Northern Territory Government

DEPARTMENT OF
NATURAL RESOURCES, ENVIRONMENT, THE ARTS AND SPORT

ASSESSMENT REPORT 69

MCARTHUR RIVER MINE - PHASE 3 DEVELOPMENT PROJECT

MCARTHUR RIVER MINING PTY LTD

ENVIRONMENTAL ASSESSMENT REPORT
AND
RECOMMENDATIONS

by the

Environment and Heritage Division
Department of Natural Resources,
Environment, the Arts and Sport

July 2012

Table of Contents

Glossary

AHD	Australian Height Datum
ANC	Acid Neutralising Capacity
AMD	Acidic and/or Metalliferous Drainage
ANCOLD Guidelines	Australian National Committee on Large Dams Guidelines
ANZECC	Australia and New Zealand Environment Conservation Council
ANZECC 2000 Guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000). These guidelines provide a summary of the water quality guidelines proposed to protect and manage the environmental values supported by the water resources. The guidelines also provide advice on designing and implementing water quality monitoring and assessment programs.
Aquifer	A geological formation bearing groundwater that is permeable (unconfined) or impermeable (confined) to the transmission of groundwater
ARI	Average Recurrence Interval. The expected period between exceedances of a given rainfall total, accumulated over a given duration
Bund	Also called a bund wall and bunding, is an embankment that is constructed around an area and/or structure that is designed to prevent inflow or outflow of various liquid types.
Concentrate	Zinc-lead-silver concentrate
Decommissioning	The closing down of a mine after mining has finished. This involves taking away buildings and equipment and rehabilitating the mine site area.
Draft EIS	Draft Environmental Impact Statement
EA Act	NT *Environmental Assessment Act 1982*
EAAP	NT *Environmental Assessment Administrative Procedures 1984*
EHD	Environment and Heritage Division of NRETAS
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement. The Draft EIS, Supplement and any further information submissions together constitute the complete EIS for the project.
EMM	Environmental Monitoring Manual
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESD	Ecologically Sustainable Development. Using, conserving and enhancing the communities' resources so that ecological processes, on which life depends, are maintained and the total quality of life now and in the future can be increased. ESD is development that aims to meet the needs of Australians today,

	while conserving our ecosystems for the benefit of future generations
Flood	An overflow of water onto lands that are normally above local water levels. Can be caused by stream discharge exceeding the capacity of the stream channel, storm winds and reduced pressure drawing water from a lake or ocean onto the coastline, dam failure, lake level increase, local drainage problems or other reasons
GHG	Greenhouse Gas
HDPE	High density polyethylene
IM	Independent Monitor for the McArthur River Mine. See **www.mrmindependentmonitor.com.au** for reports
Long term	In relation to mining facilities such as TSFs long term is defined as >1000 years, following the ANCOLD Guidelines on life of mine planning for TSFs
Macroinvertebrate	An invertebrate large enough to be seen without magnification
MRM	McArthur River Mining Pty Ltd
NAF	Non-acid forming. A sample of waste rock is usually defined as NAF when it has a negative NAPP and the NAG pH ≥ 4.5. Material classified as NAF is considered unlikely to be a source of acidic drainage. Where there is significant total S (>1%), more detailed investigation may be required to confirm that the ANC measured is available at the same rates as acid production through sulphide oxidation
NAG	Net acid generation. The NAG value measures the acidity after oxidation and is expressed as kilograms of sulphuric acid per tonne of rock
NAPP	Net acid producing potential. NAPP indicates if a material has potential to generate AMD. It represents the balance between the capacity of a sample to generate acid (TAPP) and its capacity to neutralise acid (ANC). The NAPP is also expressed in units of kg H_2SO_4 per tonne ore and is calculated as follows: NAPP = TAPP – ANC
NES	National Environmental Significance
NOI	Notice of Intent
NRD	Natural Resources Division of NRETAS
NRETAS	Department of Natural Resources, Environment, the Arts and Sport
NT	Northern Territory of Australia
NTG	Northern Territory Government
OEF	Overburden emplacement facility
Oxidation	A chemical reaction in which substances combine with oxygen
PAF	Potentially acid forming
Palaeochannel	Older river courses which were buried due to sedimentation

PER	Public Environmental Report
Permeability	A measure of how well a material can transmit water. Materials such as gravel, that transmit water quickly, have high values of permeability. Permeability is primarily determined by the size of the pore spaces and their degree of interconnection
pH	measure of acidity (<7) or alkalinity (>7) of a (water) sample. A relative measure of the acidity or alkalinity of a water based upon a scale that ranges between 0 and 14 with 7 being neutral. Values of pH below 7 indicate acid solutions and values of pH above 7 indicate alkaline solutions
Pit dewatering	The act of removing groundwater around the edges of an area that will become an underground or open pit, as the pit is progressively dug. This process keeps groundwater out of the pit so that mining can occur; often well below the water table
Responsible Minister	For this mining project it is the Minister for Primary Industry, Fisheries and Resources
ROM	Run of mine
SEWPAC	Department of Sustainability, Environment, Water, Population and Communities
Supplement	Supplementary EIS for the McArthur River Mine Phase 3 Development Project
Tailings	Fine wastes from the processing operation. The solid residual material after the processing of ore, usually transported as a liquid slurry to the TSF
TEAM NT	Technologies for the Environmental Advancement of Mining in the NT (see References for details)
the Minister	Northern Territory Minister for Natural Resources, Environment and Heritage
the Project	McArthur River Mine Phase 3 Development Project
the Proponent	McArthur River Mining Pty Ltd (MRM)
the Report	This Assessment Report 69, for McArthur River Mine Phase 3 Development Project
TPH	Total petroleum hydrocarbon
TPWC Act	*Territory Parks and Wildlife Conservation Act* 2006
TSF	Tailings storage facility. An area used to confine tailings, usually divided into cells (Cell 1, 2, 3 etc), in this report referred to as TSF 1, TSF 2, etc.
URS	URS Corporation
WDL	Waste Discharge Licence
WMD	Water Management Dam
Xstrata	Xstrata plc (public limited company)

Units and Symbols

>	Greater than
<	Less than
%	Percent
/d	Per day
/L	Per litre
dmtpa	dry metric tonnes per annum
ha	hectare
kL	kilolitre
km	kilometre
L	litre
m	metre
M	Million
mg	milligrams
Mm^3	Million cubic metres
Mt	million tonnes
Mtpa	million tonnes per annum
MW	megawatt
t	tonnes

Executive Summary

Environmental impact assessment (EIA) is the process of defining those elements of the environment that may be affected by a development proposal and analysing the risks associated with the identified potential impacts. This Assessment Report (the Report) assesses the environmental impact of the McArthur River Mine Phase 3 Development Project (the Project), proposed by McArthur River Mining Pty Ltd (MRM) (the Proponent).

The McArthur River Mine Phase 3 Development Project would allow MRM to access defined ore bodies deeper below the existing mine and to increase the production of mining at the McArthur River Mine. The Project involves an approximate doubling of the open pit footprint and depth, mining rate and production of zinc concentrate, and extends the mine life by nine years, to 2036.

This Assessment Report forms the basis of advice to the Northern Territory (NT) Minister for Natural Resources, Environment and Heritage on the environmental issues associated with the Project. The Minister is required to make comment and/or recommendations with regard to the proposal to the Minister for Primary Industry, Fisheries and Resources (the Responsible Minister).

The Report is based on a review of the Draft Environmental Impact Statement (DEIS), Supplement to the EIS (Supplement), comments from the public and NT government agencies, documents presented by MRM as part of previous environmental assessment processes for currently approved operations, and annual audit reports by the McArthur River Mine Independent Monitor (IM) also with regard to current operations.

Major Issues

The major issues associated with the Project as identified through the environmental assessment process are:

- Existing impacts
- Management of contaminated groundwater
- Final pit void
- Acidification of tailings
- Dust management
- Design of TSF 4
- Groundwater monitoring

Conclusion

The Proponent has presented a well researched and thorough Environmental Impact Statement (EIS). Whilst an understanding of the complexities of the existing operation and its potential to impact on, and interact with components of the Phase 3 Project was identified, there remains a high level of uncertainty around the Phase 3 Project. Ongoing research and remediation of current impacts is essential to provide confidence that the Phase 3 Project can proceed with acceptable impact. The EIS and this Assessment Report provide a structured pathway for the

Proponent to progress the expansion project, based on the undertaking of a program of corrective actions to inform detailed design.

A key residual risk presented by the current operations and the Phase 3 proposal is the site-wide build up, long-term storage, and release of contaminant loads. Current data shows elevated metals and sulfates have entered, and will continue to accumulate in water bodies (groundwater and surface waters), soils and aquatic sediments; are potentially bioaccumulating in aquatic fauna (macroinvertebrates and fish); and may be affecting macroinvertebrate populations.

Long term storage facilities containing high contaminant loads and acidic and/or metalliferous drainage potential, such as in tailings and PAF waste rock storages represent large heads of potential future environmental contamination, post closure.

The Environment and Heritage Division (EHD) considers that the environmental issues associated with the proposed project have been adequately identified. Appropriate environmental management of a number of these issues has been resolved through the assessment process, with the exception of issues relating to the full environment assessment of TSF 4, and the final form of the pit lake.

Design details for TSF 4 are only conceptual at this stage as is not required to receive tailings until around 2032. Prior to this, TSF 4 is proposed to be built and operated as a lined water management dam (WMD). The construction and operation of the WMD was not considered in this assessment as the details were not advised until after the draft EIS had undergone public consultation. The proposed WMD has now been referred under a separate NOI, for consideration under the EA Act.

It is expected that both TSF 4 and the pit void will be required to meet contemporary environmental standards at the time of approval, which will be informed by ongoing research for the operational life of the mine.

Subject to the above, based on its review of the EIS and the submissions from relevant Northern Territory Government agencies, affected stakeholders and the public, EHD considers that the project can be managed without unacceptable environmental impacts. This is provided that the environmental commitments and recommendations detailed in the EIS, this Assessment Report and in the Mining Management Plan are implemented and managed and subject to regular reporting and compliance auditing.

List of Recommendations

1. Recommendation

The Proponent shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards:

- **Identified in the McArthur River Mine Phase 3 Development Project's Environmental Impact Statement (draft EIS and Supplement); and**
- **Recommended in this Assessment Report (No. 69).**

All safeguards and mitigation measures outlined in the Environmental Impact Statement are considered commitments by the Proponent and should be included in the Mining Management Plan for the Project.

2. Recommendation

The Proponent shall advise the Minister of any changes to the proposal in accordance with clause 14A of the Administrative Procedures of the *Environmental Assessment Act*, for determination of whether or not further assessment is required.

3. Recommendation:

The Proponent should develop and present viable contingencies for prevention, treatment and recovery of contaminated seepage and groundwater.

4. Recommendation

It is recommended that the Proponent continues to explore options of alternative methods to develop self sustaining, biodiverse aquatic and riparian ecosystems in and around a future pit lake. The objective should be to achieve the most appropriate treatment of the pit lake at the time of closure with respect to ESD principles.

5. Recommendation

The Proponent should comprehensively address the risk of future acidification of tailings and release of AMD to the environment.

The Proponent focuses effort on preventative approaches to AMD at the tailings source, such as in further tailings processing to avoid long term storage of PAF material, over downstream strategies such as recovering seepage plumes.

TSF 4 designs be informed by the above actions, and refined to comprehensively prevent seepage escape from the facility. Impervious linings and effective drainage and recovery systems that would continue to be effective in the long term should be explored.

6. Recommendation

It is recommended that the environmental assessment of TSF 4 be undertaken when the design is further advanced, based on the acquisition of detailed research and monitoring of the current seepage and acidification impacts.

7. Recommendation

It is recommended that the Proponent reviews the groundwater monitoring program to:

- **optimise bore location;**
- **consider additional bores to inform potential final pit void levels over time;**
- **review QA/QC program procedures; and**
- **adopt ANZECC 2000 Guidelines when comparing and assessing groundwater monitoring results.**

1 Introduction and Background

This Assessment Report assesses the environmental impact of the McArthur River Mine Phase 3 Development Project (the Project) and informs the public and the Responsible Minister of the outcomes of this assessment.

The proponent, McArthur River Mining Pty Ltd (MRM) proposes to expand existing operations at the McArthur River Mine site, 70 km south of Borroloola. The Project will result in a doubling of the mining rate, from 2.5 million tonnes per annum (Mtpa) of ore to 5.5 Mtpa, and an increase in zinc-lead concentrate from 360 000 dry metric tonnes per annum (dmtpa) to 800 000 dmtpa. The total volume of waste rock will increase from an approved 185 Mt facility to a 715 Mt facility.

Major components of the Project include:

- Expansion of the open pit from the current footprint of 145 ha to 210 ha and to a depth up to 420 m from 210 m;
- Addition of a new cell on the existing tailings storage facility (TSF) to create additional tailings storage capacity;
- Expansion of the existing north overburden emplacement facility (OEF) and the construction of new OEFs to the east and south of the open pit to store an additional 530 Mt of overburden; and
- Construction of a new gas fired power station through a 'Build, Own, Operate' style contract, which is expected to double in output from the existing station (20 MW to 45-50 MW).

This Environmental Assessment Report (the Report) is based on a review of the draft Environmental Impact Statement (draft EIS), Supplement to the draft EIS (Supplement), comments from the public and NT government agencies, documents presented by MRM as part of previous environmental assessment processes for currently approved operations, and annual audit reports by the McArthur River Mine Independent Monitor (IM) also with regard to current operations.

The draft EIS and Supplement to the draft EIS are collectively referred to as the EIS. Submissions received on the draft EIS are summarised in Appendix 1. The EIS can be viewed on the Department of Natural Resources, Environment, the Arts and Sport (NRETAS) website at: **www.nretas.nt.gov.au/environment-protection/assessment/register/mcarthur/mcarthur_phase3**.

1.1 Environmental Impact Assessment Process

Environmental impact assessment (EIA) should:

- identify potential impacts on the environment (where environment is defined broadly according to the *Environmental Assessment Act*); and
- evaluate the risks of those impacts occurring.

Through its assessment of Project risks the Proponent must demonstrate:

- that these risks can be satisfactorily managed within acceptable levels e.g. impacts would not result in unacceptable environmental detriment; and
- the effectiveness/feasibility of management measures in a precautionary/risk management framework.

Assessment gives weighted consideration to:

- values and risks;
- estimation of the likelihood of success of preventative and remedial measures; and
- the validity and comprehensiveness of monitoring programs established to provide ongoing measures of the environmental impacts of the proposed Project.

The assessment of risks can be more reliably evaluated where there is good baseline information. Where this information is limited or not available, risk assessment is constrained and it is appropriate to use the precautionary principle in the evaluation of potential impacts. If potential impacts are understood with a reasonable level of certainty, monitoring programs can be better informed to detect impacts, and management measures can be more effectively targeted to address those impacts.

This Report evaluates the adequacy of baseline information, commitments and environmental safeguards proposed by the Proponent to avoid or mitigate the risks of potential impacts identified in the assessment process. The safeguards may be implemented at various levels within the planning framework of a project and include (among other approaches):

- Design and layout of components and other infrastructure on the site;
- Management of construction activities; and
- Management of processes used in operations of the facility (e.g. inputs and outputs).

An outline of the commitments made by the Proponent is at Appendix 1. Additional safeguards are recommended in this Assessment Report where appropriate. The contents of this Report form the basis of advice to the NT Minister for Natural Resources, Environment and Heritage (the Minister) on the acceptability of environmental impacts, the adequacy of mitigation measures and the residual risks to the environment that are to be borne by the current and future community.

1.2 Regulatory Framework

Environmental assessment was undertaken in accordance with the requirements of the Northern Territory *Environmental Assessment Act 1982* (EA Act). The proposal was referred for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and was deemed not to be a controlled action.

This Report forms the basis of advice to the Minister on the environmental issues associated with the Project and informs the decision as to whether or not the Project should proceed. The Minister is required to make comment and/or recommendations with regard to the proposal to the Minister for Primary Industry, Fisheries and Resources (the Responsible Minister) for consideration in the *Mining Management Act* process.

