as found in petroleum.

Incomplete conformance partial conformance with a commitment. More evidence or action is required to award a conformance.

Infiltration passage of water, under the influence of gravity, from the land surface into the subsurface.

Ionic Exchange adsorption occurs when a particle with a charge imbalance, neutralises this charge by the attraction (and subsequent adherence of) ions of opposite charge from solution. There are two types of such a charge: pH dependent; and pH independent or crystalline charge. Metal hydroxides and oxy-hydroxides represent examples of the former type, whilst clay minerals are representative of the latter and are normally associated with cation exchange.

Ions an ion is a charged element or compound as a result of an excess or deficit of electrons. Positively charged ions are called cations, whilst negatively charged ions are called anions. Cations are written with superscript +, whilst anions use - as the superscript. The major aqueous ions are those that dominate total dissolved solids (TDS). These ions include: Cl^- , SO_4^{2-} , HCO_3^- , Na^+ , Ca^{2+} , Mg^{2+} , K^+ , NH_4^+ , NO_3^- , NO_2^- , F^- , PO_4^{3-} and the heavy metals.



Iron concretions accumulation of dissolved iron which results in the formation of soft to hard orange to red to maroon nodules, can be diffuse or concentrated. A result of periodic wetting and drying.

Leachate water that flows through waste material (or other material) will liberate soluble molecules to form leachate.

Net acid generation potential (NAGP) difference between the TOS and ANC reported on a kilogram H_2SO_4 production per tonne of soil.

Nitrogenous compounds most nitrogen occurs as a gas (N_2) in the atmosphere. Nitrogen compounds are transformed by biological processes. In the presence of oxygen, organically bound nitrogen is oxidised: ammonium (NH_4^+) to nitrite (NO_2^-) to nitrate (NO_3^-). However in the leachate from refuse tips the oxygen demand is great, as expressed by high COD and as a result nitrogen compounds are reduced, i.e. the reverse of oxidation.

Organochlorine pesticides synthetic organic chemicals which are persistent and may bioaccumulate along the food chain.

Oxidation originally referred only to the addition of oxygen to elements. However oxidation now encompasses the broader concept of the loss of electrons by electron transfer to other ions.

Parameters population value of a particular characteristic, which is descriptive of the distribution of a random variable.

Permeability property of porous medium relating to its ability to transmit or conduct liquid (usually water) under the influence of a driving force. Also referred to as hydraulic conductivity.

Piezometer a cased borehole with a short slotted screen for measuring standing water level (SWL), which represents a potentiometric surface or elevation of the water table; also used to obtain sample of groundwater for quality assessment.

pH logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Plume spreading of a contaminant from a point source, under the influence of dispersion, diffusion and the like.

Potentiometric Surface water level that represents the standing or total hydraulic standing head. In an aquifer system it represents the levels to which water will rise in tightly cased wells (e.g. a cased borehole).

Putrescible waste food waste, waste consisting of animal matter (including dead animals or animal parts) or biosolids categorised as Stabilisation Grade C in accordance with the criteria set out in the Biosolids Guidelines.

QA/QC Quality Assurance / Quality Control.

Remediation restoration of land or groundwater contaminated by pollutants, to a state suitable for other, beneficial uses.



Shale fine-grained sedimentary rock formed by the compaction of silt, clay, or sand that accumulates in deltas and on lake and ocean bottoms. It is the most abundant of all sedimentary rocks.

Stratigraphy vertical sequence of geological units.

Suspended Solids (SS) matter which is suspended in water which will not pass through a 0.45 μm filter membrane.

Topsoil part of the soil profile, typically the A1 horizon, containing material which is usually darker, more fertile and better structured than the underlying layers.

Total Dissolved Salts (TDS) total dissolved salts comprise dissociated compounds and undissociated compounds, but not suspended material, colloids or dissolved gases.

Turbidity describes the degree of opaqueness produced in water by suspended particulate matter.

Water table interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.



ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services

The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report

A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change

Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others

Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences VIC. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval

The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability

This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences VIC disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences VIC disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences VIC's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.



APPENDIX A RISK MATRIX AND RISK RATING TABLE



RISK MATRIX

		Likelihood (regardless of potential time latency)				
		1	2	3	4	5
Consequence		Certain	Likely	Possible	Unlikely	Improbable
1	Catastrophic	2	3	4	5	6
2	Major	3	4	5	6	7
3	Moderate	4	5	6	7	8
4	Minor	5	6	7	8	9
5	Insignificant	6	7	8	9	10

RISK RATING EXPLANATIONS

Risk Matrix result	Risk Rating	Description
2 to 3	E	Extreme - Immediate intervention required to eliminate or reduce risk at a Senior Management/ Government level.
4 to 5	H	High Risk - It is essential to eliminate or reduce risk to a lower level by the introduction of monitoring and assessment measures implemented by senior management.
6 to 7	M	Moderate - Corrective action required, and monitoring and assessment responsibilities must be delegated.
8 to 10	L	Low Risk - Corrective action should be implemented where practicable, and risk should be managed by routine monitoring and assessment procedures.

KEY TO RISK RATING TABLE

Location of impact	
RI	Regional impact (>2km radius outside mining lease)
OM	Impact outside mine lease area - (<2km radius)
WM	Wide impact within mining lease boundaries
L	Localised area within mining lease boundaries
P	Small point source within mining lease boundary
Potential Duration of impact	
G	Geological long term (>100 years)
L	Long term (30- 100)
M	Medium term (5-30 years)
S	Short term (1-5 years)
E	Ephemeral/seasonal impact



APPENDIX B UPDATED RISK REGISTER

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue-Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
3	TSF	3.4	Geotechnical	3.4.2	Cell 1 embankment fails - spillage into Surprise Creek	M	WM	Poor Design, construction and/ or maintenance; Significant Storm Event, Seismic Event	Daily MRM visual inspections, AWA annual inspections, Monitoring from recovery wells d/s of embankment.	1	3	4	H	5,H	No quantitative means of monitoring the embankment (surveying) AWA have recommended in their 2009 report that this is undertaken, along with the installation of Piezometers to monitor the phreatic surface within the tailings and embankments. It is understood that these works are being undertaken in 2010. Clay capping of the TSF 1 to prevent water infiltration was also recommended, however testing of capping is insufficient.
3	TSF	3.4	Geotechnical	3.4.3	Over-flow of Cell 1 due to inadequate spillway.	M	OM	Under-designed for Flood event	Identified in AWA 2008 annual inspection that it is unclear if the spillway has been adequately designed. OPSIM modelling undertaken annually.	1	3	4	H	6,M	AWA has identified that the spillway for Cell 1 is possibly undersized. A comprehensive inspection and Dam Safety Review would include covering this issue.
3	TSF	3.4	Geotechnical	3.4.4	Cell 2 embankment fails- Stability failure.	M	WM	Poor Design, Poor Construction, Poor Maintenance, Significant Storm Event, or Seismic Event.	Daily MRM visual inspections, AWA annual inspections, Monitoring from recovery wells d/s of embankment.	1	3	4	H	5,H	The independent monitor group has not been provided with a copy of the Cell 2 design report, therefore it is not possible to comment on whether construction and subsequent operation are in accordance with the design intent (or if the design approach is satisfactory). This review needs to be completed. The Independent Monitor recommends that Cell 2 be included within the scope of the 'Comprehensive Inspection' and 'Dam Safety Review', which should be conducted for Cell 1 and the Water Management Dam.

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue- Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
3	TSF	3.4	Geotechnical	3.4.5	Cell 2 embankment failure due to stability failure.	M	WM	Elevated water pressure in embankment	Changes to spigot locations means tailings now placed against embankment first	1	3	4	H	Not previously assessed	TSF was observed by Independent Monitor team in May 2010 to be storing high levels (~7 m) of standing water against the Cell 2 embankment on the southern embankment. It is not known whether the TSF has been designed to function in this manner. The Independent Monitor has not received the Cell 2 design or construction reports, so the intended operation cannot be verified. No piezometers are installed in the embankments to monitor water pressure within the embankment.
3	TSF	3.4	Geotechnical	3.4.6	Cell 2 Embankment failure due to scouring at toe of embankment.	M	WM	Wet season flooding - Creek at Western corner of Cell 2 scours out toe of embankment and causes collapse.	None known.	1	3	4	H	Not previously assessed	Identified issue in May 2010 visit. No embankment protection has been installed to guard against this event. Hydrology assessment is needed to determine risk of this occurring. As per AWA's 2009 TSF report, the TSF has been assigned a High Hazard Category rating under the IAW ANCOLD guidelines for Tailings Dams. This should be followed up by a Dam Risk Assessment as per ANCOLD guidelines to determine monitoring requirements.
3	TSF	3.4	Geotechnical	3.4.7	Overtopping of TSF Cells leading to embankment failure.	M	OM	Spillway under- designed for flood event	Inspections and OPSIM modelling undertaken annually.	1	3	4	H	6,M	AWA has identified in successive reports (2008 and 2009) that the spillway may be under-designed. An analysis of existing storage capacity by AWA in their 2009 report indicates that there is not enough freeboard within the TSF Cell 2 to cope with design rainfall events. Reduction in stored water within the TSF is recommended by AWA.

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue-Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
3	TSF	3.4	Geotechnical	3.4.8	Failure of spillway on Cell 2 leading to failure of embankment.	L	OM	Spillway under designed for flood event.	Inspections and OPSIM modelling undertaken annually.	1	3	4	H	Not previously assessed.	AWA has identified in successive reports (2008 and 2009) that the spillway may be under-designed. An analysis of existing storage capacity by AWA in their 2009 report indicates that there is not enough freeboard within the TSF Cell 2 to cope with design rainfall events. Reduction in stored water within the TSF is recommended by AWA.
3	TSF	3.6	Water management dam.	3.6.1	Failure due to overtopping of spillway	M	OM	Under-design for potential flood event. Water dam undersized and/or spillway under-designed.	None known.	1	3	4	H	6,M	AWA has identified that the spillway for the Water Management Dam is possibly undersized. Given that the TSF flood management strategy has this spillway as critical component this design issue should be resolved as a high priority. A comprehensive inspection and Dam Safety Review should include this issue.
4	OEF	4.2	Geotechnical	4.2.1	Water infiltrates into OEF PAF cells and degrades integrity of structure.	M	OM	Poor construction of PAF cells, foundation, poor quality control over placement of clay lining. Poor construction of OEF cap.	No specific monitoring or testing. MRM is currently relying on testing done from stockpile of material used for bund and channel construction (although this has not been provided). This is not appropriate as permeability is a function of material properties, compaction and moisture content. Hence properties have to be confirmed at point of placement.	1	3	4	H	5,H	All future cell linings should be quality control tested. For completed cells, if possible, retrospective testing should be undertaken (unlikely to be possible, unless drill through existing cells). It is noted in the URS test results that the permeability results for the in-situ soils are <1x10-9 m/sec.

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5	Mine Site (ROM and Pacrim)	5.1	Dust emissions	5.1.1	Contamination of surface soils, vegetation, sediment with salts, heavy metals	L	Loc	Spread of zinc and lead laden dust from mining operations and Pacrim yard/ROM Pad.	Dust monitoring program and dust mitigation measures including water sprays and upgrading of Pacrim conveyors.	3	1	4	H	No Change	Dust mitigation practices should increase for the ROM/ Pacrim. Monitoring should consider long term trends to assess effectiveness of measures.
7	River diversions	7.4	River diversion design	7.4.2	Erosion at toe of mine levee wall and along unplanned overland flow path from the old McArthur River Channel into diversion channel.	E	Loc	Flood flows returning to river from the direction of the remnant river channel.	Lack of reporting during the current audit period. It is understood that an initial 'scope of works' report (dated April 2010) has been produced	2	2	4	H	7,M	As part of the design process for long term scour protection, hydraulic flood modelling to be undertaken (for example, through including this flowpath explicitly in the current HEC-RAS model) to quantify flow velocities over a range of flood events.
1	Bing Bong dredge spoil	1.1	Drainage	1.1.1	Migration of saline/ hypersaline seepage causing local and regional vegetation die-back.	M	RI	Drainage and seepage occurring into adjacent land due to seepage through pond wall.Blockage of drain to sea.	Drain to sea re-established. Land survey. Creation of outer spoon drain to redirect saline seepage back to sea.	2	3	5	H	3, E	Monitor re-growth in areas around spoil piles for signs of stress and dieback.Ongoing monitoring and maintenance of berm walls and drains.

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1	Bing Bong dredge spoil	1.2	Geotechnical	1.2.1	Catastrophic failure of dredge pond walls leading to inundation of adjacent areas with saline material.	M	OM	Failure of pond walls/bund as a result of poor design and construction of the dam walls/bund. Overtopping and failure of walls may also occur due to high rainfall.	Infrequent inspections undertaken by Bing Bong personnel. Commitment to undertake rehabilitation trials. Culvert system installed to allow water to drain off top of dredge spoil and back out to sea.	2	3	5	H	3, E	Conduct more frequent inspections of containment pond walls. Manage future placement of dredge spoil to reduce the pressure on pond walls. Increase drainage from the containment ponds to prevent saturation of wall and piping failure. Explore possibilities of forcing water to pool towards the centre of the containment cell to reduce interstitial water away from the dam/bund wall and lower the phreatic surface. Assess suitability of existing drain pipes/culverts to cope with high rainfall events. Ongoing monitoring and maintenance of culverts and drains to ensure that water in spoil ponds is flowing freely to drainage ditches. Increase free-board to allow for design storm (as per design criteria) and confirm or re-assess the current rainfall and evaporation data and water balance.
2	Bing Bong Port	2.4	Fauna	2.4.1	Reduction in wallaby population numbers	M	OM	Seepage from Dredge spoil resulting in die-back of native vegetation. Human presence and traffic from Bing Bong operations. Increased predators (dingoes) due to cessation of baiting at Bing Bong.	Dredge spoil pond drainage completed. Photo monitoring undertaken.	3	2	5	H	4, H	Correct dredge spoil seepage and drainage management . Survey and monitor vegetation regrowth and monitor seepage. Investigate presence of dingoes at Bing Bong. Investigation into wallaby and dingo populations

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3	TSF	3.3	Leachate seepage	3.3.2	Seepage from TSF causes loss of flora and fauna, or bioaccumulation of metals in flora and fauna.	S	Loc	Seepage from TSF into Surprise Creek.	TSF geopolymer barrier; TSF design; Seepage monitoring, downstream water quality testing	3	2	5	H	No Change	Undertake further investigation into TSF seepage monitoring and mitigation; undertake periodic visual inspections of Surprise Creek and surrounds to monitor vegetation condition.
4	OEF	4.2	Geotechnical	4.2.2	Reduced stability of structure and generation of acidic and/or saline leachate.	G	RI	NAF material may be acid-forming and therefore incorrectly placed.	Reports show very high sulfide is present with excess ANC. Structural association of sulfides in waste rock not entirely understood.	1	4	5	H	3, E	Evidence has been provided of procedures and checks for 2009 which suggest that active grading/ monitoring is currently occurring. Grading by mine geologist is substantially more detailed than that undertaken in accordance with relevant waste rock planning/ procedures documents. Procedures need to be updated in line with this practice. Lysimeter trials "at life size" need to be considered to evaluate fate of high Sulfate NAF. Monitoring of foundations
4	OEF	4.2	Geotechnical	4.2.3	OEF wall fails and falls into McArthur River	M	WM	Abnormal storm event, poor construction	Visual inspections of wall condition	1	4	5	H	No Change	"As-built" construction reports of final structure.
6	Mine site	6.1	Groundwater	6.1.1	Degradation of groundwater, surface water and land quality within the mine site	M	WM	Long- and short-term generation of acidic and/or saline leachate from tailings and waste rock	Groundwater, surface water, tailings and waste rock monitoring, checking procedures, kinetic testing of materials with uncertain classification	2	3	5	H	No Change	Increased monitoring and modification of the analytical regime for groundwaters and interstitial water in and around the TSF; modifications to the kinetic testing of tailings and waste rock sorting procedure; more rigorous annual reporting and modelling of groundwater.

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7	River diversions	7.2	Rehabilitation	7.2.1	Erosion and stock damage revegetated areas.	M	WM	Poor or delayed rehabilitation of diversion channels, broken fences let cattle and donkeys on site.	Re-channelling erosion assessment prepared in years 1,3,5 and 10 and as required until mine closure; fences in place to keep cattle and donkeys out (however these have been damaged).	3	2	5	H	7,M	Increase rehabilitation efforts increase planting of tube-stocks prior to wet season; Perimeter fence re-design and rapid maintenance to keep cattle out.
7	River diversions	7.2	Rehabilitation	7.2.2	Difficulty in establishing desired vegetation corridor.	S	Loc	Flood-time loss of soil and vegetation. Drought, selection of common species, planting technique.	Plot surveys of plant densities after twelve months and longer time frames	3	2	5	H	No change	Confirmation that the plot surveys will be adequate to assess this issue. Specific monitoring targeting preferred rehabilitation species could be useful over a greater length of the diversion.
7	River diversions	7.2	Rehabilitation	7.2.3	Desired vegetation corridor will not establish within required time frame	S	Loc	Lack of structures to facilitate soil deposit and plant growth and/ or inappropriate species selection.	River diversion rehabilitation program and monitoring, woody debris placement.	3	2	5	H	Not previously assessed.	Rapid stream flow prevents deposit of soil and sites for establishment of plants. Back eddies are a feature of the original channels and this provides sites for soil deposit, plant growth and migrating and residential fish resting places. Seed collection has been local but mainly of common species of minimal habitat or foraging value.

