18 Hazard and Risk Management

18.1 Introduction

As the McArthur River Mine Phase 3 Development Project (the Project) is an extension of the McArthur River Mine (MRM), many potential risks are already known. Well established control procedures will be carried forward into the Project, with due regard to potential variation to procedures that the Project may require at different stages.

As well as drawing upon considerable experience to date, a wide range of other sources have contributed to an overarching environmental risk assessment study identifying hazards, risks and controls for each stage of the Project – through construction and operation, to decommissioning and rehabilitation. Sources include: the parent company Xstrata Zinc; Project information; site personnel; the Northern Territory Government; ISO-31000 Guidelines; the MRM Risk Management Procedures; and existing Site Management Plans.

Xstrata Zinc submitted key Project information to the risk study, as well as qualitative advice from mine personnel and consultants to the Project.

Diverse factors taken into account when considering risks and hazards include, and are not limited to the following:

- Climatic, environmental and economic conditions which are variable and unpredictable
- Risks and hazards to humans and facilities; Hazards to the environment identified in each relevant chapter, along with mitigation measures where required
- Both natural and man-made hazards
- Hazardous materials used, transported or stored during the life of the Project, as well as the potential for adverse effects on members of the community and surrounding property owners.

The risk profile of the Project is similar to the current operations undertaken at the existing MRM. Existing management systems in place to reduce hazard and risk will be extended to include the Project. Established systems are continuously improved and updated to reflect any changes to the risk profile that may occur over time. MRM already has a number of comprehensive plans in place for the existing open pit mine to minimise risk, such as a:

- Annual Sustainable Development (SD) Management Plan
- Catastrophic Hazards Management Plan
- SD Mining Management Plan
- SD Water Management Plan
- Overburden Emplacement Facility Management Plan
- Tailings Storage Facility Management Plan
- Preliminary Mine Closure Plan
- Weed Management Plan
- Waste Management Plan.

These plans will be updated for the Project in order to minimise any potential environmental impacts.

Project risks and mitigation measures associated with the community addressed in Chapter 15 - Social Environment are cognisant of the main stakeholders.

Information provided throughout this chapter offer an understanding of the likelihood (e.g. frequency of the risk occurring and frequency of exposure) of the risk, potential severity (history direct scenario and modelling analysis) and any uncertainty about the effectiveness of controls. If levels of uncertainty do not permit robust quantification of risk, then this is acknowledged as the Precautionary Principle. The Precautionary Principle requires that if there are threats of serious or irreversible environmental harm, lack of full scientific certainty should not be used as a reason for postponing measures to prevent this harm.

ISO 31000:2009 *Risk Management – Principles and Guidelines* states: 'The confidence in determination of the level or risk and its sensitivity to preconditions and assumptions should be considered in the analysis, and communicated effectively to decision makers and, as appropriate, other stakeholders. Factors such as divergence of opinion among experts, uncertainty, availability, quality, quantity and on-going relevance of information, or limitations on modelling should be stated and can be highlighted.'

Ways that certainty can be defined include: mathematical modelling, historical experience using the planned controls, the experience of the persons making the assessment and failure history.

As discussed in Chapter 2 – Regulatory Environment, MRM supports an annual independent environmental monitoring review. MRM has conducted an environmental monitoring program since the MRM's inception, and the Independent Monitor audit reports have verified that mining and associated related operations at MRM are not impacting significantly on the surrounding environment. Verification of the effectiveness of environmental management controls in minimising site environmental impacts is demonstrated in the extensive monitoring program and accumulated large database, providing a high level of certainty in terms of environmental risks. The monitoring program will be continued and refined for the Project.

18.2 Risk Assessment Objectives

A preliminary review of risks assessed, together with mitigating management practices, has been made based on the level of detail available for the Project at the feasibility stage, and methodology provided in Australian and New Zealand Standard AS/NZS ISO 31000:2009 and the MRM risk management procedure. Objectives for the risk assessment were specifically to:

- identify the hazards and resultant risks from the Project as a whole, and threats from aspects to the Project
- rank and prioritise risks through a risk assessment process
- evaluate the risks and identify management measures to mitigate the risks.

Value judgments are involved in determining key assumptions based on existing knowledge, as well as determining a level of tolerable risk. The determined tolerable risk levels are based on previous experience at the mine and whether the risk would change for the Project.

The tolerable risk approach using the 'As Low As Reasonably Practicable' (ALARP) concept helps identify and rank potential risks according to the ability of the Project to manage the risk. This method identifies risks that are either:

- intolerable—risk cannot be justified or managed
- tolerable—risk can be managed
- acceptable—risk is minimal and requires little if any intervention or management.

Risk management measures to be implemented aim to reduce significantly the likelihood and consequence of hazards and ultimately, seek to eliminate any potentially extreme or high risks to people, property and the environment.

MRM site personnel were consulted to conceptualise all the Project activities that may have the potential to create a hazard or risk using a series of flow diagrams for construction, operational and decommissioning related activities. Process inputs, chemical storages and wastes were also included in these flow diagrams.

The Project's construction, operation and decommissioning phases will present a number of hazards and risks similar to the current risk profile at MRM. Once the detailed Project design is completed and before construction commences, a review of this risk assessment will be conducted and communicated to all relevant stakeholders.

Should Project design changes occur during operations, then the risk assessment process will be reassessed and repeated. A regular review of risk assessment will also be conducted during the operational phase of the Project to ensure that it remains appropriate.

A discussion of Project health and safety management is provided in Chapter 17 - Health and Safety.

18.3 Hazard and Risk Management Definitions

Terminology used in this chapter is defined below:

- Risk Management Process—The process of identifying hazards, assessing the risks that may result from the hazard, deciding on control measures, monitoring and reviewing the effectiveness of measures
- Hazard—A potential source of harm/damage to life, health, property and environment
- Likelihood—An assessment of the probability of occurrence
- Consequence—The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event
- Risk Rating Matrix—A matrix used to combine consequence and likelihood to a single value of risk
- Risk Score—The single numerical, priority value obtained from the risk rating matrix
- Risk—The chance of unwanted negative consequence from an injury, damage, near miss or hazard. It is measured in terms of likelihood and consequence
- Hierarchy of Control—The implementation of control methods in a formalised manner to ensure that the most disciplined controls are completed first
- Residual Risk—The remaining level of risk after risk treatment measures have been taken
- ALARP—As Low As Reasonably Practicable
- S.L.A.M.—Stop Look Assess Manage: an informal risk assessment for work tasks used by MRM
- JSA—A Job Safety Analysis is a task oriented documented risk assessment which can be applied by a work team prior to undertaking a potentially hazardous task
- WRAC—Workplace Risk Assessment and Control is an internationally recognised and used method for identifying, understanding and controlling risk.

18.4 Potential Hazard Categories

Hazard categories for the Project's construction, operational and decommissioning phases are based upon the loss of control of the environment, people and machinery in potentially hazardous situations. These hazards have the potential to occur at any time throughout the Project's life and are categorised as follows:

18.4.1 Construction Hazards

- unauthorised access to the mine site, resulting in risks of falls, drowning, engulfment, contact with vehicles, equipment and machinery, and exposure to blasting

- transport of personnel, equipment and materials to site
- working at height
- hot work
- exposure to energy sources
- confined space entry
- interaction with equipment and machinery (refer to Chapter 4 – Project Description)
- increased traffic (on-site and off-site)
- transportation, storage and use of dangerous goods
- equipment maintenance.

18.4.2 Operational Hazards

- transportation of personnel, equipment and materials to and from site
- interaction with vehicles, machinery and equipment (refer to Chapter 4 – Project Description)
- dust (from blasting, roads and stockpiles)
- fly rock from blasting
- noise and vibration impacts from blasting and machinery
- storage of chemicals/dangerous goods (e.g. explosives) and fuel on-site
- physical injuries from manual handling
- fatigue
- working at height
- excavation and management of the open pit
- ore handling, stockpiling and processing
- sewage treatment
- interactions with wildlife
- waste disposal
- road transportation of bulk concentrate
- chemical release, spills and leaks
- contact with high voltage electricity
- fire and other natural disasters.

18.4.3 Decommissioning and Rehabilitation Hazards

Decommissioning and rehabilitation hazards include:

- demolishing and removing mine infrastructure (e.g. equipment, demountables, etc.) from the site
- unauthorised access to the mine site and dangerous structures and landforms such as pit walls, dams, Overburden Emplacement Facilities (OEF) and the Tailings Storage Facility (TSF)
- loss of containment of mine water from the open pit
- erosion and OEF management
- landslides.

These hazards may result in the following risks or impacts on either human health and safety or the environment and property:

- physical injury (crushing, amputation)
- fatalities due to drowning/suffocation or other causes
- muscular injury (aches, pains)
- burns
- poisoning
- disease
- electrocution or shock
- permanent disability
- environmental damage (habitat, ecosystems, populations or individuals)
- damage to property.

18.5 Risk Management Process

The risk management process used by MRM has various levels or stages which correspond to the stages of the Project's development with an on-going process of risk assessment and management which is discussed below. This process is consistent with AS/NZS ISO 31000:2009.

The risk management process encompasses qualitative and quantitative methods typically following the stages below:

- formal risk identification
- risk reduction (via analysis)
- residual risk control to acceptable levels.

