

4.0 Proposed Open Cut Operations

4.1 Proposed Project

MRM proposes to change its McArthur River mine from the existing underground mine to an open cut mine. The underground mine will be phased out and a new open cut mine phased in. The basis of the decision to proceed with the open cut option is discussed in Section 6.2.

Run of mine ore will be trucked from the open cut to the existing processing plant where it will be crushed and ground. The ground ore will be slurried with flotation reagents and pumped to flotation cells where the zinc and lead bearing minerals will be recovered in the form of a bulk concentrate. The existing processing facilities that are currently used for the underground mine will be used. They have sufficient capacity to treat 1.8 Mt/y of ore and will produce 320,000 dry metric tonnes per year (dmt/y) of concentrate.

The majority of the overburden rock from the open cut will be stored at an overburden emplacement facility (OEF) to be located to the north of the mine area. Smaller overburden storages will be located around the pit perimeter. The area used to store runoff from the existing tailings storage facility will be used to accommodate the additional volume of tailings that will be produced.

The footprint of the open cut project is shown in Figure 4.1. An artist's rendition of the layout is shown in Figure 4.2.

As is currently the case, the concentrate will be trucked to the port at Bing Bong for export. The existing port facilities have sufficient capacity and will not require any upgrades as the throughput from the open cut operation will be slightly less than at present.

A comparison of the key operational components of the existing operation and how they will change with the expansion is given in Table 4.1.

Table 4.1
Summary Comparison of Existing Operation with Proposed Development

Component	Current Operations	Open Cut Operations
Resource	23.2 Mt proved and probable (subsequently upgraded to 40 Mt total)	Pit designed to recover 43 Mt of ore
Mine Life	Subject to annual review	25 years
Mining method	Underground	Open cut
Mining Rate	1.6 Mt/y	1.8 Mt/y
Tailings	Tailings discharged to tailings storage facility	Existing tailings storage facility to continue to be used



MCARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT

OPEN CUT MINE FOOTPRINT

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Figure: 4.1

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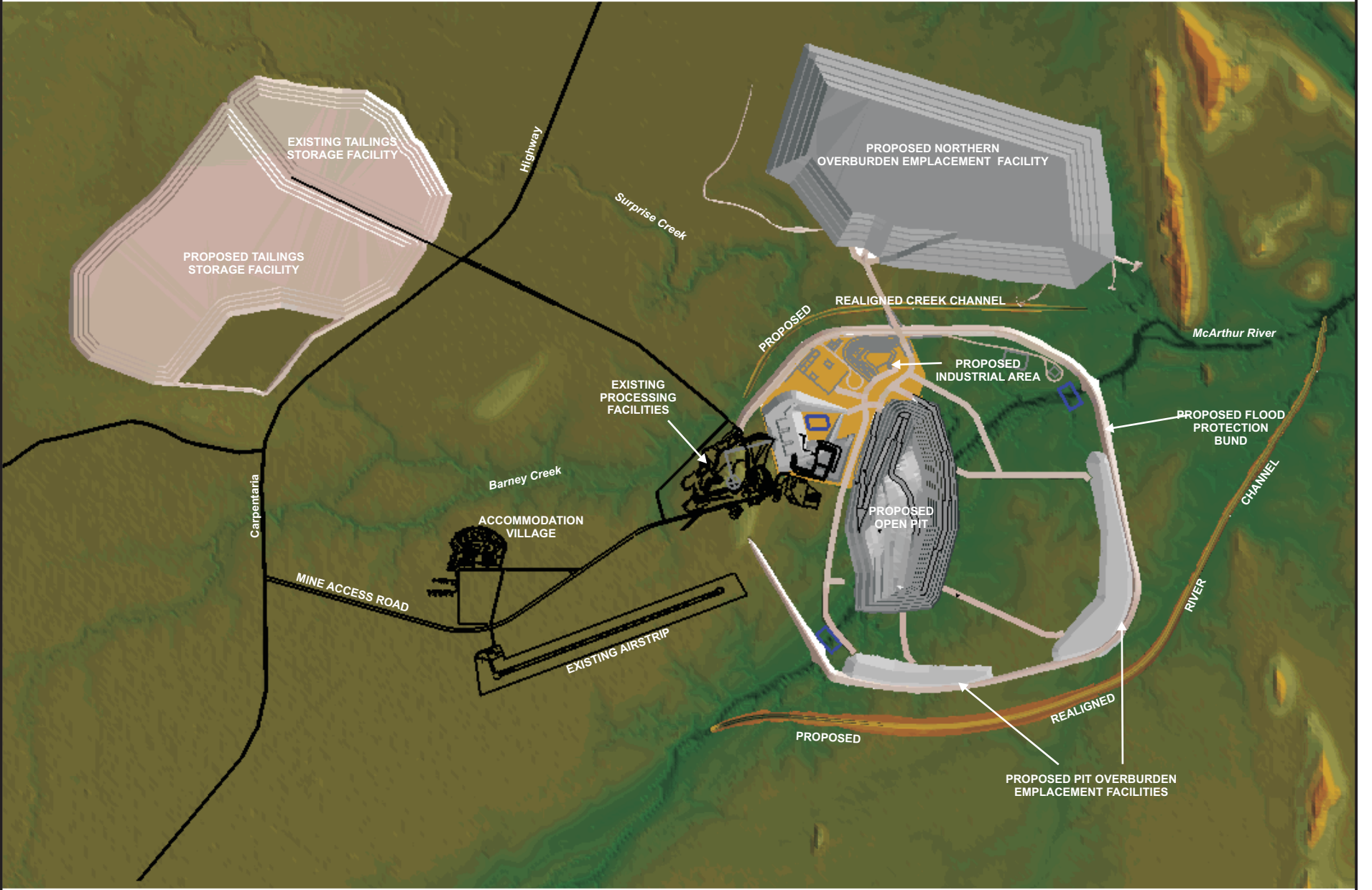
0 750 1500m

Scale 1:45 000 (A4)

Horizontal Datum: AGD84, Zone 53

Date of Aerial Photography, 2001

Source:



**McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT**

**OPEN CUT
MINE DEVELOPMENT**

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Component	Current Operations	Open Cut Operations
Waste rock	No waste rock brought to the surface – used as backfill in underground mine	Stored on surface in overburden emplacement facilities – capacity 185 Mt
Processing	Flotation process producing concentrate (46% Zn con grade)	Flotation process producing concentrates (average 46% Zn con grade)
Power	Gas fired turbines producing 22 MW. Fired with natural gas delivered to site via a pipeline from Daly Waters	Existing power station to be used.
Product	330,000 dmt/y of lead-zinc-silver concentrate	320,000 dmt/y of lead-zinc-silver concentrate
Transport	Concentrate trucked to Bing Bong port, transferred to barge, then offshore loading onto ships	Concentrate trucked to Bing Bong port, transferred to barge, then offshore loading onto ships
Groundwater	Mine dewatering is pumped to the surface and used in the process. Borefields water supply	Borefields water supply to continue Pit water to be collected and used in process
Surface water	Dirty water collected and utilised in the process. Emergency discharge licence in place	Dirty water collected and utilised in the process. Emergency discharge licence in place Realignment of McArthur River and Barney/Surprise Creeks around open cut
Air Emission Sources	Power station Fugitive emissions	Power station Fugitive emissions
Workforce	330 operational personnel	Peak of 150 construction personnel 270 operational personnel