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7	River diversions	7.2	Rehabilitation	7.2.4	Channel erosion and poor water quality causes changes to the riparian community species.	L	WM	Inadequate rehabilitation of the river diversions, including soil deposit sites, vegetation growth sites, fish resting places and sites for residential fish and invertebrates.	River diversion rehabilitation program and monitoring.	3	2	5	H	6,M	Monitoring results not available in this reporting year therefore complete assessment has not been undertaken.
7	River Diversions	7.3	Weed Management	7.3.1	Increase in spread of listed Northern Territory noxious weed species, particularly along the River Diversions.	M	RI	Historical mining and pastoral activities. Uncolonised bank and bed of river diversions. Weed Management Plan implemented during shutdown (Dec 2008-Feb2009)	Weed Management Plan in place.	3	2	5	H	4,H	Implementation of existing Weed Management Plan needs to be augmented with other activities to compensate for shutdown. Invest more resources to accelerate revegetation and weed control (MRM have expressed an intent to do this prior to the 2009/2010 wet season).
8	Sir Edward Pellew Islands (SEPI) and McArthur River Estuary	8.1	Heavy metals	8.1.1	Bioaccumulation of metals in seawater, sediments and biota in vicinity of SEPI and MR estuary. Unknown sub-lethal/ chronic effects, effects on higher trophic species (including humans)	L	RI	Contamination from McArthur River upstream mine activities or Bing Bong Port operations	Annual mollusc, seagrass and sediment monitoring program	2	4	6	M	Not previously assessed	Future sampling to include monitoring for inorganic arsenic. Further investigation into seemingly random high levels of metals in oysters from some sites. Further assessment of the contribution of increased heavy metals from natural background sources. Include samples from Barramundi tissue and mud crabs from SEPI/MR estuary area.

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1	Bing Bong dredge spoil	1.3	Dust migration	1.3.1	Development of salt and/or heavy metal loads in vegetation, soils and sediments.	M	OM	Poor dust management and control. Onshore placement of contaminated sediments from dredging.	Dust monitoring program and dust mitigation measures, metal testing of sediments to be dredged, proposed and actual rehabilitation trials to stabilise dust, soil testing	3	3	6	M	No Change	Additional dust monitoring sites should be installed around dredge spoil area adjacent to remnant vegetation to assess off-site impacts. The Independent Monitor understands further dust monitoring is planned for 2010. Monitor vegetation surrounding the spoil. Commencement of revegetation trials.
1	Bing Bong dredge spoil	1.4	Revegetation	1.4.1	Failure of revegetation on dredge spoil causes habitat loss or alteration.	M	RI	Spoil material unsuitable for vegetation establishment. Revegetation trial cancellation by student. Inappropriate or inadequate research. Severe weather. Ongoing dredging.	Monitoring by orthophoto mapping and ground truthing of vegetation. CDU PhD student to commence revegetation trials on a section of the spoil. Dredge Management Plan.	3	3	6	M	Not previously assessed.	Continue to monitor surrounding vegetation by aerial mapping and ground truthing and inspections by MRM staff. Ensure rehabilitation is not hampered by future dredging requirements. Spoil deposition and rehabilitation could be planned so any future additional spoil does not impact on previously rehabilitated areas.
2	Bing Bong Port	2.2	Surface water	2.2.1	Overflow of Bing Bong surface runoff pond (BBSRP) contaminates surrounding environment	S	Loc	High-rainfall storm event, or failure to clean out sediment from pond	Additional adjacent containment pond under construction. BBSRP maintenance program. Annual OPSIM modelling undertaken. Evaporation of pond water through use of pond water as dust suppression across site. Annual marine heavy metal monitoring.	3	3	6	M	No change	BBSRP should be cleaned out on a regular basis and emptied as far as practicable prior to the wet season. Note: This risk came close to happening and an emergency dam was dug to hold the contaminated water from rainfall runoff from Cyclone Paul (March 2010). The dam will become a permanent structure, which was under construction during the Independent Monitor's site inspection in May 2010. The final constructed runoff pond will be reviewed by the Independent Monitor as part of the next audit.

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2	Bing Bong Port	2.4	Fauna	2.4.2	Bing Bong Port operation Impacts on migratory bird populations	L	P	Metal contamination of sediment impacting food sources for migratory bird habitat	Monitoring of metal contamination in sediments and biota in potential habitat for migratory birds. Recommencement of Migratory Bird studies	3	3	6	M	No Change	Further reduce dust emissions from Bing Bong Port operations.
2	Bing Bong Port	2.5	Dust migration	2.5.3	Dust migration from Bing Bong storage shed cause heavy metal contamination of marine sediments in Bing Bong Port, which may affect flora and fauna.	M	Loc	Concentrate dust from Bing Bong concentrate storage shed transported by winds.	Dust suppression sprays in operation across the site. Annual marine monitoring of heavy metals in seawater and sediments	3	3	6	M	No Change	Continued dredging of swing basin to remove localised contaminated sediment. Further investigation should occur regarding why mine-sourced lead and other metal concentrations have been found to increase in marine sediment at Bing Bong since 2004. Dust audit.
3	TSF	3.1	Dust migration	3.1.1	Development of salt and/or heavy metal loads in vegetation, soils and sediments surrounding the TSF	M	OM	Poor dust management and control	Dust monitoring programme and dust mitigation measures proposed and actual rehabilitation trials (TSF Cell 1)	3	3	6	M	No Change	Continue rehabilitation of Cell 1 to cover exposed tailings. Recommence watering of Cell 1 until capping is completed

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3	TSF	3.1	Dust migration	3.1.2	Dust contamination of Surprise creek causes loss of flora/ fauna or bioaccumulation of metals within tissues. Dust migrates downstream.	M	WM	Dust blown from TSF towards Surprise Creek.	Surface water monitoring programme; dust control measures (clay cap and watering) at TSF surface.	3	3	6	M	No Change	MRM should complete initial clay cover of TSF as soon as practicable and consider recommending the watering of the TSF as elevated heavy metal concentrations have been recorded in Surprise Creek sediments.
3	TSF	3.7	Pipeline to TSF	3.7.1	Pipeline foundations fail over river, rupturing pipe resulting in discharge of tailings into Barney Creek.	S	Loc	Flood event undermines footings	Daily monitoring during wet season to inspect pipeline integrity.	2	4	6	M	No Change	Regular monitoring should identify any gradual deterioration of footings before it has potential to damage pipeline. It is understood that a bund is to be constructed around the pipeline on the TSF abutment to contain any leaks over the crossing and that this should also contain any leaks a result of failure of the pipeline footings
4	OEF	4.1	Soil and sediment	4.1.1	Development of salt and/ or heavy metal loads in vegetation, soils and sediments. Vegetation dieback.	M	OM	Poor dust management and controls	Dust monitoring program and dust mitigation measures such as water trucks.	3	3	6	M	No Change	Regular visual inspections of vegetation condition.
5	Mine Site (ROM and Pacrim)	5.1	Dust emissions	5.1.2	Dust blown from ROM Pad and Pacrim yard causes loss of water and sediment quality and loss of flora/ fauna in Barney creek.	M	Loc	Fugitive dust emissions from Pacrim Yard and ROM Pad.	Dust mitigation measures at mine site including Water spray trucks. Introduction of double-lipped rubber lining to sides of Pacrim conveyors.	3	3	6	M	No Change	Heavy metal concentrations have increased at some Barney Creek sediment sampling sites. Upgrading of crusher should decrease dust levels at monitoring locations in the area and thus mitigate input to the creek. Monitoring should consider long term trends to assess effectiveness of measures.

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	Mine Site (ROM and Pacrim)	5.1	Dust emissions	5.1.3	Dust blown from ROM Pad and Pacrim yard causes loss of water and sediment quality and loss of flora/ fauna in The McArthur River	L	Loc	Fugitive dust emissions from Pacrim Yard and ROM Pad.	Dust mitigation measures at mine site including Water spray trucks. Introduction of double-lipped rubber lining to sides of Pacrim conveyors.	3	3	6	M	No Change	Dust mitigation measures should be increased around ROM Pad/Pacrim yard. Upgrading of crusher should decrease dust levels at monitoring locations in the area and thus mitigate input to the creek. Monitoring should consider long term trends to assess effectiveness of measures.
5	Mine Site (ROM and Pacrim)	5.2	ROM Pad design	5.2.1	Erosion of bund wall causes release of contaminated water into Barney Creek	S	Loc	Abnormal storm event	Regular inspections of condition	4	2	6	M	No Change	Complete quantified design of water flows (determine likely volumes), and design spillway (protected low point) to prevent total loss of bund / road and release of large volume of contaminated material and to prevent Barney Creek scouring out bund.
6	Mine site	6.2	Groundwater Dependent Ecosystems	6.2.1	Depression of groundwater table due to extraction .	L	OM	Depression of groundwater table due to extraction .	None known	3	3	6	M	Not previously assessed.	MRM should undertake studies on Groundwater Dependent Ecosystems to assess effects of mining operations.
7	River Diversions	7.1	Fauna	7.1.1	Loss of freshwater sawfish and other fish populations	M-L	RI	Loss of in-stream habitat, reduction in water quality. Altered stream flow. Increase in predation	Freshwater Sawfish Monitoring and Management Programme in place.	3	3	6	M	5,H	Signage to prevent people fishing. Addition of Large Woody Debris along channel, planting of native vegetation, regular visual or electronic monitoring of large fish or reptile passage along bypass.

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue-Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
7	River Diversions	7.1	Fauna	7.1.2	Loss of riparian forest corridor impacting bird populations	M	Loc	Loss of habitat due to mining operations, reduction in water quality	Seasonal monitoring of riparian birds using colour banding	3	3	6	M	No Change	Intensify revegetation efforts. Use species mix similar to original channel. Add favoured bird habitat species such as cane grass, <i>Barringtonia</i> and <i>Pandanus</i> . Seed collection should be targeted at important species, not common weedy species. Exclusion of stock from revegetation areas
7	River diversions	7.4	River diversion design	7.4.1	Flooding within mine pit and related consequences	S	Loc	Very rare flood event (>500 years ARI)	Monitoring of flood warning station intranet information (with accompanying basic action plan)	1	5	6	M	No Change	Current flood warning scheme does not address/flag such an abnormal event. It is recommended the scheme be amended to address the very rare events. It is also recommended that the flood warning scheme also be improved to relate early warning river levels to imminent flooding of other potentially critical site infrastructure elements. Site Emergency Response Plan document needs to be upgraded with regard to flooding.
3	TSF	3.8	Rehabilitation	3.8.2	Contamination of topsoil stockpiles due to dust from tailings storage facility .	L	Loc	Spread of zinc and lead laden dust from mining operations	Dust monitoring program and dust mitigation measures	4	3	7	M	Not previously assessed.	Dust mitigation measures should be increased around ROM Pad/Pacrim yard and TSF. Rehabilitation of TSF Cell 1 should improve dust levels at monitoring locations north of TSF. Clay capping to be completed as early as possible.
1	Bing Bong dredge spoil	1.6	Mosquitoes	1.6.1	Staff contraction of disease by vector mosquitoes.	E	Loc	Water stagnation in dredge pond providing suitable habitat for mosquitoes. Elevated number of problem mosquito. Lack of staff awareness and PPE	Mosquito monitoring. Staff awareness and safety program, and chemical control.	3	4	7	M	Not previously assessed.	Training programs regarding personal protection in areas where widespread breeding locations are not controllable. Drainage of on-site waters should be undertaken where practical.

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue- Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
2	Bing Bong Port	2.1	Groundwater	2.1.1	Impact on groundwater quality and beneficial uses, from hydrocarbons, reagents and other liquid products used or stored at Bing Bong Port.	M	P	Vehicle movement over sub-surface fuel and liquid pipelines, corrosion of infrastructure, accidents and spills.	Groundwater and surface water monitoring. Inspection procedures of pipelines and infrastructure. Incident report forms.	4	3	7	M	No Change	Integrity testing of fuel tanks and pipelines should be undertaken in conjunction with a hydrocarbon audit of the facilities.
2	Bing Bong Port	2.3	Flora	2.3.1	Loss of seagrass, which may affect seagrass dependent communities or populations (e.g. dugongs).	M	WM	Loss of seagrass from dredging operations. Regular Aburri passage. Cyclones or severe weather. Dugong grazing	Annual seagrass monitoring program.	4	3	7	M	No Change	Further investigation into the causes of seagrass not recolonising the barge channel area.
2	Bing Bong Port	2.4	Fauna	2.4.3	Bioaccumulation of metals in seagrass and molluscs in vicinity of load out facility. Effects further along food chain. Unknown sub-lethal/ chronic effects	M	Loc	Dust migration, spillage of ore	Annual marine monitoring programme. Dust monitoring programme and dust mitigation measures	3	4	7	M	No Change	Monitor elevated levels of metals from ore derived sources. Future sampling to include monitoring for inorganic arsenic. Include samples from Barramundi tissue and mud crabs from SEPI/MR estuary area
5	Mine Site (ROM and Pacrim)	5.1	Dust emissions	5.1.4	Bioaccumulation of metals in flora and fauna within or around river diversions.	M	WM	Dust from mining operations and changes to creek flows. Elevated metal concentrations at downstream monitoring sites at FS03 and FS05.	Sediment monitoring program, vegetation monitoring, fish surveys	3	4	7	M	No Change	Dust mitigation measures should be reassessed to increase frequency of water spraying at Rom pad and Pacrim yard, for example. Include evaluation of heavy metal in fish tissue Sediment monitoring data and interpretation should be included in the AER to effect thorough assessment of sediment monitoring results.

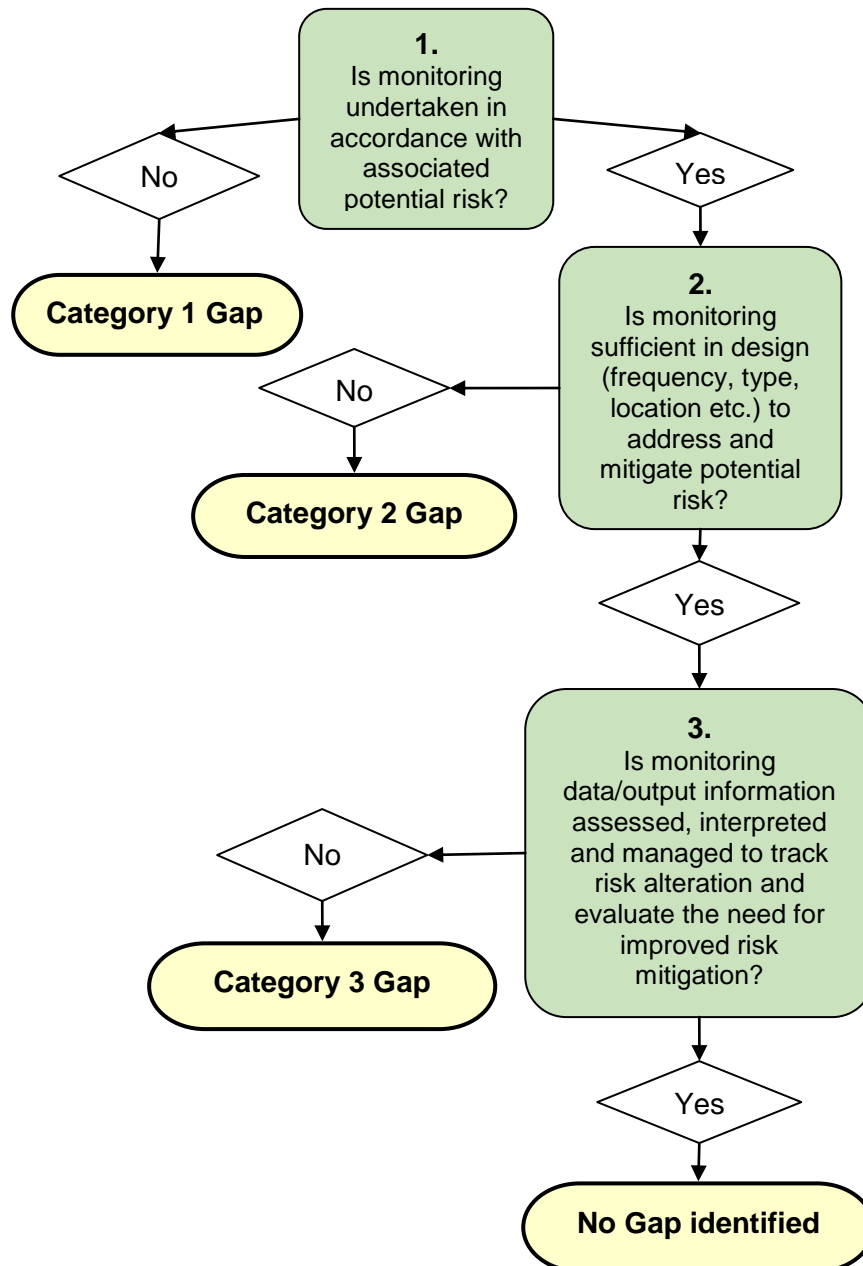
Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue-Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
6	Mine site	6.1	Groundwater	6.1.2	Complete depressurisation of aquifers, reduction in yield and water quality affecting regional groundwater and groundwater dependent ecosystems	M	OM	Excessive drawdown of aquifers due to dewatering for mine pit and water supply	Groundwater monitoring.	3	4	7	M	No Change	Calibration of the groundwater modelling undertaken in 2006 (EIS) should be undertaken annually and the model re-run every 5 years.
6	Mine site	6.1	Groundwater	6.1.3	Impact on groundwater quality and beneficial uses from hydrocarbons, reagents and other liquid products used at the Mine.	M	P	Vehicle movement over sub-surface fuel and liquid pipelines, corrosion of infrastructure, accidents and spills.	Groundwater and surface water monitoring; various inspection procedures of pipelines and infrastructure; incident report forms.	4	3	7	M	No Change	Integrity testing of fuel tanks and pipelines should be undertaken in conjunction with a hydrocarbon audit of the facilities.
6	Mine site	6.3	Water extraction from the McArthur River	6.3.1	Water extraction impacts aquatic flora and fauna	E	OM	Over-extraction reduces dry season flows in river	Gauge board/U/S & D/S River Station Data/ pump flow meter monitoring system proposed (and approved) in July 2008 (with adherence to earlier extraction limits imposed by DRDPIFR) Annual aquatic fauna surveys	4	3	7	M	6,M	Evidence of 08-09 monitoring regime and associated pump volumes is very limited. Mining Management Plan 2008-2009 fails to address the associated environmental issues attached to the DPIFM approval letter of 11 August 2008. (It is noted that a different irrigation sled-based extraction system commenced in March 2010.)
7	River diversions	7.4	River diversion design	7.4.3	Vegetation cleared in a manner that does not allow fauna to move away from disturbance.	M	Loc	Broad-scale clearing undertaken rather than progressive clearing	Clearing permit	3	4	7	M	No Change	Continued use of Clearing Permit process. Continued monitoring of bird populations, particularly tagged birds.

