3 Project Rationale and Alternatives

3.1 Introduction

This chapter addresses the rationale, benefits and the potential alternatives considered during the planning process for the McArthur River Mine Phase 3 Development Project (the Project). Design of the Project was considered by examining the best opportunity for the most efficient resource recovery in the context of the existing infrastructure and operations. Alternatives considered as part of the Project planning phase, including the 'no-development' scenario are also provided.

3.2 Project need and benefits

The Project will extend the successful development of an internationally significant zinc-lead-silver resource at the existing McArthur River Mine (MRM). Ongoing worldwide demand for zinc provides assurance of economic benefits to be derived from extension of mining, not limited to employment opportunities and increased export trade for the Northern Territory and national economies.

As outlined in Chapter 1 – Introduction, the Project is a component of Xstrata Zinc's US$900 million global plan that involves an increase in mine production at MRM, the installation of proprietary hydrometallurgy technology in Xstrata Zinc's San Juan de Nieva smelter in Spain and the Nordenham smelter in Germany, and potentially, further improvements in the Brunswick Lead Smelter in Canada. The plan aims to secure the long-term future of MRM in the face of a decline in availability of the traditional international markets for the bulk zinc-lead concentrate produced by the mine.

As one of the largest mines in the Northern Territory, MRM plays a significant role in the region's economic development. Current operations support local industry and business, provide jobs and training opportunities, and contribute to government revenue through taxes and royalties.

The Project rationale is driven by:

- decline in the Imperial Smelting Process (ISP) market
- growing demand for zinc
- opportunity for Xstrata Zinc to manage integrated supply chain not influenced by general ISP market.

The largest benefits of the Project are:

- increased production
- cost efficiencies from expanded operations
- increased mine life
- asset optimisation.

MRM contributes to the Northern Territory and Australian economies through:

- direct employment for staff and contractors, generating annual wages payments
- taxes and charges including payroll and group tax paid to the Northern Territory Government and Australian Government
- long-term commercial contracts for the supply of electricity and utilities by the Northern Territory Power and Water Authority
- a growing percentage of commercial suppliers sourced within the Northern Territory and the local Borroloola community including contractors, office rental, labour hire and goods and services
- investments in corporate social involvement programs
- royalties payable to the Northern Territory Government.

This important economic role will continue by extending the existing mine life by nine years until 2036. Up to 700 additional employees will be engaged directly during the respective peak construction and operation phases. Indirectly the Project will support the creation of 1,584 full-time equivalent positions across various industries both regionally and nationally.

A substantial and long-term mining operation will be secured by the Project, which will produce significant direct and indirect benefits to the Northern Territory and Australia. Economic impacts of the Project are discussed in detail in Chapter 16 – Economic Environment. Significant benefits associated with the Project range from economic support through increased employment and provision of custom to local businesses, to increased resource royalties and taxes, export income and economic support for Australia's economy and mining industry.

The benefits from the proposed Project include:

- continued contribution to the Northern Territory and Australian economies: the Project will enable the economic benefits of the mine to continue, and increase. It will contribute approximately $5.0 billion to the Gross State Product of the Northern Territory and $5.5 billion to Australia's Gross Domestic Product
- capital investment: the Project will result in a capital investment of approximately $270 million
- increased mine life: the mine life will be extended by nine years to 2036, securing the future of the mine, its output and its employees
- construction employment: during construction, there will be an average of 310 jobs created in the Northern Territory (including flow-on effects) and 330 new jobs nationally (including flow-on effects) for each year of the construction phase
- operational employment: during operations, total employment in the Northern Territory generated by MRM (including flow-on effects) will be approximately 500. National total employment will be 540 (including flow-on effects)
- sustainable growth of the current Indigenous employment and training program and local employment initiatives as a proportion of increased total employment
- industry output is expected to be boosted by approximately $8.4 billion within the Northern Territory economy. Nationally, the Project will boost industrial output by $9.3 billion
- direct purchases for equipment, goods and services during Project construction (2012 and 2013) will input more than $191 million into the local and regional economies of the Northern Territory. During the Project's operational phase between 2014 and 2036, direct expenditure for goods and services by the Project will total over $5.5 billion supporting a wide array of business support sectors within the Northern Territory's economy
- local economic activity: during both construction and operations, increased employment opportunities will be available for local residents as well as opportunities for local businesses to provide goods and services to the Project.

The Project will continue to support graduate employment and training and vacation work for students, as well as provide financial support to eligible employees wishing to undertake further postgraduate studies. These initiatives are undertaken in order to secure ongoing development and retention of a skilled and diverse workforce.

Royalty arrangements are dictated by the *McArthur River Project Agreement Ratification Act 1992* as well as the *Mineral Royalty Act 1987*. Arrangements are calculated based on a formula that takes into consideration revenue, operating costs, capital deductions, exploration expenses and other deductions approved by the Northern Territory Treasurer.

Payment of royalties is largely dependent on global commodity prices and the recovery of costs of both the mine's establishment and the open pit development. Once these costs are recovered then royalty payments are due to the Northern Territory Government. The amount paid is calculated as 20% of profit.

3.2.1 Market opportunities for zinc

World-wide, zinc is the fourth most utilised metal after iron, aluminium, and copper. Zinc is mined in more than 50 countries and produced as metal and compounds in about 40 countries. In current markets, zinc is used in a wide range of everyday consumer applications.

Zinc is a significant resource commodity for both the Northern Territory and Australia. MRM is the world's largest producer of bulk concentrate. Bulk concentrate, essentially a zinc concentrate with a high lead content, is best used as a raw material feed to zinc smelters using the Imperial Smelting Process where the zinc and lead are easily recovered from concentrate.