4.2 Mine

4.2.1 Overview

Open cut mining will involve the following activities:

- Realignment of the McArthur River and Barney and Surprise Creeks around the proposed open cut.
- Construction of a flood protection bund around the open cut and associated infrastructure facilities to prevent floodwaters inundating these operational areas.
- Excavation of the alluvial cover materials that lie above the bedrock. This material will be used for construction purposes, encapsulation of other waste rock, or rehabilitation.
- Excavation of overburden above and in between the orebody. This waste rock will be placed in the overburden emplacement facilities.
- Excavation of ore from the pit. The ore will be hauled to the run-of-mine pad (ROM) where it will be fed into the existing ore processing plant.

- Rehabilitation of the disturbed areas in accordance with statutory requirements and agreed post-mine land uses.

Facilities associated with the mining operations will include:

- Open cut excavation.
- ROM pad and ore stockpiles.
- Overburden emplacement facilities.
- Water management devices (pumps, drains, small receiving dams, dewatering bores and interception trenches).
- Offices, crib facilities, and change house.
- Heavy vehicle hardstands (parking areas) and light vehicle car parks.
- Heavy equipment workshop with associated wash down bays and service areas.
- Stores warehouses and lay down areas.
- Blasting agent storage and explosives magazines.
- Interconnecting roads and a culvert across the Barney Creek realignment.

4.2.2 Pit Excavation

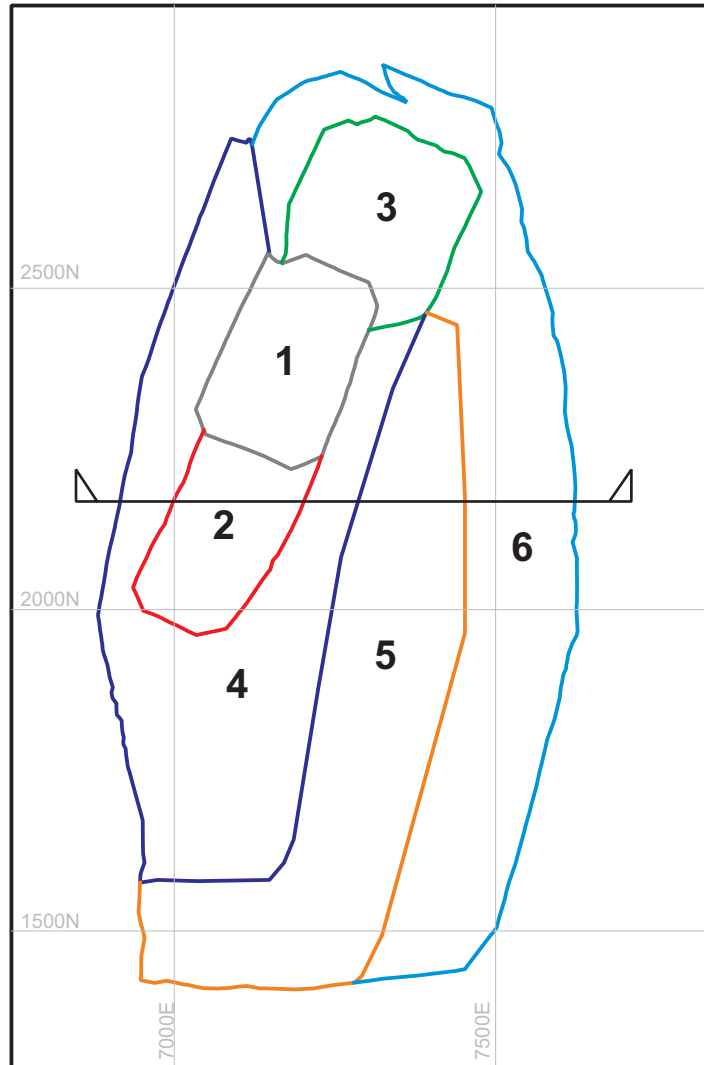
The open cut mining will involve excavating overlying waste earth in horizontal benches to expose the target ore, which will then be removed for processing. As much of the deposit dips at 25° to 35° to the east, the excavation will be undertaken in stages, commencing at the shallowest part of the ore body.

As the orebody deepens, ever increasing amounts of waste must be uncovered for each tonne of ore. The ratio of the tonnes of waste rock mined to the tonnes of ore mined is termed the 'strip ratio'. Above a certain strip ratio, depending on ore grades, metal prices, and mining and processing costs, it is no longer economic to mine the ore by open cut methods. Thus, the proposed open cut does not plan to extract all of the ore resource. The pit size currently being considered will enable the removal of 43 Mt of ore.

The target ore production rate from the pit is 1.8 Mtpa of ore. At this rate, the life of the open cut operation would be 25 years.

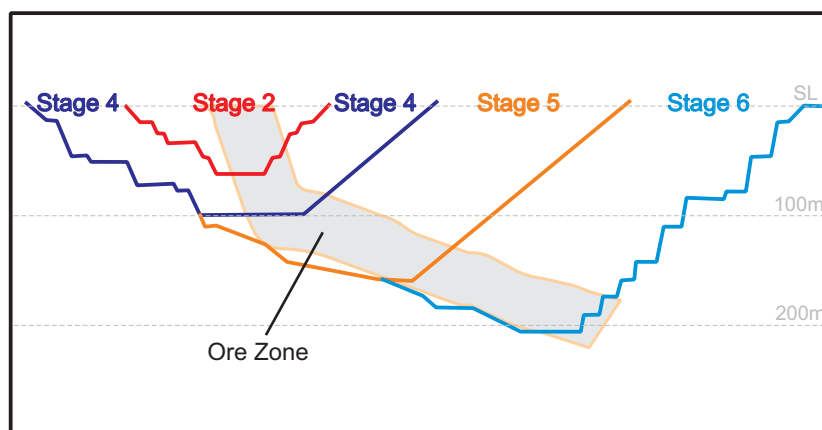
To balance the strip ratio, the excavation will be undertaken in six stages as shown in Figure 4.3. Stages 1 to 3 will target the shallowest ore to the west of the McArthur River channel. Figure 4.2 also shows a cross section indicating how Stages 4 to 6 will target progressively deeper ore. Table 4.2 shows some key operational parameters associated with each stage.