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue- Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
2	Bing Bong Port	2.5	Dust migration	2.5.2	Dust blown from Bing Bong Port facility causes loss of water and sediment quality and loss of flora/ fauna in St Edward Pellew Islands	L	Loc	Fugitive dust emissions from concentrate shed and during loading of vessels	Monitoring of sediment and seawater within the estuary and St Edward Pellew Islands. Improved concentrate loading practices.	4	4	8	L	Not previously assessed	Dust mitigation measures should be increased at Bing Bong. Ventilation and vacuum system to be implemented as soon as practicable within the concentrate shed. Monitoring should consider long term trends to assess effectiveness of measures.
1	Bing Bong dredge spoil	1.5	Weeds	1.5.1	Habitat alteration due to weed infestations on dredge spoil/rehabilitated areas.	M	RI	Insufficient weed management.	Weed inspections by District Officer and MRM staff. University of Queensland Parkinsonia trials. Control of weeds as per the Weed Management Plan.	4	4	8	L	Not previously assessed.	Regular monitoring and control of weeds; particularly Parkinsonia infestation. Biological control of Parkinsonia trials to cease, as chemical control is more effective in this area.
7	River diversions	7.4	River diversion design	7.4.4	Sudden and significant flood-induced channel bank erosion/collapse leads to unexpected increase in flood level	S	Loc	Flood event	Taking of photographs along one bank (at 250 metre spacings)	4	4	8	L	No Change	Review of evidence of erosion shown in photographs. Production of similar set of photographs from opposite bank (with associated review of erosion evidence). Utilisation of annual aerial survey plans to assess on-going changes in bank and bed levels which would then potentially trigger the need for assessment of potential bank instability.
3	TSF	3.8	Rehabilitation	3.8.1	Stockpiled topsoil not available for rehabilitation of tailings dam or waste dumps.	L	P	Topsoil not used progressively, not labelled or mapped, used for wrong purpose or buried.	Plans show location of topsoil storage locations but date not clearly indicated and relies on memory of staff.	4	4	8	L	Not previously assessed.	Clear maps showing location and date top soil stored should be available. Labelled signs should be placed on topsoil piles in the field.

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue- Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
5	Mine Site (ROM and Pacrim)	5.2	ROM Pad design	5.2.2	Failure of pump within ROM Pad sump area during heavy rainfall event causes sump water to flow towards Barney Creek.	S	Loc	Abnormal storm event and pump or power failure.	Regular inspections have been carried out since February 2009	5	5	10	L	Not previously assessed.	It is understood that MRM have constructed a storage that is larger than previous. It is anticipated that the storage within the ROM would not overtop rapidly and that there would be enough time to deploy a substitute pump in case of failure. However, analysis of the storage size against design rainfall events should be undertaken to give an estimate of the duration the ROM storage could run for without a pump, before overtopping occurs.



APPENDIX C GAP ANALYSIS PROCESS FLOW CHART



Independent Monitor Gap Analysis process flow chart.

UPDATED RISK TABLE – PRESENTED IN RISK RATING ORDER

Asset #	Asset	Consideration #	Consideration	Risk #	Risk Issue-Potential Hazard/ loss scenario	Potential duration of impact	Location of impact	Causes	Existing Controls/ Monitoring and Assessment undertaken	Consequence	Likelihood	Matrix Result	Risk Rating	Previous Year's matrix result and Risk Rating	Additional Controls, monitoring , assessment or actions required
2	Bing Bong Port	2.5	Dust migration	2.5.1	Spilling of concentrate dust during barge load out causes contamination of marine and terrestrial sediments with metals	L	Loc	Spread of zinc and lead-laden dust from ship-loading operations.	Dust monitoring programme and dust mitigation measures. Annual marine monitoring of heavy metals in seawater and sediments	3	1	4	H	No Change	Further investigation into increased dust levels at Bing Bong should be undertaken. Dust Monitoring system requires upgrading.
3	TSF	3.2	Geochemical	3.2.1	Acid production of tailings.	L	RI	Acid-producing tailings not expected, Lack of TSF liner. Close location of TSF Cell 1 to Surprise Creek.	Seepage recovery bores Shallow Cut-off barrier Monitoring of surface water and groundwater and incoming tailings	2	2	4	H	No Change	Ascertain velocity of groundwater (and acid and dissolved metals). Establish long-term oxidation rate of tailings Response to monitoring results of current tailings. Geochemistry of tailings is yet to be understood. Potential for acid production must be considered within the Mine Closure Plan.
3	TSF	3.3	Leachate seepage	3.3.1	Discharge of seepage containing salt, acid, and metals enters Surprise Creek and causes flora die back and/ or bioaccumulation of metals in flora.	S	Loc	Seepage from TSF into surprise creek.	TSF geopolymer barrier; TSF design; Seepage monitoring.	3	1	4	H	No Change	Undertake further investigation into TSF seepage monitoring and mitigation; undertake periodic visual inspections of Surprise Creek and surrounds to monitor and assess flora health. Flora dieback is currently observed to be occurring.

APPENDIX D UPDATED GAP REGISTER



UPDATED GAP REGISTER (LISTED BY MONITORING AREA)

Monitoring area	Monitoring Gap	Gap Category			Recommendations/ Comments
		1	2	3	
Mine Site					
Waste rock	Inadequate geochemical analysis and confirmation testing of waste rock and tailings.		x		The Independent Monitor advises that procedures should be updated to match practice and undertake accelerated trials of actual size.
Tailings geochemistry	Acid/base accounting .			x	The Independent Monitor advises that results be reviewed in terms of initial projections of tailings geochemistry, acid production and long term weathering effects.
Tailings geochemistry	Monitoring of water at the surface and within Tailings Cells 1 and 2.			x	Monitor pH of ponded water at the surface of the cells and from within piezometers within TSF.
Civil works	Inadequate monitoring of diversion channel bank erosion/slumping.		x		The Independent Monitor cannot confirm that spacing of photograph locations is adequate to identify all erosion /slumping. MRM are advised to produce ongoing series' of diversion channel photographs from opposite banks (to provide a 'complete' picture). Reporting should include documentation of instances of erosion & associated repair works (with photographs of damaged condition and post-rectification works condition). Reporting should also provide commentary on size of flood/s which caused erosion.
Civil works	Lack of hydraulic engineering assessment of as-built diversion channels.	x			As-built details of channel cross sections should be inserted into design hydraulic model and results compared with design basis. Report should include a detailed comparison of any differences reported by the two models and the associated implications of those differences.
Civil works	Inadequate clay lining materials testing / compaction test results for OEF.		x		The URS Design Report specifies clay placement requirements and how this is to be measured. Without this information it is not possible to verify that the PAF cell linings have been correctly constructed. The only testing that the Independent Monitor can confirm at this stage is related to material property testing of potential fill. No test results for compaction results have been made available to the Independent Monitor.

Monitoring area	Monitoring Gap	Gap Category			Recommendations/ Comments
		1	2	3	
Civil works	Absence of as-built drawings for OEF foundation, and geotechnical verification of foundation grades, topsoil, and any foundation soft spots to be removed.	x			Without this information it is not possible to verify that the OEF foundation has been correctly constructed.
Civil works	There appears to be a lack of monitoring regarding TSF Cell 1 embankment. The current monitoring consists of visual inspections and water level monitoring (downstream of the toe). However, little is known about the geotechnical integrity of this asset.		x		MRM are advised to complete a 'Comprehensive Dam Inspection' and 'Dam Safety Review' for the TSF (including WMD) in accordance with the definitions described by ANCOLD 1999 and 2003. It is understood that AWA has completed a Dam Safety Review, however, it is noted that the current condition downstream of Cell 1 embankment does not meet MRM's performance criteria in the 2007-2008 MMP Section 5.2.1. Works in order to facilitate monitoring of the TSF embankment have been recommended yet these have not been carried out at this stage. It is understood however, that these works are scheduled to occur in 2010.
Civil works	Incomplete/not provided information on the design and construction of the water management dam (WMD) at the TSF.	x			Technical drawings, specifications and as-built reports for the WMD should be provided as part of the next Audit, and monitoring for geotechnical stability should be incorporated into mine management practices.



Monitoring area	Monitoring Gap	Gap Category			Recommendations/ Comments
		1	2	3	
Civil works	Inadequacy of MRM Monthly inspections and reports regarding the TSF.		x		Periodic MRM visual monitoring appears to be completed by different personnel, which based on the information provided to the Independent Monitor, may be leading to a lack of continuity between inspections and how issued are being followed through. Furthermore, the 'tick the box' approach to the regular inspections does not include monitoring groundwater levels (in Cell 2 embankment), nor is it clear as to exactly what areas were visited and what has changed since the last inspection. No quantitative measurement of the embankment is taking place and the monitoring of the soundness of the TSF embankment walls appears to only extend to logging seepage locations. The TSF operating guidelines outline (within paragraph 1.17) the topics to be covered by the monthly report; however, not all these topics are mentioned in the monthly reports. The Independent Monitor recommends that the annual AWA (e.g. AWA, 2007) recommendations for TSF geotechnical monitoring are incorporated into the monthly geotechnical inspections of the TSF. The Independent Monitor also recommends a review of the MRM TSF Operating Guidelines (Feb 2007) so that they comply with ANCOLD 1999 and 2003.
Civil works	Inadequate geotechnical monitoring/ reporting of TSF and WMD monitoring bore results.		x		2007-2008 MMP indicates that additional monitoring boreholes will be installed in the embankments of the TSF and WMD, and that piezometric levels will be monitored to determine any adverse impacts on stability. The IM has not viewed the results of such monitoring within the AWA annual inspection reports or any other MRM reports. A review of these piezometric levels should be included within the annual inspection scope of works, and documentation/interpretation of water levels is on a monthly basis is recommended.
Civil works	Apparent lack of a Dam Emergency Response Plan for the TSF.	x			The 2008-2009 MMP refers to a site wide Emergency Response Plan, but it is unclear if all possible dam emergency scenarios are covered within this document. The Independent Monitor would like to see evidence of a Dam Emergency Response Plan during the next Audit period.
Civil works	Lack of regular embankment quantified monitoring system for the TSF	x			As identified in the AWA 2008 annual inspection, survey pins should be installed to determine lateral displacement and settlement trends. Should be surveyed once a year or monthly. It is understood that these works are to be completed during 2010.



Monitoring area	Monitoring Gap	Gap Category			Recommendations/ Comments
		1	2	3	
Flora/fauna	Vegetation monitoring along the river diversions by CDU does not include sufficient analogue sites. Comparison to baselines not undertaken, and results are not interpreted thoroughly.		x		The upstream analogue site on Surprise Creek is potentially downstream of TSF seepage issues. It would be useful to continue monitoring this site but consider including an analogue site on Surprise Creek upstream from TSF. Glyde River was a reference site in EIS baseline study but is in a very different geological structure. Perhaps an additional analogue site could be established upstream on Barney Creek. Report to include more comparison to baseline data as revegetation progresses. Assessment should also include whether 5000 stems per hectare after first 12 months (as per the 2009/2010 MMP) is appropriate.
Groundwater	Impacts of mine and TSF on local and regional groundwater.			x	Annual hydrogeological and hydrological "stand-alone" monitoring reports should be prepared by suitably qualified professionals to evaluate effects of seepage, and drawdown on aquifers, etc. Annual results should be compared against conceptual models.
Surface water	Fluvial sediment chemistry and physical particle size distribution has not been provided or interpreted within the 2005-2008 Annual Environmental Report.			x	The Independent Monitor recommends that chemical and physical monitoring and interpretation of fluvial sediment data be included in subsequent Water Management Plans.
Rehabilitation	Lack of fencing maintenance to keep cattle from destroying revegetation along river diversions.		x		Fencing maintenance required to keep cattle out of rehabilitated areas, and reseeding should occur to improve revegetation cover. The Independent Monitor has viewed evidence of MRM's planned re-fencing activities to minimise flood damage and improve access for repairs.
Surface water	Apparent discrepancies in water levels/flow levels recorded at upstream and downstream McArthur River gauges.			x	Assessment of apparent discrepancies should be undertaken, and associated report be produced on whether the data as recorded/reported is adequate for intended purposes. While it is understood that the flow reporting information for the various river stations is about to be reviewed it is unclear to the Independent Monitor if there will be any reporting to address the discrepancy issues.
Surface water	The Independent Monitor is unclear of the methods employed for measurement of river flows for the purposes of complying with Government approval for water extraction		x		Details of method used to monitor river flows to be provided/reported. (It is acknowledged that the river flow details for the upstream river station are about to be reviewed.)



Monitoring area	Monitoring Gap	Gap Category			Recommendations/ Comments
		1	2	3	
Surface water	Inadequate reviews of condition of/performance of sediment control structures.		x		Current lack of reports of inspections (with the single exception of the structure behind the ROM pad) should be addressed and results of quantitative measurements should also be reviewed.
Surface water	Warning system for an extreme flood event		x		The consequences of a flood which is similar in size or larger than that which would overtop the levee wall are very serious. The current flood warning water level data reporting system is advised to be upgraded such that the relative size of a flood coming down the McArthur River can be measured and urgently reported. (While it is understood that there will be a review of the flow data able to be generated from the flood forecasting station it is unclear how that information will be used.)
Dust	Improper placement of dust gauges, and failure during the wet season.		x		There is a lack of dust gauges near the OEF and Southern side of McArthur River channel. Sample bottles have been noted to overflow during the wet season, which could affect the accuracy of the results. We understand that MRM are planning to upgrade many of the dust sampling stations with dust samplers of a design that will not be affected by rainfall. It is recommended that the number of dust monitoring sites be increased to provide a greater sample size for analysis. Analytes requested are also not consistent between monitoring rounds - this is recommended to be rectified in subsequent dust monitoring events.
Soil	Insufficient number of sampling locations, which are also limited to dust locations.		x		The number of soil samples is currently considered to be insufficient considering the large area of the mining leases. It is recommended that additional soil monitoring locations be included in the soil monitoring program to increase the sample size. As soil is monitored at the dust monitoring locations, increasing the number of dust monitoring locations will also increase the number of soil monitoring locations. We recommend that a complete soil landscape study of the mine leases be conducted in the next 2-5 years to update the study already undertaken as part of the EIS for the Mine's expansion in 2007.
Dust, Soil and Sediments	Background heavy metals have not been appropriately determined.		x		Determine background heavy metal levels as recommended in the Technical Review (Section 8.4) in order to assess potential mining impacts and current conditions, and improve development of sit-specific criteria.
Bing Bong Port and McArthur River Delta					
Surface water	Lack of monitoring of seepage water through Bing Bong dredge spoil walls.	x			Monitor water quality and vegetation outside dredge spoil dam walls to ensure seepage is not causing impact to flora.