MRM currently supplies 70% of the world bulk concentrate market. MRM currently produces nearly 10% of Australia's production of zinc in concentrate, and 3% of the world's total zinc resources used by all types of smelters each year.

Typical zinc applications are listed below:

- galvanising: approximately half of all the zinc used is to protect steel from rusting, by using a coating process called galvanising. Steel is dipped into molten zinc, often also with aluminium. Galvanised products include steel beams, roofs, poles, wires, nails, household appliances and car bodies
- diecast objects: zinc mixed with small amounts of aluminium produces a very strong alloy. Its low melting point enables it to be diecast (cast into different shapes in steel moulds) to make a number of items (some requiring fine detail) including carburettors, door handles, staples and zips
- brass: brass (70% copper, 30% zinc) which is particularly rust-resistant and is used to make the hulls of sailing boats and other marine hardware. Other brass products include musical instruments, decorative pieces, light fittings, taps and instruments for astronomy, surveying, navigation and other scientific purposes
- batteries: when alloyed with other metals, zinc becomes an efficient electrical conductor. Zinc-bromide and zinc-nickel power cells are amongst the newest types of batteries
- health: people and animals need to ingest zinc for proper growth and the healing of wounds. Fruits, nuts, meat, oysters and other shellfish are good sources of zinc and marketing opportunities exist for the manufacture of dietary zinc supplements
- zinc oxide: zinc oxide is a unique and very useful material, used in the manufacture of rubber tyres, skin products (such as sunscreens, anti-dandruff shampoos, antiseptic ointments, and calamine lotion for healing skin disorders), paints, floor coverings, plastics (to help prevent cracking) and ceramic glazes
- zinc sulphide: zinc sulphide is used in luminous dials on watches, TV screens and fluorescent lights
- other zinc compounds: zinc is also used as a dissolving agent, to help prevent plastics from cracking, in surgical dressings, glues, and to preserve and fireproof timber.

Zinc metal output is related to zinc concentrate supply. The global market is currently in surplus. However zinc demand is closing the gap with concentrate production since the Global Financial Crisis of 2008. In 2010, global zinc demand surged 11% on the back of increased vehicle production and growth in demand from the Chinese infrastructure and construction sector.

Global zinc production in 2010 was forecast to increase to 12 million tonnes (Mt), mostly owing to increased production in Australia and China. According to the International Lead and Zinc Study Group, refined metal production increased by 11% to 12.5 Mt, while world metal consumption increased by 13% to 12.3 Mt, leaving a market surplus of 233,000 tons.

Demand for zinc generally follows industrial production or, more generally, global economic growth. Global economic activity expanded during 2010. The rise in global zinc consumption in 2010 was credited to an economic recovery in Europe (24%) as well as continued strong economic growth in China (11%). Consumption of zinc is underpinned by strong demand in China, particularly due to an increase in galvanised steel production to service growth in the construction and automotive manufacturing industries.

Global zinc demand is expected to grow approximately 4% per annum in coming years, driven by strong demand in developing countries. The forecast gap between known zinc supplies and the global demand for zinc in concentrates (refer to Figure 3-1) provides an opportunity for MRM to increase its participation in the zinc business and to capture an opportunity in the market by expanding a highly competitive zinc-lead mine operation.

The outlook for zinc demand can be summarised as follows:

- global zinc demand is forecast to grow with the strongest demands coming from China and other developing countries, especially from the galvanised sector and underpinned by vehicle production, infrastructure projects and consumer goods
- galvanising will remain the largest end-use of zinc, but demand growth is expected to be fastest in brass semis/casting and in zinc alloy consumption (principally die-casting)
- while the zinc market is currently in surplus, a market deficit is expected to emerge within the next few years as a number of existing mines reach the end of their lives and insufficient new projects have currently been identified to satisfy this forecast growth in demand.