A risk analysis and a risk assessment is undertaken to identify the safety, health, environmental, social and financial risks and potential hazards associated with all significant aspects of the operation. The key requirements of hazard and risk management are as follows:

- management will ensure that all personnel have been trained and assessed as competent to manage risks associated with their role

- the risks associated with all identified hazards will be assessed. The assessment methodologies and processes will be selected having due regard for meeting the requirements of legislation and other corporate or statutory due diligence processes
- hazard identification processes shall address all life-cycle stages of a project or activity, including design, procurement, construction, commissioning, operation and maintenance, decommissioning and demolition
- processes will be established to report and record risk issues, and to enable trend analysis to be conducted
- control measures are to be implemented and monitoring programs arranged to demonstrate effective control for the reduction or elimination of risk. This process will be evaluated, documented and modified as appropriate.

To meet these requirements MRM has:

- developed a hazard management system that allows for the identification, reporting, risk assessment, recording and follow-up of actions that have been instigated through this process
- developed a business risk register and site risk profile through the use of catastrophic hazards assessments, and quantitative and qualitative risk assessments
- identified the appropriate risk assessment training and instigated the on-site training of employees and contractors who are required to manage risk-related issues
- developed a safety risk management procedure that ensures there is adequate action closure processes in place and that the emphasis is on elimination of risk, if possible, or the reduction of the risk profile to an acceptable level
- developed a site database to monitor the closure of actions and to ensure the risk management system functions, thereby reducing MRM's risk profiles to an acceptable level.

18.6 Risk Methodology

The methodology used for risk management on the Project is based upon the staged hazard study process developed in the chemical industry. The following diagram (Figure 18-1) outlines the process and identifies when the various risk management stages of the process align with the Project stages.

Hazard Studies 1 and 2 are carried out at the feasibility, development and Project specification stages and prior to capital approval of the Project. Hazard Study 3 (Hazard and Operability (HAZOP) Study and Control Hazard and Operability (CHAZOP) Study) is carried out as soon as suitable design information is available, usually when the process and instrumentation diagrams are reasonably firm.

Hazard Studies 4 and 5 are pre-commissioning studies and must be completed before process materials are introduced. Hazard Study 6 is a study of initial operation which is to be completed not earlier than three, and not later than six months after beneficial production. The objective is to develop a comprehensive understanding of the hazards and risks associated with the operation of the Project and the adequacy of the safeguards.

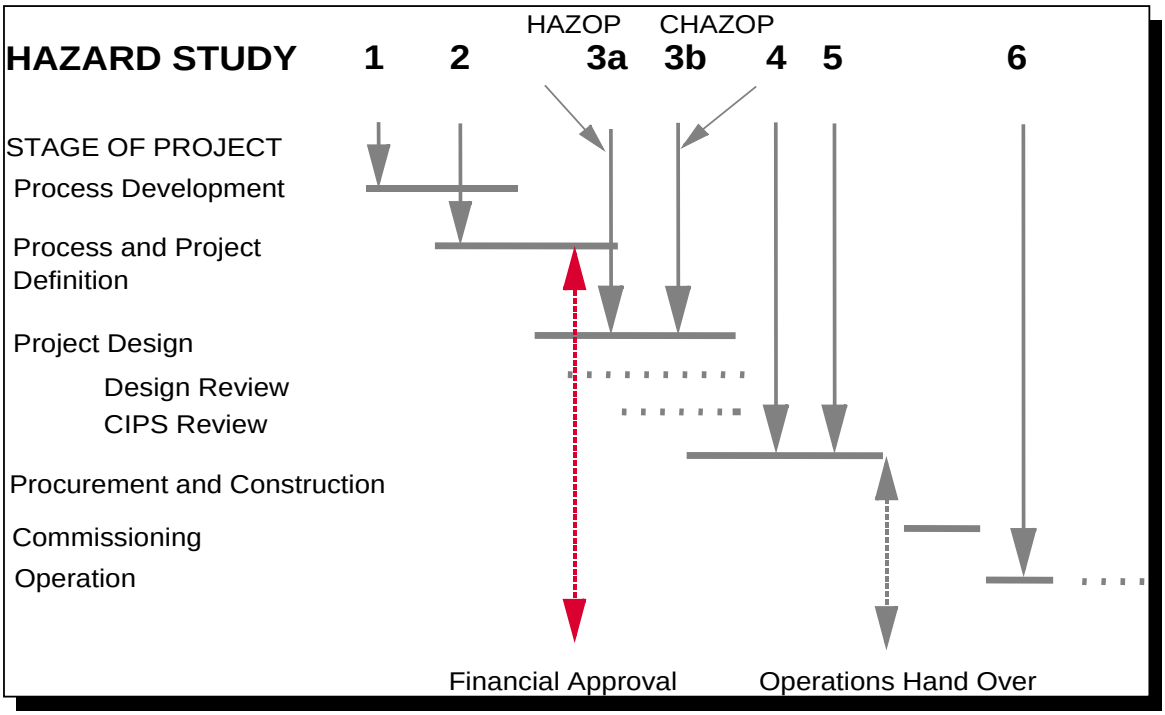

Figure 18-1 Hazard Study diagram

The relative order in which risk is managed is as follows:

- Step 1—Protect the health and safety of the general public (typically off-site risk)
- Step 2—Protect the health and safety of the personnel in the facility (on-site risk)
- Step 3—Protect the natural environment from contamination (on-site and off-site risk)
- Step 4—Protect plant equipment and property (on-site risk)
- Step 5—Protect the business (financial and reputation risk).

Risk management is a dynamic (or iterative) process, as much about identifying opportunities, as avoiding or minimising losses. Risk potential is minimised via several strategies, not limited to the appropriate selection of materials to be utilised, modern design and construction of facilities that are appropriate for the climatic and other conditions, minimising the levels of stock of hazardous materials held on-site and appropriate management.

The 'Hierarchy of Controls' is the recommended method for reducing risk in order of preference from:

- elimination of the hazard
- substitution of the hazard with a lesser risk
- use of engineering controls
- isolation of the hazard from people, plant and processes
- use of administrative controls such as training
- use of personnel protective equipment (PPE).

18.7 Hazardous Materials

Current systems for managing hazardous materials on-site outlined in this section will be expanded and adapted for the Project.

18.7.1 Management System

MRM implements a combined Sustainable Development Management System in line with Xstrata plc's Sustainable Development Framework. This management system comprises policy, standards and procedures which can be cross mapped to ISO 140001 and AS/NZS 4801. Each standard has also been developed in-line with the Minerals Council of Australia Enduring Value Principles for Sustainable Development.

Risk management at MRM is conducted via the following systems:

- maintaining a Catastrophic Hazards and Departmental Risk Registers
- conducting formal risk assessments
- development of Job Safety Analysis for tasks
- implementation of an informal risk assessment process (S.L.A.M.)
- Assessment of controls through workplace inspections and safe work observations and training personnel in risk assessment procedures.

The process of identifying and managing sustainable development related risks as per the register at MRM is achieved by completing the following steps:

- identification of material activities and processes using checklists, incidents, and brainstorming system analysis;
- considering:
    - current and future legal requirements
    - internal and external audits
    - occupational and environmental hazard records
    - complaint records
    - potential incident and accident records
    - relevant published data
    - specialist and expert judgements.
- understanding the risks associated with the activities
- defining the hazard
- determining the cause of the hazard
- identification of current control
- consulting with key internal and external stakeholders, when appropriate, at each stage of the risk management process
- assessment of likelihood of the hazard occurring and the consequence using MRM's Risk Matrix which complies with the methodology outlined in Xstrata Zinc's Risk Matrix

- recommendations and application of further controls based on the 'Hierarchy Of Controls' as required
- planning how these controls will be implemented and by when
- periodic assurance of the adequacy and effectiveness of controls
- communication of risk register contents to MRM personnel and contractors
- integration of risks into MRM's overall risk management and planning process
- the development and implementation of incident recovery plans
- recording risks in defined registers which are reviewed at least annually.

The system incorporates the standards, policies and procedures required to meet Xstrata Zinc's corporate requirements and community obligations.

18.7.2 Hazardous Substances

MRM standards relating to the management of hazardous materials require that there are systems to:

- maintain a current inventory of all raw materials, intermediates, products, wastes and other materials that have the potential to harm the environment
- identify and assess their environmental hazards
- maintain appropriate information to enable all these materials used on site, or manufactured for sale, to be properly handled, stored, transported, used and disposed of
- establish and disseminate appropriate limits for environmental exposure to relevant materials and physical agents
- evaluate the effects of the materials, products and activities on the human environment.

To meet these requirements, MRM:

- evaluates all chemicals before they come onto site by considering safety, environmental, and supply aspects of each new chemical
- maintains a Material Safety Data Sheet (MSDS) for all site chemicals recorded on an electronic chemical management system.

MSDSs are obtained for all hazardous substances at MRM. Containers or systems in which hazardous materials are contained are labelled. Disposal of hazardous substance containers is carried out in accordance with the MSDS and relevant Northern Territory and Commonwealth Government legislation.

A hazardous substance request system is in place requiring safety, supply, and environmental approval before hazardous materials come to site. Requirements for storage, handling and disposal are determined before a chemical is purchased. All personnel handling these substances are trained in the associated procedures, including clean-up. Essential safety equipment is available at all times. An external hazardous substance and dangerous good audit is conducted annually to ensure that all of the required procedures are being followed.

18.7.3 Transportation, Storage and Handling

A variety of hazardous substances and dangerous goods are used in various areas of the operation. The supplier or supplier's contractor transports dangerous goods and hazardous substances to the mine site. All transport companies must have the correct licences for transporting dangerous goods and comply with the requirements of the Commonwealth's Dangerous Goods Code.