Monitoring area	Monitoring Gap	Gap Category			Recommendations/ Comments
		1	2	3	
Surface water	Lack of monitoring to assess whether Dredge soil drain is effective in draining saline water from dredge ponds to sea as designed.	x			Confirm through surveys regular monitoring that dredge water and seepage drains flow to the sea.
Surface water/ artificial water	Lack of records indicating monitoring of Bing Bong Surface Runoff Pond (BBSRP) to prevent potential overflow.	x			Monitoring should be undertaken to ensure that sufficient freeboard is maintained and sediment regularly removed to minimise potential impacts from overflow. The IM, however, recognises that OPSIM modelling now includes the Bing Bong facility.
Civil works	There is no documentation regarding design/construction or subsequent geotechnical monitoring of the Bing Bong Spoil Facility.	x			MRM are advised to reassess the strategy for the use of this facility, then develop an engineered solution in the context of the proposed future usage.
Flora	Monitoring of vegetation outside dredge spoil.	x			Vegetation trials within the dredge spoil should go ahead. In addition annual monitoring and reporting of vegetation surrounding the spoil. This should include comparable aerial photography with area affected by dieback (e.g. 2005 Google Image) and ground truthing. Also to include reference sites and a strategy for managing future dredging operations with rehabilitation commitments.
Flora	Trials for dredge spoil rehabilitation.	x			Proposal sighted, but has not been undertaken as yet.
Fauna	Monitoring of Wallaby populations (and dingos as a potential predator) at Bing Bong	x			Address community concern over decline in wallaby population. Compare with previous studies possibly from 1992 EIS to assess whether MRM operations are causing a decline in wallaby population numbers. Monitoring of Dingoes and Wallabies is only reliable way to get data to show change.
Fauna	Fauna monitoring around the mine	x			The IM noted a lack of information on the threatened species that have been found in the mine area in the past and are included in a table in the MMP. More information is required in the MMP beneath this table to explain the current status of these species in the project area and management strategies or reasons species are not of concern.
Fluvial Sediments	No monitoring of sediments within other McArthur River Delta		x		McArthur River Delta sediments should be included in the fluvial sediment monitoring program. Suspended sediments have not been reanalysed and monitored for lead isotope ratios to compare with the settled sediments on the Delta floor.



APPENDIX E LIST OF DOCUMENTS REVIEWED

DOCUMENTS PROVIDED BY MRM

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>MEMO 091121 Actions from IM Audit</i>	21-Nov-09	Memo from Gary Taylor addressing action items of the 2009 Independent Monitor Report
General Reports	08-09 MMP February 2009 final	<i>MRM 20090915 Approval of MMP no change to security</i>	15-Sep-09	Letter from R. Ball to E. Moller
		<i>LETT 090309 MMP Submission letter.GT</i>	13-Mar-09	Letter from E. Moller to R. Ball
		<i>Final Mining Management Plan Doc V4</i>	01-Jul-05	MMP Issue 1 Revision 0
		<i>Appendix 1</i>	01-Jul-05	Calculation of closure costs
		<i>Appendix 2</i>	01-Jul-05	Summary of Commitments
		<i>Appendix 3</i>	01-Jul-05	Northern OEF Design NOT PROVIDED
		<i>Appendix 4</i>	01-Jul-05	Maps of operational areas
	AER Final Version 2005-2008	<i>2008 MRM AER Final Version</i>	Nov-08	Issue 2 Revision 0
		<i>AER approval from DOR</i>	04-Mar-09	
		<i>LETT 081201 acknowledgement letter of submission of AER</i>	01-Dec-09	
		<i>LETT 090119 re additional info for AER to Mines</i>	19-Sep-09	
		<i>LETT re request for additional information form DOR</i>	05-Jan-09	
	Community Complaints	<i>100209 Report from AIMS (Parry)</i>	08-Feb-10	Investigation and Characterisation of white material at Burketown Crossing: Borroloola
		<i>ADM-CRE-PRO-6020-0003 Community Complaints Procedure I002 Rev 0.doc</i>	Nov-09	Community Complaints Procedure Issue 2
		<i>Incident #27730</i>	06-Jan-10	Community report of material along road way

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>Incident #27791</i>	10-Feb-10	Community complaint of white material on rocks at Burketown Crossing
		<i>LETT 100318 re DOR satisfied with community complaint finding</i>	18-Mar-10	letter from Dept. resources to MRM
	Incidents 2009	<i>Incident Number 27291</i>	02-Jan-09	Sump area failure at toe of ROM pad.
		<i>Incident Number 27300</i>	03-Feb-09	Sump area failure at toe of ROM pad.
		<i>Incident Number 27364</i>	29-Apr-09	Leaking pipe transporting void water to TSF
		<i>Incident Number 27377</i>	30-Apr-09	Fluvial sediment exceedences for Pb.
		<i>Incident Number 27379</i>	20-May-09	TSF Water seepage under road towards Surprise Creek.
		<i>Incident Number 27384</i>	25-May-09	Burst pipe in wheel washing area
		<i>Incident Number 27393</i>	27-May-09	Natural surface water exceeded ANZECC for Cu, Pb, Zn.
		<i>Incident Number 27394</i>	01-Jun-09	Natural surface water exceeded ANZECC for Cu, Pb, Zn.
		<i>Incident Number 27395</i>	25-May-09	Ni and Pb potable water exceedence
		<i>Incident Number 27396</i>	27-May-09	Potable water sample above drinking guideline for Pb
		<i>Incident Number 27398</i>	29-Apr-09	Marine sediment lead and zinc guideline exceedence
		<i>Incident Number 27499</i>	12-Aug-09	Poly Pipe from TSF recovery bores rolled off TSF and water pumped into area outside the TSF.
		<i>Incident Number 27501</i>	12-Aug-09	Potable waste sample above Bacteria guidelines
		<i>Incident Number 27525</i>	09-Sep-09	Potable waste sample above

Folder	Sub-folder	File name	Date	Comment/ Description
				Bacteria guidelines
		<i>Incident Number 27532</i>	12-Sep-09	Pipe leak from Water Management Damp Pipeline that connects with the Tailings pipeline.
		<i>Incident Number 27575</i>	21-Oct-09	Recovery bore water from TSF Cell1 allowed to run onto road and down TSF wall face.
		<i>Incident Number 27637</i>	28-Oct-09	Marine sediment lead guideline exceedance
		<i>Incident Number 27640</i>	18-Nov-09	Potable water sample above drinking guideline for Pb
		<i>Incident Number 27641</i>	04-Nov-09	Sediment samples exceed NEPC Guidelines for Pb and Zn
		<i>Incident Number 27650</i>	30-Nov-09	Soil samples exceeded NEPC Guidelines
	Updated Procedures	<i>GEN-ENV-PLN-6040-0001 Environmental Management Plan I004 Rev 0.doc</i>	Nov-09	
		<i>GEN-ENV-PLN-6040-0005 Rechannel Rehabilitation Plan I003 Rev 0.doc</i>	Nov-09	
		<i>GEN-ENV-PRO-6040-0001 MRM CLEARING PERMIT PROCEDURE I002 Rev 0</i>	Nov-09	
		<i>GEN-ENV-PRO-6040-0002 Vegetation Clearance Procedure I003 Rev 0.doc</i>	27-Apr-09	
		<i>GEN-ENV-PRO-6040-0004 General Spill Response Procedure I003 Rev 0</i>	Nov-09	
		<i>GEN-ENV-PRO-6040-0005 Clean Vehicle and Equipment Procedure I002 Rev 0</i>	Nov-09	
		<i>GEN-ENV-PRO-6040-0008 Management & Disposal of Waste Oils I003 Rev 0</i>	Nov-09	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>GEN-ENV-PRO-6040-0009 Management & Disposal of Waste Cooking Oil I003 Rev 0</i>	Nov-09	
		<i>GEN-ENV-PRO-6040-0010 Disposal of Aluminium Cans I003 Rev 0</i>	Nov-09	
		<i>GEN-ENV-PRO-6040-0011 Disposal of Scrap Metal I003 Rev 0</i>	Nov-09	
		<i>GEN-GEN-PLN-6040-0001 Site Emergency Response Plan I003 Rev</i>	24-Aug-09	
		<i>GEN-SD-PLN-6040-0001 SD Annual Plan 2010 I004 Rev 0</i>	Sep-09	
		<i>GEN-SD-PLN-6040-0002 SD Strategy I002 Rev 0</i>	20-Oct-09	
		<i>GEN-SD-POL-6040-0002 HSEC POLICY I004 Rev0</i>	Sep-09	
		<i>GEN-SD-STD-6040-0005 Risk and Change Management I002 Rev 0</i>	20-Oct-09	
		<i>GEN-SD-STD-6040-0006 Catastrophic Hazards I002 Rev 0</i>	29-Oct-09	
		<i>GEN-SD-STD-6040-0017 Incident Management I003 Rev 0.doc</i>	Nov-09	
		<i>GEN-SD-STD-6040-0018 Monitoring and Review I003 Rev 0</i>	Nov-09	
		<i>GEN-SD-STD-6040-0019 Emergencies, Crises and Business Conti</i>	Nov-09	
		<i>GEN-ENV-PRO-6040-0015 Tyre Management Procedure I002 Rev 0.doc</i>	May-09	
	Water Management Plan	<i>091108 Water Management Plan I001 Rev final</i>	Nov-09	
		<i>LETT 090831 letter for submission.gt</i>	31-Aug-09	
		<i>LETT 090907 re receipt notification of WMP</i>	07-Sep-09	
		<i>LETT 091021 re additional info required by DOR</i>	21-Oct-09	
		<i>LETT 091118 Additional info for water Management Plan.gt</i>	18-Nov-09	
		<i>LETT 100322 re flow meter at fed bore</i>	22-Mar-10	
		<i>MRM 201001 MR20090408 WMP Approval Letter</i>	05-Jan-10	
	Environmental Monitoring	<i>GEN-ENV-MAN-6040-0001 Environmental Monitoring Manual 2009</i>	Mar-10	

Folder	Sub-folder	File name	Date	Comment/ Description
	Waste Management	<i>GEN-HSE-PLN-6040-007 Waste Management Plan I002 Rev 0</i>	Jun-09	
	Closure plan	<i>Xstrata_Zinc_MRM_Closure_Plan_20080320</i>	Mar-08	
	Environmental Monitoring Plan	<i>Commonwealth Environmental Monitoring Plan final 090831</i>		
Bing Bong Dredge Spoil Management	Design reports plans and photographs	<i>Photos of dredge spoil area 04</i>	26-Jun-05	Photos of dredge pond construction.
		<i>Photos of dredge spoil area 09</i>	01-Jul-05	Photos of re-worked Spoon Drain (?)
		<i>Dredge Spoil pond schematics 1</i>	Unknown	
		<i>Dredge Spoil pond schematics 2</i>	Unknown	
		<i>Dredge Spoil quality of material report during design</i>	28-Jun-05	Materials testing reports
		<i>Picture 171</i>	Feb-10	
		<i>Picture 172</i>	Feb-10	
		<i>Picture 173</i>	Feb-10	
		<i>Picture 174</i>	Feb-10	
		<i>Picture 175</i>	Feb-10	
		<i>Picture 176</i>	Feb-10	
		<i>Test results and schematics</i>	28-Jun-05	Materials testing reports and map locations
	Dredge Management Plan	<i>LETT 081007 re acceptance of original plan</i>	07-Oct-08	BB Dredge management plan acceptance
		<i>LETT 090617 re commencement of dredging proposal</i>	07-Jun-09	Notice to Dept. Resources to soon commence dredging
		<i>PLAN 080815 Dredge Management Plan Final - CLJ</i>	No date	Environmental Management Plan - Bing Bong Swing Basin 2008 Dredge Program

Folder	Sub-folder	File name	Date	Comment/ Description
	Dredge Monitoring	<i>Water quality at Discharge</i>	Nov 2009 to Feb 2010	
		<i>Water quality Field Data at discharge</i>	Nov 2009 to Mar 2010	
		<i>4-15 11 2009</i>	Nov-09	Dredge Monitoring data - Turbidity
		<i>7-13 12 2009</i>	Dec-09	Environmental Weekly summary
		<i>11-17 1 2010</i>	Jan-10	Dredge Monitoring data - Turbidity
		<i>14-20 12 2009</i>	Dec-09	Environmental Weekly summary
		<i>16-22 11 2009</i>	Nov-09	Environmental Weekly summary
		<i>18-24 1 2010</i>	Jan-10	Dredge Monitoring data - Turbidity
		<i>23-29 11 2009</i>	Nov-09	Environmental Weekly summary
		<i>25-31 1 2010</i>	Jan-10	Dredge Monitoring data - Turbidity
		<i>30 11 - 6 12 2009</i>	Dec-09	Dredge Monitoring data - Turbidity
		<i>Spoil Monitoring at ponds</i>	Nov 2009- Mar 2010	Excel data spread sheets of Turbidity readings
		<i>LogSheetSummaryNo4_Bing Bong_100212</i>	Unknown	Summary of log sheets - UNCLEAR OF DATA SUBJECT
	Soil Sampling	<i>090618 Dredge Spoil Soil Sampling</i>	Jun-09	Map showing soil sampling locations
		<i>EB0909986_0_XTAB</i>	Jun-09	EC and TDS readings for soil - Laboratory results
		<i>EB0909986_COA</i>	Jun-09	Laboratory results of EC and TDS soil sampling at BB
		<i>EB0909986_COC</i>	Jun-09	Laboratory results of EC and TDS soil sampling at BB
		<i>EB0909986_QC</i>	Jun-09	Laboratory results of EC and TDS soil sampling at BB
		<i>EB0909986_SRN</i>	Jun-09	Laboratory results of EC and TDS

Folder	Sub-folder	File name	Date	Comment/ Description
				soil sampling at BB
		<i>MISCBB090618JSB</i>	Jun-09	COC - dust samples
		<i>Results Total Salts</i>	Jul-09	Map showing soil sampling locations
	Sediment sampling	<i>Sediment quality</i>		As per the Dredge Management Plan SPOCAS testing is conducted on sediment sampled at the outlet of the dredge spoil drain
	Vegetation Mapping	<i>100303 Mapping of Bing Bong vegetation - JSB</i>	02-Jul-05	MRM Dredge Spoil Report
		<i>BingBong_025m_0909.tab</i>	Oct-09	Could not open file - unrecognisable file type.
		<i>BING BONG DREDGE SPOIL research proposal 2010</i>	5-Mar-10	Charles Darwin University research proposal to undertake vegetation studies at BB Port.
	Dredge Spoil Report 2010	<i>100303 Mapping of Bing Bong vegetation - JSB</i>	2010	
	Bing Bong Hydrology Plan	<i>Bing Bong Hydrology Plan - Final</i>	27-Apr-10	URS Report to MRM
Tailings Storage Facility	Design and Reports on TSF	<i>bowen-geotechreportamend</i>	26-May-04	Memorandum - Tailings dam raises MRM
		<i>klubbereport-tailingsdamfailure_27Jan2003</i>	23-Jan-03	Tailings storage embankment inspection report.
		<i>MaunsellMcRept_Stg3_Cell1_Design</i>	20-Apr-01	Cell 1 Tailings Dam Raising - Stage 3 Design Report.
		<i>MRM Water Mgmt Project Completion Report</i>	Jan-02	Tailings and water management project completion report, McArthur River Mine.
		<i>Report-Deterioration TailsDamEmbank-MRM_Jan2003</i>	Jan-03	Report on the deterioration of tailings dam embankment, MRM
		<i>Stage 1 Construction Report-RevA</i>	Apr-01	Cell 1 Tailings Dam Raising Stage 1 Construction report

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>STAGE 1 CONSTRUCTION SPEC</i>	Aug-00	Design report for the proposed raising of Cell 1 of the Tailings Dam - Construction Specification
		<i>STAGE 1 DESIGN REPORT</i>	Aug-00	Design report for the proposed raising of Cell 1 of the Tailings Dam
		<i>STAGE 3 CONSTRUCTION SPECRevA</i>	04-Apr-01	Stage 3 Raising of Cell 1 of the Tailings Dam
		<i>STAGE 3 CONSTRUCTION SPECRevC</i>	08-May-01	Stage 3 Raising of Cell 1 of the Tailings Dam
		<i>Stage 3 Design Report RevA</i>	Apr-01	Cell 1 Tailings Dam Raising - Stage 3 Design Report.
	Dust Control and Rehab	<i>4 project claims of payment for TSF rehab CDE</i>	30-Dec-08	Progress claim invoice for TSF Capping
		<i>invoice for TGC at the TSF</i>	5-Nov-09	Tax invoice for Total Ground Control covering of TSF
		<i>Quote from RST on TGC</i>	20-Aug-09	Quote for Total Ground Control covering of tailings
		<i>Tender Contract request for TSF 2008</i>	25-Nov-08	TSF Stage 1 rehabilitation - request for tender form.
	Inspections	<i>Email summarising findings from Annual inspection from AWA Dam Safety</i>	8-Jan-10	
		<i>Tailings Dam Infrastructure inspection March 2010</i>	Mar-10	
		<i>Tailings Dam Infrastructure inspection December 2009</i>	Dec-10	Monthly TSF infrastructure inspection
		<i>Tailings Dam inspection April-June 2009</i>	April- June 2010	Monthly TSF infrastructure inspection
		<i>Tailings Dam inspection December 2009</i>	Dec-09	Monthly TSF infrastructure inspection
		<i>Tailings Dam inspection February 2010</i>	Feb-10	Monthly TSF infrastructure inspection