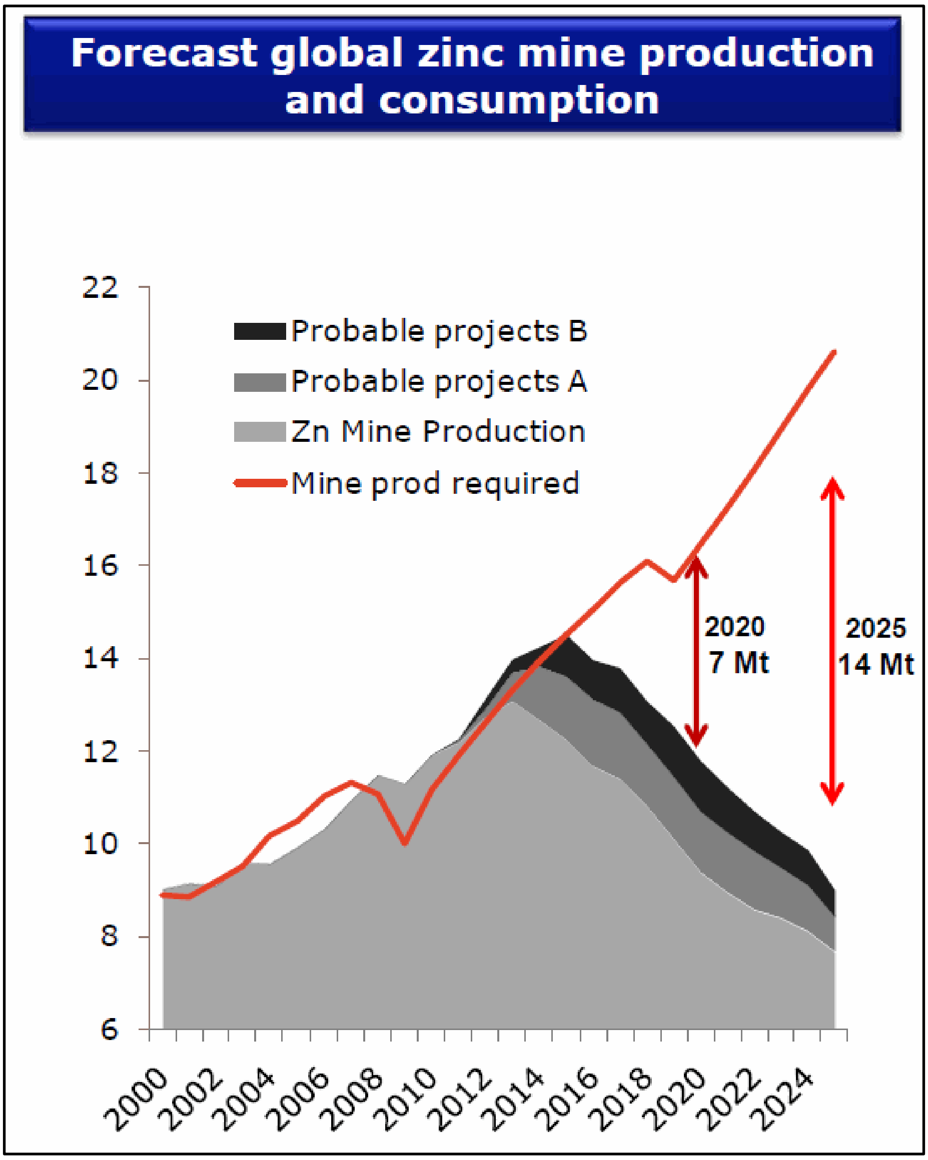

Figure 3-1 Forecast global demand for zinc (Source: Brooke Hunt, Xstrata Zinc 2010)

There has been a significant increase in global zinc production since 1996 although in recent years higher mine output from new mines has been offset by mine closures. Total world zinc consumption continued increasing at a faster pace of over 4% driven by strong growth in Eastern Europe and China where galvanising capacity has grown markedly. China has become a net importer of zinc metal since early 2004 as a consequence of higher internal consumption.

Several zinc mines are expected to close in the near future as reserves become depleted. Capacity closures of 1.9 million tonnes (Mt) are expected by 2016, while only 0.8 Mt worth of new projects are expected to come online at the same time. With the expected mine closures, about 7 Mt of new mine capacity is required by 2020 and 14 Mt by 2025 in order to meet expected demand.

China is forecast to be a net importer of zinc and lead concentrates, contributing to a tight market. Industry forecasts predict a widening gap will emerge between known zinc mine supplies and the demand for zinc in concentrates which reflects the underlying growth in demand for refined zinc.

The net effect of higher zinc consumption and a moderate growth in global metal output will place the zinc metal market supply into deficit, which should effectively support zinc prices.

Continuation of the existing MRM operation at the current capacity of 2.5 Mtpa will severely restrict Xstrata Zinc's global expansion plans. Increasing the production rate will enable the deeper and lower grade ore-bodies to be economically mined, increase the utilisation of the ore-body by extracting up to 120Mt of ore compared to the current mine plan of approximately 50Mt and increase the MRM's life by a further nine years to 2036, whilst increasing the viability of the Xstrata Zinc smelters that will process the Project's bulk concentrate. The Project will also allow Xstrata Zinc to capture a larger share of the expanding zinc market.

In summary, Xstrata Zinc aims to secure the long-term viability of the MRM operation by increasing production via maximum economic use of the mineral resource.

Should the Project not proceed, mining at MRM will be restricted as the current MRM model allows for a lower production rate only for a shorter length of time, due to reduced economies of scale. This will result in a loss of economic production for the Northern Territory and Australia, the loss of employment for the existing workforce, as well as flow-on detrimental socio-economic impacts in the region.

3.2.2 Viability of the Project

As an expansion of the current open pit mining operation, the Project will utilise an upgraded processing facility that is to be built in 2012-13. The upgrade is required for current operations as well as the Project. Sustainable development management systems currently in operation at MRM will be adapted and utilised for the Project. Additional infrastructure includes expansion of the accommodation village, water management system and power supply infrastructure.

Based on a number of vigorous economic modelling tests and decision making processes, Xstrata Zinc considers the Project to be commercially viable and of significant benefit to the future investment in its operations in the Northern Territory and Australia. The commencement of operations will still depend on economic considerations and markets once all approvals are granted. Exploration in areas surrounding MRM will be ongoing throughout the life of the Project to determine if new economical ore bodies exist that could further extend the mine life.

3.3 Environmental Objectives

3.3.1 Xstrata Zinc's Sustainability Policy

The Xstrata plc Board (the Board) establishes the strategic direction of the Group, which the Executive Management Team then implements. The Group operates a decentralised management model with authority delegated to Commodity Business Boards for Xstrata Alloys, Xstrata Coal, Xstrata Copper and Xstrata Zinc. Commodity Businesses are given a high degree of autonomy to pursue their business objectives and they operate within the Group Policies governing:

- risk management

- sustainable development
- bribery, fraud and corruption.

The Board has set the Sustainable Development (SD) Policy for application across the whole Group and expects the commodity businesses and supporting functions to implement the SD management standards and policies within the confines of what the commodity businesses consider reasonable and operationally viable.