Upon completion, the pit will have a surface area of 83 ha and a depth of 210 m. The maximum length of the top of the pit will be 1,400 m and the width will be 750 m.



LOCATION OF CROSS SECTION

PROPOSED PIT STAGING



CROSS SECTION SHOWING PROPOSED PIT STAGES

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McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT

PROPOSED PIT STAGES

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Figure: **4.3**

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Table 4.2

Operational Pit Parameters

Stage	Years	Ore (Mt)	Overburden (Mt)	Total (Mt)	Strip Ratio	Mined Ore Grade (% Zn)	Area (ha)	Pit Depth (m)
1	2006	0.8	3.5	4.3	4.1	10.8	6	65
2	2006	1.3	3.7	5.1	2.8	11.1	11	65
3	2006-07	1.0	6.2	7.1	6.4	10.5	18	80
4	2007-12	7.7	19.8	27.5	2.6	10.7	29	110
5	2010-21	16.7	65.3	82.0	3.9	10.5	57	170
6	2018-29	15.2	84.8	100.1	5.6	10.1	83	210
TOTAL		42.8	183.3	226.1	4.3 (av)	10.4 (av)	83	210

av - average

4.2.3 Test Pit Project

Prior to open cut mining commencing, MRM has developed a Test Pit in the area proposed for Stage 1 of the open cut operations. The objectives of the Test Pit project are to determine the following:

- The depth and variability of the Base of Partial Oxidation and Base of Complete Oxidation.
- Identification of oxide, transition and primary (fresh) ore (where no mining has occurred in the underground operation). Samples will be collected to enable metallurgical testing of the various orebodies from different weathering states.
- Rock properties of the range of orebodies.
- Dilution and ore loss associated with attempting to segregate multiple bedded ore and overburden bands.
- Structural data through the ore zone which can be used to confirm geotechnical parameters.
- Blast vibration monitoring.

Elements of the Test Pit project which is being developed during the second half of 2005 include:

- Development to a depth of 40 m and extraction of 1.3 Mm³ of material (including 180,000 m³ of ore).
- Construction of a flood protection bund around the Test Pit.
- Construction of an engineered overburden emplacement facility within the bunded area to store the overburden produced.
- Construction of a haul road from the Test Pit to the processing plant.

The layout of the proposed Test Pit operations is shown in Figure 4.4.



McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT

TEST PIT PROJECT FACILITIES

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Figure: 4.4

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0 100 200m

Scale 1:8 000 (A4)

Horizontal Datum: AGD84, Zone 53

Date of Aerial Photography, 2001

The environmental impacts of the Test Pit project are discussed in URS (2005b). Approval from the Northern Territory Government was obtained by means of a modification to MRM's mining management plan.

4.2.4 Pit Stability

Rock quality data have been gathered to enable the open cut excavation to be designed with sound geotechnical engineering parameters. The main aspects of open cut mining that require careful design are:

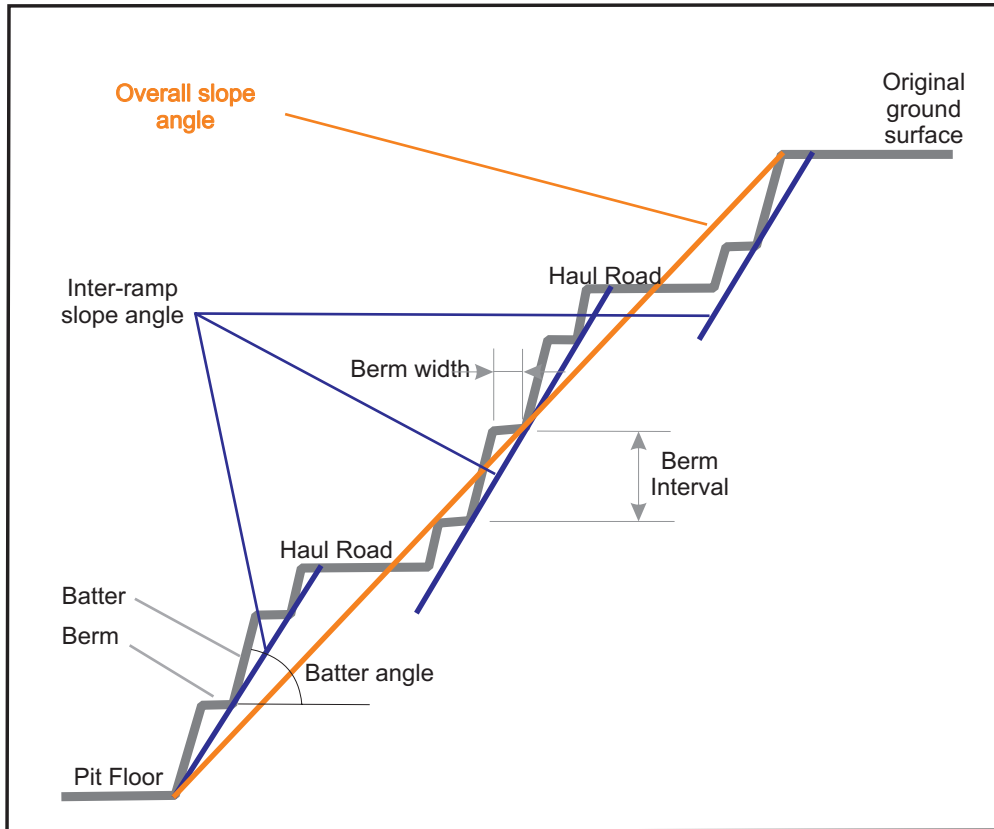
- Pit wall slopes, on an overall scale and on a bench scale.
- Batter angles and berm widths and intervals.
- Ground support requirements.
- Rock stability around old underground workings.

The geotechnical parameters take into account the variation in rock types, orientations, geological structures and old workings.