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>Tailings Dam inspection February- March 2009</i>	Feb- Mar 2009	Monthly TSF infrastructure inspection
		<i>Tailings Dam inspection January 2010</i>	Jan-10	Monthly TSF infrastructure inspection
		<i>Tailings Dam inspection July-September 2009</i>	July- Sep 2009	Monthly TSF infrastructure inspection
		<i>Tailings Dam inspection November 2009</i>	Nov-09	Monthly TSF infrastructure inspection
		<i>Tailings Dam inspection October 2009</i>	Oct-09	Monthly TSF infrastructure inspection
		<i>Daily mill notes_TSF 02-08-09</i>		
		<i>Daily mill notes_TSF 02-11-09</i>		
		<i>Daily mill notes_TSF 03-11-09</i>		
		<i>Daily mill notes_TSF 04-08-09</i>		
		<i>Daily mill notes_TSF 04-11-09</i>		
		<i>Daily mill notes_TSF 05-06-09</i>		
		<i>Daily mill notes_TSF 04-06-09</i>		
	Recovery Bores	<i>LETT 060908 TD Recovery Bore Proposal - URS</i>	8-Sep-06	Proposal to install recovery bores around the TSF.
		<i>MRM TSF Borelogs - Jan08</i>	Feb-06	Recovery bore borelogs.
		<i>Recovery Bore Monitoring Data</i>	May 2009 - Jan 2010	Flow meter readings (m3)
		<i>Non MMP committed bore monitoring locs</i>		Map showing groundwater bore monitoring locations not committed to in MMP at the TSF and 2 at the OEF
		<i>RE TSF peizometer installation</i>	04-Jun-10	
		<i>RE TSF peizometer installation 2</i>	03-Jun-10	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>Recovery Bore Meter Readings</i>	May 2009- May 2010	Flow-meter readings, excel file
		<i>TSF GW samp locs</i>	Aug-09	Location of all groundwater sampling locations around the TSF
	Tailings Geochemical Testing	<i>Final Tailings Analysis Data</i>	Nov-2008 - Dec 2009	
		<i>TSF - Cell 2 Water Quality</i>	Nov-2008 - Dec 2009	
	EM Survey Final	<i>EM Survey - TSF Monitoring Programme McArthur River Mine</i>	24-Mar-10	
	TSF Operation and seepage	<i>email to AWA re peizos and scope of work</i>	8-Apr-10	preliminary scope for TSF works
		<i>MET-GEN-GDL-2800-0001 TSF Operating Guidelines I006 Rev 0</i>	Mar-10	TSF Operating Guidelines
		<i>TSF 2009 AWA Report</i>	Apr-10	McArthur River Mine TSF Dam Safety Review Report (2009)
		<i>URS Proposal - TSF Seepage Mitigation</i>		Proposal to undertake site inspection in relation to TSF Seepage into Surprise Creek.
		<i>URS TSF Seepage Proposal</i>	29-Mar-10	URS Report to MRM
		<i>URS visit from 2009</i>	15-Jul-09	URS Memo to MRM regarding TSF Leachate migration to Surprise Creek.
	TSF Augmentation works	<i>Allan Watson and Associates Proposal</i>	13-Apr-10	TSF Augmentation works including Cell 2 Spillway Upgrade TSF Embankment Monitoring/Instrumentation Cell 1 Surface Water Management Plan
		<i>FW McARTHUR RIVER MINE - 2010 TSF AUGMENTATION WORKS</i>	2-Jun-10	Email regarding augmentation works

Folder	Sub-folder	File name	Date	Comment/ Description
River Diversions Revegetation and rehabilitation	As built Report	<i>Appendix A - Design Files</i>	Mar-10	Barney Creek and MRM Design Files
		<i>Appendix L - Photographs</i>	Mar-10	Photographs of sections of the McArthur River and Barney Creek diversions.
	Barney E Monitoring	<i>0m 616429 8183249</i>	July 08, March 09, March 10	Photos at reference points
		<i>250m 616541 8183469</i>	July 08, March 09, March 10	Photos at reference points
		<i>350m Creek 616612 8183566</i>	July 08, March 09, March 10	Photos at reference points
		<i>500m 616700 8183645</i>	July 08, March 09, March 10	Photos at reference points
		<i>600m Surprise Creek 616777 8183705</i>	July 08, March 09, March 10	Photos at reference points
		<i>750m 616938 8183769</i>	July 08, March 09, March 10	Photos at reference points
		<i>1000m 617170 8183802</i>	July 08, March 09, March 10	Photos at reference points
		<i>1250m 617410 8183819</i>	July 08, March 09, March 10	Photos at reference points
		<i>1500m 617660 8183769</i>	July 08, March 09, March 10	Photos at reference points
		<i>1750m Creek 617905 8183675</i>	July 08, March 09, March 10	Photos at reference points
		<i>2000m Creek 618096 8183629</i>	July 08, March 09, March 10	Photos at reference points
		<i>2250m 618370 8183631</i>	July 08, March 09, March 10	Photos at reference points
		<i>2500m 618620 8183624</i>	July 08, March 09, March 10	Photos at reference points

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>2750m 618904 8183600</i>	July 08, March 09, March 10	Photos at reference points
	Diversion Performance	<i>FW Quote for additional data ALS flight data for 2010</i>		Email requests for LiDAR survey - email does not state specific requestes. Is this for erosion monitoring?
		<i>Levee Wall Inspection 24-03-10</i>	24-Mar-10	Monthly levee wall inspection (Only one provided)
		<i>workplace observation 1-4</i>	Jan-Feb 2010	Observation reports
		<i>Workplace observations x2 from helicopter</i>	Jan and Feb 2010	Helicopter observation of water flow in Diversions.
	Fencing	<i>100125 Cattle Fence Maintenance Register - JSB</i>		
		<i>Fencing maintenance</i>	Sept 2008- Nov 2009	Invoice for fence repair august 2008
		<i>Fencing maintenance bill 2</i>	3-Sep-09	Fence repair invoice
		<i>Cattle Fence Relocation</i>	1-May-10	Map showing proposed fence relocation to avoid fence damage
	Gauging Stations	<i>EWFS emails</i>		
		<i>Downloading Upstream & Downstream Gauging Station Data</i>	Mar-09	Procedure for downloading McArthur River level data from the upstream and downstream gauging stations
		<i>Draft - Barney Ck and Glyde River Gauging Stn Dwnld Procedure</i>	No date	
		<i>Early Flood Warning System Procedure</i>	Mar-09	
		<i>Gauging Station front end</i>	No date	Gauging station data intranet management system grabs
		<i>Gauging station updates</i>	Nov-09	Software invoice
		<i>Greenspan Service Report 2009</i>	Oct-09	Site inspection and calibration of gauging stations
		<i>Inv for hardware upgrades</i>	26-Oct-09	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>Inv for hardware upgrades (2)</i>	26-Oct-09	
		<i>Inv for servicing calibrating gauge stns 2009</i>	20-Nov-09	
		<i>Invoice for pump at USGS</i>	9-Nov-09	
		<i>Quote for ratings curve at Barney Creek Stn</i>	17-Feb-10	
		<i>Radio configuration</i>	Apr-10	Schematic diagram of gauging station setup
		<i>Solar Panels Invoice</i>	19-Jan-10	
		<i>Purchase order raised for recalculation of gauging stations</i>	2-Jun-10	Computer screen grab
		<i>Quote for review of gauge stn. ratings table</i>	17-May-10	
		<i>Scope of Works for remediation on the MRM channel</i>	22-Apr-10	MRM Memorandum
		<i>Sled Flow Meter Readings</i>	22/4/2010- 26/5/2010	Irrigation sled flow meter readings
	Lower Mc River Monitoring	<i>0m 620209 8183810</i>	Oct-09,Mar -10	
		<i>250m 620421 8183949</i>	Oct-09,Mar -10	
		<i>500m 620660 8184061</i>	Oct-09,Mar -10	
		<i>750m 620837 8184213</i>	Oct-09,Mar -10	
		<i>1000m 621065 8184361</i>	Oct-09,Mar -10	
		<i>1250m 621307 8184311</i>	Oct-09,Mar -10	
		<i>1500m 621531 8184236</i>	Oct-09,Mar -10	
		<i>1600m Glyde River 621609 8184280</i>	Oct-09,Mar -10	
		<i>1750m 621709 8184413</i>	Oct-09,Mar -10	
		<i>2000m 621721 8184698</i>	Oct-09,Mar -10	
		<i>2250m 621782 8184953</i>	Oct-09,Mar -10	
		<i>2500m 621898 8185177</i>	Oct-09,Mar -10	

Folder	Sub-folder	File name	Date	Comment/ Description
		2750m 622038 8185392	Oct-09, Mar -10	
	Mc River Erosion Monitoring	0 m 0616215 8181126	Oct-08, Mar-09, Mar-10	
		280m Creek 0616485 8181206	Oct-08, Mar-09, Mar-10	
		500m Creek 0616704 8181212	Oct-08, Mar-09, Mar-10	
		810m Creek 0617023 8181177	Oct-08, Mar-09, Mar-10	
		1000m 0617217 8181174	Oct-08, Mar-09, Mar-10	
		1250m 0617467 8181150	Oct-08, Mar-09, Mar-10	
		1500m 0617718 8181154	Oct-08, Mar-09, Mar-10	
		1750m 0617969 8181182	Oct-08, Mar-09, Mar-10	
		2000m 0618211 8181234	Oct-08, Mar-09, Mar-10	
		2250m 0618467 8181309	Oct-08, Mar-09, Mar-10	
		2500m Creek 0618706 8181381	Oct-08, Mar-09, Mar-10	
		2680m Creek 0618864 8181464	Oct-08, Mar-09, Mar-10	
		2750m 0618931 8181508	Oct-08, Mar-09, Mar-10	
		3000m 0619086 8181703	Oct-08, Mar-09, Mar-10	
		3130m Creek 0619151 8181823	Oct-08, Mar-09, Mar-10	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>3250m 0619208 8181938</i>	Oct-08, Mar-09, Mar-10	
		<i>3420m Creek 0619288 8182093</i>	Oct-08, Mar-09, Mar-10	
		<i>3500m 0619332 8182173</i>	Oct-08, Mar-09, Mar-10	
		<i>3750m 0619441 8182397</i>	Oct-08, Mar-09, Mar-10	
		<i>3980m Creek 0619560 8182584</i>	Oct-08, Mar-09, Mar-10	
		<i>4040m Creek 0619596 8182632</i>	Oct-08, Mar-09, Mar-10	
		<i>4250m 0619703 8182819</i>	Oct-08, Mar-09, Mar-10	
		<i>4410m 2 Creeks 0619785 8182956</i>	Oct-08, Mar-09, Mar-10	
		<i>4850m Creek 0619888 8183114</i>	Oct-08, Mar-09, Mar-10	
		<i>5100m Creek 0620016 8183320</i>	Oct-08, Mar-09, Mar-10	
		<i>5200m Creek 0620062 8183416</i>	Oct-08, Mar-09, Mar-10	
		<i>5480m Creek 0620134 8183701</i>	Oct-08, Mar-09, Mar-10	
	Revegetation	<i>100325 Civil Rehabilitation Progress - JSB</i>	No date	Unclear where this document fits - No titles
		<i>GEN-ENV-PLN-6040-0005 Rechannel Rehabilitation Plan</i>	01-Jun-09	Issue 2
		<i>Invoice for supply of Native Seed - McArthur Diversion</i>	23-Dec-08	
		<i>Invoice for supply of Native Seed - McArthur Diversion (2)</i>	23-Dec-08	
		<i>McArthur Diversion irrigation system</i>	01-Mar-10	Photo

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>MRM Planting Register</i>	Dec 2008 to April 2010	Ongoing planting register
		<i>Planting Data Sheets</i>	04-Dec-08	
		<i>Planting Data Sheets 2</i>	06-Apr-10	
		<i>Planting Data Sheets 3</i>	09-Apr-10	
		<i>Quote and purchase order number for labour costs - planting</i>	26-Mar-10	
		<i>Quote for irrigation pump</i>	09-Mar-10	
		<i>Quotes & purchase order numbers for labour costs - direct seeding</i>	10-Feb-10	
		<i>Quotes and Req no. for supply of seedlings</i>	04-Mar-10	
	Water extraction	<i>Approval from DOR for abstraction</i>	16-Mar-10	
		<i>LETT 100302 RE ammendment to WMP gt</i>	31-Mar-10	
		<i>Minutes from environmental meeting re flowmeter</i>	31-Mar-10	
	Weed Management	<i>100408 Devils Claw Spray Path - JSB</i>	10-Apr-08	Google Earth Map with spray overlay
		<i>Aerial Spraying Devil's Claw JSA</i>	06-Apr-10	JSA for spraying
		<i>Aerial Spraying Devils Claw JSA Map</i>	NO DATE	Map with spray overlay
		<i>DSCN8503</i>	08-Apr-09	(Date=file last modified) Actual date unknown.
		<i>DSCN8504</i>	08-Apr-09	(Date=file last modified) Actual date unknown.
		<i>DSCN8505</i>	08-Apr-09	(Date=file last modified) Actual date unknown.
		<i>DSCN8506</i>	08-Apr-09	(Date=file last modified) Actual date unknown.
		<i>Noogoora Burr Data Collection Sheet</i>	Mar- Apr 2009	Weed infestation evaluation data sheet

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>Noogoora Burr Sprayed Mar April 2009</i>	Mar- Apr 2009	Map of sprayed area along Barney Creek channel
		<i>Parkinsonia Data Collection Sheet</i>	06-Dec-09	Weed infestation evaluation data sheet
		<i>Quote for ChemCert Training for MRM</i>	01-Mar-10	Correspondence regarding training for pesticide use.
		<i>Quote for Devil's Claw Spraying</i>	01-Mar-10	Quote for aerial spraying of Devil's Claw
		<i>Weed Management Plan 2009</i>	2009	Weed management plan. Next one due May 2010
	Inspection	<i>Post rain inspection 01-04-10</i>	01-Apr-10	Photographic report of water collection and erosion at various assets around the mine.
	sediment and erosion inspections	<i>July 2009 inspection</i>	01-Jul-09	
		<i>March 2010 inspection</i>	01-Mar-10	
		<i>May 2009 inspection</i>	01-May-09	
		<i>November 2008 inspection</i>	01-Nov-08	
		<i>ROM PAD sump inspections and work orders</i>	Feb 2009- Feb 2010	
		<i>workplace observation 1-4</i>	01-Feb-10	
		<i>Workplace observations x2 from helicopter</i>	31-Jan-10	
	Large Woody Debris	<i>I&S for LWD invoice 1</i>	31-May-10	Invoice for plant hire to move large woody debris
Overburden Emplacement Facility	Clay Testing	<i>North OEF QC Clay test results 2</i>	24-Feb-10	INVOICE ONLY- Moisture content, PSD, Plasticity and linear Shrinkage
		<i>North OEF QC Clay test results 3</i>	23-Feb-10	Test results for 2 samples

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>North OEF QC Test results 1</i>	08-Mar-10	Australian Soil Testing Pty Ltd - Soil Classification test data. 1 Sample.
		<i>MIN-TEC-PRO-1000-0015-EOM NOEF Sampling procedure I001 Rev 0</i>	29-Mar-10	NOEF sampling procedure
		<i>NOEF_IEM_Notes (2) (2)</i>	NO DATE	North Overburden Emplacement Facility - NOEF, clay liner current sampling practice
	HSEC Inspections	<i>July 2009 inspection</i>	21-Jul-09	
		<i>March 2010 inspection</i>	Mar-2010	
		<i>May 2009 inspection</i>	May -20089	
		<i>November 2008 inspection</i>	Nov - 2008	
	Mining Monthly reports for OEF, Mine levee, pit and groundwater	<i>Aug-09</i>	Aug-09	
		<i>Dec-09</i>	Dec-09	
		<i>Feb-10</i>	Feb-10	
		<i>Jan-10</i>	Jan-10	
		<i>Nov-09</i>	Nov-09	
		<i>Oct-09</i>	Oct-09	
		<i>Sep-09</i>	Sep-09	
	Mining Weekly reports for OEF	<i>4/08/2009</i>	August-2009	
		<i>5-04-010</i>	5-04-010	
		<i>7/12/2009</i>	7/12/2009	
		<i>10/08/2009</i>	10/08/2009	