A more complete list of Government approvals and relevant legislation for the regulation of the proposal is provided in Chapter 2 of the draft EIS.

1.3 Environmental Impact Assessment History

On 22 March 2011, a Notice of Intent (NOI) outlining the proposed Phase 3 Development Project was referred to the Environment and Heritage Division (EHD) of the Department of Natural Resources, Environment, the Arts and Sport (NRETAS) by the Department of Resources (DOR) under the memorandum of understanding between NRETAS and DOR.

On 9 June 2011 the Minister determined that the proposal required formal assessment under the EA Act, at the level of an EIS and on 19 August 2011 Final EIS Guidelines were issued to the Proponent.

On 4 February 2012, the draft EIS was made available for public comment for a period of six weeks. Six government agencies and three non-government organisations provided submissions on the draft EIS to the Proponent to be addressed in the Supplement. The key issues identified included:

- Risks relating to construction and management of the TSF extension to ensure long term stability from seepage of contaminants through acid and/or metalliferous drainage;
- Risks relating to construction and management of the overburden emplacement facilities and characterisation of waste entering the facilities to ensure long term stability from seepage of contaminants;
- Potential for natural disasters and an extreme climate to degrade the integrity of infrastructure in the long term; and
- Risks relating to on-going management and rehabilitation of the McArthur River Mine.

The Proponent lodged the Supplement in response to the submissions with EHD on 4 June 2012. The draft EIS, Supplement, public and government comments have been taken into account in the preparation of this Assessment Report (the Report) by EHD. Through this Report, the Minister issued final advice and recommendations on the Project to the Responsible Minister.

Three previous project proposals in 1992, 2005 and 2006 to commence underground mining (Phase 1) and the conversion to open cut mining (Phase 2) were assessed under the EA Act, and relevant documentation is available on the NRETAS web site:

Phase 1:

www.nretas.nt.gov.au/environment-protection/assessment/register/mcarthur_river_zls;

and Phase 2:

www.nretas.nt.gov.au/environment-protection/assessment/register/mcarthur.

The Independent Monitor (IM) was established following approval of Phase 2 in late 2006.

1.4 Relevant policy for environmental assessment

1.4.1 Ecologically Sustainable Development

Australia has developed a National Strategy for Ecologically Sustainable Development (ESD) identifying four national principles (Box 1). The Strategy also identified ways to apply the principles to a range of industry sectors and issues such as climate change, biodiversity conservation, urban development, employment, economic activity, and economic diversity and resilience.

In December 1992 the NT Government endorsed the National Strategy and agreed, along with all other States and Territories, to the Intergovernmental

Agreement on the Environment. The Strategy defines ESD as: '*Using, conserving and enhancing the communities' resources so that ecological processes, on which life depends, are maintained and the total quality of life now and in the future can be increased. ESD is development that aims to meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations.*'

Box 1 - The principles of ESD and their definitions in the National Strategy for ESD

ESD Principle	Definition
Precautionary principle	Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Inter- and intra-generational equity	The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of present and future generations.
Conservation of biological diversity and ecological integrity	The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making
Improved valuation, pricing and incentive mechanisms	Should be promoted to ensure that the costs of environmental externalities are internalised and that the polluter bears the costs associated with environmental pollution.

In response to the draft EIS, some submissions raised issues relating to the application of ESD principles – specifically challenging the inter-generational equity claims of the proponent, and the principle of biodiversity conservation (in respect to development of the overall site, legacy of the mine pit lake and health of downstream habitat). The assessment of this proposal, its potential impacts (positive and negative) and the management measures used to enhance positive and reduce negative impacts was undertaken in the context of ESD principles.

Subsequent decision-making processes by approval bodies also must be guided by ESD principles and the continued project design and development, as well as the development and implementation of management and monitoring programs by the Proponent, should all aim to meet the objective of ESD.

1.4.2 Territory 2030 Strategy

Territory 2030 is a 20-year strategic plan for the Northern Territory developed by an independent Steering Committee and was produced as a road map for the future. Developed in consultation with the Territory community, Territory 2030 is a means for setting priorities and guiding government's efforts over the next two decades. As the principal policy document for the NT it is appropriate that this Project is considered and assessed and implemented within the framework of Territory 2030 (Box 2).

The NT Government aims for a balanced decision making model that considers the economic, social and environmental impacts. This ensures that policy and decision-makers critically examine the tensions that exist between and across some of the targets. Accordingly, when decisions are made, all impacts (positive and negative) across targets are taken into consideration.

Box 2 – Objectives and Targets of Territory 2030 Strategic Plan relevant to the Phase 3 Development Project

Theme	Objective	Targets
Economic Sustainability	Objective 1: The Territory invests for long-term growth	Continue to grow the Territory economy
		The Territory continues to grow the size and skills of its workforce to meet the growth target
	Objective 3: Growing local industry	Support the continued contribution of the resources sector in the Northern Territory economy.
Environment	Objective 1: Custodians of our natural heritage	Ensure no deterioration in the health of biodiversity in the Northern Territory
		Manage the Northern Territory's natural resources according to the principles of ecologically sustainable development.
	Objective 2: Sustainable living	Ensure efficient use of water by business and industry;
		Continue to meet or better national air quality standards across the Territory
		The Northern Territory contributes to the national target for greenhouse gas reduction.

It is appropriate to apply these same decision making principles when making an assessment and decision on the Project. Where appropriate, the Report draws from and refers to the targets contained in the Territory 2030 plan when reviewing and assessing the key elements of the Phase 3 Development Project.

It is anticipated that the private and community sectors would share ownership of, and become directly involved in, progressing targets within the plan. Industries and organisations are encouraged to "own" targets and contribute to them in meaningful ways. This provides the opportunity for the Proponent to offset some of the challenges that arise through its Project by contributing to other targets (such as employment, and investment in "green energy" targets).

2 The Proposal

2.1 The Proponent

The Proponent for the Project is McArthur River Mining Pty Ltd (MRM), the current mine operator. MRM is managed within the Xstrata Zinc commodity business unit of Xstrata plc. Xstrata Zinc is based in Madrid, Spain, and Xstrata plc (Xstrata) in Zug, Switzerland. Xstrata's zinc and lead operations and exploration projects are located in Australia, Canada, Germany, Peru, Spain and the United Kingdom. Xstrata acquired a 70% share in MRM when it purchased MIM Holdings Limited in June 2003. It subsequently moved to 100% ownership in September 2005 by acquiring the 30% share held by joint venture partner ANT Minerals.

2.2 Project objective

MRM aims to capitalise on a forecast gap between known zinc supplies and the demand for zinc concentrates, which now provides the company with an opportunity to increase its participation in the zinc business and develop a highly competitive operation through economies of scale. This is planned to be achieved by increasing the production rate from 2.5 Mtpa to a peak of 5.5 Mtpa. The extra production and lower unit costs would enable an increase in the ore reserves that can be economically extracted, from 53 Mt to 115 Mt.

The Project would also include improving the efficiency of the existing processing facilities, which convert the ore into a zinc-lead-silver concentrate (concentrate). The rate of concentrate production would increase from 360,000 dmtpa to 800,000 dmtpa.

2.3 Project location

McArthur River Mine is located approximately 70 km by road south-west of the township of Borroloola and 900 km south-east of Darwin in the Gulf Region of the Northern Territory. Figure 1 illustrates the location of the Project within the NT.

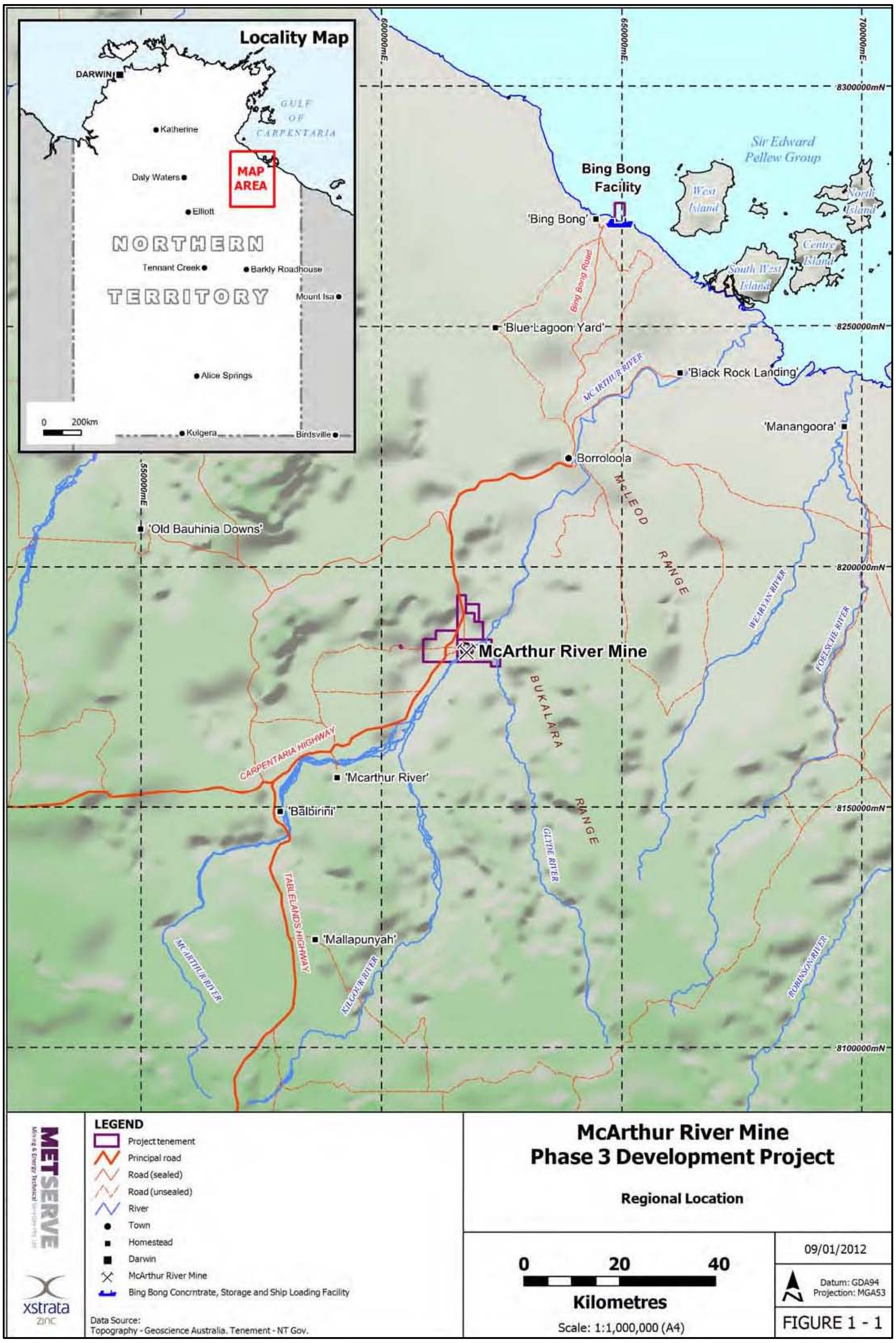

Figure 1 Location of McArthur River Mine within the Northern Territory (from draft EIS, Figure 1-1)

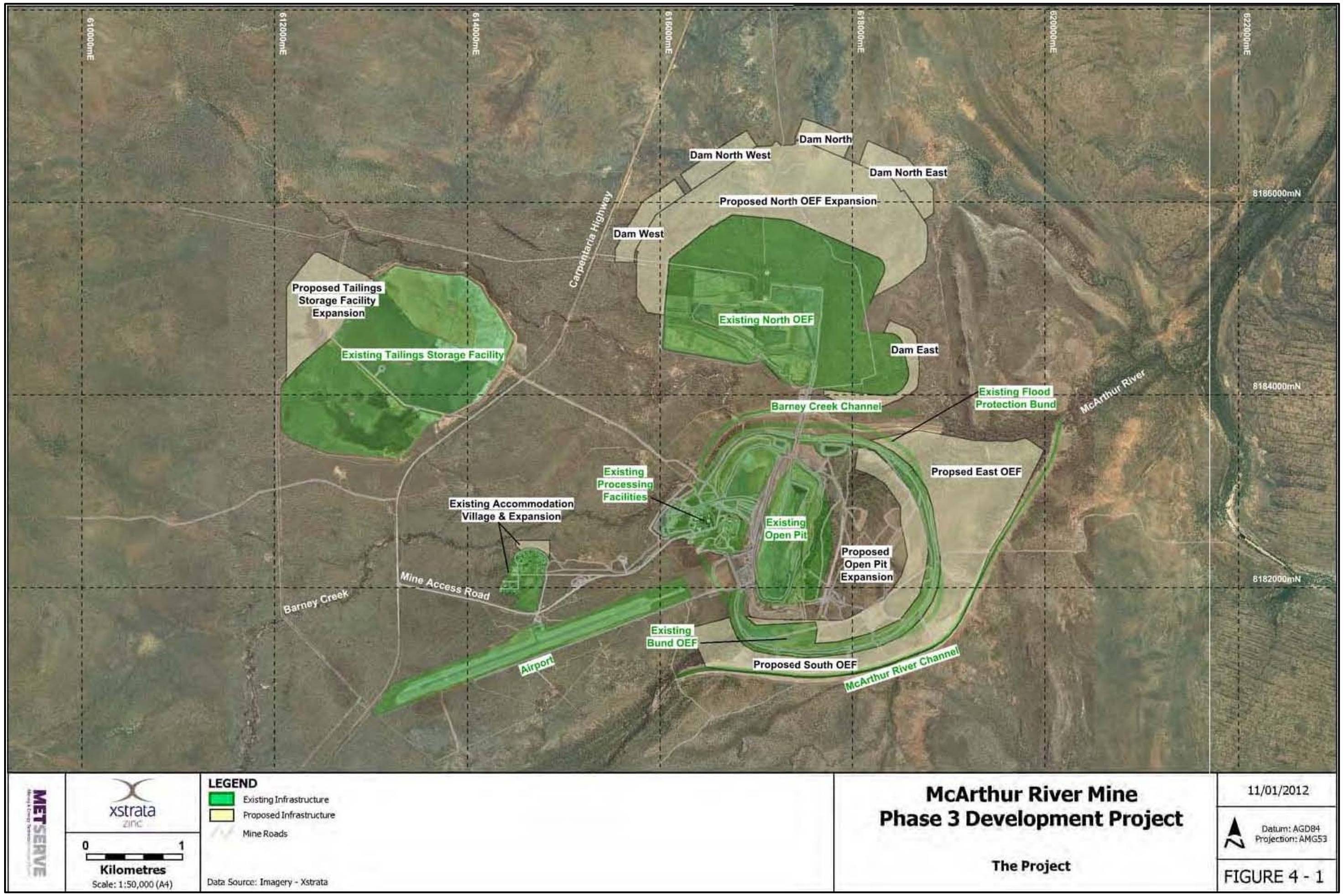

Figure 2 – Proposed Phase 3 infrastructure footprint (taken from draft EIS Figure 4-1)

2.4 Detailed project description

The layout of MRM's existing operations compared with the Project's proposed operating footprint is shown in Figure 2.

The Project would increase the currently targeted resource of 53 Mt up to a reserve of 115 Mt. Mine life would be extended by 9 years, to 2036. Ore production rate would be increased from the current approved capacity of 2.5 Mtpa of run-of-mine (ROM) ore to a peak of 5.5 Mtpa.

Key Project elements include:

- Mining operations:
    - o expansion of the existing open pit mine from the current footprint of 1,500 m long x 800 m wide (145 ha) and 210 m deep, to a footprint 1,750 m long x 1500 m wide (210 ha), 420 m deep. The expanded pit would remain within the existing bunded area;
    - o expansion of the existing north OEF and the construction of new OEFs to the east and south of the open-pit mine to store the additional 530 Mt of excavated overburden from the expanded operation;
- an upgraded and expanded mine water management system including clean water diversion drains, integrated mine area run-off collection, storages, settlement traps, and on-site water reuse procedures. A proposed an off-mining lease irrigation scheme located on the adjoining pastoral lease will no longer be considered in this assessment process;
- upgrade to the on-site ore processing facilities;
- use of the existing and already approved TSF to store Project tailings generated from ore processing, with the addition of a new water management dam which will serve as a TSF cell by 2032;
- upgrade and expansion of site offices, workshop facilities, the accommodation village and other supporting infrastructure; and
- Construction of a new gas fired power station through a Build, Own, Operate style contract, which is expected to double in output from the existing station (20 MW to 45-50 MW).