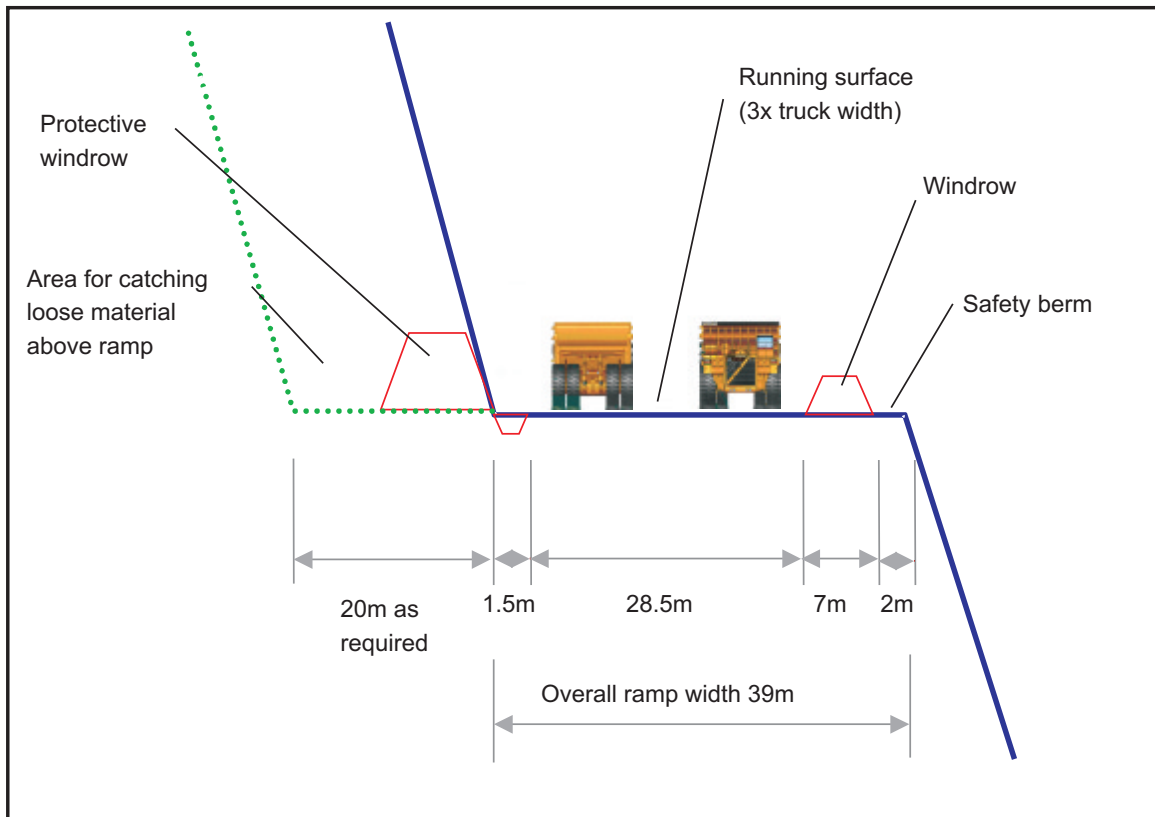
Slope Design

The open cut will be divided up into areas of discrete geotechnical properties, referred to as domains. Each domain will have a maximum slope angle that the rock could be cut to between haul ramp segments. The relationship between overall slope angle, inter-ramp slope angle (IRSA), batters and berms is shown in Figure 4.5.

The configuration of the slopes is shown in Table 4.3. The specification of a 32 m berm interval in most of the pit results in wider berms that are more capable of trapping material dislodged from batters. When calculating the inter-ramp slope angles, a factor-of-safety (FoS) is used. This quantifies the risk of failure of the slope, with a value below 1.0 indicating that the slope would be unstable. Walls that have to stand until the end of mine life, or walls in areas critical to safe and/or effective production, are designed to a higher FoS (equal to or greater than 1.5). Temporary walls have a lower FoS, but are still greater than 1.0. The FoS is determined by numerous factors including rock properties, geometry of the pit wall in relation to rock structure, stresses, weathering, life of the slope, interaction with underground voids, mining sequence and possible failure mechanisms. Use of the parameters in Table 4.3 resulted in FoS in excess of 1.0 for all slopes in the pit.



SLOPE DESIGN DEFINITIONS



TYPICAL HAUL RAMP DESIGN

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 	McARTHUR RIVER MINE OPEN CUT PROJECT ENVIRONMENTAL IMPACT STATEMENT			TYPICAL HAUL RAMP ARRANGEMENT	
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Table 4.3

Slope Design Parameters

	Alluvial and Weathered Zone	N, S, E Walls above Ore Zone	N, S, E Walls in Ore Zone	West Wall North of 2000mN	West Wall South of 2000mN
Inter-ramp Slope Angle	37°	55°	45°	51°	33°
Batter angle	45°	80°	80°	65°	50°
Berm interval	16m	32m	16m	32m	16m
Berm width	10m	17m	13m	11m	11m

Haul Ramp Design

The haul ramps will be designed to be wide enough to enable the safe two-way passage of the largest trucks, with an allowance for drains and safety bunds. The ramp width will depend on the final trucks selected. Industry practice recommends a road width of three times the width of the largest truck using the road, with an allowance of 5.5 m to 9.0 m for a safety windrow and berm and 1.5 m for drains. The resultant road widths for various trucks that may be used over the life of mine are: a 25 m road for trucks of the 90 t class; 33 m for the 220 t class; and 39 m for the 327 t class.

Ground Support

The ore body is affected by faults that can move the ore up or down relative to the adjacent rock. This could affect the pit where faults thrust blocks of rock in the ore zone upward, possibly exposing weaker rocks that lie under the footwall. Where geotechnical investigations determine that there would be potential for instability, ground support may be required. Such support may entail using encapsulated cable bolts up to 30 m long to anchor the weaker exposed rocks to stronger rock further in the walls. Installation and monitoring practices to be implemented will be similar to those used in long-life civil projects to ensure that the support is satisfactory for its proposed life.

Stability Around Underground Workings

Extensive computer modelling was undertaken by geotechnical experts to investigate the effects of existing underground mining on the stability of the open cut. The modelling predicted areas of tension in the rock above underground voids, and outside the active pit in some areas, which would result in zones of weakened rock. These findings resulted in the following design and operations practice recommendations:

- A reduction in the recommended IRSA in the ore zone (Table 4.3).
- The flood protection bund should not be located within 100 m of the planned pit wall.
- Open cut mining should not proceed closer than 60 m to any active underground operations.

- A crown pillar thickness of at least 20 m is required for safe open cut operations above unfilled bulk stopes.
- The water table should be drawn back to at least 100 m from the walls using weep holes. These are holes drilled into the walls at an upward angle to tap into water trapped in the rock, allowing it to drain freely out of the rock. This avoids pressure build-up that may cause instability.

4.2.5 Mining Activities

The open cut will have two distinct activities within the one pit: overburden removal and selective ore mining. The processes are similar for each activity; however the scale and type of equipment used may differ.

To maximise the value of the orebody, the mining operation will separate ore and waste (overburden and interburden) so that relatively pure ore will be fed to the processing plant. In the ore zone, the ore is interspersed with bands of waste rock (interburden). The ore mining fleet will be used to segregate the ore from the waste rock, with ore being delivered to the processing plant and the waste being sent to the overburden emplacement facility. The ore mining fleet will be relatively small as the ore and waste bands can be quite thin. However, in the overburden areas, the absence of any ore enables the use of larger and more productive equipment where desired.

It is proposed that the mining activities would operate 24 hours per day for 365 days per year, weather permitting, for most of the project life. There may be periods at the beginning and end of the project where the material movement schedules require operation on day shift only.

The various stages of the mining operation are described below.