Folder	Sub-folder	File name	Date	Comment/ Description
		10/09/2009	10/09/2009	
		13/08/2009	13/08/2009	
		17/09/2009	17/09/2009	
		18-02-010	18-02-010	
		18-03-010	18-03-010	
		20/07/2009	20/07/2009	
		20/08/2009	20/08/2009	
		24/09/2009	24/09/2009	
		25-01-010	25-01-010	
		25-03-010	25-03-010	
		27/07/2009	27/07/2009	
		27/08/2009	27/08/2009	
		30/10/2009	30/10/2009	
		30/11/2009	30/11/2009	
	Sampling and analysis	<i>EOM_NOEF NAF Sampling</i>	Geochemical classification of NOEF NAF sampling	
		<i>MIN-TEC-PRO-1000-0015-EOM NOEF Sampling procedure I001 Rev 0</i>	29-Mar-10	
		<i>MIN-TEC-SOP-1000-0002 Pit Wall and Face Markup I001 Rev 0</i>	16-Oct-09	
		<i>MIN-TEC-SOP-1000-0004 Pit Wall and Face Sampling I001 Rev 0</i>	16-Oct-09	
		<i>Monthly Rock sampling submission forms</i>	Jun 2009 - Mar 2010	
		<i>NOEF map of sampling locations</i>	02-Jul-05	
		<i>Post rain inspection 01-04-10</i>	01-Apr-10	

Folder	Sub-folder	File name	Date	Comment/ Description
Mosquito Monitoring	Advice December 2009	<i>Personal protection from mosquitoes and biting midges in the NT Aug 2009</i>		
		<i>probmos Top End (Apr 07 update)</i>	April -07	
	Field sheets, submission forms	MOZ090910JSB		
		MOZ091010JSB		
		MOZ091111		
		MOZ091119		
		MOZ091203JSB		
		MOZ091221MHB		
		MOZ100124MHB		
		MOZ100211AW		
		MOZ100218AW		
		MOZ100311AW		
	Results	<i>FW McArthur River Mine mosquito monitoring results 10th September 2009</i>	10-Sep-09	
		<i>McArthur River mine adult mosquito monitoring results 12 November 2009</i>	12-Nov-09	
		<i>McArthur River mine adult mosquito monitoring results 24 Dec 09</i>	24 de 2009	
		<i>McArthur River mine mosquito monitoring results 3 December 2009</i>	3-Dec-09	
		<i>McArthur River Mine mosquito monitoring results 17 December 2009</i>	17-Dec-09	
		<i>McArthur River mine mosquito monitoring results 19 November 2009</i>	19-Nov-09	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>McArthur River Mine_monitoring_20090910</i>	10-Sep-09	
		<i>McArthur River Mine_monitoring_20091008</i>	8-Jan-09	
		<i>McArthur River Mine_monitoring_20091112</i>	12-Nov-09	
		<i>McArthur River Mine_monitoring_20091119</i>	19-Nov-09	
		<i>McArthur River Mine_monitoring_20091203</i>	3-Dec-09	
		<i>McArthur River Mine_monitoring_20091217</i>	17-Dec-09	
		<i>McArthur River Mine_monitoring_20091224</i>	24-Dec-09	
		<i>Mosquito monitoring results 8th and 10th October 2009</i>	8-10 Oct 2009	
		<i>MEMO 100322 Mosquitos around site.gt</i>	22-Mar-10	Memo to personnel warning about chance of mosquitoes
		<i>mosquito invoice</i>	19-Feb-10	Quote for mosquito management - spray and breeding inhibitors
Groundwater and Surface Water	Bing Bong Pond	<i>Archived Data - Included Into Current Spreadsheet</i>	various	A range of Outlook documents containing data
		<i>BBSRP Monitoring</i>		
	Ground Water	<i>Groundwater monitoring data sheets and sample submission forms</i>	various	
	GW & SW Data	<i>Water Quality Data - GW</i>	Dec 2008- Dec 2009	Summary sheet
		<i>Water Quality Data - SW</i>	Dec 2008- Dec 2009	Summary sheet
	Surface Water	<i>Groundwater monitoring data sheets and sample submission forms</i>	Various	
		<i>Bing Bong Water Management Plan (DRAFT)</i>	23-Mar-10	
		<i>Evapotranspiration studies with URS</i>	Mar-10	
		<i>Proposal MRM TSF evapotranspiration (Memorandum) Final</i>	09-Mar-10	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>URS Standard Consulting Agreement MRM TSF Evapotranspiration.v1</i>	No Date	
		<i>URS Water Management Plan 2009</i>	Dec-09	
		<i>WS090207 - OPSIM Report</i>	22-Jul-09	
Dust Soil sediments	Dust	<i>2010 Dust Review Proposal - Synergetics</i>	22-Mar-10	
		<i>Dust Data</i>	Dec-08 - 09	Excel Spreadsheet
		<i>Dust COC and analysis scanned results</i>	Various 2008 - 2009	
	Fluvial sampling	<i>Fluvial Sediment Data</i>	April 2009- Oct 2009	
		<i>FS081106</i>	Nov-08	
		<i>FS090406MHB</i>	Mar-09	
		<i>FS090410MHB</i>	Mar-09	
		<i>FS090524JSB</i>	May-09	
		<i>FS091010JSB</i>	Oct-09	
	Marine Sediment	<i>Marine Sediment Data</i>	Mar - Oct-09	
		<i>MS090406MHB</i>	Mar-09	
		<i>MS091012MHB</i>	Oct-09	
	Modifications for dust suppression at Bing Bong	<i>Chute design change</i>	Oct-09	
		<i>irrigation one for BB dust control</i>	Mar-10	
		<i>irrigation two for BB dust control</i>	Feb-10	
	Soil	<i>SOIL081007AJD</i>	Oct-10	
		<i>SOIL091109AJD</i>	Oct-10	
		<i>Soil Data</i>	Oct-10	

Folder	Sub-folder	File name	Date	Comment/ Description
	SPOCAS at outlet	<i>Sediment quality</i>	Nov-09 – Jan-10	
	Bing Bong Dust audit	<i>Bing Bong dust sampling audit</i>	2010	
Marine Monitoring	Annual Marine	<i>AIMS Fieldwork costs 2009</i>	2009	
		<i>BING BONG Beach 2009 quote</i>	Aug-09	
		<i>New Annual marine program 2009</i>	Jul-09	
		<i>Re marine monitoring program</i>	Mar-10	Email indicating reports complete
		<i>RE Marine Monitoring Reports</i>	Apr-10	Email indicating reports complete
		<i>Samuel Evans Permission</i>	Nov-09	Permission to enter land.
	DGT's	<i>Copy of Report MRM DGT SW Dec09 Jan10 (2)</i>	Dec-09 – Jan-10	
		<i>Copy of Report MRM DGT SW Feb March 2010(1) (2)</i>	Feb – Mar-10	
		<i>MRM DGT quote 2009</i>	Aug-09	
	Marine Water Data	<i>Water Quality Data - MSW</i>	Nov-08 – Dec-09	
	Metal Microbes	<i>ARC Aims for Metal resistant Microbes</i>	2006	
		<i>MRM funding contributions for ARC project</i>	Jan-10	
		<i>Progress Report for ARC funded Research</i>	No date	
	Seagrass	<i>2009 Annual Bing Bong Seagrass Report - Draft</i>	Jan-10	
	Vibrio	<i>Vibrio Proposal final 151109</i>	Nov-09	
Flora and Fauna	Bing Bong Port Veg Monitoring	<i>850 veg monit bing bong final aug 06</i>	Aug-06	
		<i>2004 Dredging Monitoring Report</i>	2004	
		<i>Bing Bong Dredge Spoil Rehabilitation Report 2003</i>	2003	
		<i>Bing Bong Dredge Spoil Rehabilitation Report 2004</i>	2004	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>Bing Bong Dredge Spoil Relinquishment Strategy Report 2002</i>	2002	
		<i>Maintenance Dredging Bing Bong Port Facility 2003</i>	2003	
		<i>McArthur River Export Facility Dredge Spoil Study 1994</i>	1994	
		<i>Vegetation Monitoring of the Bing Bong Spoil Area - McArthur River Mine 2005</i>	2005	
		<i>Vegetation Monitoring of the Bing Bong Spoil Area - McArthur River Mine 2006</i>	2006	
	Bing Bong Port Fauna/Flora	<i>EIS Bing Bong Fauna</i>	1992	Extract from EIS (1992) regarding Bing Bong Flora and Fauna
	Fish	<i>08004 April 09 Report Final to Client Locked</i>	Apr-08	
		<i>08004 September 09 FINAL to Client with figs lock</i>	Sept-09	
		<i>Sawfish MP FINAL TO CLIENT lock</i>	Mar-09	
		<i>Monitoring of metals and lead isotope ratios in fishes of the McArthur River 2009</i>	29-Jul-10	Indo-Pacific Environmental report
		<i>Monitoring of metals and lead isotope ratios in fishes of the McArthur River 2005-2008</i>	24-May-10	Indo-Pacific Environmental report
	Macro invertebrates	<i>freshwater-macroinvertebrates-jpg</i>	2010	Poster with pictures of macro invertebrate species.
		<i>MRM Macro Assessment Recession Flow 2008 REV 6 October 2009</i>	Oct-09	
		<i>Memorandum Macro Program 10-6-2010 2_Page_1</i>	10-Jun-10	MRM Memorandum re Macro invertebrates program
	Migratory Birds	<i>LETT 100224 Letter re Migratory birds survey change JP (2)</i>	25-Feb-10	
		<i>MRM Migratory Bird Monitoring Program final</i>	Mar-09	
		<i>Port McArthur Migratory Birds Final 15 March 2010</i>	15-Mar-10	
	Rehab Monitoring Report CDU	<i>2009 Barney Creek Riparian Vegetation Monitoring Report CDU</i>	2009	

Folder	Sub-folder	File name	Date	Comment/ Description
	Riparian Birds	<i>birds-of-the-mcarthur-river-stn-jpg</i>	2010	Poster with pictures of riparian bird species.
		<i>Riparian Birds May2009 Final</i>	May-09	
		<i>Riparian Birds Oct 2009 Final</i>	Oct-09	
	Weed Management	<i>Noogoora Burr Sprayed Mar-April 09</i>	Apr-09	Photographs
		<i>Parkinsonia Trial April 2009</i>	Apr-09	
		<i>Parkinsonia Trial Oct 2009</i>	Oct-09	
		<i>RE Parkinsonia trials at McArthur River Mine</i>	03-Jun-10	Email
		<i>GEN-HSE-PLN-6040-006 Weed Management Plan 2009 I001 Rev 0</i>	May-09	
	Marine monitoring	<i>Annual marine program 2009 Report AIMS Final</i>	01-May-10	MCARTHUR RIVER MINE: ANNUAL MARINE MONITORING PROGRAM: 2009. Report by David Parry
	Feral Animals	<i>MRM Feral Animal Register</i>	June 2009- April 2010	Spreadsheet of MRM ferial animal eradication count.
Procedural Documents for Review	Community engagement	<i>090415_MRM_Memorandum%20edition%2010_final[1]</i>	Apr-09	Community newsletter
		<i>090827 Borrooloola Secondary Presentation.PPT - JSB</i>	No date	PowerPoint presentation
		<i>GEN-SD-STD-6040-0004 Communication and Engagement I003 Rev 0</i>	Nov-09	
	Rock analysis and quality control	<i>Ore Grade Control Procedure</i>	No date	
		<i>Results of NAFFAF Testing</i>	Feb-08	
		<i>Rock sampling</i>	Nov-07	
		<i>Rock sampling JSA</i>	Oct-07	
	Flora and Fauna Management	<i>GEN-ENV-PRO-6040-0017 Fauna Management Procedure I002 Rev 1.doc</i>	Apr-07	

Folder	Sub-folder	File name	Date	Comment/ Description
	Aerial photographs of the Mine	<i>2006 aerial photo</i>	2006	Photograph
		<i>2007 aerial photo</i>	2007	Photograph
		<i>2008 aerial photo</i>	2008	Photograph
		<i>2009 aerial photo</i>	2009	Photograph
		<i>ALS bill for aerial photography</i>	Sept-09	
	Potential fish barriers	<i>P5150015</i>	May-08	Photograph
	Tailings pipeline spill mitigation	<i>10 03 02 Tailings line completion tasks</i>	Mar-10	
		<i>10 04 07 Tailings line completion tasks update</i>	Apr-10	
		<i>2800C20012 Tails Line Low Point Containment Area Profile</i>	Mar-10	
		<i>2800-PI-003 Low Point Catchment Bund SD Risk Assessment</i>	20-Oct-10	
		<i>Change Management Initiation Tailings Line Catchment bund</i>	6-Mar-10	
		<i>Tails Line low point Containment bund location</i>	2010	Aerial photograph figure
	Annual assessment of Tailings Pipeline	<i>MRM tailings pipeline thickness testing and work orders</i>	Mar-10	
		<i>Tailings pipeline thickness test work order and completion instruction</i>	Mar-09	
		<i>Work order for testing of new pipeline next due in June10</i>	7-Apr-10	
	OPSIM Analysis incorporated into TSF Management	<i>100406_CM_CRP Works Note for GT (2)</i>	Mar-10	
		<i>CRP 1m increment volumes</i>	No date	Excel 3D Digital Elevation Model
		<i>CRP survey after clay liner</i>	No date	Excel Designs
		<i>Unbudgeted_CRP Cleanout_October 09</i>	Oct-09	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>Clay testing for material used at TSF for lift</i>	Nov-09	
		<i>EMAIL between Mill Manger and Allan Watson and Sons on Spillway height</i>	29-Sept-09	
		<i>Investment Proposal for lift at TSF</i>	Sept-09	
		<i>Investment Proposal to extend TSF pipeline</i>	23-Jul-09	
		<i>MEMO on justification of raising the TSF spillway height and Cell one walls</i>	29-Sept-09	
		<i>RL schematic of cell wall</i>	No date	Relative level schematic figure.
	Monitoring of water levels within TSF Embankment	<i>Email from AWA on peiso scope of works</i>	8-Apr-10	
	TSF Fenced from cattle	<i>100125 Cattle Fence Maintenance Register - JSB</i>	6-Nov-09	Excel sheet showing repair register from 2008.
		<i>Fencing Bill for annual fixing</i>	3-Jul-09	
	MRM obtained any necessary approvals	<i>LETT Request for change in Sampling and Approval</i>	11-Dec-2008	
		<i>LETT Request for concentrate storage and sampling schedule change with approval</i>	25-Nov-08	
		<i>LETT Request for delay in MMP and approval</i>	8-Oct-09	
	Six-monthly updates on environmental monitoring programs	<i>FW Quarterly Data 3rd quarter</i>	28-Oct-08	
		<i>FW Quarterly Data 4th quarter</i>	6-Jan-10	
		<i>Quarterly Data - 2nd (formatted)</i>	17-Jul-09	
		<i>Quarterly Data - 3rd</i>	28-Oct-09	
		<i>Quarterly Data - 4th</i>	6-Jan-10	

Folder	Sub-folder	File name	Date	Comment/ Description
		<i>SW & GW Data 1July08-31March09</i>	18-Aug-09	
	Annual review of site-wide risk register	<i>2009 MRM Risk Register</i>	Mar-09	
		<i>Draft GEN-SD-PRO-xxxx-xxx Development and review of Aspects & Impacts register 20100329</i>	No Date	
		<i>GEN-SD-PRO-6040-0014 Risk Register Development and Review Procedure I002 Rev0</i>	Nov-09	
		<i>MRM_Aspects_Register_20100214</i>	2010	
	Environmental incident reporting	<i>GEN-SD-PRO-6040-0002 Incident Reporting Procedure I003 Rev 0</i>		
	Maintenance of Bing Bong Port Facility	<i>Bing Bong and Aburri Inspections</i>	Aug-09 – May-10	These mainly pertain to OHS
		<i>ADM-SD-PRO-6040-0007 Workplace Inspection Procedure I002 Rev 0</i>	Nov-09	
	Bing Bong research and rehabilitation budget	<i>Budget 2010 Capital Template HSE V2</i>	09/10	