The Project would utilise existing MRM infrastructure such as the sewage treatment facility, ore processing facility, wastewater management system, site offices and industrial areas. Some of this infrastructure would be upgraded.

As per existing concentrate production, run of mine (ROM) ore would be trucked from the pit to the processing plant where it would be crushed and ground. The ground ore would then be slurried with flotation reagents and pumped to flotation cells and a leach circuit where the zinc and lead bearing minerals would be recovered in the form of a concentrate. Fine wastes (tailings) from the processing operation would be disposed of into the upgraded TSF.

The Project would approximately double the concentrate volume transported along the 120 km of public road to Bing Bong Port (increasing from an average 9 return trips per day, seven days per week to 18 trips per day), and doubling barge return trips from Bing Bong to the off-shore export vessel (increasing from 110 to 250 per year).

The construction phase would be undertaken over a two year period, with the majority of activities taking place during Dry seasons. Construction phase workforce would peak at approximately 930. Operational phase workforce would peak at approximately 735 permanent staff and contractors. The additional 400 people required for the Project construction works would be accommodated in a construction camp to be built adjacent to the existing accommodation village. The accommodation village would be expanded to the north in stages to accommodate the Project's increased operational workforce, with an extra 30 permanent rooms in 2012, and a further 80 rooms by 2020. A temporary camp of up to 300 rooms would be required for the Project's construction period, which would be decommissioned once all construction activities are complete.

The Project will also include improving the efficiency of the existing processing facilities which converts the ore into a bulk zinc-lead-silver concentrate. The rate of concentrate production would increase from 360,000 dmtpa to 800,000 dmtpa. This would require expanded crushing facilities and additional grinding mills, flotation cells and thickeners.

Frequency of flights from the airport would increase in line with the increased fly-in fly-out (FIFO) requirements.

The existing north OEF would be expanded to cater for most of the mined Project overburden, expanding from 375 ha to 860 ha, with a height increase from 55 m to 80 m. The existing bund OEF (constructed as a flood protection bund), situated between the southern pit wall and the McArthur River would be expanded to fill in the vacant area between the bund and the McArthur and Barney Creek channels. This would result a new east OEF and south OEF expanding the overall footprint from 120 ha to 270 ha, with an increase in height from approximately 15 m to up to 80 m.

Development of these OEFs would be staged so that habitat and fauna in the old McArthur River that is now cut off by the flood protection bund would be preserved until suitable replacement habitat is created in the channels.

The existing tailings storage facility (TSF) footprint would be utilised for the Project, with the use of a new cell, TSF 4, planned for construction initially in 2012 as a water management dam, and converted to a TSF to store Project tailings from 2032 as current capacity is utilised. The final level of TSF 4 would be 61 RL, 7 m lower than the final height of the currently approved TSFs 2 and 3.

Increased pit dewatering would lead to net water production by the project. An irrigation scheme is being investigated by the Proponent as a potential beneficial use of the excess water but will be considered in a separate approval process.

3 Environmental Impact Assessment

3.1 Introduction

The purpose of this Report is to evaluate the Project and to determine whether it can proceed without unacceptable environmental impacts. This is achieved by identifying the risk of an environmental impact occurring as a result of Project components and activities, and evaluating the Proponent's corresponding safeguards or prevention measures to remove or mitigate the risks. Where the proposed safeguards are considered insufficient, or where a safeguard is deemed particularly important, recommendations are made in this Report to add to or emphasise those commitments made by the Proponent.

The environmental acceptability of this project is based on analysis of the following from the EIS:

- Adequacy of information outlining the proposal (particularly which components or activities are likely to impact the environment);
- Adequacy of information on the existing environment (particularly environmental sensitivities);
- Adequacy of information on the range and extent of potential impacts and the risks of those impacts occurring within the Project context; and
- Adequacy of the proposed safeguards to avoid or mitigate potential impacts.

Conclusions and recommendations are then based on comments from the review of the draft EIS by relevant government agencies and the public, and responses from the Proponent to those comments in the Supplement.

In this Report, the recommendations (in **bold**) are preceded by text that identifies concerns, suggestions and undertakings associated with the project. For this reason, the recommendations should **<u>not</u>** be considered in isolation.

As minor and insubstantial changes are expected in the design and specifications of the proposal following the conclusion of the EIS process, it would be necessary for approval mechanisms to accommodate subsequent changes to the environmental safeguards described in the EIS and the recommendations in this Report. If the Proponent can demonstrate that such changes are not likely to significantly increase the risks of an impact on the environment, an adequate level of environmental protection may still be achieved by modifying the conditions attached to relevant statutory approvals governing this Project. Otherwise, further environmental assessment may be required.

Therefore, subject to decisions that authorise / permit the Project to proceed, the primary recommendations of this assessment are:

1. <u>Recommendation</u>

The Proponent shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards:

- **Identified in the McArthur River Mine Phase 3 Development Project's Environmental Impact Statement (draft EIS and Supplement); and**
- **Recommended in this Assessment Report (No. 69).**

All safeguards and mitigation measures outlined in the Environmental Impact Statement are considered commitments by the Proponent and should be included in the Mining Management Plan for the Project.

2. **Recommendation**

The Proponent shall advise the Minister of any changes to the proposal in accordance with clause 14A of the Administrative Procedures of the *Environmental Assessment Act*, for determination of whether or not further assessment is required.

3.2 Issues outside the scope of the assessment

Certain issues associated with the McArthur River Mine are deemed outside the scope of this assessment. These include aspects of the existing operation that are already authorised under applicable legislation, and have already been assessed under the NT *Environmental Assessment Act*. An exception to this is where examination of existing operations helps inform the assessment of potential environmental impacts from the Phase 3 Project and existing safeguards that will be applied to the Phase 3 Project. Additionally, existing infrastructure that has not been authorised under the *Mining Management Act* for Phase 3 use may be considered within the scope of this assessment. Description of the existing operation may also occur to provide context for this assessment.

Following submission of the draft EIS for the Phase 3 Project, the Proponent submitted an NOI for the development of a Water Management Dam (WMD), which is assessed as TSF 4 in this Report. It was communicated by the proponent that the site will initially be developed as a WMD, but the Phase 3 expansion would see the requirement to convert the WMD to TSF 4 as Phase 3 was implemented (c. 2032). This Report therefore assesses the use of the site as TSF 4. The initial establishment of the WMD, including the associated impacts is being assessed under a separate process which will be concluded prior to expected construction.

Historical mine infrastructure and operations will continue to be monitored through existing regulatory processes, including auditing by the IM.

3.3 Key Risks

Analysis by NT Government of the NOI (Xstrata Zinc, 2011) for the Project identified a number of environmental risks. On the basis of these, the Minister determined that an EIS was required for the Project.

Key risks that contributed to the determination included:

- Risks relating to construction and management of the TSF extension to ensure long term stability from seepage of contaminants through acid and/or metalliferous drainage;
- Risks relating to construction and management of the overburden emplacement facilities and characterisation of waste entering the facilities to ensure long term stability from seepage of contaminants;
- Potential for natural disasters and an extreme climate to degrade the integrity of infrastructure in the long term; and
- Risks relating to on-going management and rehabilitation of the McArthur River Mine.

Information requirements based upon identified risks were described in the EIS Guidelines for the Project (NRETAS, 2011a) and MRM submitted the draft EIS (MetServe 2012a) to address these requirements. A number of issues and concerns were raised in comments on the draft EIS that were addressed by information and commitments presented in the Supplement (MetServe 2012b).

It is considered that a number of key risks remain to be resolved, including:

- The Phase 3 proposal will add to existing impacts on the mine site;
- The potential for increased groundwater contamination and the need for viable contingencies to manage contamination and prevent contaminated seepage into local waterways and the McArthur River in the short to long term;
- Creation of a significant pit lake with potentially declining water quality and consequential impacts on local groundwater aquifers and ecosystems;
- The risk of long-term acidification of tailings, when inherent buffering capacity in tailings is exceeded;
- Generation of fugitive concentrate dust emissions with the increased ore-crushing and processing rates;
- Uncertainty as to whether proposed design of TSF 4 will prevent contaminated seepage to the environment; and
- The requirement for revision of groundwater monitoring.

These key risks are discussed in detail in this Report.

Other risks that are considered to have been adequately addressed by the Proponent through existing or proposed management measures, and/or can be adequately managed through subsequent regulatory processes include:

- Risks to wider and higher taxonomic orders within aquatic ecosystems from continuing inputs of mine contaminants;
- Potential for circum-neutral drainage from NAF materials used in a large proportion of the mine infrastructure;
- Uncertainty about whether clays being used within PAF cells, TSF cells, OEFs, and sediment dams to contain contaminated water, exclude oxygen and limit seepage will maintain structural integrity when exposed to low pH and high metal pore waters, or loss of moisture content;
- Potential for acidic and/or metalliferous drainage following mine closure in ongoing mine designs, leading to:
    - Risks of a post-mining legacy of environmental contamination;
    - Ongoing, intensive mine site management following decommissioning; and
    - Long term risks to Government and the local environment.

These risks have not been discussed further in this Report.

A number of risks have been identified through the EIA process that have been subsequently addressed by MRM to the satisfaction of draft EIS respondents. These risks have not been itemised or discussed further in this report but are available in the assessment documentation online at: **www.nretas.nt.gov.au/environment-protection/assessment/register/mcarthur/mcarthur_phase3**.

3.3.1 Historical context and existing impacts

The Project is proposed in the context of a brown field mine site. A number of issues impacting the local environment are currently being managed by the Proponent. The Proponent has demonstrated a commitment to invest in environmental studies to understand and remediate existing significant impacts, and over the life of the mine, it is expected that the Proponent will continue to be required to develop environmental management strategies appropriate and specific to the site.

The current operations were established in 1995 as an underground mine and processing plant with associated infrastructure. In 2006, the mine converted to an open pit operation. Consequently, large areas of the site are now highly disturbed, with the loss and fragmentation of approximately 5 km of riparian corridors and aquatic ecosystems from the diversion of the McArthur River and Barney Creek, as well as the creation of the 145 ha open pit, the 255 ha north OEF, and approximately 7 km of flood bund.

With approximately 25% of the mined material classed as PAF, and tailings estimated to be 8% PAF, the potential for acid mine drainage (AMD) to occur across the site is high. Mine-wide water quality issues have developed during this time, with discharges containing elevated sulfate and zinc levels. The existing TSFs (1 and 2) are estimated by MRM to be currently seeping at a rate in the range of 1520 and 1710 kL/d respectively.

Ongoing efforts by MRM to recover TSF seepage and prevent its migration to Surprise Creek have included an extensive array of cut-off trenches, recovery bores and geopolymer barriers. Seepage recovery has, in practice, only proved to be about 13% effective at recovering TSF seepage, with the remainder infiltrating to the water table and moving offsite, including to Surprise Creek. Current modeled seepage losses to the environment from TSFs 1 and 2 are in the order of 2.5 ML in contaminated seepage per day to the water table, beyond the TSF footprint.

With regard to the existing TSF seepage issues and consequent contamination of local waterways, recent analysis by Golder Associates (Golder 2011) and review by the IM recommended a number of actions including consideration of reprocessing historical tailings and improving TSF lining methods, and is discussed further in Section 3.3.4 of this Report. The recommendations relate to the existing authorised facility, which is not the subject of this current Phase 3 assessment. However, reprocessing of existing tailings could affect the characteristics and the AMD potential of the tailings that would report to TSF 4.

If the Proponent chooses to reprocess tailings in TSFs 1 and 2 and renovate these facilities with liners, this would temporarily increase tailings amounts being sent to TSFs 3 and 4, and possibly require TSF 4 to be commissioned earlier than currently planned. Assessment of TSF 4 is discussed further in Section 3.3.6 of this Report.

Historical and continuing impacts on the mine site provide valuable information on how the Proponent can improve its management strategies for the Phase 3 expansion. Where existing impacts are discussed in this Report, it is to put the mine site into context as a brown field site and to aid in the discussion of impact management for the Phase 3 Development Project.

3.3.2 Contingency management of contaminated groundwater

There is potential for the Project to increase groundwater contamination issues and viable contingencies are needed to manage contamination and prevent contaminated seepage into local waterways and the McArthur River in the short to long term.

The Phase 3 Project proposes to more than double production rate and volumes of ore, with a proportional increased output of PAF wastes. Placing large quantities of geochemically active tailings and waste rock into perpetual storage facilities presents an increased risk of groundwater impacts through AMD seepage, with potential impacts to aquatic ecosystems from inputs of elevated metals and salts. Contingencies are therefore required to provide multiple lines of defence against groundwater contamination to avoid long term AMD issues and intensive mine site management following decommissioning of the mine.

Historically, as for Phase 3, contingency options presented by the Proponent to address potential groundwater contamination have been based upon long term use of recovery bores. As mentioned in Section 3.3.1, recent data from TSF 1 suggests this method has been ineffective at recovering TSF seepage.

During operations, recovered seepage is pumped back to the TSF. Ongoing addition of contaminant loads to this water cycle risks creating an ever deteriorating seepage water quality.

Previous environmental assessments in 2005 and 2006 (EPA Program 2006a, 2006b) under the EA Act noted heavy reliance by the Proponent on a bank of recovery bores as its last line of defence against post-mining TSF contaminated seepage and AMD reaching the environment. The 2006 Assessment Report 54 (EPA Program 2006b) found that the recovery bore strategy would be required to operate continuously for many decades. The assessment found that a worst case scenario could include ongoing seepage and pollution of groundwater aquifers preventing closure or cessation of recovery bore operation. At that time, the level of risk of this occurring had not been well established.

The Proponent's reliance on recovery bores already indicates that closing the mine once mining ceases is unlikely, due to the need for long-term ongoing pumping. TEAM NT (2004) suggest: *'Each year that a groundwater plume develops can translate to ten years of pump and treat operations to recover the plume and restore groundwater quality.'* This translates to recovery bore operation periods of more than 200 years, based on the previous 20 year mine life.

Modelling presented in the Supplement of TSF seepage recovery rates by MRMs recovery bore network demonstrate that this method of containment has been largely ineffective, with approximately 87% of the TSF seepage lost to the local water table and able to move offsite, even whilst used in combination with a comprehensive array of geopolymer curtains and cut-off trenches. Golder (2011) suggested the reason for failure of the seepage containment and recovery network was:

> *The fractured bedrock underlying the alluvium, within which the current seepage mitigation strategies exist, is reducing the effectiveness of these strategies through the occurrence of high porosity preferential pathways, therefore seepage is still evident between the TSF and Surprise Creek and at Surprise Creek.*

The failure of this method demonstrates that other options need to be considered for reducing or capturing post-mining TSF contaminated seepage.

In the EIS the Proponent presented post-closure modelling to show that the final pit void would be a groundwater sink ensuring that contaminated groundwater in deep aquifers would inflow to the pit void (discussed further in Section 3.3.3 of this Report). Environmental contaminants are predicted to remain in the pit lake for perpetuity isolated from local waterways.

The Proponent is reliant on regional groundwater flow gradients from the TSF to the pit as a secure, post-closure solution to contain contaminated seepage within the mine lease. This may apply to contaminants in deeper aquifers but the risk remains that seepage entering shallow aquifers or expressing at the toe of TSFs could enter surface water systems and ultimately to the McArthur River.

3. Recommendation:

The Proponent should develop and present viable contingencies for prevention, treatment and recovery of contaminated seepage and groundwater.

Consideration should also be given to ongoing prevention, reduction, and/or removal of contaminant loads across the mine site from all Project process streams, storages and water cycles. Upstream management of contaminant sources is likely to provide greater benefits than downstream strategies, and in the long term, would decrease financial liabilities associated with the McArthur River Mine operations, and make closure more achievable.