Xstrata's SD Policy is the driver for implementing and improving the Group's SD Management Systems. A copy of the Policy is provided in Chapter 1 - Introduction. This SD Policy forms the basis upon which Xstrata sets objectives and targets and establishes the direction for management systems development for each of its commodity businesses. Commitments in the SD Policy are to be implemented by each business within Xstrata, through implementation of Xstrata's 17 SD Management Standards (Table 3-1) which establish the intent and performance requirements for Xstrata's SD. Copies of the Management Standards are available on Xstrata's website (www.xstrata.com).

Table 3-1 Xstrata's SD Management Standards

1. Leadership, Accountability and Ethics	10. Biodiversity and Land Management
2. Planning, Resources, Objectives and Targets	11. Contractors, Suppliers and Partners
3. Competency and Behaviour	12. Community
4. Communications and Engagement	13. Project Management
5. Risk and Change Management	14. Product Stewardship
6. Catastrophic Hazards	15. Incident Management
7. Legal Compliance and Document Control	16. Assessment and Reporting
8. Operational Integrity	17. Emergencies, Crises and Business Continuity
9. Health and Occupational Hygiene	

MRM has established an integrated SD Management System based on these Standards to assist with the overall environmental management of its operations**.** The SD Management System is fully compatible with the requirements of ISO 1400: 2004 *Environmental Management System*.

The Project is being developed with a focus on sustainability. In order for the social and economic benefits to be realised, the local, regional and wider environment has been considered to ensure that future generations inherit a healthy and safe environment with improved living standards. This draft Environmental Impact Statement (EIS) has been developed to identify the potential environmental impacts, assess their significance and to identify strategies to manage impacts. In conjunction with this, MRM will operate a framework of environmental management through the implementation of its integrated SD System.

The Project will be implemented in accordance with the existing Xstrata Zinc Sustainability Policy and SD Framework in order to ensure that potential impacts on the local, regional and the Northern Territory environment are minimised as far as practicable. MRM's existing SD System will be modified to incorporate the Project. In this way Project environmental management will be fully integrated with MRM's existing sustainable development objectives and systems.

Since the operation commenced, an environmental monitoring program has been conducted annually by MRM. This monitoring program, which has been developed and refined continuously since MRM's inception, includes monitoring of surface water, groundwater, artificial surface waters, sea water, potable water, marine sediment, stream sediment, dust, soil, noise, rehabilitation (vegetation and soil profile), flora and fauna, waste management aspects, and greenhouse gas emissions. The proposed Project will build on these existing environmental monitoring programs to ensure that environmental, cultural and socio-economic values are maintained. The potential environmental impacts from the Project and the proposed management strategies and monitoring programs are discussed in detail in the subsequent chapters of this draft EIS.

3.3.2 Ecologically Sustainable Development Principles

The National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development (ESD) Steering Committee, 1992) is defined as "development which aims to meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations".

The major elements of ESD include:

- integrating the economic, social and environmental concerns and needs of the community
- accounting properly for the economic costs of environmental degradation
- accepting that each generation is responsible for the welfare of future generations
- understanding environmental risk and uncertainty
- understanding the global scale of environmental issues.

Section 3A of the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* provides the principles of ESD as:

a) decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations

b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation

c) the principle of inter-generational equity that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations

d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making

e) improved valuation, pricing and incentive mechanisms should be promoted.

In the Northern Territory, the Environment Protection Authority (EPA) is responsible for providing independent advice and recommendations to the Northern Territory Government, businesses, and community about ESD. In 1992, the Northern Territory became a signatory to the Intergovernmental Agreement on the Environment and adopted the National Strategy for ESD. The Northern Territory refers to ESD in various legislative documents and policies.

ESD principles are built into the standard operating processes and procedures for all Xstrata operations. The consideration of ESD principles in the Project's planning and approval stages of the Project is further described below.

3.3.2.1 Integration of Economic, Environmental, Social and Equitable Considerations

Project decision-making and planning has addressed the principles of ESD by integrating the following:

- findings of risk assessments
- economic and financial modelling
- environmental assessment
- outcomes of consultation with key stakeholders.

Chapters 5 – 19 of the draft EIS supported by appended specialised studies, consider the potential short and long-term impacts of the Project on land resources, transport, waste, water resources, air quality, noise and vibration, nature conservation, cultural heritage, social environment, health and safety, economic environment and hazard and risk.

The assessment of risk, feasibility and the development of the mitigation measures proposed in this draft EIS demonstrate that the Project can be operated in accordance with the principles of ESD.

3.3.2.2 Precautionary Principle

MRM has conducted a Preliminary Hazard Analysis (PHA) (refer to Chapter 18 - Hazard and Risk) to identify the hazards and risks associated with the Project and propose appropriate controls and mitigation measures where required.

Where the PHA identified extreme or high risks, additional controls and mitigation measures were identified and the potential risk was reassessed with these controls in place. These controls are designed to reduce the risks to an acceptable level.

Mitigation measures to minimise the risk of serious or irreversible environmental harm as a result of the Project are proposed in Chapters 5 – 19 of the draft EIS.

3.3.2.3 Inter-generational and Intra-generational Equity

The principle of inter-generational equity requires the present generation to ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. Intra-generational equity refers to equity across communities within one generation.

The potential social and economic benefits and impacts of the Project, along with mitigation measures, have been identified and quantified in Chapter 15 – Social Environment, Chapter 16 – Economic Environment and Appendix D10 and Appendix D11.