DOCUMENTS PROVIDED BY THE DEPARTMENT OF RESOURCES

Sub-folder	File name	Date	Comment/ Description
Procedures	AP1-001 Authorisation Work Procedure	01-Jun-07	Procedure to grant Authorisations
	AP2-003 Document Review Procedure	01-Jan-10	Procedure to review documentations
	CP4-001 Audits and Site Inspection Procedure	Oct 03- Sept 04	
Assessments and Audits undertaken	MRM 200809 MMP MR20080351 Document Review Comments	19-Aug-08	
	MRM 201001 Mdoc20090058	15-Dec-08	Field Visit Report
	MRM 201002 Mdoc20100326	11-Feb-10	Monitoring unit field report
	MRM 20100204 MMP MR 20090454 Document Review Comments	18-Dec-09	Document review comments
	MRM Northern Pit Extension MMP - DNRETAS Assessment (Minister's Memo)	09-Feb-09	
	MRM 200910 MR 20090296 WMP Request for Additional Information	21-Oct-09	
	MRM 200911 MR 20090296 WMP Additional information	18-Nov-09	
Assessment of WMPs	Microsoft Word - MRM 200904 MDoc2009 Data Request Letter	8-Apr-09	
	MRM comments WMP Letter_21102008	21-Oct-08	
	WMP Letter-MRM	1-Sept-08	
210015_Sampling procedures for Monitoring	1.0 Procedures Manual Table of Contents.doc	No date	Current procedures
	1.1 Field Trip Paper trail.doc	No date	
	1.2 Flow Chart.doc	No date	
	1.3 Field Check List.xls	No date	
	1.4 Packing the Lab Truck.doc	2010	
	1.5 Inventory for Lab Truck Mud Maps.xls	No date	
	1.5.1 Lab Truck Mud Map-Roof and Cabin.doc	No date	

Sub-folder	File name	Date	Comment/ Description
	1.5.2 Lab Truck Mud Map-Laboratory Module.doc	No date	
	1.7 pH Standard Selection for the Field.doc	No date	
	1.8 Quality Control Check List.doc	No date	
	2.1 pH Standards Preparation.doc	No date	
	2.2 Zobells Standard Solution Preparation.doc	No date	
	3.2 pH Calibration-Bench TPS labCHEM-C.doc	No date	
	3.3 pH Calibration-Field YSI pH100.doc	No date	
	3.4 Pipette Calibration.doc	No date	
	3.4.1 Pipette Calibration Sheet.xls	No date	
	3.7 mV Calibration-Field Meter YSI pH100.doc	No date	
	3.8 Field Calibration Sheet.xls	No date	
	4.1 Quality Control Samples.doc	No date	
	4.10.1 Alkalinity Drop Test Method.doc	No date	
	4.11 Discharge or Flow Rate Procedure.doc	No date	
	4.15 pH Operation-Field YSI pH100.doc	No date	
	4.17 mV Operation-Field YSI pH100.doc	No date	
	4.2 Blank Sampling Procedure.doc	No date	
	4.3 Duplicate Sampling Procedure.doc	No date	
	4.4 Control Sampling Procedure.doc	No date	
	4.5 Sampling a Bore.doc	No date	
	4.7 Surface Water Sampling Procedure.doc	No date	
	4.8 Suspended Solids Procedure.doc	No date	
	4.9 Acidity Digital Titrator Test Method .doc	No date	
	4.9.1 Acidity Test Drop Method.doc	No date	

Sub-folder	File name	Date	Comment/ Description
	5.1 Inline Filtering Procedure.doc	No date	
	5.2 Syringe Filtering Procedure.doc	No date	
	5.3 Vacuum Filtering Procedure.doc	No date	
	5.4 Washing Filter Units in the Field.doc	No date	
	7.1 Acid Dispensing.doc	No date	
	7.2 Acidification Notice.doc	No date	
	8.1 Entering Field Data into SLOG.doc	No date	
	8.2 Importing Data into SLOG.doc	No date	
	8.3 SLOG Site Naming Protocol.doc	No date	
	9.1 Dispatching Samples to NTEL for Analysis.doc	No date	
	10.1 Returning from a Field Trip-Flow Chart.doc	No date	
	10.3 Bottle Washing.doc	No date	
	11.1 Lab Truck Cleaning Procedure.doc	No date	
	11.3 Washroom Cleaning Procedure.doc	No date	
	11.4 Daily Checks.doc	No date	
	12.2 Winch Operation, Safety and Maintenance.doc	No date	
210015_Item 5_check-monitoring data	MRM DoR Check Monitoring Data Oct2008-Dec2009	Oct-08 – Dec-09	
	McArthur River Mine SW Monitoring Program 09	10-Feb-06	
	McArthur River Mine GW monitoring program 09	23-Feb-09	
	MRM DoR Check Monitoring Data Oct2008-Dec2009.xls	Oct-8 – Dec-09	Excel spreadsheet
Environmental incident and complaints	McArthur River Mine – Incident Report Submission	9-Mar-09	Re- ROM Pad sump breach
	ROM Pad Bund Breach	Feb-09	Report
	Mcarthur River Surface Crushing Circuit and surrounds	No date	Checklist and corrective actions
	MRM200905 Notification Mdoc20090021	2-Jan-09	Re- ROM Pad sump breach

Sub-folder	File name	Date	Comment/ Description
	MRM 200902 Incident Acknowledgment Letter	9-Feb-09	
	MRM 200902 Notification Mdoc20090211	3-Feb-09	
	MRM 200903 Mdoc20090479	20-Feb-09	
	MRM 200903 Mdoc20090537	3-Feb-09	
	MRM 200903 mdoc20090537 ICAM report for ROM Pad sump breach	5-Oct-09	
	MRM 200910 Mdoc 09 2198 2207 2398	5-Oct-09	
	MRM 201001 Mdoc20100166 0154 0152	22-Jan-10	White substance at Burketown Crossing
	MRM 201003 Mdoc 20100450 20100728	18-Mar-10	White substance at Burketown Crossing
	MRM 201010 Mdoc20100172	22-Jan-10	Newsflash- Re: White substance at Burketown Crossing
	Newsflash -- update water overflow 20090317	No date	
	Newsflash -- water overflow McArthur River Mine 20090102	No date	



APPENDIX F MRM COMPLIANCE AUDIT TABLE



MRM 2008/2009 MMP COMMITMENT COMPLIANCE ASSESSMENT

Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
<p>Additional statutory requirements include:</p> <p>Annual Environmental Monitoring Report to the Department of Regional Development, Primary Industry, Fisheries and Resources.</p> <p>National Pollutant Inventory (NPI), required as a National Environment Protection Measure (NEPM) by the Commonwealth Government</p>	<p>Water Management Plan 2009</p> <p>Mining Management Plan 2008-2009</p>	<p>Annual environmental reporting is now summarised within the Water Management Plan (WMP) and the Mining Management Plans (MMP). Annual Environmental Reports (AER) are no longer produced. WMP appears to be better structured and comprehensive than previous AERs, however does not contain all the information that the AER did.</p>	<p>Compliance; however lack of detail and assessment in the MMP for non-water related monitoring programs (i.e. dust and soil)</p>
<p>In August of 2008 MRM established an early warning flood system at the confluence of the Kilgour and Mc Arthur River upstream in order obtain vital information in regards to rainfall and floodwaters coming down the river.</p>	<p>Early flood warning system emails</p> <p>Early Flood Warning System Procedure</p>	<p>Emails provided show automatic response received from the warning station during a flood event and the personnel this message is sent to.</p> <p>Procedure for the Early Flood Warning System is reviewed annually.</p>	<p>Compliance</p>
<p>Water accumulating in the Open Pit (combination of groundwater inflow, water remaining after use for dust suppression and direct rainfall) is pumped via the surface drainage system to the Concentrator Runoff Pond (CRP).</p>	<p>Water Management Plan 2009</p>	<p>Various processes for water storage and use for dust suppression are provided, which is updated annually.</p> <p>The Independent Monitor observed surface water storage areas during the May 2010 site inspection and the use of water trucks for dust suppression across the site.</p>	<p>Compliance</p>
<p>Every year Mc Arthur River mine revises its HSEC Strategy, Policy and Annual HSEC Plan.</p>	<p>Sustainable Development Policy Sept. 2009</p> <p>GEN-SD-PLN-6040-0002 SD Strategy I002 Rev 0</p> <p>GEN-SD-PLN-6040-0001 SD Annual Plan 2010 I004 Rev 0</p>	<p>Documents scheduled for annual review</p>	<p>Compliance</p>
<p>The following objectives and targets have been put into the 2009 HSEC Annual Plan:</p> <p>Continue the assessment of rehabilitation establishment in 2009 to determine rehabilitation success and to identify any mitigation strategies that may be required.</p>	<p>GEN-SD-PLN-6040-0001 SD Annual Plan 2010 I004 Rev 0</p>	<p>The Independent Monitor was provided with the SD Annual Plan for 2010/2011. Although outside the 2009 Operational Period, this document refers to continuing rehabilitation and assessment that have been ongoing since 2008. This plan is reviewed annually.</p> <p>The Independent Monitor has inspected rehabilitation efforts and considers that this commitment is being met.</p>	<p>Compliance</p>
<p>Continue to monitor aspects of flora and fauna in line with both NT and Commonwealth legislative requirements.</p>	<p>GEN-SD-PLN-6040-0001 SD Annual Plan 2010 I004 Rev 0</p>	<p>This commitment is included in the 2010/2011 Sustainable Development Annual Plan. This plan is reviewed annually.</p> <p>The Independent Monitor has reviewed documentation for the monitoring period and considers that MRM are in compliance</p>	<p>Compliance</p>



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
		with this commitment.	
Further implement rehabilitation strategies for cell one at the Tailings Storage facilities.	<p>Four project claims of payment for TSF rehabilitation from CDE Capital</p> <p>Invoice for Total Ground Control at the TSF</p> <p>Quote from RST on Total Ground Control</p> <p>Tender Contract request for TSF Stage 1 rehabilitation 2008</p>	<p>During the Independent Monitor's June 2009 site inspection, the TSF Cell 1 had been partially covered with a clay layer as a rehabilitation trial. Dust was seen to have been reduced as a result since 2008 inspection.</p>	<p>Compliance</p> <p>However continuing rehabilitation is required.</p>
Implement programs in conjunction with Charles Darwin University on aspects of acid mine drainage and metal resistant microbes.	<p>ARC Aims for Metal resistant Microbes</p> <p>MRM funding contributions for ARC project</p> <p>Progress Report for ARC funded Research</p>	<p>Microbe profile project is underway as per progress report.</p>	<p>Compliance</p>
Where available, further rehabilitation activities will be conducted in 2009 in areas of the McArthur River Channel and Barney Creek.	<p>100125 Cattle Fence Maintenance Register - JSB</p> <p>Fencing maintenance invoice</p> <p>Fencing maintenance bill 2</p> <p>100325 Civil Rehabilitation Progress - JSB</p> <p>GEN-ENV-PLN-6040-0005 Rechannel Rehabilitation Plan</p> <p>Invoice for supply of Native Seed - McArthur Diversion</p> <p>Invoice for supply of Native Seed - McArthur Diversion (2)</p> <p>McArthur Diversion irrigation system</p> <p>MRM Planting Register</p> <p>Planting Data Sheets</p> <p>Planting Data Sheets 2</p> <p>Planting Data Sheets 3</p> <p>Quote and purchase order number for labour costs - planting</p> <p>Quote for irrigation pump</p> <p>Quotes & purchase order numbers for labour costs - direct seeding</p> <p>Quotes and Req no. for supply of seedlings</p>	<p>The Independent Monitor inspected revegetation and rehabilitation efforts along the river diversions in June 2009. The last Independent Monitor Audit report identified that improvements needed to be made to control weeds and maintain fencing to keep out cattle and feral donkeys.</p> <p>In May 2010, MRM identified the proposed plan to move sections of the mine site perimeter fence to a new location where it is less likely to be damaged by floods.</p> <p>An irrigations sled has been put in place to aid revegetation efforts along the McArthur River Diversion.</p> <p>Documentation provided indicates MRM has increased efforts to rehabilitate the river diversions since</p>	<p>Compliance;</p> <p>However, further fence maintenance/fence relocation required.</p>
Provide the Department of Regional Development, Primary Industry Fisheries and Resources (RDPIFR) with an Annual Environmental Monitoring report which will include the results of all monitoring programs.	<p>Annual Environment Report 2005-2008</p> <p>Water Management Plan 2009</p>	<p>Annual Environment Report (AER) was provided for 2008.</p> <p>The Water Management Plan covers the need for an AER in 2009.</p>	<p>Compliance</p>
Monitor the provision of planned or scheduled HSEC training at regular intervals during the year.	<p>Sustainable Development Policy</p> <p>Sustainable Development Management Standard18</p> <p>Monitoring and Review</p>	<p>Sustainable Development Policy outlines commitment to training.</p> <p>Safety and Training Advisor's responsibilities are outlined.</p>	<p>Compliance;</p> <p>Independent Monitor will request to see MRM's training</p>



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
			records next audit.
To continue the development and review of HSEC risks on all aspects of the MRM project along with relevant codes, standards and relevant legislation.	2009 MRM Risk Register Draft GEN-SD-PRO- Development and review of Aspects & Impacts register 20100329 GEN-SD-PRO-6040-0014 Risk Register Development and Review Procedure I002 Rev0 MRM_Aspects_Register_20100214	The Independent Monitor has reviewed MRM risk assessments over the past two audit periods and acknowledges that this commitment is being addressed.	Compliance
The HSEC Management System at MRM consists of 19 major standards, based on the Xstrata 17 Sustainable Development Standards.	Risk and Change Management Catastrophic Hazards Incident Management Monitoring and Review Emergencies crises and business continuity	The sustainable development standards provided are considered to be those related to environmental performance. Other standards were not reviewed as part of the Independent Monitor's audit. Standards are reviewed annually.	Compliance
All employees within the Environment team have their own responsibilities which are outlined in their job descriptions.	Discussions with MRM staff Organisational schematic diagram in MMP 2009/2010.	The Independent Monitor notes that the environmental team schematic diagram does not link with other MRM sections such as metallurgy or mining. The Independent Monitor will examine the interaction between the sections next audit.	Compliance
Any task that is required to be undertaken within the environment team normally has a procedure for it which is on the MRM intranet site, known as Pasidium and if one does not exist a JSA is completed and filed for future use.	Aerial Spraying Devil's Claw JSA Aerial Spraying Devils Claw JSA Map	Compliance may be inferred from example provided and from discussions with MRM staff during the Independent Monitor's site inspection.	Compliance
Any environmental incidents that do occur are reported in Site Safe and actions are assigned to staff with appropriate time frames in which to complete.	All environmental incidents for the monitoring period were provided to the Independent Monitor	The documentation provided indicates a satisfactory process whereby incidents were documented and followed through to close out, with relevant responsibilities assigned. The Independent Monitor will view 'site safe' next audit.	Compliance
Various methods on site are used to communicate environmental issues and awareness and include the following: Regular Environmental team Meetings Inductions Site memorandums on notice boards Regular HSEC meetings Morning Superintendent and Manager Meetings Manager meetings	2010 04 07 Dust Management Meeting Minutes Minutes from environmental meeting re flow-meter.	Compliance may be inferred from example provided and from discussions with MRM staff during the May 2010 Independent Monitor's site inspection.	Compliance



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
Emails HSE intranet page			
McArthur River Mine has an Emergency Response Plan which is reviewed annually by the Emergency Response Coordinator.	GEN-GEN-PLN-6040-0001 Site Emergency Response Plan 1003 Rev	This plan is reviewed annually	Compliance
Monitoring of the natural surface water in upstream and receiving water environments of Barney Creek, Surprise Creek, and McArthur River is undertaken.	Water Quality Data – Surface Water Groundwater monitoring data sheets and sample submission forms	Water quality data indicates that monitoring is being undertaken.	Compliance
Two automatic sampling stations located upstream (USGS adjacent to SW10) and downstream (DSGS adjacent to SW11) of the Mine Site will continue to be utilised and maintained by MRM	Downloading Upstream & Downstream Gauging Station Data Draft - Barney Ck and Glyde River Gauging Stn Download Procedure Gauging Station front end Gauging station updates Greenspan Service Report 2009 Inv for hardware upgrades Inv for hardware upgrades (2) Inv for servicing calibrating gauge stns 2009 Invoice for pump at USGS Quote for ratings curve at Barney Creek Stn Radio configuration Solar Panels Invoice	Improvements and upgrades to these gauging stations have been undertaken and the Independent Monitor's comments regarding the gauging stations as part of the last audit have been followed up.	Compliance
Artificial waters (i.e. ponds and dams) will continue to be monitored on a monthly basis.	Water Management Plan 2009 BBSRP Monitoring (water levels/volumes) TSF - Cell 2 Water Quality data	Assessment provided in water management plan.	Compliance
A groundwater monitoring network has been developed on the Mine Site and at the Bing Bong Facility to assess potential impacts of the operation on local groundwater. Production bores are also monitored.	Groundwater monitoring data Groundwater sample submission forms Groundwater field data sheets	Compliance is inferred from the Water Management Plan 2009 It is also acknowledged that the number of monitoring bores at the Mine site have increased	Compliance; However, the Independent Monitor does not know of the existence of any monitoring bores at the Bing Bong Facility. Shallow water monitoring may be required at the Dredge Spoil Ponds.
In February 2007 a further EM survey was conducted and another will be undertaken in 2009 to determine the effectiveness of these strategies with a summary	EM Survey - TSF Monitoring Program McArthur River Mine – dated March 2010	This has been reviewed as part of the Independent Monitor Audit.	Compliance