3.3.3 Final pit void

Proposed mining operations will result in a significant pit void. The proponent proposes to allow the pit to fill and become a lake as part of mine closure. Contaminant inputs from various sources on the mine site could potentially reduce water quality into the long term with consequential impacts on local groundwater aquifers and groundwater dependent ecosystems. Potential sources of AMD that are likely to report to the pit lake following decommissioning of the mine include:

- Groundwater seepage generated from the TSF. The EIS states that seepage from the TSF to the deeper aquifer is expected to migrate towards the mine pit and eventually will be discharged in the pit lake;
- PAF material exposed in the pit walls could also release AMD to the pit lake. Further geochemical investigations will verify the final pit wall geochemistry, which the Proponent expects will be largely acid neutralising because of the abundance of a large dolomite rock unit;
- Post-closure management of TSF seepage includes a proposal to pump the seepage to the pit void;
- Any seepage or surface runoff from the Western OEF and its contained PAF cell; and
- Stormwater runoff and seepage, including AMD and sediments from within the crests of the flood bund.

If these inputs occur following mine decommissioning, pit water quality will continue to decline as a result of concentration by evaporation, with sulphate concentrations (and concentrations of other ions and metals) gradually increasing with time. The 2005 modelling showed that sulphate concentrations would increase to approximately 2800 mg/L after 33 years, and be in the order of 4900 mg/L after 99 years (reported in MetServe 2012a).

Groundwater simulation results suggest that regional groundwater levels following mine decommissioning will recover progressively, reaching equilibrium conditions after approximately 300 to 400 years.

Modelling based on available information on post-closure groundwater rebound and the pit lake level, including assessment of major rainfall events (ARI 100 years and water level responses), indicates that the final equilibrium between evaporation and water inputs would occur when pit lake water level rebound reaches -15 m Australian Height Datum (AHD). The seasonal water level in McArthur River on the other side of the constructed flood bund varies between 21 m AHD to 40 m AHD, considerably higher than the water level expected in the pit void.

The modelling predictions suggest, therefore, that the pit lake will form a long term groundwater sink. The Proponent states that the pit lake would be too low, approximately 30 m below the recovered post-mining water table level, to result in outflow and therefore it will not have a significant impact on surrounding groundwater resources.

For the final pit void, the Proponent suggests that the principles of ESD are being satisfied by isolating pit water within the pit, to minimise its potential impact on the surrounding environment. The Proponent suggests that no outflows will occur into the surrounding aquifers or surface water features. These assertions are based on modelling, which requires further refinement to improve certainty.

The creation, by design, of a scenario of ever-degrading water quality in the pit void is not considered to be compatible with the principles of ESD. At this point, it would be appropriate to plan to prevent and/or remediate contaminated waters created on the mine site with the ultimate goal to achieve a consequent water body which is regarded as a beneficial use to surrounding ecosystems, the community and future generations.

Significant remediation costs for mining sites with legacies of contamination have been realised and borne by Government in the past. Principles of intergenerational equity, and of internalisation of environmental responsibilities and costs, both dictate that current proponents should be fully responsible for all environmental costs associated with their project through its full life cycle. This issue is addressed through the requirement for 100% security bond determined by the Security Assessment Board, and administered by the Department of Resources.

The Proponent has committed to ongoing development of the hydrodynamic, hydrogeological and conceptual models to continue to refine estimates around the final pit lake and its predicted water quality, as new data is acquired. The Proponent states that its proposal to isolate the final pit lake from the McArthur River is not final, and will be reviewed throughout the life of the project. The Proponent considers new advances in technologies and methodologies will be adopted to produce the best practicable outcome for the management of all disturbance areas on site. NRETAS supports the Proponent's commitment to ongoing research into advances in technologies and methodologies for remediation of the mine site and on-site water quality, with the view to improving final long term post-closure outcomes for stakeholders and the environment.

4. <u>Recommendation</u>

It is recommended that the Proponent continues to explore options of alternative methods to develop self sustaining, biodiverse aquatic and riparian ecosystems in and around a future pit lake. The objective should be to achieve the most appropriate treatment of the pit lake at the time of closure with respect to ESD principles.

The option of backfilling the pit on closure was not explored due to the identification of further resource recovery opportunities that may be accessed from the final pit in the future. These options could be inhibited by the placement of overburden in the pit (Metserve 2012b). It is recommended that the Proponent continues to consider closure options including backfill configurations that do not compromise future access to a resource.

3.3.4 Acidification of tailings

There is a risk that tailings could acidify in the long term, when inherent buffering capacity in tailings is exceeded. This would lead to a significant increase in the generation of acidity and heavy metal concentrations in leachate.

The IM (2011) concluded that tailings deposited over the last five years will generate acid:

> *'sulfide minerals in the tailings dam are in excess of the buffering capacity of the tailings carbonate minerals. When the buffering capacity is exceeded, acidity will be generated and heavy metal concentrations in leachate will increase more than 100 times. The acidity together with high concentrations of heavy metals will have a significant adverse impact on Surprise Creek'.*

The IM considered that *'planning for the long term acidification of these tailings and mitigation of acidic seepage is likely to be the most significant issue for mine closure'* and classed acidification of tailings seepage as an 'extreme risk'.

These statements are relevant to existing, approved tailings facilities, however, understanding the nature and extent of the risk of tailings acidification will enable this risk to be accounted for in the design and management of TSF 4 and the expanded Phase 3 processing plant.

The EIS reports that in general, tailings are high in metals and contain approximately 8% sulphides, which designates them as PAF. A material characterisation program reported in Appendix E to the draft EIS found:

'the paste pH and conductivity of the tailings material are in the range of 5.4 to 7.8 and 0.9mS/cm to 19.2mS/cm, respectively. Near surface material exhibited relatively high conductivity and low pH. The trend in data would suggest that oxidation of the tailings material is occurring and oxidation products are evapo-concentrating at the surface.'

The Proponent, however, considered significant acidification of oxidised zones within the TSF as unlikely, and noted that the sulphides in the tailings, although reactive, did not produce sufficient acid to lower the pH of the material which is typically around pH 8.

The IM makes the point that some material, while generating a neutral leachate, produced high sulfate and metals concentrations, and warned that the acidity from metal sulfide oxidation precedes the dissolution of the neutralising carbonate. Therefore, there is a risk that all of the inherent buffering capacity would eventually be consumed by the acid. In the long term, buffering would be insufficient to prevent acidification of the tailings. The IM also raised the potential issue of tailings seep water physically bypassing mineralogy that could otherwise neutralise leachate due to preferential flow paths through the tailings cells.

The Proponent indicated that acid drainage is not currently occurring and the IM's prediction of tailings acidification is a potential future risk. The Proponent has been working with the IM to investigate the issue and commissioned a specialist consultant to analyse this risk (Golder, 2011) with the input of the IM.

Despite the differences in the detail between the two reports, both the IM and Golder recommended that mitigation strategies should be undertaken to improve the current situation, including reprocessing the tailings and ensuring the TSF included an impermeable liner to intercept the seepage.

The Proponent has indicated in the Supplement that it will engage another specialist to conduct an additional review on the issue and gain further advice. NRETAS supports this approach and notes the potential need for the Proponent to reconfigure its current approach to tailings seepage management, in the terms recommended in both the Golder and IM reports, to address the risk of future tailings acidification. NRETAS considers that the information gained through the experience of current TSFs should be applied to siting and construction of the proposed TSF 4.

5. Recommendation

The Proponent should comprehensively address the risk of future acidification of tailings and release of AMD to the environment.

The Proponent focuses effort on preventative approaches to AMD at the tailings source, such as in further tailings processing to avoid long term storage of PAF material, over downstream strategies such as recovering seepage plumes.

TSF 4 designs be informed by the above actions, and refined to comprehensively prevent seepage escape from the facility. Impervious linings and effective drainage and recovery systems that would continue to be effective in the long term should be explored.

3.3.5 Dust

Recent IM reports (EES, 2011) flagged concentrate-dust management as an ongoing environmental issue at the Mine site and the Bing Bong Port. Fine dust, contaminated primarily with lead and zinc may be transported via wind and water where it can accumulate in soil and river/marine sediments. Elevated levels of lead and zinc were recorded in two gastropod species, as well as in surface sediments from the beach immediately west of the Bing Bong Port Facility.

Improved dust management measures have been approved for the Bing Bong Port, independent of the current proposal. However, both mine-site processing and the Bing Bong Port loading volumes are now proposed to more than double in throughput, raising the risk setting and potential for fugitive dust and marine spills. Decreased opportunity will now exist for operations to avoid periods of high wind conditions at Bing Bong Port, and at the offshore barge decanting area.

As a toxin to humans, lead uptake by workers, via inhaled dust, needs to be managed. NT Worksafe was satisfied with MRM's safety procedures and records, and indicated that these met required health and safety standards.

3.3.6 Design of TSF 4

Design details for TSF 4 are only conceptual at this stage as is not required to receive tailings until around 2032. Prior to this, TSF 4 is proposed to be built and operated as a lined water management dam (WMD). The construction and operation of the WMD was not considered in this assessment as the details were not advised until after the draft EIS had undergone public consultation. The proposed WMD has now been referred under a separate NOI, for consideration under the EA Act*.*

Commitment is made in the EIS to design TSF 4 to meet ANCOLD 1999 design standards. Whilst this design standard may be an appropriate standard for construction of the interim WMD (which is proposed to be constructed in 2012/13), the conversion of the WMD to TSF 4 should consider the relevant design standard at the time of expected TSF 4 commissioning, in addition to the correction of any degradation of the structure over its operational life as a WMD.

Due to the provision of conceptual designs of TSF 4 and a history of leakage of contaminants with current TSFs, there remains a high degree of uncertainty that the proposed design of TSF 4 will prevent the addition of contaminated seepage to the environment.

The risks presented by the TSF 4 proposed design includes the potential for:

- TSF 4 not fully containing tailings and/or capturing seepage with acidic and/or metalliferous drainage potential, from the environment;
- Construction issues, such as:
    - Inferior-quality, insufficient or inappropriate construction materials, such as clays;
    - Inadequate construction practices and/or quality control;
    - Construction not to design specifications; and
    - Severe weather events.
- Exceedance of the design life of the liner;
- Lack or loss of integrity, stability and/or design containment functionality within the long term (>1000 years);
- Inappropriate design, such as for environmental or risk setting or contents actually received;
- TSF cover failure;
- Inappropriate site: choice, characteristics or preparation;
- Leakage and/or developed faults such as in the liner, embankments or drainage systems in the short or long term, due to punctures, failure of sheet joins, vehicle traffic, unbalanced or excessive loadings, liner sheet creep, groundwater upwelling,

wind uplift, earth movement, (subsidence, faulting, seismic activity), erosion, or biota or chemical attack; and

- Changes to climatic or mine regimes outside design tolerances, such as premature mine closure, drought, excessive flooding or cyclones.

The Proponent raised concerns regarding the use of a lined TSF before approval of TSF 2 in 2006 (URS 2006). The reasons stated included:

- Liners reduce the density of tailings, leading to strength and stability issues. Tailings remain too weak to support upstream lifts, thus require a larger TSF footprint;
- Undrained tailings lead to a long-term legacy risk of a remaining groundwater head that will drive long-term seepage;
- Risk of clogging the drainage layer at the base of the tailings, due to fine grained tailings;
- Risks of crushing, distortion and blockage of under-drains;
- Lined tailings dams are generally not located in floodplains, due to risk of uplift pressures during a flood event damaging the geomembrane; and
- Risks of long-term creep and localised defect development over time leading to high seepage rates. The degree of quality control during installation is an important factor in this risk.

The Proponent advised recently why its proposed TSF seepage management approach is different for TSF 4. Reasoning included:

- The seepage and recovery rates eventuating from the existing TSF are unacceptable, and therefore alternative seepage management options were required for cells 3 and 4;
- Engineering solutions will be implemented to maximise the drainage of the tailings material, which assists in resolving a number of the previously identified potential issues in the URS report, including tailings density (and therefore footprint area) and long term stability. An investigation will be conducted during the detailed design phase into the options to deal with potential of clogging of the above-liner drainage system;
- The under-liner drainage system is designed to minimise uplift pressures during a flood event and hence will prevent potential issues raised in the URS report associated with uplift;
- The HDPE liner will provide greater seepage control while the cell contains water only, compared with other earthen liner options;
- The manufacturer advises the liner is designed to have a minimum longevity of 100 years when buried, as the liners at MRM will be; and
- TSF cover designs will be assessed and refined to provide the most effective exclusion of water from the TSF following closure.

A resolution of the above issues has not yet been demonstrated and needs more consideration by the Proponent, before TSF 4 is commissioned. Consideration should include investigation and analysis of recognised risks with regard to use of a HDPE lined tailings storage facility in the flood plain, including:

- issues described above in this Report;
- issues previously identified by MRM (URS 2006); and
- further relevant issues as identified at the time.

The footprint of TSF 4 is proposed to overlay the current upper (~700 m) reaches of the main drainage channel of Little Barney Creek. Appendix B of the Supplement suggests TSF 4 would cover approximately 700 m of Little Barney Creek. TSF 3 has already been built over a lower adjoining ~1.5 km section of Little Barney Creek.

Experience from TSF 1 has been that building a TSF over an in-filled creek line offers a preferential rapid pathway for transmission of any seepage (EES, 2011) to downstream creek lines (Barney Creek for TSF 4, or Surprise Creek for TSF 1). Consideration should be given to the development of strategies to mitigate and remediate a potential groundwater plume to Barney Creek.

The proposed location of the TSF 4 northern boundary is within 250 - 300 m north-east of Surprise Creek. It is possible that connection with the water table could develop between TSF 4 and Surprise Creek as a result of future groundwater mounding within TSF 4. Monitoring of the sulfate plume around TSF 1 showed that a seepage plume is able to migrate radially from the TSF contrary to the eastward regional groundwater flow direction. For TSF 1 the sulfate plume is reported in the Supplement as extending 160 m to the north-east, beyond Surprise Creek.

Drainage of the Little Barney Creek catchment is proposed to be diverted around the foot of TSF 4 through a clean water diversion drain that reconnects with Little Barney Creek to the south-east of the TSF 3 footprint. The engineered diversion (figure 4-10 Draft EIS (MetServe 2012a)) appears close to the foot of TSF 4, compared to the distance between Surprise Creek and TSF 1. If significant leaks were to occur from TSF 4, leachate would likely report to Little Barney Creek. A lack of buffer between the Little Barney diversion drain and TSF 4 provides little scope for installation of contingency recovery infrastructure to prevent leachate from contaminating surface and groundwater. Confidence in the internal drainage systems of TSF 4 would need to be very high.

The Proponent is currently tasked with resolving issues associated with the current TSFs including contaminated seepage, subsequent groundwater contamination, and acidification of tailings. It is likely that the acceptable parameters of 'best practice' as realised by the mining industry, the Proponent, and Government will undergo significant advances over the next 20 years. Outcomes of research and development of satisfactory environmental management strategies for these current issues, along with contemporary design standards, will inform siting and design at the appropriate time.

It is not possible to adequately assess the TSF 4 component of the Project due to the high degree of uncertainty with regard to its design and the mitigation and management of potential impacts, particularly in the context of Industry Best Practice that will be required in 20 years.

6. Recommendation

It is recommended that the environmental assessment of TSF 4 be undertaken when the design is further advanced, based on the acquisition of detailed research and monitoring of the current seepage and acidification impacts.

3.3.7 Groundwater Monitoring

Review of the Groundwater Monitoring Program as presented in the EIS indicates that the program may not be providing optimal results for current and future operations, and revisions are recommended.

The updated groundwater monitoring program details sampling frequency, analytes and proposed additional bores. A location map was included in Appendix J of the Supplement identifying existing monitoring bores and proposed bores. However, the location of sites is unclear in terms of the pre-diversion and current water courses. The location of GW84 should be reviewed to improve monitoring of groundwater quality before it reaches Barney Creek from mine activities in the area of west OEF.

Groundwater quality monitoring occurs at the Mill area for a range of parameters including Total Petroleum Hydrocarbon (TPH). However, it is noted that TPH is only monitored for bores GW3A, GW5A and GW15 and not for GW16, located hydraulically down gradient of the Mill area (Table 10-7 under comment 89 (MetServe 2012b)). It is recommended that GW16 be included for TPH analysis.