All hazardous and dangerous goods are handled and stored according to the information provided on the MSDSs. This information is required upon delivery of substances to MRM, or sent prior to delivery. MRM personnel have access to the safety equipment essential for the correct handling of hazardous goods and are aware of the spillage clean-up procedures.

18.7.4 Fuel and Oil

Contractors transport fuel and oil to the mine site in designated containers. Fuel is stored on-site in bulk containers located within bund walls meeting the specifications of AS 1940:2004 - *The storage and handling of flammable and combustible liquids*. Waste oil is stored in bulk containers, each of which is transported from site for recycling, as required.

18.7.5 Chemicals

Reagents used in the mineral processing plant are either delivered in bulk and transferred to designated storage tanks or are delivered in bulk bags, mixed and then transferred to designated storage tanks. Before mixing, bulk bags are stored either in shipping containers or in the reagent storage shed. Hazardous and dangerous goods are stored on-site in either a specific location (such as the reagent shed), or contained within purpose-built, bunded structures.

18.8 Risk Assessment, Management and Controls

18.8.1 Existing Operations

MRM's risk management procedures require the maintenance of a site hazard and risk register to ensure that any potential risk to the safety, health, environmental and business aspects of the operation are minimised. The register is formally reviewed by, systematically identifying the potential hazards during normal, abnormal, start-up/shutdown and maintenance operations, assessing the risks; documenting how they are to be controlled; and identifying any actions required to further mitigate the risks.

Development of the risk register involves the following steps:

- dividing MRM operations, into appropriate areas for the analysis of risk
- defining the significant activities of each area
- utilising the HIRARC database to document the risk register
- defining the hazard scenario associated with these activities
- listing the causes of the hazard category
- listing the consequences of the hazard category
- completing a gross risk ranking based on the MRM's Risk Analysis Matrix
- listing the prevention controls currently in place to prevent the hazard becoming an incident
- listing minimisation controls, human aspect controls and generic risk management procedures
- completing a net risk ranking based on the MRM's Risk Analysis Matrix
- proposing additional controls or improvement tasks as required, including allocating responsibility with an agreed date
- entering these actions into CURA for tracking purposes
- reviewing on an annual basis, or in the event of a major process change or new development.

For each of the hazard scenarios assessed, MRM has developed controls and actions to be implemented to minimise the risks. The prioritised risk management procedures undertaken by MRM are as follows:

- continue with more detailed risk assessments at a departmental level to gain improved understanding of the risks relevant to each area and provide documented improvement and contingency plans
- continue with the development of the site risk management procedure linking the various levels and techniques for risk reviews and their associated frequencies
- document and detail the risk management plans for the extreme and high risk scenarios at a site level
- continue and report on action progress
- conduct an internal auditing program to confirm existence and effectiveness of the identified controls starting with the highest risk scenarios first
- continue risk reduction/existing control improvement activities using the hierarchy of controls linked to the budget planning cycle prioritising highest risk scenarios first
- develop a site safety, health, environment and business improvement (risk reduction) plan on a timetable agreed by stakeholders
- review the common procedural controls, e.g. Permit system, Modification control, Contractor Management, SD Training/Education, Incident Management/Reporting/Analysis, Emergency Planning, and include in the improvement plan.

The team compiling the risk register determines if the current controls in place are acceptable. If controls are considered inadequate, additional actions will be proposed to reduce the risk level. The proposed action list includes target dates and responsibilities.

Each manager reviews and accepts or modifies the proposed actions. Modifications made by the manager are documented. Actions are documented in the CURA Databases a method of tracking action closure.

18.8.2 The Project

Key hazards during the Project are similar to those already identified and managed by MRM. However, a preliminary hazard study was undertaken by MRM during the Project feasibility study to identify health, safety, environmental, community and business risks associated with the Project. Following the identification of hazard scenarios and their corresponding hazard categories, the level of risk involved with each was assessed.

Assessment of risk involves two processes:

- identification of current controls (procedures, equipment etc.) that reduce risks to an acceptable level
- quantification of the likelihood of an impact occurring and the consequences of the residual impact, based on the original risk and the current controls in place.

The Project assessment was undertaken in a series of workshops attended by senior site managers and key health, safety and environmental personnel familiar with all relevant aspects of the operations. Initially all potential hazards were identified. This process generated a site hazard category table listing potential hazards.

For each of the identified hazards, the consequence and likelihood of the hazard occurring was determined and categorised according to the consequence and likelihood classifications shown in Table 18-1 and Table 18-2.

Table 18-1 Consequence Categories

Rating	Financial impact US$ EBIT	Property Damage US$	Investment Return US$ NPV	Health and Safety	Environment	Community/Reputation	Legal and Compliance
5	$100 m+ loss or gain	$20m+	$600 m+ loss or gain	Multiple fatalities and/or significant irreversible effects to tens of people	Category 5 - an incident that has caused disastrous environmental impact with long term effect requiring major remediation	Prominent negative International media coverage over several days Significant negative impact on share price for months	Major litigation or prosecution with damages of $50 m+ plus significant costs Custodial sentence for company executive Prolonged closure of operations by authorities
4	$20-$99.9 m loss or gain	$2 m-$19.9	$60 -$599.9 m loss or gain	Single fatality or Permanent disability or illness to one or more persons	Category 4 - an incident that has caused serious environmental impact with medium term effect requiring significant remediation	National media coverage over several days Significant negative impact on share price for weeks Community/NGO legal actions Impact on local economy	Major litigation costing $10 m Investigation by regulatory body resulting in long term interruption to operations Possibility of custodial sentence
3	$2 m-$19.9 loss or gain	$200 k - $2 m	$6 -$59.9 m loss or gain	Serious bodily injury or illness (e.g. fractures) and/or Lost time injury (LTI)> 2 weeks	Category 3 - an incident that has caused moderate reversible environmental impact with short term effect requiring moderate remediation	Local media coverage over several days Negative impact on local economy Persistent community complaints	Major breach of regulation with punitive fine Significant litigation involving many weeks of senior management time
2	$200 k - $1.9 m loss or gain	$10-$199.9 k	$6oo k -$5.9 m loss or gain	Medium term largely reversible injury or illness to one or more persons Restricted work injury LTI < 2 weeks	Category 2 - an incident that has caused minor reversible environmental impact requiring minor remediation	Local media coverage Complaint to site and/or regulator	Breach of regulation with investigation or report to authority with prosecution and/or moderate fine possible
1	<$200 k loss or gain	<$10 k	<$599.9 k loss or gain	First aid or medical treatment	Category 1 - an incident that has caused negligible reversible environmental impact requiring very minor or no remediation	No media coverage No community complaints	Minor legal issues, non-compliances and breaches of regulation

Table 18-2 Likelihood Categories

Level	Descriptor	Description	Guide
A	Almost Certain	The event is expected to occur on most circumstances or 'A Common or Frequent Occurrence'	Once per week
B	Likely	The event will probably occur in most circumstances or 'It has happened'	Once per month
C	Occasional	The event should occur at some time or 'I've heard of it happening'	Once per year
D	Unlikely	The event could occur at some time or 'Not likely to occur'	Once per 10 years
E	Rare	The event may occur only in exceptional circumstances or 'Practically impossible'	Once per life of facility (30 to 100 years)

By considering both the likelihood of the hazard occurring and its consequence, it is possible to categorise the risk of each scenario. For example, a hazard which is almost certain to occur and with catastrophic consequences would be rated as an extreme risk, while one that would occur rarely and have insignificant consequences would be rated as low risk. The risks have been categorised as shown in Table 18-3.

It is the nature of standard risk assessment methodology to consider all eventualities however remote their likelihood. The criterion of 'once per life of facility' is, as Table 18-2 states, a guide only. This does not mean that it will occur. It indicates the lowest likelihood of all of the scenarios assessed. Despite the expectation that such an event will not occur, it has been included in the risk assessment to ensure that adequate mitigation measures are in place. Exclusion of rare events from risk assessment would place them outside the focus of on-going management attention.

Table 18-3 Risk Categories

Likelihood of the Consequence		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
Almost certain	**A**	11	16	20	23	25
Likely	**B**	7	12	17	21	24
Possible	**C**	4	8	13	18	22
Unlikely	**D**	2	5	9	14	19
Rare	**E**	1	3	6	10	15

Risk legend:

Extreme	High	Medium	Low
18 to 25	10 to 17	6 to 9	1 to 5

A risk assessment was then undertaken for the Project by combining the consequence and likelihood of each of the identified hazards and categorising them as shown in Table 18-3. The extreme risk scenarios and the high risk scenarios (10 and above) identified by this risk assessment are shown in Table 18-4.

All of the high and extreme risks identified and evaluated in the risk assessment presented below were determined as tolerable. Likelihood of each risk was determined with consideration of MRM's proposed mitigation strategies, management actions, controls and procedures. Additional secondary risks identified in this assessment include risks to humans and facilities (such as impacts on humans as a result of vehicle accidents) and contact with hazardous and/or flammable substances.

Under MRM's continual improvement approach to risk, the latest developments in research and monitoring for high ranked risk will be reported through the annual SD Mining Management Plan, SD Water Management Plan and the Waste Discharge Licence.

As the risk assessment shown in Table 18-4 has also been identified as 'preliminary', review will occur throughout the Project's life. The first review will focus on stakeholder comments received on this draft EIS.