Clearing and Soil Removal

Firstly, the pit stage to be mined will be pegged out for clearing. Vegetation will be cleared in accordance with current site land disturbance procedures, before removal of the topsoil and subsoil by scrapers or loaders and trucks. These soils will be either stockpiled for later use in rehabilitation of disturbed areas, or used directly in rehabilitation.

The hard rock is overlain by 5 m to 30 m of alluvial materials (such as sand, clays and gravels) that will be excavated using scrapers or diesel-powered excavators loading into trucks. The alluvial materials may be used for construction purposes, capping potentially-acid-generating material or stockpiled for later use.

Drilling and Blasting

Once hard rock is encountered, drilling and blasting will be used to break the rock up into suitable sizes for loading and hauling. Details of proposed blasting are given in Table 4.4. Blasts could be expected every two to three days and multiple shots may be blasted at the same time. Blasting would occur on day shift only.

Table 4.4

Blasting Parameters

Material	Bench height (m)	Hole depth (m)	Hole diameter (mm)	Holes drilled per day	Area of typical shot (m ²)	Shots per year
Ore zone	8.0	9.0	115-165	10	1,200	94
Overburden	16	17.5	140-250	67	6,250	75

The raw materials (blasting agents), which are not classed as explosives, will be stored in a secured compound. These materials will be loaded into purpose built mobile manufacturing unit trucks for transport to the area to be blasted. The materials will not become explosives until they are mixed as the product is loaded into the drill holes. Detonators and boosters, which are classed as explosives, will be kept secure in licensed magazines in accordance with the relevant Northern Territory legislation.

Loading and Hauling

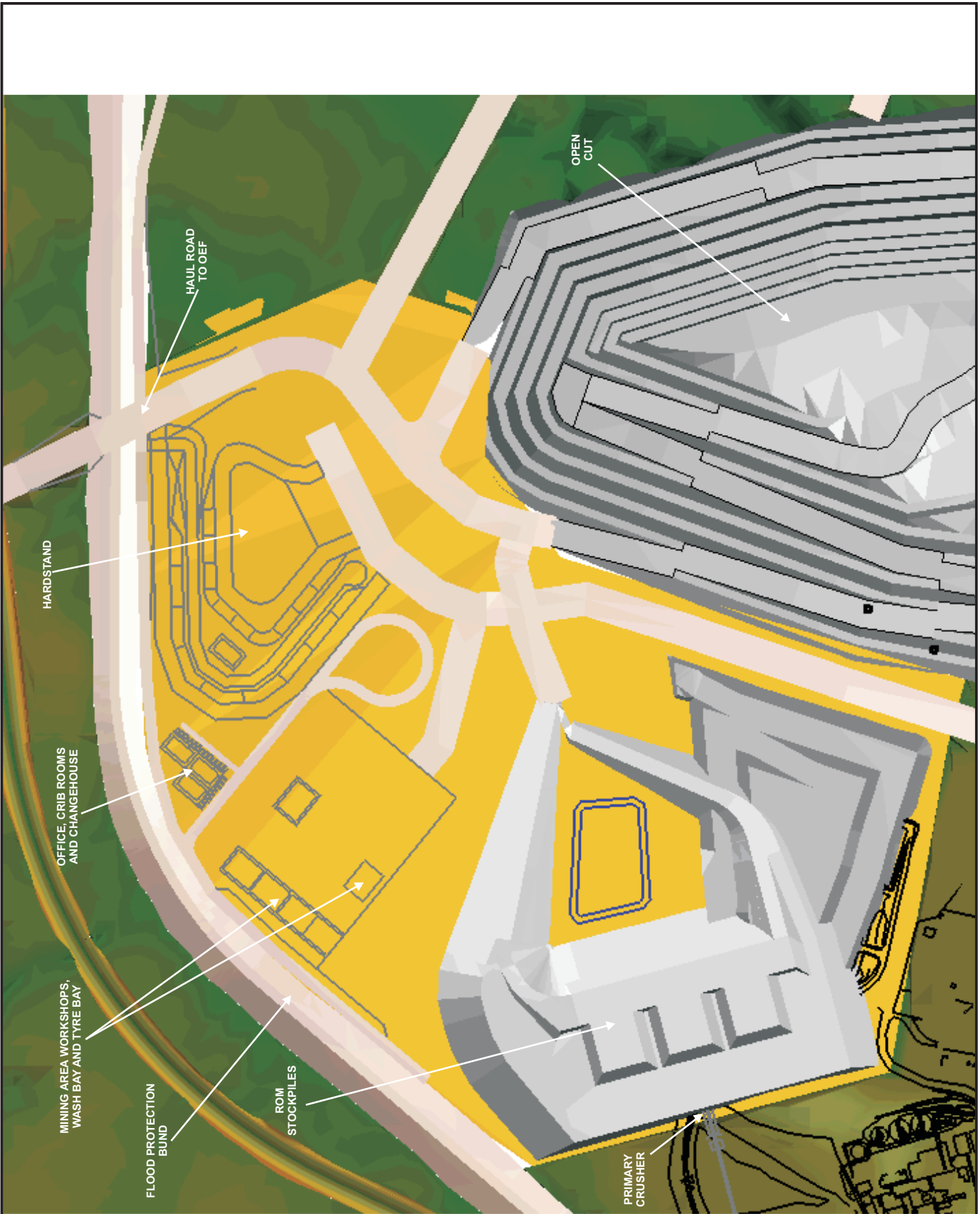
Conventional loading and hauling equipment will be used in the pit. Selective mining in the ore zone will use diesel-hydraulic excavators ranging in size from 180 t to 250 t capacity. These will load into 90 t rear dump haul trucks.

Due to the modest total mining requirements to achieve the schedule, overburden removal will also be undertaken by the ore mining fleet. Larger rear dump trucks, of up to 150 t capacity may be used to increase the efficiency of mining.

Ore from the pit will be hauled to the run-of-mine (ROM) pad from where it will be fed into the processing plant. The ore stockpiles on the ROM would be sized to hold two to three months of concentrator feed. As part of the Test Pit project a ROM will be located on an extended pad near the existing secondary crusher. A haul road will be constructed from the pit area to this ROM over a cut-down Barney Hill and the concentrator runoff pond. Fill material to be used to construct the ROM will be alluvial and NAF overburden from the Test Pit.



A pad for the stockpiling of transition ore material from the Stage 1 pit will be constructed on Barney Hill, adjacent to the concentrator runoff pond and processing area during the Test Pit project. For subsequent stages, a larger ROM will be constructed with a new primary crusher near this location on the side of Barney Hill (Figure 4.6).

Most of the overburden from the pit will be hauled to the overburden emplacement facility (OEF) located to the north of the pit area. Details of this facility are given in Section 7.2. Smaller overburden storages will be located around the pit perimeter. These smaller storages will contain non-acid forming (NAF) materials only. The locations of these emplacement facilities are shown on Figure 4.7.