An extract of the IM's audit report (Appendix K of the Supplement) recommends that MRM present or discuss Quality Assurance/Quality Control (QA/QC) practices. The report also recommends that MRM present groundwater contours for each formation to gain a better understanding of the hydrogeology of the area and the impacts the mine activities may have on the system. It is noted that the report states that these are recurring recommendations by the Independent Monitor and are yet to be adequately addressed. These recommendations are supported.

Section 21 of MRM's Environmental Monitoring Manual (EMM) addresses MRM's updated QA/QC procedures. Only one field duplicate and blank sample is proposed for each monthly monitoring round. Given the number of groundwater bores to be sampled, a regime considered appropriate would be to include one field duplicate taken for every 10 primary samples. To provide a higher level of confidence, it would be appropriate for the Proponent to consider taking field triplicates to be sent to a secondary laboratory for analysis and comparison of data precision. Section 21.2 of the EMM discusses blank samples, however, it is unclear whether this type of blank is a field, equipment or transport blank sample. A more rigorous QA/QC program would be ensured if all three types of blank samples were taken, to assess possible cross contamination during the sampling program.

The EMM does not mention a procedure for washing down field equipment between each bore. To eliminate the risk of cross contamination of samples, field equipment such as water level metre and pumps would need to be thoroughly cleaned between each bore, according to an appropriate standard (for example, with a solution of Decon 90 and then rinsed again with demineralised water).

Currently, all groundwater samples are compared against the National Environment Protection Council Agricultural Livestock Purposes 1999 guidelines. However, given the groundwater in some areas is directly connected to the rivers and creeks, it is appropriate to compare with ANZECC 2000 Guidelines for Protection of Freshwater Ecosystems (ANZECC 2000 Guidelines) for groundwater samples.

Predicted groundwater flow post mine closure, has been modelled to flow into the pit, however MetServe's Further Assessment and Design Works Report (in MetServe 2012b) states the groundwater modelling is being undertaken to determine final void pit lake levels. Although the Proponent has proposed to monitor post mine groundwater levels in five monitoring bores surrounding the open pit, given the uncertainty of the final lake level, provision should be made to consider additional bores between the pit and McArthur River. The Proponent acknowledges the requirement to reassess and revisit the monitoring program throughout the life of the project.

7. Recommendation

It is recommended that the Proponent reviews the groundwater monitoring program to:

- **optimise bore location;**
- **consider additional bores to inform potential final pit void levels over time;**
- **review QA/QC program procedures; and**
- **adopt ANZECC 2000 Guidelines when comparing and assessing groundwater monitoring results.**

4 Conclusion

The Proponent has presented a well researched and thorough EIS. Whilst an understanding of the complexities of the existing operation and its potential to impact on, and interact with components of the Phase 3 Project was identified, there remains a high level of uncertainty around the Phase 3 Project. Ongoing research and remediation of current impacts is essential to provide confidence that the Phase 3 Project can proceed with acceptable impact. The EIS and this Assessment Report provide a structured pathway for the Proponent to progress the expansion project, based on the undertaking of a program of corrective actions to inform detailed design.

A key residual risk presented by the current operations and the Phase 3 proposal is the site-wide build up, long-term storage, and release of contaminant loads. Current data shows elevated metals and sulfates have entered, and will continue to accumulate in water bodies (groundwater and surface waters), soils and aquatic sediments; are potentially bioaccumulating in aquatic fauna (macroinvertebrates and fish); and may be affecting macroinvertebrate populations.

Long term storage facilities containing high contaminant loads and acidic and/or metalliferous drainage potential, such as in tailings and PAF waste rock storages represent large heads of potential future environmental contamination, post closure.

The EHD considers that the environmental issues associated with the proposed project have been adequately identified. Appropriate environmental management of a number of these issues has been resolved through the assessment process, with the exception of issues relating to the full environment assessment of TSF 4, and the final form of the pit lake. It is expected that both of these items will be required to meet contemporary environmental standards at the time of approval, which will be informed by ongoing research for the operational life of the mine.

Subject to the above, based on its review of the EIS and the submissions from relevant Northern Territory Government agencies, affected stakeholders and the public, EHD considers that the project can be managed without unacceptable environmental impacts. This is provided that the environmental commitments and recommendations detailed in the EIS, this Assessment Report and in the Mining Management Plan are implemented and managed and subject to regular reporting and compliance auditing.

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Appendix 1 – Commitments register (App E3 of the EIS and App D of the Supplement)

Commitments made by the Proponent of the McArthur River Mine Phase 3 Development Project.

Introduction

This Appendix identifies the new commitments particular to the McArthur River Mine Phase 3 Development Project (the Project). Commitments that are already current, or standard practice at MRM, have only been included where they aid in the understanding and/or context of Project specific items.

Draft EIS Commitments

Chapter 5 – Rehabilitation and Decommissioning

Section 5.8.1 – Design Criteria

The Project's rehabilitation design will be based on the following criteria:

- all areas significantly disturbed by mining activities will be rehabilitated to a stable landform with a self-sustaining vegetation cover
- outer OEF slopes will be designed at no greater than a 1(V):4(H) overall slope.
- the OEF will have a 600 mm layer of growth media (mix of NAF rock, alluvials and soils) to provide a layer for storing water and nourishing vegetation
- the surface of the OEFs will be shaped with a gentle slope of 1(V):100(H) and will be directed towards drop chutes to transport water down to ground level
- until further geotechnical and geochemical assessments are completed, PAF cells must have at least 20 m of NAF surrounding them at the end of construction. No PAF material shall be placed below the 1-in-100 year flood level in any ex-pit OEFs

Section 5.8.2 – Rehabilitation

All areas disturbed by mining activities will be rehabilitated to a stable landform with a self-sustaining vegetation cover, with progressive rehabilitation commencing within one year of when areas become available for rehabilitation purposes.

The Proponent will progressively rehabilitate where practicable, however there will be large areas of disturbed land that will not be available for rehabilitation until later in the mine life for the following reasons:

- the disturbed area is effectively integrated with nearby, unavailable areas
- it necessitates an uneconomic use of resources to undertake the work at the time
- the chemical characteristics of the OEF may improve with time of exposure, thereby improving the success of the rehabilitation

Section 5.9 – Decommissioning

Consultation with government and local stakeholders is expected to continue over the next five years for the development of post-mining land-use strategies for the Project.

Section 5.9.5 – Final Open Pit

The open pit will be stabilised, with rock armour placed over the alluvial materials where water will flow back into the open pit. The open pit void will be fenced off and allowed to flood. The open pit will be left to fill naturally from groundwater inflows, direct rainfall, surface water flow off the internal slope of the OEFs surrounding the open pit, together with TSF seepage pumped to the open pit. No surface water inflows to the open pit from the McArthur River will occur.

Section 5.9.9 – Chemical Contaminated Sites

Sites which have been contaminated during the life of the mine will have contaminated soils and aggregates removed and placed into the designated area at the TSF. A 500 mm layer of ungraded material will be placed on top of the sites, and then they will be topsoiled, ripped and seeded. Potential contaminants include tailings, pyritic material, ore, hydrocarbons, reagents or other chemicals.

Chapter 7 – Land Resources

Section 7.3.5.1 – Erosion Controls

- erosion and sediment control measures will be employed which are consistent with the practices described in the Northern Territory Erosion and Sediment Control Guidelines. The existing erosion and sediment control practices will be upgraded and implemented throughout construction and operation phases of the Project
- report results of erosion monitoring in SDWMP or SDMMP

Section 7.3.6 – Topsoil Management

- stockpiles which need to be retained for extended periods and which have not revegetated naturally, will be seeded with plant species planned for the revegetation component in the rehabilitation program

Chapter 9 – Waste

Section 9.5.4 – Waste commitments and targets

Waste commitments and targets have been developed by MRM to assist in effective waste management to:

- reduce the total amount of, and environmental impacts from waste
- recover and recycle 10% more than currently recycled over the next five years

Chapter 10 – Water Resources

Groundwater

Further definition of factors that influence groundwater predictions will be collected before the open pit intersects the Western Fault and Cooley Dolomite, which may be a source of additional groundwater.

The groundwater monitoring network will be expanded to meet environmental requirements of the Project. Particular focus will be on monitoring of groundwater quality at depth and drawdown associated with the proposed interception bores that will surround the open pit. Detailed planning work for this monitoring program is anticipated to commence later in 2012.

Surface Water

The existing flood mitigation measures at the MRM site will remain during Project mining operations. In addition, a number of additional measures are proposed to minimise the impact of flooding on Project mine infrastructure. The additional measures include:

- constructing a new erosion protection bund to protect South and East OEFs from erosion up to the 1% AEP (100 year ARI) flood level;
- continuing to place North OEF PAF material and North OEF PAF Runoff Dam spillway levels above the 1% AEP (100 year ARI) flood level

Undertaking a regular erosion monitoring program along channel reaches and floodplain areas where potentially elevated velocities and velocity increases have been identified. If any evidence of erosion is found at these locations following major flow events, appropriate erosion protection works at these affected locations would be undertaken.

Changes to the surface water monitoring program include:

- the removal of the existing stream gauging station on Barney Creek (SW19) and replacing it with two new stations – one on Barney Creek approximately 5 km upstream of the removed station at the Carpentaria Highway crossing (SW4) and the other on Surprise Creek at the at the Carpentaria Highway Crossing (SW2);
- the installation of three new surface water quality monitoring stations to monitor the impact of the North Overburden Emplacement Facility (NOEF) runoff on Emu Creek receiving waters; and
- the installation of six new stations to monitor water quality in the new ‘contaminated’ storages proposed for the site. These are the two new storages in the TSF area (TSF Cell 3 WMD and TSF Cell 4 WMD) and the four new storages in the NOEF area, namely South-East PAF Runoff Dam (SEPROD), East PAF Runoff Dam (EPROD), North-East PAF Runoff Dam (NEPROD) and North-West PAF Runoff Dam (NWPROD)

During Project mining operations, it is proposed to direct runoff from NAF areas in the North, South and East OEFs towards sediment ponds. This is based on the assumption that runoff and seepage from the North, South and East OEF areas can be considered 'dirty' and can be released to the receiving waters after treatment in a sediment pond. Monitoring of water quality in these sediment ponds would be required to demonstrate that the water quality is within the limits specified in MRM’s WDL prior to release into receiving waters. If runoff and/or seepage from North, South and East OEF areas is found to be ‘contaminated’, active management measures and/or additional storage volume would be required to fully contain the ‘contaminated’ water on site.

An additional 'contaminated' water storage may be required to manage water dewatered from the open pit water when TSF Cell 4 is used for tailings deposition after 2032. The additional post-2032 storage requirement will be assessed in the future when more Project operational data becomes available

Further scheduled geochemical investigations will verify the final void wall geochemistry.

It is proposed to remove SW19 from the surface water monitoring network and replace this station with two new stations – one on Barney Creek approximately 5 km upstream of the removed station at the Capricorn Highway crossing (SW4) and the other on Surprise Creek at the at the Capricorn Highway Crossing (SW2).

Three new surface water quality monitoring stations are proposed to monitor the potential impact of the NOEF runoff on Emu Creek receiving waters. These stations will monitor the background (upstream) water quality in Emu Creek, the quality of surface runoff entering Emu Creek from the NOEF area and the potential impact of the NOEF on Emu Creek receiving water quality. The proposed locations of the above three stations are provided in Appendix D3. No changes to the existing suite of parameters monitored or the monitoring frequency are proposed.

It is proposed to expand the artificial surface water monitoring network to include the monitoring of the six new ‘contaminated’ storages proposed for the site. These are the two new storages in the TSF area (TSF Cell 3 WMD and TSF Cell 4 WMD) and the four new storages in the NOEF area, namely South-East PAF Runoff Dam (SEPROD), East PAF Runoff Dam (EPROD), North-East PAF Runoff Dam (NEPROD) and North-West PAF Runoff Dam (NWPROD).

During the Project, it is proposed to direct runoff from NAF areas in the South and East OEFs towards sediment ponds. This is based on the assumption that runoff and seepage from the North, South and East OEF areas can be considered 'dirty' and can be released to the receiving waters after treatment in a sediment pond. Monitoring of water quality in these sediment ponds would be required to demonstrate that the water quality is within the limits specified in MRM's WDL prior to release into receiving waters. If runoff and/or seepage from North, South and East OEF areas is found to be 'contaminated', active management measures and/or additional storage volume would be required to fully contain the contaminated water on site

Irrigation

The following will be required in a detailed design phase of irrigation systems to further develop the concept before implementation:

- Further water quality sampling and analysis, including complete water analyses (covering major anions and cations, pH, conductivity and total alkalinity)

Suitable sites for irrigation will be identified in the detailed design phase of the irrigation investigations. The key parameters to be used in this search will include:

- Soil selection
- Physical properties – soil type, structure, thickness and profile, permeability, particle size
- Chemical properties – nutrients, salinity
- Terrain – slope is ideally less than 4° so that pivot machinery does not become unstable.
- Proximity to mine site. Closer sites will reduce distribution costs. Fields are preferably on the same side of the river to avoid flooding access issues and possible damage of pipe crossings.
- Groundwater
- No shallow groundwater flows that could mobilise contaminants
- Surface water
- Out of flood zones
- Buffer zones to watercourses

Chapter 11 – Air Quality and Greenhouse Gases

Section 11.7 – Mitigation Measures

An additional monitoring programme will be undertaken at monitoring points at the accommodation camp to:

- measure PM10 that will evaluate the effectiveness of dust controls in place at the mine and, in particular, at the mill's grinding and crushing points
- monitor nitrogen dioxide emissions from the power station (on a campaign basis) to confirm ambient standards are being met

Section 11.10.2 – Climate Change Adaption

The Proponent is committed to reducing its GHG emissions on a per-tonne mined basis and is a contributor to research programs to develop energy efficiency technologies, such as technology and improvements to grinding processes.

Chapter 12 – Noise and Vibration

Measures proposed in order to avoid or minimise potential adverse noise and vibration impacts associated with the Project are described below.

- by locating the power plant at site 2, noise levels for the Project's accommodation village are expected to remain below guideline specifications. If an alternative site is selected, then ameliorative measures will be undertaken to ensure noise levels remain below guidelines

In order to comply with the blasting goals, the maximum instantaneous charge will be below 500 kg for a regular blast and below 1,050 kg for a void blast, where practicable, for blasting only during daylight hours.

Chapter 13 – Nature Conservation

Section 13.3.7 – Management of Aquatic Fauna

- where practicable, development of the old McArthur River Channel will be delayed until riparian ecosystem functionality of the surrounding channel has been enhanced
- In order to retain the Barney Creek and the McArthur Channels as functioning ecosystems and avoid impacts on aquatic biodiversity, buffer zones in excess of 70 m will be maintained between the OEF/ bund and waterways
- when the eastern OEF is established, banks will be stabilised by increased planting of the channel batters, direct seeding and planting of established trees to help prevent excessive erosion due to elevated flow rates and provide slow back-waters to aid upstream fish migration. Building additional baffling on the western channel wall to reduce erosion will be implemented if erosion appears
- Appropriate water management infrastructure will be incorporated into the expanded North OEF to prevent flow of contaminants into the McArthur River via drainage lines entering below the channel

Section 13.3.8 – Recommendations for monitoring of aquatic fauna

- development of the East and South OEFs will result in disturbance of the two old McArthur River channel areas. Should ecological values within the old channel areas exist immediately prior to disturbance of this area, surveys of aquatic fauna will be undertaken to identify their relevance as dry season refugia and wet season resting areas, as well as to inform the management of the potential impacts of this Project component
- due to the presence of elevated sulphate levels both within surface waters and deposited along banks of Surprise and Barney Creeks, monitoring of fish abundance and diversity in these systems will be incorporated into the ongoing monitoring program.

Section 13.4.10 – Project impacts on terrestrial fauna

- where practicable, development of the South and East OEF within the old McArthur River channel will be delayed to allow sufficient time for the ecological value of the Channel to be enhanced.