The Project is expected to provide significant socio-economic benefits, including approximately 700 new employees during the respective construction and operational phases and an approximate 1,500 additional jobs in other industries. The Project is projected to provide significant ongoing benefits to the local, regional, Northern Territory and national economies.

The extended mine life will also extend the term of the MRM Community Benefits Trust which is the primary vehicle for the mine to support the social and economic development of the Gulf regional community.

As described above, the Proponent proposes to implement mitigation measures to minimise the risk of environmental impact as outlined in Chapters 5 – 19 in the draft EIS.

3.3.2.4 Biodiversity Conservation

Conservation of biodiversity has been a fundamental consideration in the Project's decision-making. Existing nature conservation values have been identified and the potential impacts described and quantified in Chapter 13 - Nature Conservation. From an ecological perspective, the Project will predominantly affect areas of remnant vegetation that have been disturbed by cattle grazing activities.

A range of management and mitigation measures have been proposed to manage impacts on biodiversity values. These include rehabilitation for biodiversity conservation purposes and ongoing monitoring as part of post-mining rehabilitation works.

3.3.2.5 Valuation Mechanisms

ESD requires that Project decision-making considers and internalises environmental costs, many of which currently fall outside the current market system.

The Project's economic assessment (refer to Chapter 16 – Economic Environment and Appendix D11) quantifies the economic value of the remnant vegetation proposed to be cleared.

MRM intends to internalise the costs of environmental impacts through implementing mitigation measures proposed in this draft EIS.

3.4 Potential Project Alternatives

3.4.1 Introduction

A number of alternatives were considered for the various Project components. MRM conducted a systematic evaluation of those alternatives during the scoping and feasibility studies based on a number of criteria including economics, technical feasibility and environmental and social acceptability.

Project alternatives and options considered during the planning process included:

- a range of mining methodologies, including improvements in energy consumption and efficiencies
- open pit optimisation and mining schedules, to enable sustainable production in a controlled manner
- open pit size
- location of industrial facilities
- Run-of-mine (ROM) ore handling, preparation and processing
- bulk concentrate handling and transportation
- overburden and tailings disposal for long-term, stable landforms
- disposal of general waste after all recycling options have been exhausted
- disposal of sewage
- raw water supplies for construction and operations
- improved water storages to capture and reuse mine affected water
- power supply during construction and operations
- distribution of site power
- energy use and efficiencies
- accommodation options
- methods to transport the construction and operations workforce
- rehabilitation methods
- environmental management techniques
- on-site metal production
- final void management
- no project.

The selection of the proposed development options for each Project component considered leading industry practices for construction and operation activities, energy efficiency opportunities, as well as regulatory, environmental, social and economic assessment criteria.

The alternatives presented in this section are those which have had a significant influence on the Project's development.

3.4.2 Alternatives to location

The nature of mining dictates that operations must be undertaken at fixed locations where suitable ore-bodies are found. There is very limited scope for changing the location of a mining operation because the further from the resource that mine infrastructure is located, the less likely it is that the operation will be financially viable. This relationship is the foundation of the interdependency of the Project's components.

The ore resource, the processing plant, key infrastructure and mine personnel need to be located within a certain distance of each other in order for the Project to be profitable and sustainable. Every additional kilometre of ore haulage and employee travel, decreases efficiency, thus increasing energy consumption, emissions and environmental impacts which ultimately decreases the Project's economic value.

As MRM is an existing mining operation, given the proximity of the proposed Project to MRM's existing infrastructure and operations, there is limited scope for an alternative location.

Alternatives within the Project site itself, such as the location of components of infrastructure and the choice of technologies and methodologies to be utilised become very important for maintaining the Project's profitability and reducing potential environmental impacts. These alternatives are discussed below.

3.4.3 Mining Method

MRM's ore deposit consists of seven ore bodies stacked above each other, with varying widths, separations and grades. Initially, the deposit was extracted via an underground mine. The extent of these ore bodies that could be economically extracted was restricted by this mining method, as well as ore body faulting, which precluded further economical extraction by underground means. Accordingly, the mine was converted to an open pit operation in 2005 following the 2005 environmental assessment process.

Extensive modelling of alternative Project mining options was undertaken to select the preferred mining methods and mine plans. During options modelling the following considerations were taken into account:

- site geology
- ore quality
- topographical considerations (i.e. drainage lines, surface features and existing infrastructure)
- production rates of various ore types
- existing mining methods and extent of existing operations
- ore processing methods
- transportation needs
- potential environmental influences and impacts.

Underground mining techniques result in reduced impacts on surface environmental values due to the reduced requirement for external waste rock emplacements and hence, minimal surface disturbance. Mining induced subsidence can, however, result in impacts on surface environmental values such as flora and fauna, cultural heritage, groundwater and surface water resources. While underground mining has previously occurred, due to significant faulting and the requirement to backfill voids to maintain stability, MRM's underground mining operation eventually became impractical and uneconomical.

Open pit mining allows for the full recovery of all the in-situ resources, inclusive of a number of ore bodies that would have been unviable using underground mining techniques. As a result, the continuation and expansion of the existing open pit mining methodologies to mine a wider and deeper pit are proposed for the Project resource at a higher rate of 5.5 million tonnes per annum (Mtpa) which compares to the current rate of 2.5Mtpa.

Further, the open pit mining method offers the best overall combination of mining costs, energy consumption efficiencies, safety and ore body dilution control and recovery. This method is viable and represents the preferred financial outcome when compared to mine closure or continuing with existing production capacity of 2.5 Mtpa.

Selection of the Project's mining equipment will be made with a view to achieving increased efficiencies in energy consumption where practicable for the task.