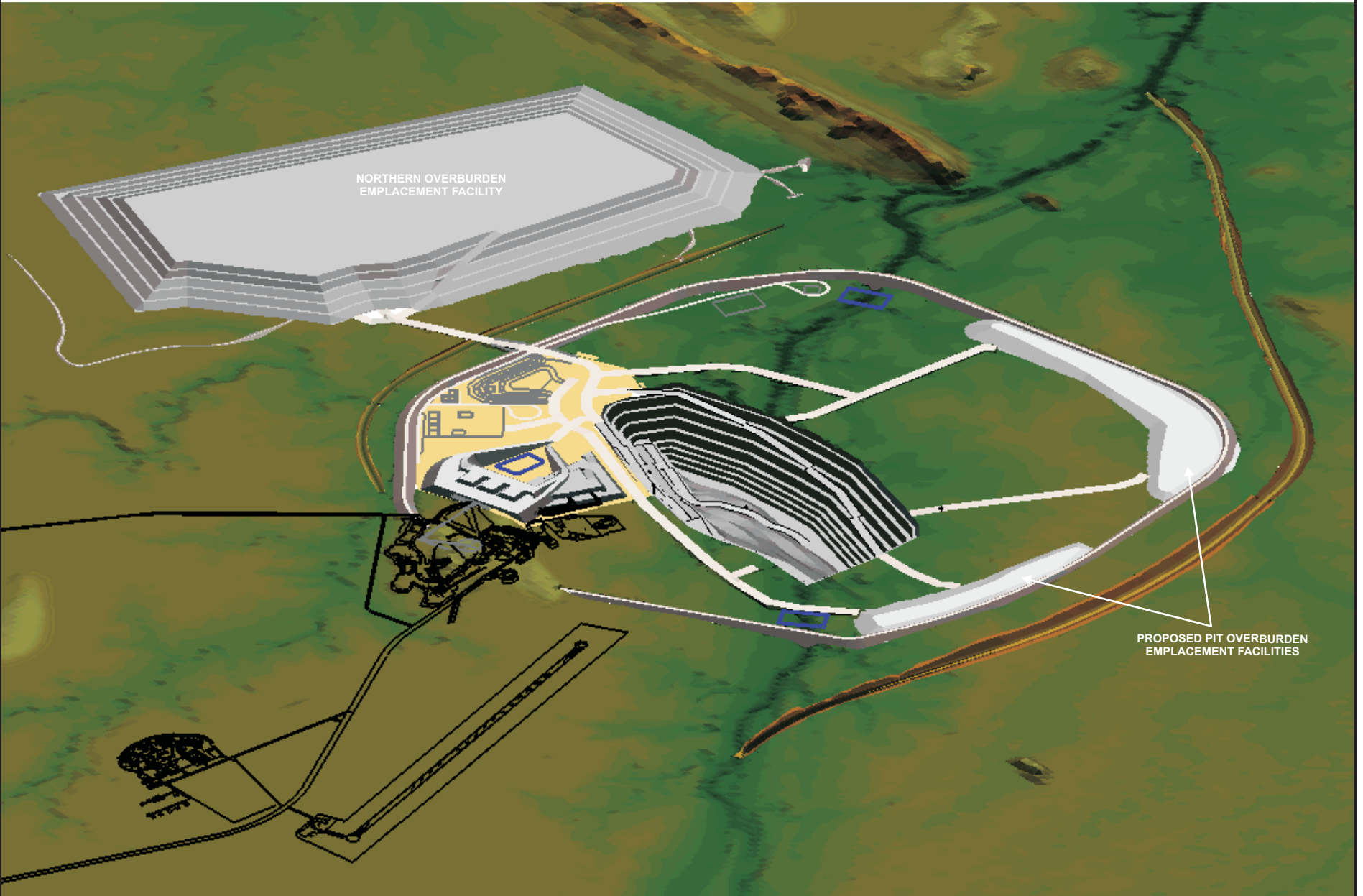


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Source:

	<p>McARTHUR RIVER MINE OPEN CUT PROJECT ENVIRONMENTAL IMPACT STATEMENT</p>		<p>PROPOSED INDUSTRIAL FACILITIES</p>	
	<p>Drawn: VH Job No.: 42625552</p>	<p>Approved: CMP File No. 42625552-g-142.cdr</p>	<p>Date: 12-07-2005</p>	<p>Figure: 4.6</p>
				<p>Rev. A A4</p>

Source:



McARTHUR RIVER MINE
OPEN CUT PROJECT
ENVIRONMENTAL IMPACT STATEMENT

OVERBURDEN EMPLACEMENT
FACILITIES

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File No: 42625552-g-143.cdr
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Figure: 4.7

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Ancillary Tasks

Many support tasks will be required to enable the mine to function safely and efficiently. The nature of these tasks and the type of equipment required are summarised in Table 4.5.

Table 4.5

Ancillary Tasks

Equipment	Tasks
Water cart	Dust suppression on roads, drills, rock piles and blasted ground
Grader	Formation and maintenance of haul roads and work areas, clearing of new mine areas, formation of drainage furrows and swales
Track dozer	Clean-up at loading areas, clearing of new mine areas, road building, pushing and rehabilitation on the overburden emplacement facility
Compactor	Compaction of roads and parts of the overburden emplacement facility
Small excavator	Rock breaking, pit wall scaling, pump moving
Wheel loader	Miscellaneous loading, loading the crusher
Wheel dozer	Clean up at loading areas and roads, pushing on the overburden emplacement facility
Lighting plants	Illumination of working areas at night

Underground Void Backfilling

Selected voids in the underground mine would be targeted for backfilling. This would enhance the stability of the surrounding rock as the open cut progressed through the ore zone. Backfilling would be undertaken using rock fill from the open cut operations. Placement into the voids would be through one of two means:

- Small quantities of rock fill may be trucked down the underground decline to the fill target areas, or transferred through unused shafts and rehandled into stopes using remote loaders.
- Where larger quantities of fill are required, angled bore holes (300 mm diameter) drilled from the surface within the flood protection bund will be used to allow the transfer of crushed material directly into the voids.

Pit Dewatering

The nature of the rain events at the site and the surrounding catchments elevates the importance of keeping the pit dry to enable mining to take place. There are several potential sources of water inflow into the pit. These are:

- Direct rainfall;
- Surface or sub-surface runoff; and
- Groundwater seeping through the pit walls or floor.

To ensure dry working conditions in the open pit, it is proposed to install a network of interception bores around the pit to remove groundwater that would otherwise flow into the pit threatening the stability of the pit walls and hampering mining operations. In addition, drain holes will be drilled in the pit walls as necessary to relieve water pressure behind the walls. Further information of the proposed dewatering and its effects are given in Sections 11.7 – 11.8.