The level of certainty surrounding controls mitigating risk were evaluated and are listed in Table 18-4, refer to column Control Effect/Certainty. As an example, 'H' represents a high certainty that risk will be mitigated, resulting in the net likelihood of the hazard occurring, reducing to a point where residual risk is low.

Primary environmental risks for the Project identified by the Northern Territory Government in the EIS Guidelines were:

- seepage of contaminants and potential migration of tailings at the TSF
- seepage of contaminants from the OEFs
- natural disasters and extreme weather or climatic conditions that may degrade the integrity of infrastructure in the long term
- on-going management and rehabilitation of MRM.

These risks (identified in Table 18-4 above) are also addressed in detail in Chapter 5 – Rehabilitation and Decommissioning and Chapter 9 – Waste, as well as in other relevant chapters.

These risks, with accompanying control strategies are briefly discussed below.

Extreme risks identified by MRM during the Project (Table 18-4) risk assessment, are:

- palaeochannel aquifer may flood the open pit
- mine closure, including OEF rehabilitation (refer to Chapter 5 – Rehabilitation and Decommissioning and Chapter 9 – Waste)
- project approvals (refer to Chapter 2 – Regulatory Environment)
- lack of communication and consultation with the local community (Chapter 15 – Social Environment).

With the continued implementation of current risk management strategies already employed at MRM, it is considered that residual risk will not exceed generally accepted levels. Based on final detailed design and operating plans, a rigorous, more specific evaluation of hazards associated with the Project will be undertaken prior to the commencement of both the construction and operational phases.

Table 18-4 Summary of High and Extreme Risks Identified for the Project

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
Open pit Expansion	1	E-21	H-14	Strategic	Geology	Lack of data	Insufficient drill density data	• OEF not big enough • Excess acid leach drainage • Environmental impacts • Cost • Incorrect grade and metallurgical data	B	4	• Drilling program • Experience from underground mining • Current reconciliation	M	D	4	Metallurgical test work Expanded drill program	Project Manager
	2	E-24	H-15	Health & Safety/ Environment	Geotechnical issues voids Pit wall management	Pit wall failure	Groundwater pressure	• Injuries • Cost due to damage • Delays and rework • Closure issues	B	5	• Design of walls based on geotechnical modelling and experience in existing pit • Void management plans • Prism monitoring • Monitoring and inspections • Engineering mining techniques • Dewatering • Sub-surface monitoring • Surface water management • Blast design	H	E	5	Consider radar monitoring	Principal Geotechnical Advisor
	3	E-18	H-10	Health & Safety/ Environment	Geotechnical voids	Floor failure	Voids	• Injuries/ fatalities • Damages to equipment • Wall failure • Production delays	C	4	• Void management procedures • Probe drilling • Back filling allowances • Data from underground operations	H	E	4	Micro-seismic monitoring	Principal Geotechnical Advisor

Table 18-4 Summary of High and Extreme Risks Identified for the Project (cont)

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
	4	E-18	H-14	Environment	Geochemistry	• OEF manage-ment • Surface and ground-water contamin-ation	• Poor waste character-isation • Insufficient cover material • Poor water manage-ment	• Possible release of AMD (Acid Mine Drainage) • Rehandle and material cost • Metal mine drainage and contaminants • Flora and fauna impacts	C	4	• More drilling • More information to allow rigorous design and schedule of OEF • Inspections and monitoring • Leach testing • Placement of lysimeters • Cover trials by operations • Surface water management	M	D	4	• Further geochemical testing from future drilling program Increased contingency for PAF volume	Project Manager
	5	E-19	H-15	Health & Safety/ Environment	Water management groundwater	• Expansion may crack the McArthur River Channel and the levee bank	• Expanding open pit operations	• Major failure of pit due to wall collapse and/or flooding	D	5	• Monitoring • Dewater the wall in advance of mining • Groundwater and geotechnical modelling • Geotechnical design	H	E	5		
	6	E-22	E-18	Health & Safety/ Environment	Water management groundwater	• Palaeo-channel aquifer may flood the pit	• Increased inflows due to mine expansion	• Increased pumping costs • Delays to operation	C	5	• Monitoring • Groundwater modelling • In-pit pumping • Discharge license • Scheduling	L	C	4	• Options for groundwater management are under investigation	Civil Engineer

Table 18-4 Summary of High and Extreme Risks Identified for the Project (cont)

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
Tailings Storage Facility (TSF)	7	E-22	H-15	Environment	TSF expansion	Dam wall failure	• Greater pressure on the wall • Liquefaction • Piping	• Impact on ground /surface water • Mine shut down • Large fines • Reputation damage fatality	C	5	• Design and monitored to ANCOLD guidelines • Monitoring e.g. piezometers • Annual independent inspections • Survey control • Dam construction e.g. quality control • Build an additional TSF cell • Improved water management by installation of a water management dam will decrease water in the TSF • Not to be used for water storage	H	E	5	• Lowering the dam with an increase in footprint • Operation tailings deposition management • Piping to manage seepage detection • Ongoing monitoring of seepage issues	Project Manager
	8	E-24	H-14	Environment	TSF expansion Monitoring	Increased groundwater contamination	• Increased mine operations	• Seepage • Impact on ground/ surface water • Mine shutdown • Large fines • Loss of reputation	B	5	• Civil/survey monitoring of the wall-surface and position • Increased environmental monitoring • Lining of Cell 4 due to contaminated water and loss of clay • Source Cell 3 clay from Cell 4 to improve seepage control • Ongoing monitoring of seepage issues	M	D	4	• Consider increased seepage capture such as bentonite slurry wall around perimeter of TSF (consider alternative seepage management controls)	Project Manager
	9	E-24	E-22	Financial	Mine closure	• Increased footprint • Increased cost of rehabilit-ation on TSF	• Increased tailings products	• Ongoing rehabilitation cost increased due to failure to relinquish lease • Unable to recover security bond due to not meeting requirements	B	5	• Closure plan being updated to incorporate the Project • Annual security calculations in mining management plan • Progressive rehabilitation	M	C	5	• Must demonstrate a reliable strategy to allow relinquishment of the lease and successful closure of the operation	Project Manager

Table 18-4 Summary of High and Extreme Risks Identified for the Project (cont)

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
Overburden Emplace-ment Facilities (OEFs)	10	H-14	H-10	Health & Safety/ Environment	Geotechnical stability	• OEF failure i.e. slumps • May take up some sediment dam capacity due to increased erosion	• Increased risk due to increased height	• Damage to equipment • Injury/fatality • Increased cost • Truck tip over • Landform instability	D	4	• Correct design • Stability monitoring and inspection weekly & monthly • PAF preparation • Bunding around the OEF to capture any drainage intended or unintended • Windrows • Adherence to Traditional Owners request to keep height below 80 m • Communication to traditional owners • Survey and ALS imagery	H	E	4		
	11	E-22	E-19	Strategic	• Approvals • Traditional Owners	• No approval for OEF from regulators and Traditional Owners	• OEF location • OEF height • Visual amenity	• No expansion • Significant increased/ prohibitive cost	C	5	• EIS & consultation with Traditional Owners on the new designs	H	D	5		
	12	E-22	E-19	Financial/ Environmental	Mine closure	• Increased footprint • Increases cost of rehabilit-ation on OEF	• Ongoing environ-mental impacts following the end of operations	• Ongoing rehabilitation cost increased due to failure to relinquish lease • Unable to recover security bond due to not meeting requirements	C	5	• Closure plan being updated to incorporate the Project • Annual security calculations in mining management plan • Progressive rehabilitation	M	D	5		
Infra-structure	13	E-19	H-15	Health & Safety	Road to Bing Bong	• Increased traffic nine to 18 trucks a day • Increased night shift operations	• Increased traffic due to increased production	• Increased possibility of accidents • Road surface degradation • Truck rollover spills concentrate	D	5	• Roster schedules • Fatigue management • Fitness for work • Spill clean-up procedures for concentrate	H	E	5	Investigate issues relating to increased road use	EHS Manager

Table 18-4 Summary of High and Extreme Risks Identified for the Project (cont)

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
Community	14	E-25	E-19	People (HR)	Communi-cation Consultation	• Failure to commun-icate with community	• Expanding operations may provoke community reaction	• Failure of community to understand the benefits of the project and lack of support and approvals for the Project • Major delays to EIS • Failure to consult will result in regulators not accepting the EIS	A	5	• Implementing an appropriate and effective community consultation program	H	D	5		
	15	E-25	E-22	Strategic	• Approvals • Traditional Owners • Regulatory	• No approvals	• Expansion creating concern with specific groups	• Delays or no project risk to reputation • Community fails to receive benefits of services, training, and employment • Failure to consult will result in regulators not accepting the EIS	A	5	• EIS • Implementing an appropriate and effective community consultation program • Identify the key stakeholders and their positions and address appropriately • Specialist advice	M	C	5		
Concentrator	16	E-18	H-14	Health & Safety	Re-grading and drainage	Vehicle interactions	Vehicle/ Pedestrian impact	• Injury • Equipment damage	C	4	• TMP refined for delivery of plant JSEAs • Fitness for work • Safety management plan • Specific job site plans	H	D	4	Investigate scheduling options to reduce interactions	Project Manager
	17	H-17	H-13	Health & Safety		• Manual handling	• Poor manual handling practices	• Injury	B	3	• Fitness for Work • Manual handling training • Planning of tasks • Lifting equipment	M	C	3		
	18	E-18	H-14	Health & Safety		• Vehicle impacts on people or structure	• Vehicle /pedestrian impact	• Injury • Equipment damage	C	4	• TMP refined for delivery of plant JSEAs • Fitness for Work • Safety management plan • Specific job site plans	H	D	4	Investigate scheduling options to reduce interactions	Project Manager