3.4.4 Open pit optimisation

Following the decision to increase ore production via the continuation of the open pit mining method, a mine optimisation computer program was used to optimise the Project's pit size. Aspects considered during this optimisation program included:

- site operating costs including mining, processing, transport and rehabilitation costs
- geological characteristics of the deposit and surrounding overburden
- grade variability within the deposit
- expected open pit slope angles
- financial assumptions including market demand and prices.

The optimisation program undertook a series of iterative runs to identify possible ore and waste volumes in an open pit for a range of revenues. The result was a series of open pit shells that are the optimum final pit size for the specified inputs at a specific revenue factor. Lower revenue factors resulted in smaller pit shells where the combinations of stripping ratio, grades and ore quality gave the highest financial return. Higher revenue factors resulted in increasing open pit shell size, until the cost of moving ever-increasing amounts of waste per tonne of ore made further ore extraction uneconomic. Based on Xstrata Zinc's long-term outlook and corporate strategy, a pit shell between the two extremes was selected to provide a balance between short-term profit and stable long-term investment.

Once the Project's final open pit shell had been selected, detailed open pit designs, mining schedules, and operating costs were developed as input into a corporate commercial model to generate more accurate estimates of operating costs and revenues. Project capital costs (such as infrastructure upgrades) were also incorporated into the model allowing for an overall assessment of the entire Project.

This process, which was undertaken during the Project's feasibility study, conducted during 2010 and 2011, yielded a project that was both technically and financially attractive for investment.

3.4.5 Open pit size

Open pit mining involves excavating overlying waste rock in horizontal benches to expose the target ore, which can then be removed for processing. To maximise the value of the deposit, which dips from 25° to 35° to the east, the excavation needs to be undertaken in stages: progressing from the shallowest parts to the deepest parts of the ore-body.

As the ore-body deepens, ever increasing amounts of waste rock must be uncovered for each tonne of ore mined. The ratio of waste rock tonnes mined to ore tonnes mined is termed the 'strip ratio'. Above a certain strip ratio and depending on ore grades, metal prices and mining and processing costs, it is no longer economic to mine the ore by open pit methods.

The size of the Project's final open pit would depend upon the economic conditions present at the time. Using the current economic assumptions for long-term metal prices and operation costs, a final pit producing 115 Mt of ore has been calculated as the optimum size at a mining rate of 5.5 Mtpa. As mentioned in Table 4-1 in Chapter 4 – Project Description, it is anticipated that the final open pit depth will be approximately 420 metres (m), with the open pit dimensions being approximately 1750 m by 1500 m. This compares to the current approved open pit size of approximately 1500 m by 800 m, with a pit depth of 210 m.

3.4.6 Location of industrial facilities

MRM's processing plant and power station are located on Barney Hill which provides flood free ground in close proximity to the open pit. Where practicable, the Project's industrial facilities will be located adjacent to the existing facilities. The Barney Hill site has been selected for the following reasons:

- it is adjacent to existing facilities to enable easy interconnection of services and facilities, and does not require the disturbance of new ground

- it is in close proximity to the Project's open pit to minimise haul distances, which in turn minimises costs and emissions
- it is within the existing flood protection bund and hence is at minimal risk of flooding
- no other suitable areas have the same locational advantages as the site proposed for the Project.

3.4.7 Accommodation village and transport of construction/operations workforce

The following workforce accommodation alternatives were considered for the Project:

- the permanent workforce and their families accommodated in a new town, or in Borroloola
- flying the workforce in and out from Darwin and accommodating them in the existing and expanded accommodation village, as is the current practice.

The preferred alternative is continuing the existing Fly-In/Fly-Out (FIFO) arrangement. FIFO has the advantages of avoiding:

- the need to construct a new town and new infrastructure
- a significant change to the social fabric of Borroloola
- additional pressures on the limited social and community facilities at Borroloola
- additional pressures on regional recreational facilities
- social pressure likely from moving families accustomed to an urban environment to a remote rural location with limited facilities
- social and economic issues of closure
- a significant change to the accommodation arrangements of the existing workforce.

Apart from employees residing in Borroloola driving daily to the site, the preferred option is to continue to house FIFO employees at the Project's expanded accommodation village.

3.4.8 General waste

Disposal of general municipal waste will continue to use the current facilities, after all recycling options have been exhausted. Use of current facilities is preferable to the creation of new facilities that would create a larger footprint and environmental impacts. Existing sewage facilities have recently been upgraded to accommodate the increased personnel on-site. A construction workforce sewage facility will be required to handle the peak workforce numbers during this time. This facility will be removed following the construction period. General waste is discussed further in Chapter 9 – Waste.

3.4.9 Overburden emplacement facility locations

Overburden Emplacement Facilities (OEFs) need to be located in positions that limit land disturbance whilst maintaining a physically and chemically stable landform and achieve the minimum costs over the Project's life (which extends beyond the cessation of mining activities). The choice of an OEF location depends on many factors, including:

- ore-body and open pit excavation geometry
- extraction sequence
- physical limitations on the surface
- geographical features (topography, watercourses)
- geological features (underlying rock and soil types)
- environmental features (flora and/or fauna habitats)
- heritage and cultural values

- presence of other infrastructure
- possible further economical ore deposits
- methods of transporting overburden.