Section 13.4.11 – Management

- to maximise success of rehabilitation of the McArthur River Channel, where practicable, these areas will be avoided and buffer zones in excess of 70 m will be established and maintained according to best practice management
- where practicable, development of the old McArthur River channel will be delayed, until the ecological value of the channel has been enhanced through revegetation activities
- clearing of vegetation for the South and East OEF areas is to be staged over four years. Monitoring of riparian birds, aquatic fauna and other species of conservation significance will occur as clearing progresses
- impacts of staged clearing will be monitored within revegetation sites to allow mitigation of any impacts on successful rehabilitation, particularly along the McArthur River Channel
- increased planting and seeding of the channel batters and planting of established local provenance trees along and adjacent to the channel will be undertaken Revegetation will be conducted in accordance with MRM’s revegetation strategy

- the feasibility of a program to relocate populations of purple-crowned fairy-wrens and buff-sided robins from within the pit area and the two old McArthur River channel sites will be investigated by suitably qualified ecologists
- consideration will be given to increasing the cattle exclusion areas along the McArthur River channel and expanding these into woodland habitats will mitigate removal of habitat for purple-crowned fairy wrens, Australian bustards, Merten's water monitors and other threatened species
- fencing will be rapidly maintained following each wet season to minimise potential for cattle to enter the exclusion areas

Section 13.4.12 – Monitoring

- should the option to increase cattle exclusion areas be adopted as a management strategy, a monitoring program to assess the success of habitat improvement and fauna communities, including threatened species and indicator species, will be established.

Section 13.5.5 – Flora – Management of Impacts

- buffer areas in excess of 70 m will be retained between new mining facilities and drainage lines that are to remain functional
- where practicable, final landforms will be contoured to resemble the original local topography to include hill slopes and rocky drainage lines. This will provide a structure to facilitate the establishment of a variety of habitat types.
- buffer zones around riparian vegetation of the McArthur River Channel will be mapped and maintained and designed to prevent development of the southern and eastern OEF impeding revegetation of the channel

Chapter 14 – Cultural Heritage

Section 14.7.2 – AAPA Certificates

- prior to construction commencing, the Proponent will also apply for a new AAPA certificate for the East OEF area not currently covered by an Authority Certificate

Section 14.7.3.2 – Archaeological and Historical Sites Management

Site No.	Actions to be taken
MRM3	Fenced with star pickets at regular intervals along the boundary and signage indicating that entry is prohibited.
MRM4	Avoided during previous works and should also be avoided during any future works. Fenced with star pickets at regular intervals along the boundary and signage indicating that entry is prohibited.
MRM5	Permission sought to destroy the site from the Minister for Heritage. Detailed surface recording of the area carried out before disturbance by a qualified archaeologist.
MRM6	Permission sought to destroy the site from the Minister for Heritage. Detailed surface recording of the area including sample collection of artefacts carried out before disturbance by a qualified archaeologist.
BS30, BS35-36, BS38-39, BS41-55, BS58-59, and BS64-67	Permission sought from the NRETAS Heritage Branch for areas to be disturbed before works begin.
Section of the old	No further action required.

Borroloola Rd	
Mobile cattle yard	No further action required.
Clay Pigeon Shooting range	No further action required.

- a rapid response plan will be put in place to ensure that the NRETAS Heritage Branch is contacted in the event of the discovery of protected heritage objects during works at the Project site

Chapter 15 – Social Environment

Section 15.7 – Mitigation and Enhancement

- MRM is to investigate impact on family/community cohesion of personnel leaving the community to become FIFO employees from Darwin
- MRM is to work with Territory Housing to highlight limitations the social housing policy poses on expanding Indigenous employment
- MRM is to explore opportunities to encourage private developers to enter the community and develop private accommodation options, seeking input from Northern Land Council on land tenure issues
- utilise the Trust to identify proactive opportunities to work with the NT Government
- house the workforce in purpose built on-site accommodation village

Increases in local employment during the construction and operation phases may lead to a greater use of alcohol and drugs within the community. The following impact mitigation measures are proposed for the Project:

- continue enacting zero tolerance drug and alcohol policy at the Project's work site during work hours
- support community health initiatives through the Trust, sponsorships and donations, including drug/alcohol education programs and substance abuse support services
- investigate incorporating more substantial drug and alcohol management on-site as part of induction/training to encourage behaviour that can be replicated when back in the community

Increases in local employment during the construction and operation phases may lead to increases in humbugging. The Project recommends the following impact mitigation measures:

- MRM is to explore strategies to overcome social issues in consultation with NT Government and Traditional Owners/Indigenous leaders, including the possibility of setting up new models for salary payments, undertaking community education programs, and providing support to workers experiencing humbugging.

Increased traffic during the Project's construction and operation phases may lead to accelerated degradation of roads and require greater maintenance. The Project recommends the following impact mitigation measures:

- work with NT Government to highlight the importance of undertaking improvements to existing roads
- continue MRM voluntary maintenance of Mule Creek Road (located at Bing Bong)

Increased traffic during the construction and operation phases may increase the potential for more road accidents. The Project recommends the following impact mitigation measures:

- work with MRM Community Reference Group, NT Government and other groups to develop driver education programs

- work with NT Government regarding lowering the speed limit
- investigate providing bus in/out service from Borroloola to MRM mine site for all local employees.

Increase in transportation of zinc-lead concentrate during the operations phase may lead to increased risk of spills. The Project recommends the following impact mitigation measures:

- maintain and review the existing zinc-lead concentrate handling and transportation policy
- maintain the existing emergency response plan, including longer term rehabilitation requirements
- follow the disclosure policy to ensure that government and community stakeholders are made immediately aware of any incidents involving hazardous material

Extension of the life of Trust means increased potential for youth services and facilities to be implemented in the local area during the construction and operation phases. The Project recommends the following enhancement strategies:

- MRM to provide results of consultation relating to youth opportunities to the Trust Project Officer and work to help encourage grant applications in this area

Section 15.7.4 – Employment and income

The following section identifies mitigation measures and enhancement strategies for potential impacts on employment and income.

Increased employment opportunities during the Project's construction and operations phases act as a potential community benefit. The Project recommends the following enhancement strategies:

- develop community partnerships allowing flexible workplace arrangements in support of greater engagement of Indigenous personnel
- engage with the community to increase awareness regarding Project employment opportunities
- review and update communication processes to facilitate advice about employment opportunities is available in a timely manner and local people are provided with support to develop their skills and become better positioned to maximise employment opportunities
- raise awareness about MRM's Indigenous Employment Coordinator through internal engagement with staff
- review staff retention programs regularly to draw on lessons learned
- source skilled construction workers from the local area. It is anticipated that the majority of the Project's construction and operational workforce will be employed on a FIFO arrangement from Darwin

Increased employment opportunities for locals and youths during the construction and operation phases act as a benefit to the community. The Project recommends the following enhancement strategies:

- continue involvement in and support of the Northern Territory Government Department of Education and Training Strong Start, Bright Future program
- identify and implement mechanisms to support proactive dissemination of information about youth employment and training opportunities.

The potential extended operational mine life until 2036 acts as a benefit to the community. The Project recommends the following enhancement strategies:

- review Trust funding in 2015 (in line with the legal agreement for the establishment of the Trust) to consider contribution levels made by the Trust to community development in the local region and determine the level of ongoing annual financial commitment
- The Trust has been established for the life of mine and so will automatically be extended with the Project's implementation. Subject to periodic reviews, this will increase the total commitment of the Trust from in the order of $32 million (by 2027) to $43.3 million by 2036
- promote the Trust Project Officer's visiting times to the local community more widely.

Section 15.7.5 – Education

The following section identifies mitigation measures and enhancement strategies for potential impacts on education and training.

Increased education opportunities for locals and youths during the Project's construction and operation phases act as a benefit to the community. The Project recommends the following enhancement strategies:

- continue MRM's commitment to support local skills development and training through the Pathways to Employment strategy
- review and update the Project's communication processes to facilitate advice about education opportunities is provided in a timely manner and local people are provided with support to develop their skills and become better positioned.

Section 15.7.6 – Social, economic and political organisations

The following section identifies mitigation measures and enhancement strategies for potential impacts on social, economic and political organisations.

Opportunities for local and regional businesses to engage with the mine during construction and operation phases act as a benefit to the social, economic and political organisations. The Project recommends the following enhancement strategies:

- continue the local procurement program underpinning operations throughout the proposed Project
- communicate with local businesses to increase the level of awareness about MRM's expectations and requirements for supplier accreditation
- explore opportunities to work with business and industry groups to support local businesses wishing to attain supplier accreditation
- report success and development of local procurement programs through the MRM Community Reference Group and other local services/non-government organisations (NGO)

Chapter 16 – Economic Environment

Section 16.5.3 – Local Community infrastructure and services

in 2007, MRM, in conjunction with the Northern Territory Government, established the MRM Community Benefits Trust. MRM commits $1.35 million per year to the Trust for the first eight years. The level of funding is then subject to review for subsequent defined periods

Appendix E1 – TSF Management Plan

Section 2.1 – TSF Risk Assessment

- any seepage that does occur will be contained by a combination of measures including the low permeability clay core and cut-off key in the TSF embankment, the geopolymer cut-off barrier, the network of recovery bores and surface perimeter drains, and underliner drainage to designed collection zones

- operation of the seepage recovery bores after mine closure (if required, based on monitoring performance) will reduce the groundwater head within the TSF, so that expression of ongoing seepage will not occur on the surface
- MRM will continue to be responsible for post mine closure monitoring, and maintenance of the recovery system (if required), until closure criteria have been met and it is demonstrated that recovery wells are no longer required

Section 4.3 – TSF Cell 4 Embankment Design

- cell 4 will also include an engineered liner (such as HDPE, bentonite or clay) to further limit potential seepage from the TSF

Section 4.7 – Future Seepage Quality and Control Measures

Appropriate practices to limit the degradation of the quality of seepage water that may be released from the system will be adopted. As a minimum, provisions to be made to maintain seepage water quality or the impact of seepage migration will include:

- maintaining an appropriate tailings deposition regime (in terms of cycling periods) such that oxidation of tailings solids, with associated release of oxidation products to seepage waters, is limited. This relates to maintaining defined levels of saturation/moisture within the beach to inhibit oxidation
- monitoring of surface water and groundwater quality around the TSF to detect excessive seepage migration
- implementation of effective rehabilitation works to minimise the potential seepage footprint

It is appropriate, however, that seepage collection points be formed downstream from the embankment to enable recovery of any seepage expression occurring beyond the storage. A network of under-drains to collect any seepage and channel it to sumps for collection will be investigated during detailed design. Predictions of seepage volumes, quality and impact will occur throughout the life of mine to determine the effect of the six lines of defence.

Section 5.5 – Future Environmental Monitoring

Monitoring data will be collected as per current schedules and reported as part of the mine's Water Management Plan

Section 6.1 – Decommissioning Objectives

The main rehabilitation and decommissioning objectives of the TSF are:

- further monitor groundwater levels for five years after the seepage recovery systems have been decommissioned to confirm the mitigation of seepage from the TSF

Appendix E2 – OEF Management Plan

Section 3 – North OEF

Section 3.2.3 – NOEF Design and Operations for Stability

The design of the NOEF used the following parameters to meet the requirements of the stability analysis:

- The overall slope of the final OEF is approximately 1:4.3, comprised of the following slope components:
- nominal 13.6 m high lifts at an angle of repose of 35°, with 35 m wide berms; or

- nominal 13.6 m high lifts with batters flattened off to 1:4 slope, with a 10 m berm on every second lift

The combination of batter and berm parameters depends on the location of the slope and the rock used in its construction, as will be discussed in upcoming sections.

On-going investigation and testing of foundation conditions will be required in advance of the active NOEF areas to verify the presence of bedrock and gain site specific material properties to enable appropriate designs and operating practices to be planned.

Section 3.3 – Other Design Parameters

The NOEF has been limited to a maximum height of approximately 80m to match the height of the surrounding natural landforms. Note that the true height varies dependent on ground elevation – the design criteria employed was to limit the highest point of the OEF to 116 RL, which is the top of the nearby Mt Stubbs hill.

Section 3.7.4 – NAF Dams (Sediment Ponds)

Sediment ponds will be sized and configured during the detailed design phase of the OEFs and the TSF in accordance with the Best Practice Erosion and Sediment Control guidelines (IECA, 2008). Sediment ponds will be designed as ‘Type F’ sediment basins (see IECA, 2008).

The following is of note:

- the sediment ponds will have two zones: a settling zone to treat the sediment laden water; and a sediment storage zone for the collection of sediment that drops out of the water
- the settling zone of the sediment ponds will be sized to capture the required 63% AEP (1 year ARI) 5-day rainfall event from the contributing catchment area. The size of the sediment storage zone of the sediment pond will be 50% of the settling zone. Note that the adopted sediment pond volumes mean that the capacity of the sediment ponds will be exceeded regularly and water will spill to the receiving waters at least once in most years
- where possible, sediment ponds will be located in old drainage channels such as old or abandoned creek channels that have been isolated due to mining activities to minimise the amount of excavation required for the storage and allow water to overflow/be pumped into a natural downstream channel after treatment
- the sediment ponds will be designed for a 5-day cycle where by the sediment laden water fills the sediment pond, is treated and then pumped out to the receiving environment within a maximum of five days. The water will be then pumped down to the sediment storage zone in preparation for the next runoff event
- de-silting of the sediment pond should be undertaken as required when the sediment storage zone is close to full
- long-term sediment ponds that will be active for longer than 2 wet seasons, will be constructed with spillways designed to convey the 1% AEP (100 year ARI) discharge plus a 300 mm freeboard to the crest of the dam wall
- short-term sediment ponds that will be active for 2 wet seasons or shorter, will be constructed with spillways designed to convey the 10% AEP (10 year ARI) discharge plus a 300 mm freeboard to the crest of the dam wall
- adequate erosion protection will be required at and downstream of the spillway of the sediment pond

Section 4 – East and South OEFs

The OEFs have a setback of at least 75 m from the crest of the channels, and this buffer is over 125 m in many areas

A feature of the EOEF is a step in the top lift, which extends to a height of 80 m above ground level. This is required to ensure that the rockpile (and equipment operating on it) is safely below the Obstacle Limitation Surface (OLS) of the McArthur River airstrip. The OLS ensures safe operation of the aerodrome is possible in all weather conditions.

As a risk mitigation measure, these OEFs will not be used to store PAF overburden.

Section 4.1 – Stability Analysis

Further foundation investigations will be required to increase confidence in the design parameters before the OEFs are developed. Investigation of drainage parameters of the soils will be important.

Due to exposure of the toe of the OEFs to floodwaters of the channels, special precautions will be taken to protect them from erosion and scouring which may lead to local instability. The construction of an Erosion Protection Bund (EPB) as an integral component of the OEFs will be elaborated in later sections.

Section 4.2 – Other Design Parameters

The EOEF has been limited to a maximum height of approximately 80 m to match the height of the surrounding natural landforms, and to remain under the airstrip OLS.

The lift heights vary depending on the lift being constructed. Due to the set height of the mine levee wall (at 44 RL), the base layer is from 12 m to 18 m high. The other lifts have been designed to a nominal height of 15 m. Lower lift heights may be used to enhance stability and reduce differential settlement in certain circumstances, depending on materials used and compaction factors.

The EPB is a trapezoidal shaped bund wall that will be constructed out of select NAF fill. The rock wall must be permeable to enable any high levels of water to drain away from the toe of the OEFs. The crest width is a nominal 20 m wide, assuming that mining operations haul trucks will be used to construct the wall – this may be reduced if smaller equipment is utilised. The outer face will be constructed to a 1:4 slope with a coarse rock erosion protection armour layer. The inner batter will be constructed to an angle of 1:2. The crest elevation has been set to the 100 year ARI event level, which changes along the length of the wall, but is typically around 39 m AHD to 41 m AHD. This makes the wall from 5 m to 13 m high, depending on local topography.

Section 4.5.2 – Dirty Water Drains and Sediment Ponds

If runoff and/or seepage from South and East OEF areas are found to be contaminated, active management measures and/or additional storage volume would be required to fully contain the contaminated water on site

Dirty runoff drains constructed on the outer perimeter of the dump (which is exposed to McArthur River and Barney Creek floodwaters) will be located on the inside toe of the proposed Erosion Protection Bund. Runoff from the contributing areas will be directed to temporary sediment ponds located at the inside toe of the erosion protection bund.