Table 18-4 Summary of High and Extreme Risks Identified for the Project (cont)

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
	19	E-18	H-14	Health & Safety	Transport by road to site	• Traffic accidents • Vehicle interaction on haul road • Damage to equipment • Delays	• Vehicle / pedestrian impact	• Injury • Equipment damage	C	4	• TMP refined for delivery of plant JSEAs • Fitness for Work • Safety management plan • Specific job site plans	H	D	4	Investigate scheduling options to reduce interactions	Project Manager
	20	E-18	H-10	Health & Safety	Erection of steelwork	• Working at heights • Lifting, slinging (rigging, craneage) • Manual handling • Hot work • Vehicle movements • Extreme weather • Power tools • Poor scheduling	• Heights 2m-30m	• Injury/fatality	C	4	• Barricades and edge protection • Fall arrest equipment • Working at heights procedures • Designated access areas • Inspections • Dedicated construction safety advisor	H	E	4		
	21	H-14	H-10	Health & Safety	Installation of equipment	• As above plus • confined spaces	• Toxic atmospher e and heat exposure due to welding and exhaust	• Injury/fatality	D	4	• Confined spaced procedures and training • Planning • QA to minimise rework • Offsite fabrication	H	E	4		
	22	E-18	H-10	Health & Safety	Installation of services	• As above plus • tie-ins of energy sources	• Isolation failure • Poor communi-cation	• Injury/fatality	C	4	• Planning • Isolation procedures • Commissioning • Plan • HAZOP	H	E	4		
	23	E-18	H-10	Health & Safety	• Testing • Function testing	• Poorly installed or missed equipment (electrical/ energy source is greatest risk)	• Incorrectly installed plant and equipment that hasn't been recognised	• Injury/fatality	C	4	• Punch list • Experienced construction personnel	H	E	4		

Table 18-4 Summary of High and Extreme Risks Identified for the Project (cont)

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
	24	E-18	H-10	Health & Safety	Energisation & rotation and mechanical testing	• Moving parts and stored energy	• Incorrectly installed plant equipment • Ineffective punch listing and function testing	• Injury • Equipment damage • Business interruption	C	4	• Commissioning plan (incl. checklists) • Communications • Guards and barricades • Fire protection • Isolation procedures • Training (to take place prior to commissioning phase) • Mechanical planning (spare parts, MST prior to commissioning phase) • Punch lists	H	E	4		
	25	E-18	H-10	Health & Safety	Process testing	Operational related hazards	• Introduction of process feed	• Injury • Equipment damage • Business interruption	C	4	• Commissioning plan (incl. checklists) • Communications • Guards and barricades • Fire protection • Isolation procedures • Training (to take place prior to commissioning phase) • Mechanical planning (spare parts, MST prior to commissioning phase)	H	E	4		
	26	H-17	H-17	Health & Safety	New crushing plant	Dust	• Material handling • Transfer points • Crushing and breakage	• Lead and general hygiene • Environ-mental damage • Equipment damage through abrasion and corrosion • Work environment risk	B	3	• Sprays • Covers • Dust extraction • Enclosed transfer points	M	B	3	Detailed dust management plan for the crushing facility	Infrastructure Manager

Table 18-4 Summary of High and Extreme Risks Identified for the Project (cont)

Component	Hazard No.	Gross Risk Value	Net Risk After Controls	Risk Category	Task	Description of Hazard	Causes of Hazard	Consequences of Hazard	Gross Likelihood	Gross Conseq.	Controls and/or Response	Control Effect /Certainty	Net Likelihood	Net Conseq.	Improvement Required/Planned/ Mitigating actions	Responsibility
	27	E-19	H-15	Health & Safety	New crushing plant	Fire	• Conveyor belts • Electrical fire • Bushfire • Hot work • Lubricants and hydraulics • Cigarette butts	• Fatality • Equipment damage • Business interruption	D	5	• Automatic suppression in the switch rooms • Hydrants and hose reels • Extinguisher • Multiple means of egress • No smoking policy • Hot work procedures • Fire equipment maintenance contractors • Emergency response team • Emergency response plan	M	E	5		

18.8.2.1 Overburden Emplacement Facilities

Research and monitoring into the potential impacts of PAF) material and OEF management at MRM will be on-going throughout the Project's life. Detailed testing for PAF material of each area proposed for mining will take place prior to development. Management actions aimed at encapsulating the PAF materials will be continued and refined where necessary to accommodate the site specific issues.

Actions include:

- monitoring of erosion and sedimentation during operations, decommissioning and closure
- regular monitoring of surface and ground water quality
- awareness, encapsulation and monitoring of PAF wastes.

As PAF materials must be managed over timeframes beyond the Project's mining activities, the risk has been identified as high. MRM is aware of the potential impacts of operations and intends closing the site so that it may be relinquished from their care. To this end, development of the existing mine closure plan will be on-going throughout the Project's life as research continues and rehabilitation trials are monitored. More detailed information on OEF risks and their management is presented in Chapter 9 – Waste and Appendix E4 – Mine Closure Plan.

18.8.2.2 Tailings Storage Facility

Research and monitoring into the potential impacts of TSF seepage at MRM will continue throughout the Project's life, as is the current case. MRM is aware of the potential impacts of the TSF operations and intends closing the site to ensure no significant off-site impacts occur. Chapter 9 – Waste and Appendix E4 – Mine Closure Plan provides further information on TSF issues and risks.

18.8.2.3 Natural Disasters

Risk management plans have been developed to prevent and address natural hazards of bushfires and monsoonal rains that occur in the tropical north of Australia where MRM is located. Bushfires can impact people, the environment, and mine infrastructure. Fire breaks have been installed where appropriate and will be installed and maintained at all future development sites. Activities at MRM will be monitored to reduce the risk of starting wildfires. Upgrading of bushfire management plans involves consultation with the pastoral lease holder and the traditional land managers. A 'no open fire' policy will be continued on site. Currently the risk of fire is managed through MRM Catastrophic Hazard Management Plan – 'Fire' which is regularly monitored using the CURA Database.

Northern Australia experiences pronounced dry and wet seasons. Periods of high intensity rainfall increase the risk of erosion and sedimentation of mine landforms such as the OEFs and TSF. More information on the natural disaster risks are shown in Chapter 9 – Waste and Appendix E4 – Mine Closure Plan.

18.8.2.4 Rehabilitation and Mine Closure

Poorly designed mine decommissioning and rehabilitation activities can result in erosion and sedimentation, potentially uncovering encapsulated PAF material beyond mining activities. The existing OEF design will be continued, reviewed and revised according to on-going monitoring of the success of progressive rehabilitation. MRM is committed to ensuring OEFs are rehabilitated to a stable state and perform according to design.

From Xstrata Zinc's significant experience in mine closure planning and execution, the aforementioned risks have been identified as associated with decommissioning of the Project at the end of operations. To help reduce risks, a mine closure plan has already been developed and will be refined over the Project's mine life. This will continually address any hazards identified in progress.

The final closure plan will address the following:

- stakeholder involvement
- landform stability
- land use limitations
- water management
- infrastructure management.

The closure strategy will ensure the site is left in a sustainable condition, without the risk of causing harm to the community, surrounding property or the environment. Mine Closure issues are discussed in detail in Chapter 5 – Rehabilitation and Decommissioning and Appendix E4 – Mine Closure Plan.

18.8.2.5 Wastewater and Sewage

Conditions set in the Waste Discharge Licence will be met by restricting mine and process water discharges to waterways to emergency discharges only during extreme rainfall/flood conditions, significantly diluting discharges with flood waters. Any water discharge off-site will be monitored (and treated, if required) to ensure requirements of the Waste Discharge Licence are met. Water management is discussed in more detail in Chapter 10 – Water Resources.

Groundwater monitoring and management plans currently in place will be amended for the Project. Plans identify monitoring actions and potential remediation activities should groundwater dependant ecosystems experience impacts. To date this has not occurred with the existing mine. More information on groundwater management is detailed in Chapter 10 – Water Resources.

The impact of chemical spills will be minimised, as outlined in this chapter and in Chapter 9 - Waste, while sewage will be treated at the sewage treatment plant via the existing system. No sewage effluent will be discharged to waterways. Excess sludge build up will be periodically collected and will be disposed of at the TSF.

18.8.2.6 Fuel and Chemicals

In terms of volume required, the use of diesel fuel oil presents the most significant use of dangerous goods or hazardous substances for the Project. Diesel presents a low risk of uncontrolled combustion and a moderate environmental risk of potential spillage. Storage tanks will be constructed and bunded in accordance with the relevant specifications of AS 1940. Fuel storage will be expanded to cater for the increased numbers of mobile equipment on-site. Fuel tankers will continue to visit the site to refill bulk storage tanks on a regular basis.

To minimise the hazards associated with diesel leaking during tanker unloading, the following controls will be continued to reduce risks to health and safety of site personnel and potential adverse impacts to the environment:

- equipment inspection and testing programs will be undertaken to ensure reliable performance of fuel tanks and bunds
- training will be provided in the safe operation of equipment and knowledge of emergency response procedures in the event of diesel leakage
- spill containment equipment (e.g. bunds) will be built to contain any spillage of liquids
- clean storm water will be diverted away from the bunded fuel storage areas
- sumps will be constructed to collect any spillage and allow recovery
- ignition sources will be monitored and managed to avoid fire

- standard operating procedures will be developed for operators
- spill kits will be available at all fill/transfer points
- appropriate fire fighting facilities and suppression systems will be installed, maintained and available to extinguish fires
- an approved fire protection system is to be installed and maintained around new hydrocarbon storage areas.