The proposed construction of high quality haul roads will enable pit operations to continue during light to moderate rain events, though in the interests of operator safety, heavy rainfalls would likely cause temporary cessation of pit operations. During periods when flood waters are above the base of the flood protection bund, personnel would only be permitted to operate in areas deemed safe (as ascertained by risk assessments and monitoring).

4.2.6 Interaction of Underground and Open Cut Operations

The open cut excavation will intercept the abandoned underground workings from around 2009 onwards. Work practices will be altered to ensure the safety of personnel working in the open cut. The rock around the old underground workings is expected to be fractured, which will impact on the open pit operations. Drilling and blasting practices may change due to broken ground, however the open cut benches will be dry as groundwater and runoff will flow through the cracks into the underground workings. Where possible, groundwater and rain landing on or running down the footwall side of the open cut will be directed to small sumps in the bench floor for pumping to the surface or into the underground workings.

The underground mine will be kept accessible for a period of time after the start of open cut mining. This will enable the underground pumping system to continue to control water levels in the workings. This water will be reused in the processing plant. Subsequently, a replacement system will be installed to dewater the underground that does not rely on personnel entry into the workings. This system will use existing shafts and new boreholes into the underground workings, with submersible pumps. Water pumped from the underground mine using this system will continue to be reused in the processing plant.

4.2.7 Industrial Facilities

The initial open cut operation will use existing facilities for offices and crib rooms. A temporary workshop will be used until the cessation of underground mining activities when the underground operations surface workshop will become available.

Once the river and creeks have been realigned and the flood protection bund completed, new surface infrastructure will be constructed to service the open cut operations. The new industrial area will occupy approximately 28 ha within the flood protection bund. This will include mining offices, change house, crib rooms, hardstand, heavy equipment workshop, and stores (Figure 4.6). The blasting agent storage

compound and detonator magazines will be located approximately 650 m to the east of the hardstand, to separate them from the main work areas (Figure 4.2).

Vehicles entering the workshop for maintenance are first cleaned on the washdown pad, where built up earth, oils and greases are cleaned off the machine and collected in traps. The machines can then be worked on in the workshop or tyre bay. Accumulated material in the washdown pad will be removed and buried in the tailings storage facility.

4.2.8 Mining Schedule

A possible mining schedule is summarised in Table 4.6. It shows that the mining rate will have several distinct phases over the project life. The peak total mining rates of over 20 Mt/y will occur in years 7 to 8 and 15 to 17 of the mining operation, and are associated with stripping down overburden in the major pit cutbacks. The mining rates will then drop to around 3 Mt/y until the end of mining, some 25 years after the commencement of overburden stripping.

Table 4.6

Proposed Mining Schedule

Year	Ore Mined (Mt)	Overburden Mined (Mt)	Total Mined (Mt)
1	0.4	3.2	3.7
2	1.6	7.4	9.0
3	1.8	14.3	16.1
4	1.8	4.0	5.8
5	1.8	1.9	3.7
6	1.8	9.9	11.7
7	1.8	18.3	20.1
8	1.8	18.6	20.4
9	1.8	7.1	8.9
10	1.8	4.0	5.8
11	1.8	3.0	4.8
12	1.8	2.6	4.4
13	1.8	1.2	3.0
14	1.8	17.1	18.9
15	1.8	18.6	20.4
16	1.8	18.8	20.7
17	1.8	19.2	21.0
18	1.8	4.6	6.5
19	1.8	2.2	4.0

Year	Ore Mined (Mt)	Overburden Mined (Mt)	Total Mined (Mt)
20	1.8	1.9	3.7
21	1.8	1.3	3.1
22	1.8	1.2	3.0
23	1.8	1.0	2.8
24	1.8	0.9	2.7
25	1.1	0.8	1.9
Total	42.8	183.3	226.1

A possible equipment fleet required to achieve the above schedule is shown in Table 4.7.

Table 4.7
Equipment Fleet

Machine Type	Example Machine	Average Number
Track dozer	Cat D8	3
Small tophammer drill	Ingersoll-Rand ECM700	3
Ore zone hydraulic excavator	Hitachi EX1900/EX2500	2
Wheel loader	Cat 992	1
Haul truck	Cat 777D	15
Water cart	Cat 777 W/C	2
Grader	Cat 16H	2
Rockbreaker	Cat 330 Ex	1

The expected major consumables for the mining operation are shown in Table 4.8.

Table 4.8
Annual Use of Consumables by the Mining Operation

Consumable	Unit	Low Use Period (Years 9-13, 18-25)	Medium Use Period (Years 2-3, 16)	High Use Period (Years 7-8, 14-17)
Diesel	Million L	2.5	6.5	12
Electricity	MWh	0.4	0.5	1.0
Tyres	Number	50	100	200
Explosives	tonnes	750	2,750	5,100

4.3 Processing

4.3.1 Processing Facilities

The open cut operations will use the same processing plant as is currently used for the underground operations. This process is described in Section 3.4 and the process flowsheet is shown on Figure 3.2.

The only new processing facilities proposed will be the run of mine (ROM) pad to receive the haul trucks from the open cut and a new primary crusher to replace the existing one which is located underground. The location of these facilities is shown on Figure 4.6.

The ROM pad will be located adjacent to the new primary crusher. The ore will be loaded into the primary crushing circuit using front-end loaders or direct tipped by the open cut haul trucks. The primary crushing circuit will consist of the ROM receiving hopper, an apron feeder, a vibrating feed grizzly and a primary jaw crusher.

Product from the primary crushing circuit will be conveyed to a double deck screen. Oversize material will be conveyed to the existing secondary crusher feed bin, while the undersize material will be conveyed to the fine ore stockpile. The secondary crusher product will be conveyed back to the double deck screen for classification.

Following crushing, the ore will be processed through the existing plant as described in Section 3.4. The plant has sufficient capacity to cater for the ore production rate of 1.8 Mt/y.

Concentrate will be produced at a rate of 320,000 t/y. It will be stored in the existing concentrate storage shed.

Waste from the processing plant is called tailings which is the finely ground material that remains after the mineral bearing component of the ore has been extracted during processing. The tailings will be removed from the processing stream as a slurry and pumped to the tailings storage facility (TSF) for storage. The existing TSF footprint will be used for the open cut operations. No additional land disturbance will be necessary. Tailings placement will shift west of the existing deposition location into the area currently used for the evaporation pond, the dirty water dam, and the clean water dam. This will enable the current cell to be decommissioned and rehabilitated.

Details of the existing and proposed tailings management operations are given in Sections 7.3 and 7.4.

4.3.2 Process Inputs

Table 4.9 lists the input materials required for the processing operation.