A number of alternative sites were considered for the location of the OEFs to handle overburden from an expanded mine. Comments on the various alternative sites are given below:

- North OEF (an expansion of the current OEF):
  - must allow room for potential flood extent from Barney and Surprise Creeks
  - must not encroach on the Carpentaria Highway to the west and Mount Stubbs to the east
  - topography is relatively flat, enabling drainage (both seepage and surface runoff) to be managed effectively
  - longer distance for the haulage of overburden material due to the Barney Creek floodplain.
- East and South OEF:
  - these would be located between the Project's open pit and Barney Creek to the east and the McArthur River Channel to the east and south
  - would require shorter haulage of overburden material from the eastern and southern end of the Project's open pit
  - must be located outside any possible future open pit expansion areas
  - must allow room for McArthur River and Barney and Surprise Creeks floodwaters and limit risks of physical erosion and instability.
- Airstrip OEF
  - this location would provide a reasonable short haul for overburden in the southern end of the pit
  - use of this OEF location would require re-location of the airstrip which would be a significant cost and and take time to complete.
- In-pit OEF
  - the use of available areas within the open pit would minimise hauling costs and the site disturbance area
  - large-scale use of in-pit dumping was evaluated in the open pit mining studies however, the geometry of the deposit rendered this option unworkable
  - portions of the footwall where the dip of the pit floor is flat enough to enable safe operations to continue below the dumped piles were identified as possible sites for small in-pit OEFs, subject to further geotechnical assessment
  - areas would not become available until towards the end of the mine life.

After assessing all of the above considerations, it was determined that a combination of the North, East and South OEF alternatives would be utilised for the storage of Project mine overburden.

3.4.10 Overburden emplacement facility construction and rehabilitation

Project overburden consists of a mixture of potentially acid-forming (PAF) and non-acid forming (NAF) materials. PAF material is one which when exposed to oxygen and water during the mining process, can result in the leaching of sulphuric acid resulting in acidic runoff. It is important that the PAF material be protected from oxidation to minimise the potential for acid leachate to be generated which could harm the surrounding environment.

Traditional PAF material storage incorporates layers of PAF material interpolated between low permeability NAF material to minimise oxygen and rainfall reacting with the PAF material. However, at MRM this method was seen to pose a significant risk in the event that there was a failure in the integrity of the NAF material OEF cover in the long term.

The technique currently used at MRM is to encapsulate the PAF in a series of clay-lined cells, covered by NAF material deep inside the OEF. This results in improved environmental performance of the OEF as it minimises the time that PAF materials are exposed to the atmosphere and therefore reduces the risk of environmental harm from the potential generation of acidic runoff.

Constructing a clay lined PAF cell within the OEF also reduces the costs of final rehabilitation works, given that a low permeability cover will not be required across the surface of the OEF. It will also eliminate the long-term cover failure risks associated with traditional PAF OEF design: cover erosion, surface runoff ingress, localised cover failure through deep rooted trees, burrowing animals and uprooting of trees in storm events.

This technique has been effective at MRM and will be continued for the Project. Only NAF material will be dumped in the East and South OEFs.

Project OEF management is further discussed in Chapter 5 – Rehabilitation and Decommissioning, Chapter 9 – Waste, Appendix E2 – Overburden Emplacement Facility Management Plan and Appendix E4 – Mine Closure Plan.

3.4.11 Processing technologies

Alternative processing technologies to produce a bulk concentrate were considered in the context of MRM's existing technology.

The technology currently used at MRM is known and understood to the point where future prediction of ore performance can be accurately made. Based upon the low risk of non-performance with the existing technology, the current processing plant technology will be used for the Project.

Also, due to the complex nature of the ore, fine grinding is the only economically feasible method to extract the concentrate from the ore. The development of fine grinding technology, utilising the IsaMill process, has enabled mining operations to be developed at a number of mine sites previously considered uneconomic. IsaMill process technology has allowed the MRM resource to be efficiently processed to produce an economically competitive marketable concentrate.

3.4.12 Power supply

The Project will require an upgrade and expansion to the existing power plant for operations. The existing power supply is adequate for the Project's construction phase.

The options considered include the upgrade to the existing power station, or construction of a new one. It was determined that the preferred option is to upgrade and expand the power generation infrastructure at a location that is currently under review.

Gas is the current source of power station energy and supply will be continued for the Project utilising the supply pipeline infrastructure that currently exists. Other power sources were considered, such as coal and renewables, however these were discounted due to potential increases in environmental impacts and reliability factors.

3.4.13 Tailings storage facilities

Alternative Tailings Storage Facilities (TSF) options were considered during the Project's mine planning process. Options include the expansion of the existing TSF to manage the Project's processed mining waste and considering alternative tailings disposal technologies.

Alternative tailings disposal technologies can be broadly considered as follows:

- the use of earth or rock fill to create embankments behind which 'wet' or 'low density' tailings can be stored

- separation of the coarse fraction of the tailings from the fines and using the coarse fraction for embankment construction to store the fines
- thickened, high density tailings impoundment.

The first alternative relies on a conventional dam to store tailings that are not thickened. Such a dam would need to be located in a valley with moderately graded slopes and a limited upstream catchment. No suitable natural valley areas exist within close proximity of the Project site. Furthermore, this arrangement would require the diversion of upstream water and involves disturbing a significant area of presently undisturbed land.

The second alternative of separating coarse and fine fractions would have limited benefit at MRM because the ore grind is extremely fine and only a relatively small amount of coarse tailings are generated.

The third alternative is the technology currently employed at MRM. Thickened tailings form a beach slope by sub-aerial discharge from a central discharge point. Thickening the tailings avoids the segregation of the coarse and fine fractions.