Based on the chemical handling and storage management practices to be implemented at the Project, the residual health risk and environmental harm presented by these chemicals is expected to be low. All chemicals will be managed in accordance with the hazardous material management system developed for MRM, incorporating the provision and use of the respective MSDS.

18.8.2.7 Explosives

Blasting is currently undertaken at MRM and the number of blasts will increase slightly as a result of the Project. However, when required, and depending on the location, blasting can pose a number of potential risks, most notably, fly rock, dust, noise (overpressure) and vibration. Further discussion of these aspects is provided in Chapter 11 – Air Quality and Greenhouse Gases and Chapter 12 – Noise and Vibration.

All blasting activities are authorised by designated personnel and conducted under MRM operating procedures. Regulated procedures cover activities such as transport, loading and firing of explosives and handling of misfires. Mitigation measures currently in place at MRM include controlling access to the blast area and ensuring that blasts are undertaken by suitably qualified personnel with appropriate knowledge and training.

Transportation of initiating explosives to site will be carried out by a licensed transporter that operates in accordance with the Australian Dangerous Goods Code. The storage of explosives, detonators and boosters, will meet the requirements of AS 2187.2 *Explosives-Storage, Transport and Use*.

Explosives are stored on site and used in accordance with the relevant Northern Territory legislation (refer to Chapter 2 – Regulatory Environment) and AS 2187.2. The explosives storage facility is licensed to hold ammonium nitrate fuel oil and heavy ammonium nitrate fuel oil.

Relevant staff are trained in the storage and handling of these products. Explosives are stored on-site in a storage facility separate from other significant activities on the mine and protected from natural incidents such as flood, fire and lightning. Explosives do not pose a human risk as they are located approximately 45 km from the nearest public residence and approximately 2 km from the Project's accommodation village.

18.8.2.8 Haulage and Shipping Operations

Risks to people, the environment or nearby facilities from potential accidents associated with haulage and shipping operations have been identified as follows:

- injury or death to people from road accidents during haulage operations
- spillage of concentrate as a result of road accidents during haulage operations
- spillage of concentrate from accidents during barge loading operations
- spillage of concentrate from accidents during ship loading operations
- spillage of concentrate or fuel from accidents during barge transit.

Development of the risk analysis for haulage and shipping activities used an approach that compared the change in the level of risk between the current operations and the Project.

Current haulage and shipping operations that will be upgraded for the Project are outlined as follows:

18.8.2.9 Road-Train Loading Operations

Drivers follow a set procedure with vehicle loading. When the road-train arrives at the mine site, the first two trailers are positioned for loading. In this position, the vehicle is refuelled if required. The concentrate is loaded onto the trailers using a front-end loader.

The loader has a Roll-Over Protection Structure (ROPS) cabin with fully enclosed, pressurised air-conditioning and an absolute filtration system. The loading bay is wide enough to allow one trailer to be positioned for loading at a time. Hence the road-train is re-positioned several times to complete the loading activity.

18.8.2.10 Road-Trains and Haulage

Road-trains with covered, side-tipping trailers are used for the transport of concentrate from the mine site to Bing Bong. The trailer arrangement consists of prime movers with quad-axle trailers in a double AB configuration. The road-trains usually have a payload of approximately 120 tonnes.

MRM is approximately 115 km from Bing Bong connected by the Carpentaria Highway (including Old Bing Bong Road). This carriageway is a two-lane highway including a section which bypasses the town of Borroloola. Currently there are approximately 3,285 haul truck return trips per year between the mine and Bing Bong – an average of nine return trips per day. With the Project operations this will increase to approximately 6,570 trips, or an average of 18 return trips per day. Consequently, though Project traffic flows generated along the haul route will double from an existing very low traffic count, there will be little change in the overall risk profile.

During the history of MRM's operations there have been no overturning incidents that have resulted in spillage of concentrate into waterways or during heavy rainfall. Spillages onto the side of the road have been cleaned up with no resulting contamination. There is very little public traffic movement along this route.

For the road haulage operation, the two transfer points have been identified as the higher-risk areas for potential spillage. The transfer areas are the loading facility at MRM and the unloading ramp at Bing Bong.

Safeguards in place for loading the concentrate at the mine site include:

- loading operations taking place under cover, except as specified
- roads cleaned using a road-sweeper
- a wheel wash being used for all vehicles leaving the compound.

Safeguards at the unloading ramp at Bing Bong include:

- an unloading operation taking place undercover
- alignment of the road-train in pre-determined, marked positions for tipping
- a tipping position where the side of the trailer extends over the edge of the ramp preventing spills onto the ramp
- inspection of the road train to ensure that no concentrate is caught up in the vehicle
- provision of written tipping procedures and sequences
- a wheel wash used for all vehicles leaving the compound.

In the event of an accident that results in the spillage of concentrate, MRM's Major Concentrate Spill – Trucking Incident environmental procedure will be followed. This procedure is available to all personnel and is also located on the MRM Document Control System. Executing this procedure requires the road-train driver (or other haulage personnel) to undertake or organise the initial communication, notification, traffic control and spill containment. MRM and the haulage contractor will be contacted to clean up the spill as specified in

the procedure. In the event of a roll-over, the protective cover over each trailer of the road-train minimises any concentrate spilt.

More information on traffic and transport issues is shown in Chapter 8 – Transport.

18.8.2.11 Concentrate Shipping

Layout of Bing Bong is shown in Chapter 4 - Project Description. The concentrate storage shed at Bing Bong which currently can hold 60,000 tonnes (t) of concentrate, will be extended to hold 90,000 t in 2012 as part of the current operations. A central ramp divides the shed in half, with the conveyor tunnel creating four compartments. Depending on which compartments are to receive the load, the road-train either proceeds directly into the shed via the western entrance, or proceeds around the site run-off pond and through the eastern entrance. Stockpile control and maintenance is carried out using front-end loaders to move concentrate away from the truck discharging area near the ramp, to be stacked at the rear of the shed compartments. Concentrate holding moisture content of 12% reduces dust generation during handling.

Carpentaria Shipping Services is the contractor responsible for delivery of the concentrate to ocean-going ships anchored in the Offshore Transfer Zone. MRM staff are responsible for the management of Bing Bong and the loading of concentrate onto the bulk carrier MV Aburri (Aburri), used to transport concentrate to offshore bulk sea-going vessels.

The Aburri was designed specifically for MRM and its dimensions are 79.95 m by 18.5 m with a draft of 3.5 m and a capacity to carry 3,200 t. The bulk carrier was built to all applicable Northern Territory Marine and Australian Standards and has an International Lloyd's classification of '100 A1'. A feature of the Aburri is its ability to self-load (from a single shore mounted loading chute) at an average rate of 900 t to 1,000 t per hour (tph) and then discharge at the same rate into an ocean-going vessel. The cargo capacity of each consignment may vary from 6,400 t to 45,000 t.

The cargo handling system consists of conveyor belts, a plough station (for even distribution of the load within the hold) and a bucket wheel. The bucket wheel is the primary discharge unit that feeds concentrate onto internal conveyors, then onto a discharge boom that reaches across and into the hold of the sea-going vessel. All the equipment is managed by computer process control systems. An overview of all cargo operations, both ashore and at sea, is maintained through the use of closed-circuit cameras.

This process will be continued for the Project.

18.8.2.12 Bulk Carrier Loading Facility

An 'Autodock' system secures the vessel in a set position against the wharf using a hydraulic claw and swing arm. This arrangement guarantees precise location under the loading chute and assists with a rapid turnaround time during the loading cycle. Twin bow thrusters and twin rudders augment manoeuvrability of the Aburri.

When the Aburri is ready to be loaded, the gantry is positioned out over the edge of the wharf into position above the hold opening. Once in place and 'plugged-in', the conveyor can be started and front-end loaders feed the conveyor hoppers located inside the concentrate shed. If the loading chute is not securely in place, the conveyors cannot start.

The chain of command involves the Master of the vessel assuming final responsibility. Two or more experienced people are at all times involved with the loading process. There is a preventative maintenance program in place aboard the Aburri and at the Bing Bong plant area. As part of the program, the plant is inspected and maintained on a continuous basis. Prior to any loading, the conveyor system is operated briefly to ensure that it is functioning correctly. These tests are carried out after a thorough 30-point safety checklist has been signed off.

An interconnecting system between the Aburri and the concentrate loader instigates a shutdown when a fault is detected. This system, which prevents blocked chutes and overloaded conveyors, will be continued for the Project.

18.8.2.13 Transit Route

Once the Aburri is loaded it disengages its moorings and shuttles out to the ocean-going vessel waiting in the designated and approved offshore transfer zone (Latitude 15°15' to 15°28'/Longitude 136°25' to 136°35'). The transfer zone has an average depth, at low tide, of 14.75 m (range 13-16.5 m).

- Potential spills of concentrate or oil may occur from the following situations:
    - grounding of the vessel
    - collision with trawler or jetty
    - potential sinking during a cyclone
    - collision with ship or ship's anchor.

The risk of collision between the Aburri and sea-going vessels is very low as all approaches are carefully controlled. The two vessels are held apart by heavy-duty inflated rubber fenders. The fenders are capable of absorbing extensive pressure, able to cushion any relative differential movement that may be generated by average wind and wave conditions.