Overflows from the sediment ponds will either seep through the EPB or flow through a spillway (overflow) pipe through the EPB. The final design of the sediment pond spillways will depend on the permeability of the erosion protection bund. One-way flap gates may be required on the end of the sediment pond pipe spillway to prevent McArthur River water from back-flowing into the sediment pond during periods of high flow.

The proposed drainage system would be protected from the McArthur River and Barney Creek flooding by the EPB. However, the proposed drainage system would be inundated by McArthur River floodwater seeping through the EPB on average every 2 to 5 years. Note that the dirty runoff management controls located along the EPB will be progressively covered over by NAF material as the OEFs progress towards the EPB. Rehabilitating the OEF close behind the advancing face will be important in managing erosion once the ground level sediment controls are buried.

Section 4.6 – Staged Development and Rehabilitation Strategy

The SOEF and EOEF staging is shown in the below figures. The strategy for the development of these OEFs is outlined below:

- the EPB will always be advanced in front of the bulk OEF tipping to ensure that water management and erosion controls are in place. Vegetation clearing and topsoil stripping will only occur in the dry season. Cleared and stripped areas not protected by the EPB must have rock tipped over them before the annual wet season
- the SOEF will be developed first, as this can be constructed to finished level very quickly, providing a large open area for storage of rehabilitation materials that will be stripped out from the EOEF footprint (topsoil and alluvials)
- the western end of the SOEF that fills in the old remnant McArthur River channel will be delayed until suitable habitat is established for fauna living in this area, subject to satisfactory control of ground and surface water in this area.
- the EOEF will then develop from the south out to the point of the triangle, but avoiding the old McArthur River channel in the north until the new channel has achieved agreed rehabilitation targets enabling this to occur
- much of the base layer of the EOEF will have to be constructed to enable a large enough area for upper lifts to be placed

The external faces of the OEFs closest to the channels will be rehabilitated as soon as practicable after construction to minimise erosion.

Section 6 – OEF Monitoring

Section 6.2 – Further Geochemical Assessment

Over 5,000 m has been drilled and sampled by both a combination of regular sample intervals and specific targeting of known PAF strata. This information will add to the existing overburden geochemistry data base. This work will continue throughout the mine life to increase data density ahead of mining.

Section 6.3 – Monitoring Program

Background soil samples in the vicinity of the proposed OEF footprints will be tested for metals to determine the significance of any enriched metals with respect to final rehabilitation. Rehabilitation of the OEF surface will be progressively undertaken and field trials will be conducted to determine any significant effects on rehabilitation success from any elevated metal concentrations in potential outer cover materials.

As the construction of the NOEF progresses, lysimeters will be installed at appropriate locations to monitor water infiltration. The lysimeter installation program commenced in 2011 at existing operations and will be described in future Sustainable Development Mining Management Plans.

Section 6.4 – Monitoring Frequency

Three new surface water quality monitoring stations are proposed to monitor the impact of the North OEF runoff on Emu Creek receiving waters. These stations will monitor the background (upstream) water quality in Emu Creek, the quality of surface runoff entering Emu Creek from the NOEF area and the impact of the NOEF on Emu Creek receiving water quality.

It is also proposed to expand the artificial surface water monitoring network to include the monitoring of the six (6) new storages proposed for the site, of which four new storages in the NOEF area, namely South-East PAF Runoff Dam (SEPROD), East PAF Runoff Dam (EPROD), North-East PAF Runoff Dam (NEPROD) and North-West PAF Runoff Dam (NWPROD) will be included.

Supplementary EIS Commitments

Introduction

This section provides an update to the commitments to further environmental and engineering works at McArthur River Mine (MRM) that were made in the draft EIS Appendix E3. It incorporates commitments made in the supplementary EIS

Overburden Characterisation

Objective

Improved overburden characterisation is required to better understand its long-term behaviour and potential environmental impact. This has applications across the project area, including the Overburden Emplacement Facilities (OEFs), the Tailings Storage Facility (TSF) and the final pit void.

Standard Geochemical Characterisation

In late 2011, 915 overburden samples were collected from 18 drillholes for geochemical analysis. All of these samples are undergoing standard geochemical analysis including:

- Total Sulphur
- Net Acid Production Potential (NAPP) including:
    - Total Sulphur (S)
    - Acid Production Potential (APP)
    - Acid Neutralising Capacity (ANC)
    - Net Acid Generation (NAG)
    - Total Carbon (C)

These tests form the basis for Acid-Base Accounting techniques used to determine the classification of overburden material as either potentially acid forming (PAF) or non-acid forming (NAF).

Specialised Geochemical Characterisation

Results from the standard geochemical characterisation will be reviewed and interpreted by suitably qualified and experienced geochemists to determine any necessary specialised geochemical analysis that may be required (e.g. sulphur speciation, carbon speciation, kinetic NAG testing, sodicity, dispersion, multi-element analysis, etc.) for a detailed characterisation of the overburden material at MRM.

A report will be produced outlining the analysis undertaken, results, conclusions and recommendations. This will have applications in the improvement of the understanding of overburden material within the OEFs, the tailings material in the TSF and the chemistry of the planned final void surface of the open cut.

Geological Block Model

In addition to the standard suite of geochemical characterisation analyses, the 915 overburden samples are also being tested for parameters which are used in the current MRM geological block model (maintained by Quantitative Group (QG)). This analysis included:

- Zinc (Zn)
- Lead (Pb)
- Silver (Ag)
- Iron (Fe)
- Copper (Cu)
- pH

The results from this analysis will be used to increase the resolution and reliability of the block model and will improve the prediction accuracy of PAF material.

Field PAF/NAF Classification

Classification of PAF and NAF material is currently based on the geological block model and the geological understanding of the ore body and overburden. A recent drilling program was undertaken targeting the hanging-wall waste material to increase the data density of the geological block model. Visual checks by the Pit Technicians are conducted on blasted material to confirm the accuracy of the block model predications prior to allocating material to PAF or NAF locations within the OEFs.

A site visit from an experienced and suitability qualified geochemist is planned to review the current in-field PAF/NAF classification processes and to provide an updated procedure. The review will seek opportunities to apply classification techniques independent of the block model predications, such as the use of samples from the drilling conducted to place blasting charges, while maintaining the use of geological block model predictions and visual assessment by Pit Technicians.

Overburden Emplacement Facility

Objective

The OEFs are permanent structures designed to accommodate the overburden material extracted in the mining process. The North OEF (NOEF) and West OEF (WOEF) accommodates both PAF and NAF material, while the South OEF (SOEF) and East OEF (EOEF) will only receive NAF material. Following the overburden characterisation work outlined in Section 2, the following studies will be conducted to make any necessary improvement to the OEF design.

Geochemical Assessment

A geochemical assessment of the OEFs will be conducted, primarily focusing on the NOEF where PAF material will ultimately be stored in discrete cells within NAF material and lined by impermeable clay.

The results of the overburden characterisation investigation (Section 2) will provide an improved understanding of the nature and distribution of PAF and NAF material that will serve as a basis for this review of the OEFs.

PAF Cell Geochemistry

Geochemical assessment of the PAF material will be conducted to determine the long-term behaviour of the PAF cells within the NOEF based on the current design and construction processes. The investigation will primarily focus on the potential for acid leachate from the PAF material and the heavy metal mobilisation that could be associated with such leachate, but will also address concerns over the potential for circumneutral drainage and other forms environmental contamination.

NAF Geochemistry

The geochemistry of the NAF material will be better understood following the geochemical analysis outlined in Section 2. Of particular focus will be the potential for NAF material to act as an acid- buffer to mitigate acid leachate. NAF material will also be assessed, utilising techniques such as column leach testing, for any potential seepage of environmental contaminants including the potential for circum-neutral drainage.

Clay Liner Chemistry

Clay material is sourced on site for use as a 600 mm liner in the NOEF to prevent water and oxygen infiltration to the PAF cells, and exfiltration of potentially contaminated leachate. The geochemistry of the clay will be assessed in this investigation, to confirm its suitability for this purpose, particularly to examine the susceptibility of the clay to chemical degradation such as any potential interactions with the PAF or NAF material.

Geotechnical Assessment

Clay Liner Review

The clay material will be classified and reviewed by a suitably qualified and experienced geotechnical engineer to confirm its suitability as a clay liner for the NOEF. Particular focus will be given to confirming the optimal thickness (currently 600 mm) and moisture content of the clay liner and its long-term stability and susceptibility to cracking during extended dry periods. Any alternative liner materials identified will be assessed in comparison to the current clay material used.

Final NOEF Cover Design

The cover design of the NOEF will be reviewed to assess the required thickness of the NAF cover that insulates the PAF cells from the environment.

The final cover design will also be reviewed to determine whether the clay liner material is sufficiently covered to maintain optimal moisture levels and determine the potential for cracking and degradation of the clay as a result of periods of variable moisture.

In- pit dumping investigation

Larger-scale in-pit dumping during the mine life has been analysed by MRM in previous mine planning, with preliminary estimates of environmental and economic advantages compiled. A 2004 study shows three in-pit dumps capable of holding up to 24Mt. However, there is insufficient geotechnical data to analyse in-pit dump stability with the confidence required to include these in the current mine plan. Further geotechnical investigations will be undertaken in the future to enable the in-pit dump concept to be developed further if practicable.

Tailings Storage Facility

Objective

Tailings are deposited into the TSF, currently divided into three cells, soon to be four with the construction of an additional Cell. Cell 1 had tailings deposited by central thickened discharge and has been decommissioned and is undergoing rehabilitation. Cell 2 is currently used for tailings deposition (at approximately 48-53% solids). Cell 3 is currently used as a water management dam (WMD).

Within two years of tailings disposal in Cell 1, elevated sulphate was observed through routine monitoring of nearby Surprise Creek. While Pb and Zn concentrations have remained at background concentrations, a 2011 hydrogeochemical report on the TSF identified the potential for Pb and Zn breakthrough and the generation of acid leachate from the tailings.

MRM is committed to mitigating seepage from the TSF and will consider all available options, including but not limited to the reprocessing of tailings or relocation of TSF Cell 1. The following investigations will be conducted to determine the optimal seepage mitigation techniques and to identify potential improvements to the TSF design.

Geochemical Assessment

A geochemical assessment of the tailings will be conducted to improve the understanding of this material and to develop any necessary strategies to mitigate environmental impacts (such as seepage). The review of the overburden material (Section 2) will have applications in the understanding of the tailings material.

Literature Review

The geochemists will conduct a review and evaluation of all available documentation relating to the TSF. This review will be used to determine knowledge gaps and develop a detailed plan of works for the geochemical review of the tailings.

Site Investigation

The geochemists will conduct site visits as required to investigate the seepage and to conduct sampling. Multiple, or even regular visits may be required by the geochemists.

Tailings Characterisation

Geochemical investigation of the tailings material will be conducted to characterise the material and determine its long-term behaviour. This work will assess the potential for tailings acidification, the acid neutralising potential of the tailings and the possibility of environmental contamination from the TSF. A detailed plan of works will be determined by a suitably qualified and experienced geochemist and may involve long-term column leach testing.

Recommendations

The investigation into seepage from the TSF will be multi-disciplinary (including geophysical, ecological and geotechnical investigations). Recommendations for seepage mitigations will be supplied by the geochemists to mitigate seepage from the TSF and manage tailings material long-term.

Monitoring

As well as the geochemical report on the tailings characterisation and seepage, a suitable long-term geochemical monitoring program will be developed and implemented to determine the progress of the selected mitigation techniques.

Geophysical Assessment

Seepage Review

A geophysical investigation of TSF seepage will be conducted by suitably qualified and experienced geophysicists. This investigation will characterise the seepage from the TSF, identify preferential pathways of the seepage plume, and provide mitigation recommendations.

Literature Review

The geophysicists will conduct a review and evaluation of all available documentation relating to the TSF. This review will be used to determine knowledge gaps and develop a detailed plan of works for the geophysical review of the tailings.

Site Investigation

The geophysicists will conduct site visits as required to coordinate the collection of geophysical data. Multiple, or even regular visits may be required by the geophysicists.

Recommendations

The investigation into seepage from the TSF will be multi-disciplinary (including geochemical, ecological and geotechnical investigations). Recommendations for seepage mitigations will be supplied by the geophysicists to mitigate seepage from the TSF and manage tailings material long-term.

Monitoring

The geophysicists will also be responsible for developing any required long-term geophysical monitoring program to monitor the progress of seepage mitigation efforts. The monitoring frequency and geophysical techniques used will be determined by the geophysicist based on their investigations of the TSF and the mitigation techniques selected.

Geotechnical Review

A suitably experienced and qualified geotechnical engineer will be commissioned to conduct a review of the TSF, its seepage, overall design and final cover design.

Seepage Review

Literature Review

The geotechnical engineers will conduct a review and evaluation of all available documentation relating to the TSF. This review will be used to determine knowledge gaps and develop a detailed plan of works for the geotechnical review of the TSF.

Site Investigation

The geotechnical engineers will conduct site visits as appropriate during their investigation of the TSF and during the implementation of the selected TSF mitigation techniques as required.

Potential Acid Drainage

There is no acid drainage occurring now. The Independent Monitor has raised acid drainage as a potential future risk. MRM has been working with the Independent Monitor to investigate this potential issue, as it is a complex question that needs detailed analysis of the chemical composition of the soils and ground conditions as well as the composition of the tailings deposited. MRM has commissioned a specialist study to analyse this risk.

Tailings Cover Design Review

A review of the selected final cover design of the TSF is required to ensure the tailings material will be adequately stored as TSF cells are decommissioned and rehabilitated. This investigation will also include characterisation of the clay capping material used and justification for its use, and recommendations for improvements.

Evaporation Fans

The evaporation fans have been effective in reducing the water inventory up to date in the pit area and studies suggest up to 38% can be lost through evaporation from fans at the TSF. MRM will continue to monitor and evaluate the data which will support the adaptive management planning of evaporative fans.

Recommendations

The geotechnical investigation will produce recommendations for seepage mitigation works required as part of the multi-disciplinary study of the TSF seepage. Recommendations for the final design cover and any required changes to the TSF design will also be documented.

Water Resources

The application of water quality guidelines, in conjunction with the assessment of background water quality, is an important aspect of water quality monitoring at MRM. However the MRM site is remote and monitoring programs must consider the feasibility of obtaining analysis results within the transport and analysis limitations of the site. Whilst the ANZECC guidelines provide a decision tree, this is not necessarily practical to implement the procedure at a remote site. As this is an ongoing operational issue, the Proponent will work with the Department of Resources to improve the procedure where practicable.

Groundwater

Objective

Groundwater studies at MRM will be focussed on refining estimates of inflow into the final void and its water quality. This work will have major implications for the final closure options for the void and the operational water balance and management. Investigations into sulphate mitigation and groundwater monitoring will also continue on site.

Groundwater Monitoring

Groundwater modelling at MRM will continue and additional monitoring points will be selected to collect data to improve groundwater modelling accuracy.

Groundwater Modelling

Investigation of the basement dolomite hydrology is under development to improve the understanding of deep pit inflows and the hydrogeological processes that will determine final void pit lake levels.

Other Hydrogeological Investigations

A management plan for shallow pit seepage aimed at reducing sulphate inflows prior to the 2012-2013 wet season is currently underway.

Groundwater Contribution to Djirrinmini Waterhole

The understanding of groundwater flow to Djirrinmini waterhole is limited to groundwater level measurement at MAC4 & MAC5, with the invert level of Djirinmini waterhole and groundwater modelling. For better understanding of the groundwater contribution to Djirrinmini waterhole and its impact from Mimex bore field and from mine dewatering a staged investigation is proposed. In the event of a significant water level drop at the Djirrinmini water hole, the Proponent will investigate options to 'make good' the loss of water. This could include options such as replenishing the Djirrinmini water hole with water of a suitable quality from onsite (eg. Groundwater dewatering, subject to testing). However, modelling undertaken for the Draft EIS demonstrated there will not be a significant drop in water levels. The data obtained from the monitoring program will used to validate the Draft EIS groundwater model.