The preferred alternative is to continue to use the existing thickened slurry tailings impoundment method in the area of the TSF adjacent to the current disposal cell. This approach has the following advantages:

- the thickened slurry process is already used on-site and no operational or infrastructure changes would be required
- the area currently used to store runoff water from the existing TSF (future Cell 3) is already disturbed and is large enough to store Project tailings in the early years of operation
- using the existing TSF footprint reduces the need to disturb additional undisturbed land
- pipelines to transport the tailings to the TSF and return water to the processing plant currently exist.

Two potential options were selected for further consideration to increase the TSF capacity for the Project:

- raising the existing TSF cells (Cells 2 and 3) above the already existing approved level of RL 68 m
- raising the existing TSF cells to the existing approved level of RL 68 m, with the addition of another cell, by converting a new water management dam, Cell 4, to increase TSF capacity. The new water management dam that will be converted to a TSF Cell 4 had two sub-options – a small footprint (55 ha) and a larger footprint (73 ha). The new water management dam would also be lined to minimise potential seepage.

The option of converting a new water management dam, Cell 4, with a larger footprint of 73 ha was selected. The selection of the Cell 4 option also eliminates potential stability issues of raising Cells 2 and 3 above the existing approved level. Further, the use of the new water management dam as a TSF reduces the requirement to disturb new areas, thereby limiting the Project's environmental footprint.

This new water management dam, that is being designed and constructed to facilitate future use as a TSF, is currently being considered under the annual Mining Management Plan process pursuant to Section 40 of the *Mining Management Act 2001*

Project tailings management is further discussed in Chapter 9 – Waste Management and Appendix E1-Tailings Storage Facility Management Plan.

3.4.14 On-site zinc metal production

The potential costs of producing zinc metal at MRM are dominated by smelter, transport, handling and shipping costs and present limited opportunities for cost efficiencies. The option of on-site zinc metal production at MRM would present an opportunity to value-add to MRM's ore resource, thus improving the economic benefit to the local and regional community, the Northern Territory and Australia.

When considering the viability of the Project as a location to produce zinc metal the following four key aspects were identified as being important considerations:

- basing a zinc smelter at the mine site would eliminate the need to transport the bulk concentrate to a separate smelter, reducing transport costs
- smelting residue would need to be disposed of on-site
- zinc smelting is a high water consuming industry
- zinc smelting is an energy intensive industry. Presently, no suitably priced power source can be confirmed to meet the consumption needs of a potential Project zinc smelter.

The first key aspect is a positive reason for siting a smelter on-site; the second and third would require significant and careful environmental management; and the fourth is a significant cost impediment. After reviewing these and other relevant issues, the option of on-site zinc metal production as part of the Project was not considered further. The on-site zinc metal production alternative had been considered in previous feasibility studies and the same outcomes were reached.

3.4.15 Transportation task and facilities

No viable alternatives for Project transport, port and shipping operations are readily available. Existing infrastructure already in place for the transport and shipping of bulk concentrate from MRM has the capacity to manage increased concentrate shipments. Building new roads and a port/shipping system would create unnecessary environmental impacts considering that this infrastructure has been established and operating successfully since MRM's inception. Hence the existing haul road, the Bing Bong port concentrate storage and ship loading facilities (Bing Bong) and the MV Aburri barge will continue to be utilised for the Project.

Project transport and infrastructure arrangements are further discussed in Chapter 8 – Transport.

3.4.16 Water supply and management

In order to secure a reliable Project water supply, a number of options were investigated.

The Project's preferred water supply option is to utilise MRM's existing groundwater supply system augmented by the mine pit dewatering system. Combining these two systems will provide adequate Project water supply with minimal environmental impact.

A number of options were considered in relation to improving water storages to capture and use mine affected water. This included a number of water balance scenarios over the life of the mine. The Project's water management system is centred on a balance of minimising construction costs and minimising environmental impacts based on the extensive site experience with water management since MRM's inception.

Project water resource management arrangements are further discussed in Chapter 10 – Water Resources.

3.4.17 Final void

The following closure scenarios were considered for the Project void:

- allow the expanded open pit fill naturally from groundwater inflows and direct rainfall. No inflow will occur to the pit from the realigned McArthur River
- breach the open pit flood protection bund temporarily and allow the McArthur River to flow along its original alignment and through the pit until the pit is full. Then re-establish the bund permanently and re-divert the river to the realigned Channel
- breach the open pit flood protection bund permanently and allow the McArthur River to flow along its original alignment and through the open pit

- remove part of the open pit flood protection bund but maintain the McArthur River in the realigned river channel. River flows that overtop the McArthur River Channel will be allowed to enter the pit and overflow downstream.

Detailed water balance and water quality modelling that was undertaken for each of the above options indicated that the first option is preferred because it has least potential to impact on river ecosystems and groundwater, as well as on void water depth and water quality.

Project mine closure is further discussed in Chapter 5 – Rehabilitation and Decommissioning and Appendix E4 – Mine Closure Plan.

3.4.18 No project

The main consequence of not proceeding with the Project would be that a major base metals resource would remain undeveloped and associated socio-economic benefits unrealised. Mining is a profitable activity for the Northern Territory and Australian economies and should the Project not proceed, a significant mineral resource would remain unutilised. Local, regional, Territory and Australian economies would not benefit from the employment, trade and export of goods associated with the Project and potential mineral royalties.

Should the Project not proceed, mining at MRM will be severely limited and mine life will be reduced by nine years. This will result in a loss of economic benefit for the Northern Territory, the premature loss of employment for the existing workforce and detrimental socio-economic impacts in the region.

The economic benefits associated with the Project, as discussed in detail in Chapter 16 – Economic Environment, are considerable and would not be realised if the Project did not proceed.