Collision between the Aburri and other vessels (e.g. fishing trawlers) is a minor risk as the Aburri operations are restricted to a predictable transit route within a low traffic density area. The vessel is well lit during times of poor visibility and two radar sets ensure that all other craft in the area are immediately detected. Collision with marine fauna risk is very low, as the Aburri operates at a low speeds to ensure the risk of occurrence is minimal.

Navigation lights lining the channel enable 24-hour operation. Accurate direction is provided by a channel leading beacon which emits a bright white light when centred and red and green for either side of the channel when off-centre. The wharf and bulk carrier have adequate lighting for safe night loading operations.

18.8.2.14 Loading of Ships in Offshore Loading Area

Current safe operating procedures for on-shore and off-shore loading of ships will be continued for the Project, taking into account variations required to accommodate higher volumes involved. For instance, spills of concentrate associated with barge and ship loading could occur from conveyors or the spout to the barge or ship. To avert risk, the transfer of concentrate cannot commence until the Masters of Aburri and the ocean-going vessel are satisfied that all necessary preparations are completed and that the prevailing weather conditions are acceptable. Once the vessels are secure, the discharge point of the loading boom is positioned in the centre of the nominated open hatch, with the chute below the hatch coaming.

Exact location of the discharge point is controlled in both horizontal and vertical planes to ensure an even distribution in the hold of the vessel being loaded. The chute at the end of the discharge boom can be adjusted as required (from a vertical position) to facilitate an even loading profile. The bucket wheel feeds concentrate progressively onto the conveyor belts by and into the discharge chute at a rate averaging 900 tonnes per hour (tph) to 1,000 tph.

- Current controls in place that have been effective in dealing with ship loading risks will be continued for the Project. Existing preventative measures put in place to address the risks of a spill from the bulk carrier operations are detailed in Table 18-5. Clean-up procedures will be implemented immediately in the event of a worst case scenario in which both the control and safety systems fail and concentrate is spilt.

- A wharf clean-up will be undertaken with a loader, or similar equipment. Spilt material will be loaded into a vehicle returning the concentrate to the storage shed. Should concentrate spills occur at the offshore transfer area, they will be evaluated on a case by case basis.

In the case of a minor spill, no recovery is planned unless routine monitoring detects a significant and adverse impact on the environment. For a significant spill:

- visible spillage will be recovered using a suction dredge with the assistance of divers
- a survey will be undertaken to determine the extent of the spill. The methodology will be consistent with that used in the monitoring program
- if required, a recovery program would be developed in conjunction with Northern Territory authorities.

- However, experience with the Bing Bong's loading facilities has demonstrated that recovery plans have not been required, and existing controls minimise the risk of spillage.

Table 18-5 Spill Control Measures for Bulk Carrier Operations

Risk	Existing Controls – To be adapted for the Project
Spillage from shore loading facilities	The concentrate loading equipment for the Aburri operates on a closed circuit system, ensuring that the shore based system cannot operate unless the Aburri's system is operating, and/or ready to receive concentrate. This 'hand shake' system also ensures that the shore-based loading chute is adequately connected to the Aburri's receipt and distribution system. A failure in any component immediately shuts-down the entire system. Restarting cannot commence until the problem has been rectified. Prior to any Aburri loading, the conveyor system is briefly operated to ensure that it is functioning correctly. Tests are carried out after a thorough safety checklist has been signed off. Drainage pipes have been installed through the conveyor tunnel walls to assist with dust clean-up measures. Small amounts of concentrate underneath, or caught up in the conveyor system, can be hosed out through pipes into the wharf sump. Excess water is pumped from the sump into the Site Runoff Pond. Preventative maintenance programs occur on board the Aburri and Bing Bong plant. As part of the program, the plant is inspected and maintained on a continuous basis.
Spillage from spout to Aburri	An overview of all cargo operations both ashore and at sea is maintained through the use of closed-circuit cameras. If the loading chute from the shore to the Aburri is not securely in place, the conveyors cannot start. Two or more experienced people are always involved with the loading.
Aburri collision with wharf	'Autodock' system used to secure Aburri in a set position against the wharf using a hydraulic claw and swing arm. This arrangement guarantees precise location under the loading chute and assists with a rapid turn-around time during the loading cycle.
Concentrate transfer spillage from Aburri to sea going vessel	Transfer of concentrate from Aburri to the sea-going vessel will not occur until both masters are satisfied that the conditions are suitable and safeguards are in place.
Spillage from deck of Aburri	Construction of gutters along each side of the Aburri has allowed efficient clean-up measures to be employed. Decks can be hosed off, with water collected in a sump near the stern ramp. The water is pumped ashore into the site run-off pond via the wharf sump.
Collision between Aburri and sea-going vessels	The two vessels are held apart by heavy-duty inflated rubber fenders. The fenders are capable of absorbing extensive pressure and will cushion any relative differential movement that may be generated by average wind and wave conditions.

Table 18-5 Spill Control Measures for Bulk Carrier Operations (cont)

Risk	Existing Controls – To be adapted for the Project
Collision between Aburri and all other craft	The vessel is well lit during times of poor visibility and two radar sets ensure that all other craft in the area are immediately detected.
Grounding of Aburri	Navigation lights lining the channel enable 24-hour operation. Accurate direction is provided by a channel leading beacon which emits a bright white light when centred and red and green for either side of the channel when off-centre.

18.8.2.15 Fuel Loading

The Aburri is normally bunkered on a monthly basis prior to each loading cycle. Fuel is supplied from a tanker truck that parks adjacent to the bulk fuel store. An underground fuel line has been constructed from the truck discharging point to the northern edge of the shed ramp, from where the line runs above ground to the vessel.

The following measures are taken to prevent or minimise an oil spill from operation of Aburri:

- although capable of carrying 256 t of fuel, the bulk carrier only carries approximately 35 t during loading operations with an average daily consumption of 5 t when operating
- Carpentaria Shipping Services operate to a 'No Spills' policy and ensures all relevant personnel are familiar with the Aburri's bunkering system
- the above ground line allows immediate recognition of any leaks or damage to the pipe if this occurs. The line is regularly inspected during bunkering operations
- 'Cam-lok' hose connections are used to secure the hose to both the truck and the Aburri. The hoses are drained of all fuel prior to any couplings being separated after fuel has been transferred. A collection bucket is available to contain small quantities that may remain in hose pockets and separated couplings. Absorbent material is available for minor accidental leaks
- the Aburri has been designed so that any accidental overfilling of a fuel tank will drain into an overflow catchment tank. The overflow tank located on the Aburri feeds into the day service tank, recirculating the fuel
- oily waste is disposed of in a suitable container as part of the general routine clean up and containment procedure.

In the event of a fuel spill, the design of the swing basin results in the containment of the majority of material. In the situation of a spillage, the fuel would be broken up through agitation created by Aburri's engines. A smaller outboard-fitted boat also assists in this process. A quantity of 'seaclean' or similar product is available for a general clean-up in the event of a fuel spill onto the wharf, or the Aburri's deck. As detergents used to disperse fuel may exacerbate harm to the natural environment, they will not be used. Lubricating and hydraulic oil is transferred from drums into Aburri's tanks. Any minor spills from the small diameter transfer hose are soaked up with absorbent materials if this occurs.

As no fuel transfer will take place between the Aburri and the sea-going vessel during the concentrate loading, no fuel should be spilt whilst Aburri is at sea. As part of the Aburri receiving classification and registration as a Class 2B coastal cargo vessel, a Shipboard Oil Pollution - Emergency Plan was developed. The Australian Maritime Safety Authority (AMSA) reviewed the plan and approved copies were distributed to the relevant regulatory authorities. These processes and control measures will be continued for the Project.

18.9 Incident Management

Incident management at MRM aims to identify and correct hazards, issues and system deficiencies to prevent recurrence of incidents as well as using lessons learnt from incident investigations to take corrective action.

Incident management procedures cover the following aspects:

- reporting incidents
- investigation of incidents
- development of corrective actions
- documentation of incident reports
- statutory and corporate notification of incidents
- communication of incidents.

In the event of an incident on-site, MRM has committed to and implemented the following:

- systems will be established and maintained for personnel to identify and report hazards and incidents
- systems will be established and maintained for the investigation of all incidents. Investigation will include steps to ensure essential factors and root causes are identified and that corrective action is taken. The recording of environmental incidents and complaints occurs
- investigations will be conducted by a level of management appropriate to the potential consequence of the incident
- only persons competent in the incident investigation process will investigate incidents
- corrective and preventive actions will be prioritised
- systems will be established and maintained to ensure completion of corrective actions, to include a process for follow-up, close-out, and feedback of information to relevant personnel
- systems will be established and maintained to ensure all corporate and legislative recording and reporting requirements are met
- systems will be established and maintained for the injury management and rehabilitation of employees following a work-related injury, illness or other adverse health effect
- internal and external complaints related to safety, health and environmental aspects of the operations are recorded, acknowledged in writing, and investigated as incidents
- incidents and non-conformance investigations will be viewed as learning opportunities. Lessons learnt and trends arising from incident investigations will be reported.