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
being provided in the Annual Environmental Report.			
Additional bores in 2008/09 include two sets of bores (1 shallow and 1 deep) at the commissioned Northern OEF to identify any seepage from the South PAF Dam to the Barney Creek re-channel.	Water Management Plan 2009 Groundwater monitoring data for GW64S and GW64D	Compliance is inferred from data for the additional monitoring bores provided to the Independent Monitor and discussion of results in the Water Management Plan 2009	Compliance
Monitoring sites have been established in the port's navigation channel and swing basin, with an additional control site located outside the lease (4 km to the north-east of the facility), and will continue to be monitored on a monthly basis.	Water Management Plan 2009 Seawater monitoring data Sediment monitoring data	The Independent Monitor has received complete datasets for seawater and sediment monitoring.	Compliance
Monthly monitoring will continue to be undertaken at the Bing Bong Site Run-off Pond (BBSRP) as per Table 4.3.	Bing Bong Water Management Plan (DRAFT) BBSRP Monitoring (water levels/volumes)	Results provided.	Compliance
Fluvial sediments are monitored bi-annually (April and October) to identify potential variations in sediment physico-chemical parameters relating to river or creek flow.	Fluvial Sediment Data FS081106 FS090406MHB Chain of Custody (COC) and results FS090410MHB COC and results FS090524JSB COC and results FS091010JSB COC and results	Results provided from April-October 2009	Compliance
Monitoring of erosion and sediment control measures will be undertaken on an event basis depending on rainfall.	Levee Wall Inspection 24-03-10 FW Quote for additional data ALS flight data for 2010 Post rain inspection 01-04-10	Inspection documentation provided.	Compliance
Erosion monitoring of the re-channelled sections will occur.	McArthur River Erosion Monitoring photos Barney Creek Erosion Monitoring photos Levee Wall Inspection 24-03-10	Photographs provided at intervals along the river diversions. MRM has also take aerial laser scans of the rechannel banks. This will continue to monitor erosion.	Compliance
A potential sedimentation zone, in the McArthur River, downstream to the Bukalara Range will be monitored.	Preconstruction surveys (cross sections) Photographic reference at 250m intervals Geo-registered Aerial photography Cross-section surveys at 25m Intervals	The documentation received does not indicate compliance for the monitoring period.	Non Compliance; the Independent Monitor did not receive any preconstruction surveys, cross section surveys or any assessment of changes using aerial photography.
Depositional dust monitoring will continue to be undertaken at the Mine Site and Bing	Mining Management Plan 2009-2010 Bing Bong dust sampling audit	The objective of this program is to monitor potential contaminated particulate matter (dust particles) arising from	Compliance; however non conformances with standards were



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
Bong Facility.	2010 Monthly dust monitoring COCs sample receipts, and results. Monitoring data spreadsheet	MRM activities. Compliance is inferred from dust results and documentation provided. Monitoring procedures undertaken generally adhere to AS3580.1990-1991	noted with regard to the time the dust gauges are left before collection. In addition, there are issues with the analytical process and the reporting of results.
The soil monitoring program is conducted on an annual basis, during the late dry season, at the Mine Site and Bing Bong Facility.	Soil Data spreadsheet COC form, Laboratory sample receipt, and results transcripts for soil sampling October 2008 and November 2009	Data provided to the Independent Monitor	Compliance
Structural surveillance of the TSF and associated infrastructure is conducted regularly, in accordance with site procedure MET-GEN-GDL-2800-0001.	Production shift inspection examples TSF Infrastructure Inspections (Monthly or after 50mm Rainfall events) Geotechnical Inspections (Annual) (Dam Safety report) TSF Monthly Operating Report (Monthly) TSF Annual Operating Report (Annual) Life of Mine Tailings Management Plan (Annual)	First Pipeline thickness checks are planned for June 2010	Compliance; However the Independent Monitor did not receive the TSF Annual Operating Report or Life of Mine Tailings Management Plan
Tailings are analysed on a monthly basis for their oxidation characteristics.	Final Tailings Analysis Data TSF - Cell 2 Water Quality data	Data has been provided to the Independent Monitor	Compliance
Monitoring will be undertaken to measure the effectiveness of revegetation works as well as the extent of natural regeneration and the characteristics of the evolving ecosystem.	2009 Barney Creek Riparian Vegetation Monitoring Report CDU 100325 Civil Rehabilitation Progress – 2010 GEN-ENV-PLN-6040-0005 Rechannel Rehabilitation Plan – June 2009 Geo-referenced photographs at 250m Intervals along the Barney Creek and McArthur River Diversions.	McArthur River revegetation to be monitored and assessed by CDU in Dec/Nov, 2009.	Compliance
MRM established an aquatic fauna monitoring program as part of the approvals for the McArthur River diversion works. The aim of the program is to assess the abundance and distribution of fish populations in the McArthur River and to assess the potential impacts of the river diversion on fish populations.	Freshwater Sawfish Management and Monitoring Plan March 2009 Interim Report on the fish fauna of the McArthur River, Northern Territory, April 2009 Interim report on the fish fauna of the McArthur River, Northern Territory, September 2009, and comparison of pre and post channel re-alignment.	Independent Monitor observed Sawfish monitoring locations during the May 2009 site inspection.	Compliance; however heavy metal analysis of fish tissue was not undertaken
MRM is committed to conducting a riparian bird monitoring program to assess the impacts of the McArthur River diversion on riparian fauna and to measure the	Birds of the McArthur River Station-jpg McArthur River Riparian Bird Monitoring May 2009 McArthur River Riparian Bird	Independent Monitor inspected riparian bird monitoring areas and interviewed personnel conducting the monitoring. The Independent Monitor is satisfied that the competency of the	Compliance



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
rehabilitation success of the Barney Creek and McArthur River re-channelling works.	Monitoring October 2009	personnel undertaking the bird monitoring and the methods used meets MRMs commitment.	
MRM has committed to implementing a monitoring program in the vicinity of the Bing Bong Port Facility and the mouth of the McArthur River to assess the impact of potential metal pollution on Listed Migratory Birds.	Survey of listed Migratory shorebirds and other birds, Port McArthur area Wet Season 2010, March 2010. Migratory Waders and Other Bird Monitoring, EMS report March 2009. McArthur River Mine: Annual Marine Monitoring program 2009, Annual marine program 2009 Report AIMS Final Investigation of metal concentrations and Pb isotope ratios in beach sediments east and west of the Bing Bong Load-out Facility, August 2009.	The Independent Monitor is satisfied that these monitoring programs have been undertaken.	Compliance
All contaminated waste is disposed of within a designated area of the Tailings Storage Facility (TSF).	Waste disposal area observed during site inspection.	Independent Monitor observed the area of waste disposal during the May 2009 site inspection.	Compliance
Putrescible waste is disposed of in a series of trenches located in the south-eastern corner of the Water Management Dam at the TSF. This waste is periodically burnt.	Observed during site inspection.	A large number of metals cans were also amongst the putrescibles waste. MRM Should take greater care to dispose of cans in the appropriate recycling process.	Compliance, however waste needs to be separated.
Currently, the offsite recycling of goods includes the following items: Waste oils; Used lead-acid batteries; Aluminium cans from the Wet Mess; Waste cooking oil; Toner cartridges; Scrap steel; Cardboard.	GEN-ENV-PRO-6040-0010 Disposal of Aluminium Cans I003 Rev 0 GEN-ENV-PRO-6040-0011 Disposal of Scrap Metal I003 Rev 0 GEN-ENV-PRO-6040-0009 Management & Disposal of Waste Cooking Oil I003 Rev 0 GEN-ENV-PRO-6040-0008 Management & Disposal of Waste Oils I003 Rev 0 GEN-HSE-PLN-6040-007 Waste Management Plan I002 Rev 0	The Independent Monitor observed the putrescible and other waste dumps located at the south west of the Tailings Storage Facility. It was noted that aluminium cans were not being properly separated from the putrescible waste. MRM are advised to take greater care with waste separation and proper disposal in line with their waste management procedures.	Compliance, but improvement required.
MRM has a Weed Management Plan in place and this strategy is carried out with the assistance of NRETA.	GEN-HSE-PLN-6040-006 Weed Management Plan 2009 I001 Rev 0	A weed management plan is in place, which is updated annually. The Independent Monitor understands that weed management is an ongoing issue, particularly along the river diversions, that requires ongoing trials for different methods.	Compliance
Over the next operational year the main areas of rehabilitation will include: Progressive rehabilitation of the Northern OEF Stage one of rehabilitation, over cell one at the Tailings	Cell 1 rehabilitation 4 project claims of payment for TSF rehabilitation Invoice for Total Ground Control (TGC) at the TSF Quote from RST on TGC Tender Contract request for TSF	Progressive rehabilitation of the OEF was not undertaken during the audit period as no sections of the OEF have been completed to the final design stage where rehabilitation would be required.	Compliance; However TSF Cell 1 clay capping needs to be completed as soon as possible to avoid dust generation from



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
<p>Storage facility Rehabilitation of the Mc Arthur River Channel Maintenance rehabilitation of the Barney Creek Channel</p>	<p>2008 Barney Creek and McArthur River channel rehabilitation 100325 Civil Rehabilitation Progress - JSB GEN-ENV-PLN-6040-0005 Rechannel Rehabilitation Plan Invoice for supply of Native Seed - McArthur Diversion Invoice for supply of Native Seed - McArthur Diversion (2) McArthur Diversion irrigation system MRM Planting Register Planting Data Sheets Planting Data Sheets 2 Planting Data Sheets 3 Quote and purchase order number for labour costs - planting Quote for irrigation pump Quotes & purchase order numbers for labour costs - direct seeding Quotes and Req no. for supply of seedlings</p>	<p>Cell 1 of the TSF is still undergoing staged rehabilitation. The Independent Monitor observed in June 2010 that approximately 2/3 of Cell 1 had been capped with clay. In May 2010, the independent Monitor observed that additional areas of Cell one had been capped with clay, however exposed tailings at the south east of Cell 1 were still visible. The remaining area of exposed tailings in Cell 1 needs to be covered.</p> <p>The Independent Monitor confirms that rehabilitation efforts along the McArthur River have improved with the addition of a water irrigation sled to aid vegetation establishment, increased direct seeding using external labour.</p> <p>Barney Creek rehabilitation efforts appear to be successful and complete in this area, and maintenance is being undertaken, however, efforts to keep cattle out of this area need to be continued.</p>	<p>exposed tailings.</p>
<p>In order to facilitate faster growth rates and have some species established for the wet season MRM are employing the use of a water cart instead of irrigation as previously used on Barney Creek.</p>	<p>Conversation with personnel/inspections.</p>	<p>Barney Creek revegetation is establishing well.</p>	<p>Compliance</p>
<p>The Mc Arthur channel and Barney Creek works will be protected by rock lining. Rock chutes have been designed in several areas along both channels limiting the amount of clearing where possible.</p>	<p>Rock lining observed during May 2010 site inspection and June 2009.</p>	<p>Rock lining appeared to be washed away following 2009/2010 wet season. MRM were not planning to replace this lining, as it is anticipated to be washed away during the next flood.</p>	<p>Compliance</p>
<p>All revegetated areas have been protected with stock proof fencing.</p>	<p>100125 Cattle Fence Maintenance Register - JSB Fencing maintenance Fencing maintenance bill 2</p>	<p>Since the last audit, MRM have increased their efforts to ensure damaged fences are repaired rapidly following wet season damage by floods.</p> <p>MRM are proposing to move the location of a portion of the perimeter fence.</p>	<p>Compliance; However, fences are annually ineffective after they are destroyed by wet season flooding.</p>



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
The TSF area has been fenced to exclude stock, and permanent fire breaks will be constructed around the perimeter.	100125 Cattle Fence Maintenance Register - JSB Fencing Bill for annual fixing	The Independent Monitor has observed compliance in the May 2010 inspection	Compliance
Barney Creek rehabilitation was completed in the first quarter of 2008 and requires no further work except for annual maintenance and monitoring for full rehabilitation.	Observations during May 2010 site visit	The Independent Monitor is satisfied that rehabilitation of Barney Creek was successfully instigated, and that only ongoing maintenance is required.	Compliance
Direct seeding of tree/shrub and grass species will be carried out again during the 2008/09 wet season.	Observations during May 2010 site visit	Seeding has been carried out	Compliance; however seed collection in the Mc Arthur River diversion has been of common species of minimal habitat or foraging value
Lysimeters will be installed in the OEF at various stages to monitor water infiltration.	Mining Management Plan 2009-2010	No evidence on the installation of lysimeters was provided to the Independent Monitor.	Non Compliance: MRM had advised that lysimeters will be installed during the first quarter of 2011.
Kinetic leach testing will continue for on-site and laboratory columns.	Mining Management Plan 2009-2010	No Information on kinetic leach testing was provided to the Independent Monitor.	Non Compliance
The top of the clay layer encapsulating the PAF cells will be covered by a minimum of 3 m of NAF material.	Mining Management Plan 2009-2010	The Independent Monitor has noted during the May 2010 inspection that this has not yet been completed.	The Independent Monitor understands that works are currently being undertaken and that the encapsulation of the PAF cells is to be completed during 2010.
The West OEF will continue to drain its runoff to the Mine Dam (termed 'Duncan's Dam' on site).	Mining Management Plan 2009-2010	Figure 7.6 of the Mining Management Plan 2009-2010 indicates that runoff from the OEF is collected at the north and south PAF dams. The Independent Monitor was not able to find any mention to 'Duncan's Dam' in the documentation provided.	Not able to assess
The North OEF will be constructed outside of the flood protection bund, which surrounds the open pit.	Mining Management Plan 2009-2010 Final Report – McArthur River Mine Overburden Emplacement Facility Design (URS, 2008)	The Independent Monitor has noted during the May 2010 inspection that this has not yet been completed	Compliance; however, the Independent Monitor noted during the inspection that the North OEF has not been finalised and further works are planned for the 2010 operational period



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
The PAF dams consist of two portions: a sediment trap dam first, where any runoff and/or leachate will flow into; and a main dam.	Mining Management Plan 2009-2010 Final Report – McArthur River Mine Overburden Emplacement Facility Design (URS, 2008)	Compliance is inferred from the Mining Management Plan 2009-2010 and the May 2010 site inspection	Compliance; however, the Independent Monitor has not sighted any 'as built' report regarding the PAF dams
The PAF dams are constructed with a compacted clay core, followed by rock armouring to protect from erosion.	Mining Management Plan 2009-2010 Monthly Geotechnical Reports Weekly Inspection Reports Clay testing	Compliance is inferred from the Mining Management Plan 2009-2010 and the May 2010 site inspection	Compliance; however, the Independent Monitor has not sighted any 'as built' report regarding the PAF dams
Water quality and sediments in the OEF dams will be monitored to confirm that the PAF and NAF characterisation and management strategies are working effectively.	Mining Management Plan 2009-2010 Water Management Plan 2009 Rock Sampling	The Water Management Plan 2009 indicates that water quality is monitored at the OEF dams, however, no data was provided to the Independent Monitor. No evidence of sediment monitoring was provided	Non compliance
Topsoil (typically 100mm to 150mm thick) is stripped from areas ahead of mining, dumping, or construction. As no areas of the site are ready for rehabilitation yet, the topsoil is stockpiled for future use.	Observed during site inspection	Observed during site inspection	Compliance
By the end of November 2008 the Main Bund will have been completed and the original McArthur River will act as a long dam during the wet season.	Observed during May 2009 Site visit	Observed in the May 2010 inspection	Compliance
Tailings will be placed using a spigotted discharge system around the cell perimeter, which will minimise the risk of seepage from the TSF.	Spigotted discharge system observed during site inspection.	Observed during site inspection May 2010.	Compliance
The perimeter embankments of TSF Cell 2 have been designed by Alan Watson Associates in general accordance with the ANCOLD Guidelines (1999).	Observed during May 2009 visit	Observed during site inspection May 2010.	The Independent Monitor has not sighted any documents regarding the design of TSF Cell 2
Concentrate is transported from the mine site to Bing Bong by road-trains with covered, side-tipping trailers.	Observed during site inspection	Observed by Independent Monitor. Coverings appear to be effective and are on all trucks.	Compliance
As the 2007/08 wet season was limited in rainfall MRM obtained permission from DPIFM on the 11 th of August 2008 to abstract up to 20% of the water that was present in the channel for both dust	Letter provided dated 11 August 2008. – McArthur River Project water abstraction amendment to the McArthur River Mining Management Plan.	Permission letter provided.	Compliance



Commitment	Documentation/Evidence Provided	Evidence of competency/training and continual improvement	Compliance/ comments
suppression and tree planting activities.			
Over the last reportable period the following areas were rehabilitated: Barney Creek Channel = 52.3 hectares	Observed during June 2009 Inspection	Barney creek rehabilitation appears to be success, with the exception of cattle causing breakages to young trees.	Compliance
Over the next reportable period the following area will be rehabilitated: Cell one of the Tailings Storage Facility = 78 hectares (Partial) Mc Arthur River Channel = 102.8 hectares	Observations during May 2010 site inspection	Partial rehabilitation of Cell 1 observed during June 2009 Independent Monitor site visit. As at May 2010, the Independent Monitor observed that the clay capping had been extended, however not completed.	Compliance