Surface Water

Further surface water studies may be required depending on the results of planned groundwater investigations and cannot be ruled out at this stage. Any change in the water balance that results from groundwater investigations may necessitate a refinement of the site water management infrastructure.

The details of any planned surface water studies will be published in the annual Sustainable Development Mining Management Plan.

Ecology

Objective

Ecology work at MRM will be comprised of continuing monitoring and surveying, the development of a

Pest Animal Management Plan, and further ecotoxicological (metals) investigations.

Terrestrial flora and fauna surveys

Terrestrial flora and fauna surveys will continue to be conducted at MRM on a regular basis and will be comprised of field verification surveys incorporating quantitative and opportunistic sampling in the proposed Project expansion areas and ongoing assessment of habitats and ecosystems.

Aquatic Ecology Monitoring

Ongoing monitoring of aquatic ecology will provide further information to determine site waste discharge licence conditions.

Fish Monitoring

Fish Monitoring will continue at MRM. Objectives of the fish monitoring program are to:

- monitor fish populations in permanent and semi-permanent pools
- monitor populations of the freshwater sawfish, a Vulnerable species (EPBC Act)
- monitor fish diversity in temporary or semi-permanent pools and riffles

- monitor heavy metal levels in aquatic biota
- monitor fish passage success through the McArthur River Channel by:
  - implementing a tagging program of key fish species
  - assessing temporal migration patterns of the fish within the river and determining habitat associations and the utilisation of the Channel
  - sampling of key sites within the Channel as well as both upstream and downstream

Macroinvertebrate Monitoring

Macroinvertebrate monitoring will continue at MRM. Objectives of the macroinvertebrate monitoring program include:

- collation of baseline data on the distribution and abundance of aquatic macroinvertebrates in selected habitats within the McArthur River and associated tributaries
- monitoring of aquatic macroinvertebrates following commencement of the operational phase of the McArthur River and Barney Creek Channel
- collection of surface water and fluvial sediment data at macroinvertebrate sampling sites
- collation of environmental variable data at macroinvertebrate sites
- analysis of macroinvertebrate data to provide comparison between treatments (exposed, channel and reference sites)

Pest Animal Management Plan

MRM is committed to the production of a Pest Animal Management Plan as outlined in the EIS.

Ecotoxicology assessment

Ecotoxicology investigations are continuing. Results of the ecotoxicology assessment will factor in to the selection of TSF mitigation techniques identified in the investigations outlined in Section 4. This work will also inform application documentation for required waste discharge licences.

The Final Void

Objective

Further studies regarding the final void will be conducted to improve predictions of final void water level, water quality and potential environmental impacts associated with the various closure options.

Final Void Geochemical Characterisation

The drilling program conducted in late-2011 provides the opportunity to investigate the predicted final void surface geochemistry where drillholes have intersected with the planned final void surface, or where they have intersected strata that are representative of the final void surface.

In conjunction with the standard and specialised geochemical characterisation of overburden outlined in Section 2, a geochemical analysis of the final void surface geochemistry will be conducted. This investigation will characterise material that will ultimately remain exposed following the cessation of mining, determine its potential long-term chemical behaviour, and outline potential implications for the final void water chemistry.

Results and recommendations will be incorporated in a review of the final closure options for the void.

Closure Options

While closure options for the final void have been outlined in the draft EIS, the multi-disciplinary studies outlined in the document will have applications in the decision making process for selecting the optimal closure scenario.

This final decision will be based on the results and recommendations of the following works:

- Geochemical modelling of the predicted final void surface
- Hydrogeological modelling of inputs to the final void
- Predicted final water chemistry (hydrogeochemical analysis)

Irrigation Scheme

Objective

The Project is expected to generate water at rates the order of 30 to 40 Ml per day. Most water will be managed within existing and proposed water storage facilities. It is proposed that excess water will be directed to irrigation. A more detailed evaluation of site suitability and constraints is now required to develop a detailed design plan.

An on-site feasibility study is required to positively establish the suitability of proposed soils and the sites for irrigation development and preparation of a management plan. This will include:

- Site soil survey
- Impact assessment modelling and analysis for soils, surface water and groundwater
- Conceptual irrigation system design (potential pivot and flood irrigation areas)
- Management plan including crop establishment, crop management, irrigation management, cattle management monitoring plan, and operational resources and skill requirements
- Monitoring requirements
- Risk management plan

Soil Survey

Based on a desktop evaluation of available land system and soil mapping, a number of target areas have been identified for field investigation and soil surveying to establish suitability for irrigated pasture development.

Target sampling areas have been prioritised on the following criteria:

- Areas outside existing and planned infrastructure and known sites of cultural heritage significance.
- First preference for pivot irrigation or red and yellow Dermosols (better drained soils)
- Second preference of flood irrigation of black Vertosols (seasonally waterlogged soils)

- Proximity to the proposed Cell 4 WMD to be constructed adjacent the TSF, in order to minimise pipeline distance
- Areas deemed suitable for grazing management
- Proximity to access infrastructure
- Slopes generally less than 4 degrees

Target sampling areas are not constrained with respect to location within or outside the mineral lease boundary.

Site condition and erosion survey

With consideration to identified soil types, a high level erosion assessment will be developed to:

- Identify areas of current erosion
- Identify type of erosion
- Identify erosion hazards (potential erosion from changed management) from a desktop study
- Identify management measures by erosion type

This assessment will be carried out according to Work Instruction QWI-008 Site surveying and mapping. Erosion condition will be recorded using QMF-061 Erosion Survey Form.

Soil profile characterisation

Soil pit sampling and profile characterisation will be carried out at an intensity sufficient to map soils to a scale of 1:25:000. This will involve sampling at a density of approximately 1 pit every 6.25 ha. Based on the minimum required area of 125 ha, this equates to 20 sampling pits. Provision for sampling of 25 pits has been made based on sampling the immediate buffer of the target irrigation area, and allowance for sampling of sites that prove unsuitable due to soil depth, impeding layers, sub-soil physical or chemical conditions etc.

Initial cores will be excavated by hand auguring at the time of the initial site reconnaissance. This will be followed by pit excavation for more detailed profile characterisation using a backhoe or excavator. Subject to local soil conditions, a tracked excavator may be required. Procedures for soil pit excavation are detailed in Safe Work Method QWM-005 Machine based excavation for soil sampling.

Soil profile parameters will be collected using the methodology outlined in the Australian Soil and Landscape Field Handbook, 2009. Procedures are outlined in Work Instructions QWI-006 Land Assessment. Consistent with McKenzie et al (2008), detailed profile characterisation will be carried out at approximately 30% of sampling sites. Mapping observation pits will be carried out at the balance of sites. Procedures are outlined in Work Instructions QWI-001 Detailed Profile Characterisation and QWI-002 Mapping Observation pit characterisation. Site data for detailed profile characterisation pits will be recorded using QMF-054 Detailed pit sampling proforma, and using QMF-055 Mapping Observation pit sampling proforma for mapping observation pits. QMF-056

Soil pit proforma parameter codes details relevant codes for these forms.

Soil chemical analysis

Consistent with McKenzie et al (2008), it is proposed that all detailed profile characterisation sites be analysed for chemistry. Samples will be collected from 10 cm deep intervals throughout the profile at the depths illustrated in QMF-056 Soil pit proforma parameter codes. Chain of custody for samples will be controlled through either QMF-057 Chain of Custody Soils and Foliar TCT or the equivalent provided by a NATA Certified laboratory.

A standardised set of soil chemical analysis sufficient to adequately characterize the soil profile suitability for irrigation development and to provide parameters for input to key models is set out in QWI-007 Soil laboratory analysis for irrigated land use evaluation.

Impact Assessment

The results from site and soil surveying will be used to provide input to quantitative and qualitative assessments of likely impacts of irrigation on soils, surface waters and ground-waters, and to inform management requirements.

Soils

Modelling/Analysis approach	Outcome
Water balance modelling using How Leaky	Estimation of crop water use demand (transpiration), evaporation, runoff and deep drainage to inform maximum irrigation application rates, frequency of irrigation and irrigation system hydraulic design. Modelling to be carried out using long term climate data (SILO Data Drill).
Soil rootzone salinity using SALF	Steady state root zone salinity modelling to estimate expected root zone salinity under current land use, and future root zone salinity resulting from long-term irrigation. This will allow estimation of the impact on crop sustainability.
Soil leaching fraction using SALF	Estimation of the maximum proportion of applied water (rainfall plus irrigation) leaching below the root zone under current land use and long-term irrigation. This provides an estimate of the maximum capacity of the soils to allow leaching of salts applied in irrigation water.
Soil deep drainage estimation using SALF	Quantification of the volume applied water (rainfall plus irrigation) leaching below the root zone under current land use and long-term irrigation. This will provide inputs on salt load and water volume inputs to the estimation of groundwater and lateral seepage impacts.
Crop yield modelling using SALF	Estimation of potential crop yield decline due to accumulation of salts in the root zone.
Leaching requirement using Rhodes Equation	The required level of leaching to avoid accumulation of salts in the root zone. This will allow evaluation of the minimum leaching requirement to remain below a maximum root zone salinity. In combination with the maximum leaching capacity from SALF modelling, this allows evaluation of the capacity of a soil to sustain irrigation.
Plant available water content (PAWC)	Estimation of plant available soil water holding capacity (PAWC) using effective rooting depth and a pedo-transfer function. PAWC is a key parameter in designing irrigation rates and scheduling, to maximise crop water use, and reduce deep drainage, runoff, and risk of erosion.

Modelling/Analysis approach	Outcome
Soil sodicity/permeability impacts – interaction of ESP and SAR	Direct evaluation of TEC analysis and assessment of permeability to quantify relative and absolute changes in soil permeability due to a range of possible irrigation water qualities, and to inform required chemical amendment of water prior to irrigation to maintain acceptable permeability.
Soil and crop nutrient buffer capacity	Direct estimation of soil and crop capacity to absorb and buffer nutrients applied in irrigation water and management treatments. Provides input of nutrient loss as runoff and leaching below the root zone as input into assessment of surface and groundwater impacts.

Surface Water

Modelling/Analysis approach	Outcome
Flow regime	Using estimates of runoff volumes (this study), topography and surface water flow volumes (based on prior studies), estimate impacts on surface water flow regime. This will be a high level evaluation, and may suggest the need for more intensive sampling model development if impacts are indicated to be significant, or more detailed investigation is required by the regulator.
Water quality	Using estimates of runoff volumes, nutrient concentrations and erosion hazards (this study), topography, surface water flow volumes and stream water quality (based on prior studies) estimate impacts on surface water quality and evaluate water quality against ANZECC guideline standards. This will be a high level evaluation, and may suggest the need for more intensive sampling model development if impacts are indicated to be significant, or more detailed investigation is required by the regulator.

Groundwater

Modelling/Analysis approach	Outcome
Groundwater recharge	Based on estimates of deep drainage under rain-fed and irrigation conditions, (this study), estimate the proportional increase in groundwater recharge from irrigation. This will be a high level evaluation, and may suggest the need for more intensive sampling and groundwater model development if impacts are indicated to be significant, or more detailed investigation is required by the regulator.
Groundwater quality	Using estimates of deep drainage and nutrient concentrations (this study), groundwater depth, volume, water quality and geological stratigraphy (based on prior studies) qualitatively estimate impacts on groundwater quality, and fate of nutrients leaching to groundwater. This will be a high level evaluation, and may suggest the need for more intensive sampling and groundwater model development if impacts are indicated to be significant, or more detailed investigation is required by the regulator.

Conceptual Irrigation System Design

Using the baseline studies and environmental impact analyses, a draft irrigation system location design will be prepared showing the envelope of areas suitable for irrigation system development, preliminary centre pivot locations, flood irrigation bay layouts (if applicable), pump station location and pipeline delivery line locations based on water to be sourced from the proposed Cell 4 (WMD adjacent the existing TSF.

The concept location plan will provide the basis for subsequent detailed hydraulic engineering design.

Management Plan

An agronomy specialist will engage with the Property stock manager to understand the existing stock management system, herd type and existing skills. This will be necessary to ensure that proposed management plans for irrigated grazing integrates into the wider grazing enterprise, and to identify training requirements for implementation of an irrigated grazing program.

Following engagement with the local manager and completion of the site survey and conceptual irrigation design, a summary level management plan will be developed for the combined irrigation and grazing system addressing the following issues:

- Pasture species selection
- Land preparation
- Pasture establishment
- Pasture nutrition
- Pasture management / grazing systems - initial and during production
- Weed management
- Irrigation scheduling
- Sub divisions
- Pasture monitoring program
- Operational resources and skills required
- Recommended staff training program (management and monitoring)

Monitoring Requirements

Using the baseline studies and environmental impact analyses of this study, an outlined monitoring program addressing both irrigated pasture system control and environmental compliance will be prepared. The monitoring program will be prepared in tabular format addressing:

- Parameter to be monitored
- Specific elements/analyses for the parameter (where applicable)
- Number of monitoring sites
- Frequency of monitoring

For fixed monitoring installations or repeat sampling points, a map illustrating the proposed monitoring locations will be prepared.

Risk Assessment

A standard approach to risk assessment consistent with AS/NZS ISO 31000 will be applied to evaluation of environmental and operational risks associated with the activities proposed under this irrigation development. An objective evaluation of risk likelihood and risk consequence will be made according to defined criteria to derive a risk rating with and without the implementation of control measures. Potential risks will be identified under the following categories:

- Irrigation management
- Irrigation operations
- Crop management
- Soil management
- Construction
- Stakeholders and community
- General operations

Bing Bong Cencentrate Storage and Ship Loading Facility

Maintenance and Repair

Further works are planned to repair roofing and side sheeting for the shed as necessary.

Dust Monitoring

Mini Vol® portable air samplers will be routinely placed around the site as a component of the dust monitoring program currently under revision. The proponent will collate dust monitoring data in order to assess the effectiveness of dust management practices on an annual basis within the SDMMP.

Drainage

In 2012 investigations will be undertaken into drainage works to rectify current drainage issues at Bing Bong.

Waste

Contaminated Waste

The contaminated waste facility is operated in an alternative manner and does not have infinite capacity. The current facility has an estimated capacity to receive a further three years of waste production from the site. Prior to the exhaustion of this capacity, MRM will develop alternative contaminated waste management facility locations and select the most appropriate option on the basis of operational and environmental criteria.

Sewage Treatment Facility

In consultation with the Department of Health, the Proponent will seek approval for all on-site sewerage treatment facilities in accordance with the *Public and Environmental Health Act* 2011.

Air Quality

Fugitive Dust Monitoring

MRM will install the following instruments and equipment to monitor fugitive dust:

Tapered Element Oscillating Microbalance (TEOM) analyser.

I. The TEOM provides near continuous monitoring of particle mass. The TEOM consists of an oscillating tapered tube with a filter on its free end. As particles land on the filter, the filter mass change is detected as a frequency change in the oscillation of the tube. The mass change and the flow rate through the system provide a measure of the particle concentration. Is typically operated at 10-minute intervals.

II. Relates to Australian Standards AS 3580.9.8-2001: Method for sampling and analysis of ambient air-Determination of suspended particulate matter – PM10 continuous direct mass method using a tapered element oscillating microbalance analyser

III. Operation at 10-minute intervals, allows detailed comparison with meteorological conditions

IV. Data is stored at regular intervals

V. The TEOM can be configured with an alarm system that is set off when Trigger Levels are exceeded, which is useful for management purposes

Mini Vol® Tactical Air Sampler

I. Low volume sampler that collects particles by drawing a constant flow rate of ambient air through filter paper using a small pump

II. Provides a quantitative sampling and measuring technique for particle pollutants (active)

III. Operated over a 24 hour period

IV. Relates to the following Australian Standards:

- 1. AS/NZS 3580.9.92006; Methods for sampling and analysis of ambient air-Determination of low volume sampler – Gravimetric method;
- 2. AS/NZS 3580.9.10.2006: Methods for sampling and analysis of ambient air-Determination of
    - suspended particulate matter – PM_{10}
    - suspended particulate matter-$PM_{2.5}$
    - low volume sampler – Gravimetric method;