To meet these requirements, MRM has:

- established safety and environmental procedures that detail the system for investigating and reporting incidents and hazards
- developed a system of environmental incident categories. Generally, only those with potential for serious environmental risk are fully investigated. Complaints are logged as incidents and registered
- implemented a system for the follow up of actions and outcomes from incident investigations
- trained employees and contractors in the use of the incident reporting procedures and use of the environmental and safety report forms

- introduced all new employees and contractors to the incident reporting system and reporting form during the induction process
- developed an electronic database for the recording of incidents
- developed procedures and systems designed to ensure on-going treatment and rehabilitation of injured employees
- provided on-going incident investigation training for those personnel required to participate in incident investigations
- communicated the outcomes and learning experiences of incident investigations with employees and contractors through the MRM web page, safety meetings, toolbox meetings and notice boards where applicable.

All of these measures will continue to be applied during the Project's operations.

18.10 Emergency Management

18.10.1 Emergency Preparedness

MRM's key requirements of emergency preparedness are:

- the nature and scale of reasonably foreseeable emergencies, related to the MRM site and activities, will be identified and documented
- each site will develop and maintain the competencies, plans, processes and equipment needed to ensure effective response.

Emergency preparedness will be maintained at all times. The system to ensure preparedness will include:

- personnel trained in emergency response
- documented plans and procedures
- procedures to provide support to relatives of personnel who may be involved or affected
- procedures to manage interface with media, authorities and other external agencies
- mutual cooperation arrangements with external emergency services
- a process for regular testing and response exercises
- relevant emergency response procedures will be clearly explained to all MRM personnel, contractors and visitors
- emergency equipment will be available in sufficient quantities and maintained in good working order.

To meet these requirements MRM has:

- developed emergency procedures to ensure appropriate response to any foreseeable emergency situation
- provided all required resources to respond to any foreseeable emergency situation, this includes, and is not limited to:
    - emergency first aid centre with state of the art life support equipment
    - modern 4WD ambulance

  - emergency rescue truck equipped to respond to foreseeable emergency situations
  - mine rescue facilities to house the emergency rescue equipment
  - volunteer mine rescue teams.
- arranged regular training sessions for all emergency response personnel with an emphasis on external specialist providers
- conducted regular airport disaster exercises
- entered the MRM rescue teams in Northern Territory mine rescue competitions annually to test their capabilities and to benchmark against other teams
- conducted regular evacuation drills for all areas of MRM
- provided fire training for all new employees and permanent contractors
- regularly reviewed emergency procedures.

18.10.2 Emergency Response Plan

MRM has an Emergency Management Plan (EMP) in place that will be reassessed and updated for the Project where required. The EMP provides step-by-step guidance for the management of any emergency such as fire, flood, landslide, dam collapse, fuel spill, explosion or radiation, which can impact on MRM and its employees. The EMP is a component of the existing SD System.

- The EMP covering the Project will incorporate the following components:
  - an analysis of the key incidents likely to take place for each operational area
  - an assessment of the degree of impact likely to occur
  - an assessment of what constitutes an emergency for the particular operation
  - an on-site plan to handle incidents/emergencies
  - a plan covering off-site emergency services
  - communication, emergency responsibilities, control centre establishment
  - post emergency procedures, including recovery, debriefing and review of plan
  - emergency plan training and testing sessions.
- Regular hazard audits will be conducted to provide input into the EMP. As a minimum, the elements and response procedures described in Table 18-6 will be incorporated into EMP procedures. MRM consults with the Northern Territory Emergency Service with respect to planning for emergency response.

Table 18-6 Emergency Response Elements - MRM

Event	Level of Emergency	Emergency Services Required	Resources Needed	Organisational Aspects	Damage Control Actions
Vehicle collision	Local and site	Ambulance Service NT Police NT Fire and Rescue Service	Rescue Fire fighting capability Fuel containment measures	People control Evacuation of immediate and nearby area	Damage control actions Stabilise and manage situation Contain fuel spillages Control ignition sources
Falls and impact incidents	Local	Ambulance Service NT Fire and Rescue Service	Rescue Fire fighting capability Fuel containment measures	Communication Evacuation of immediate area	Stabilise Isolate source of incident
Mechanical and electrical failure	Local, site and external	Local maintenance Production staff	Replacement or utilisation of standby equipment (eg generators)	Major failure requires external communication Internal communication to maintenance groups	Isolation and possible shutdown for repair work
Fire on mine site	Local, site and potential external alert	NT Fire and Rescue Service NT Police Ambulance on alert	Fire fighting trucks and water tankers Plans and maps Site fire fighting team	Evacuation of affected mine personnel Communication, Roll call Evacuation notice	Fire control Shutdown of affected operations Evacuation from around fire sensitive areas such as fuel storage tanks and vehicles
Spillage of hazardous materials	Local, site and potential external alert	NT Fire and Rescue Service	Hazardous material containment measures	People control Evacuation of immediate and nearby area	Isolate source of incident Shutdown of affected operations Evacuation from around fire sensitive areas such as fuel storage tanks and vehicles
Injury to mine personnel	Site	First aid kit NT Ambulance Service (if life threatening)	Rescue Medical supplies	People control Communication	Identify extent of injury Respond and assist where possible until medical personnel arrive at the scene

Critical elements of the EMP such as evacuation, emergency power and remote alarm systems are tested regularly.

Fire drills are regularly undertaken. The Project site will have a team of employees trained in fire fighting, who will hold senior first-aid tickets. All fire fighting facilities and equipment will be installed, serviced, maintained and inspected by a certified body. The site will have a suitably equipped water truck that can support fire response requirements. External parties conduct regular audits of the fire protection standards.

Stores, workshops and offices will be fitted with approved and certified smoke detectors. The Project will be constructed to meet industry and fire protection standards. First-aid, fire fighting equipment and exit locations will be suitably signed. All work areas will be within the required distance to reach emergency exits. Designated first-aid and emergency rescue facilities and equipment will be available during the Project's construction and operational phases. Appropriately trained attendants will be on-site throughout the Project's life to provide first-aid and respond to site emergencies. First-aid response, as well as mine operating instructions, is currently included in the workplace induction training that is delivered to all staff members. Surrounding neighbours will also be notified in emergency situations, where appropriate.

All Project employees will be inducted onto the site and all contractors will undergo a contractor induction prior to commencing work. Existing MRM personnel and contractors are trained in basic first-aid, emergency response techniques and the SD System as part of the site specific inductions. All visitors are escorted by MRM personnel. The competency-based induction program covers SD System procedures that enable personnel to perform their duties. Refresher training is a continuing process aimed at informing all employees, including contractors, of their duties associated with the SD System procedures.

Review of the EMP will be conducted regularly, to include results from operational hazard and regular hazard audits, as well as after any significant emergency situation that occurs. A cross section of internal and external stakeholders will review the plan and record findings.

18.10.3 Emergency Response System

MRM has implemented a comprehensive emergency response system, establishing procedures to be implemented should an unplanned event or incident occur, not limited to, the following:

- fire
- flood
- chemical spills or product leaks
- fume, vapour or gas leaks
- explosions
- transport accidents
- radiation leaks
- electric shocks
- serious injury/fatality
- bomb threat
- unauthorised entry.

Emergency procedures are reviewed annually for relevance and effectiveness. Any changes arising at any time are communicated to all employees and contractors through regular safety meetings. All areas of the operation are required to undertake regular evacuation drills.

The Emergency Response Coordinator conducts an annual review of the procedures. Any changes made to the operation, which will impact on emergency response, are included in this review process. Changes will also be made as necessary throughout the year. Updated procedures are made available to all MRM managers in hard copy form, with copies kept in other locations. Copies are made available for all staff in crib rooms and via an internal electronic document management system.

Each MRM department conducts an emergency drill at least once a year to review the completeness of plans and the readiness of emergency personnel. Emergency drills also include an emergency response team and/or crisis management team involvement. In addition to this, MRM is required by the Civil Aviation Safety

Authority (CASA) to conduct an emergency drill at the aerodrome once every two years. External groups such as the police and local medical centre are involved in this scenario.

Specific details of risk assessments prepared for the Project's construction and operational phases will be incorporated into the emergency response procedures prior to commencement of any site works. Review and update of the emergency response plans will be conducted in conjunction with relevant external parties which may be involved in response - such as the Northern Territory Police and Borroloola Health Clinic. The emergency response manual will be modified, as necessary, to incorporate all relevant aspects of the Project.

18.10.4 Emergency Response Procedures

When an emergency occurs, the first person at the scene either:

- dials the emergency number which will put them through to the mill control room. The control room operator will obtain from them all the relevant information required in the emergency procedure. The appropriate on-duty personnel will then take control of the emergency situation
- announces the emergency on the MRM emergency channel (Channel 5) The area incident controller who will take charge of the emergency will answer this call
- activates Emergency Response Team pagers.

- Once the emergency has been reported, the duty Departmental Manager or an authorised representative takes over as the incident controller. All hazardous sites are evacuated and the relevant mine-site personnel and external authorities are notified so that accountabilities can be assigned.

18.10.5 Emergency Response Facilities

MRM has emergency response teams on standby for each crew. Two teams are always available on-site at any given time. Each team consists of members who are drawn from all areas of the operation.

Emergency response equipment on-site includes the following:

- fully equipped 4x4 rescue truck
- mine rescue station
- 4x4 troop carrier equipped with first-aid equipment
- 4x4 troop carrier ambulance
- first-aid centre.

Training for all emergency rescue teams involves one 12-hour day every four weeks, as well as specialised training in on site delivered by nationally accredited external trainers. Specialist external trainers are used extensively by MRM to ensure team members are trained in the latest rescue techniques.

Emergency response facilities will be reviewed and upgraded to reflect the Project's requirements.