Table 4.9

Process Inputs

Process Stage	Input	Quantity (t/y)
Comminution	ROM ore	1,800,000
	Mill media	2,100
	Liners	200
	Regrinding media (sand)	1,200
Flotation	Ethyl xanthate	380
	Isopropyl xanthate	970
	MIBC	70
	Dextrin	430
	Suparex	515
	Copper sulphate pentahydrate	6,635
Thickening	Flocculent	160
Total Concentrator Water	Process and decant water	3,086,000

4.3.3 Process Outputs

The outputs from the processing plant are the concentrate that is transported off site to market and the tailings which are disposed of in the tailings storage facility. The concentrate will be similar to that produced by the existing operation and will be a bulk concentrate containing zinc, lead and silver.

The quantities involved are given in Table 4.10.

Table 4.10

Process Outputs

Type	Output	Quantity (t/y)
Product	Bulk Concentrate	320,000
	Water in Concentrate	49,300
Tailings	Concentrator tailings	1,470,000
	Water in tailings	1,357,000

4.4 Truck Transport

The concentrate will be transported to the Bing Bong port in covered concentrate haulage trucks in the same manner that occurs at present. Road-trains with covered, side-tipping trailers are used and consist of prime movers with quad-axle trailers in a double AB configuration. The road-trains usually have a payload of approximately 120 t.

The haul route will be the same as that used for the existing operations ie. along the Carpentaria Highway from the mine to Borroloola and from Borroloola to the port at Bing Bong. This route is sealed for its full 115 km length and bypasses Borroloola.

The haulage rate will decrease slightly in line with the reduction in annual concentrate production. . The frequency of truck trips (return trips) will decrease from 4,200 per year to 4,100 per year. This equates to approximately 11 truck trips per day, seven days per week.

4.5 Bing Bong Port

Concentrate will continue to be exported via the port at Bing Bong in the same way that is used for the current operations. The existing facilities are adequate to cater for the production from the open cut operations.

The loadout and bulk carrier (“Aburri”) operations from Bing Bong to the off-shore export vessel will be the same as at present. The average number of return trips taken by the Aburri will decrease slightly from 130 to 126 per year.

4.6 Construction Activities

The construction phase will be undertaken over a two year period during 2006 and 2007. Most of the activities will be undertaken during the dry seasons of each year.

4.6.1 Pre-Construction Phase

Prior to on-site earthworks and construction commencing, a number of pre-construction activities will be completed. These will include:

- Procurement of any large plant or ancillary support infrastructure components which require a long lead time for delivery;
- Development of a construction environmental management plan, including site management protocols for control of erosion and sedimentation and stripping procedures for topsoil management;
- Detailed design of all facilities; and
- Tendering for civil contracts.

4.6.2 On-Site Civil Construction

One of the initial construction phase tasks will be the earthworks associated with the construction of the river and creek realignments and the flood protection bund around the proposed open cut mine and industrial area. Material excavated from the new river and creek channels will be hauled directly to the flood protection bund for placement.

All concrete requirements for the construction would be supplied from an appropriately licensed temporary batch plant located adjacent to the construction site.

The necessary construction laydown areas will be located within the proposed industrial area.

A strategy for soil and erosion management for all disturbed areas will be incorporated in the construction environmental management plan and will be the responsibility of the Principal Contractor. Strategies to be adopted to control sediment and erosion from the work areas are outlined in Section 10.5.2. Once construction work in an area has ceased, it will be rehabilitated by stabilising the surface against erosion and installing appropriate drainage measures.

Earthworks for the new industrial area will be undertaken once the temporary flood protection bund is built around the area during the 2006 dry season. Following completion of the earthworks, construction will begin on the various structures proposed for the area including workshops, wash bay, offices, crib rooms, change room etc.

4.6.3 Flood Protection Bund Construction

Bund Design

The open cut mine will be located within the floodplain of the McArthur River. Consequently a flood protection bund will be constructed around the pit and the infrastructure to protect the working areas from inundation in flood events. The location of this bund is shown in Figure 4.1. In addition a bund will be required around the Stage 1 Test Pit plus the additional temporary bunds around Stages 2 and 3.

A geotechnical study of the flood protection bund footprint and construction materials has been undertaken. This included geotechnical drilling, test pits, seismic refraction surveys, hydrogeological drilling and tests, and laboratory testing. Information from these studies was used to determine the design of the bund. The results of this investigation are provided in Golder Associates (2004). The bund has been designed to protect the site from the 1 in 500 year ARI flood event. The top of this bund will be at elevations ranging from 43.6 m RL upstream of the pit to 42.7 m RL downstream. This allows for 0.9 m of freeboard. A cut-off trench filled with compacted clay will be installed to prevent underflow beneath the bund where it is not located in areas of natural low permeability.

The Test Pit bund around the Stage 1, together with temporary bunds around Stages 2 and 3, has been designed to the same level of flood immunity as the existing mining facilities. To achieve this, the top of the temporary bunds will be at an elevation of 38 m RL.

Conceptual cross sections of both the temporary bunds and the main the two bund types are shown in Figure 4.8. Some of the footprint of the bund is located in areas having clay in the surface alluvials. This will provide an impervious foundation underneath the bund. For those areas where more permeable materials are located, a cut-off trench filled with compacted clay will be installed to prevent underflow beneath the bund.

The proposed main flood protection bund will be a zoned fill embankment, with the inner two thirds of the embankment comprised of earthfill and the outer third of the embankment comprised of rockfill. The central section of the earthfill will be a clay core to provide an impervious barrier to water ingress. It will be constructed in small lifts (in the order of 300 mm) with compaction and watering to create a homogenous earthfill embankment. Scrapers will be used to undertake this placement, with support from

dozers and water carts. Clay material will be sourced from the pit excavation and watercourse rechannelling where available. Supplementary supplies of clay are available between the bund and final pit limit if additional quantities are required. The outer third of the bund wall will be constructed of rockfill to provide protection against erosion and scouring of flood waters, however slightly more or less rock may be used in the construction depending on the amount available from the McArthur River realignment. The rockfill will consist of durable NAF rock sourced from either the river realignment or the Stage 1 Pit. The rockfill will be transported using larger dump trucks, spread with dozers and compacted in layers.

Initial construction of the main bund will be with internal and external batter slopes of 1:2 (vertical to horizontal) and a crest width of 12 m. As extra NAF rock becomes available from the pit, this material will be dumped against both the inside and outside batters of the main bund to achieve a final slope of 1:4, which will be suitable for immediate rehabilitation.

Stability analyses of the proposed main bund undertaken by Golder Associates (2004) indicated an adequate factor of safety against slope failure under worst-case assumptions of rapid draw-down of floodwaters and saturation of the bund. Saturation is unlikely to occur due to the short duration of high floodwater levels, hence the operating factor of safety should be considerably higher than those computed. An analysis of the potential for liquefaction of the bund due to blasting or seismic events showed that this risk is negligible.

Batter slopes adopted for the temporary bunds will be 1:3 for the external wall and 1:2 for the internal wall. These slopes have been based on precedent established with other similar structures, including earthfill dams of this height. The crest width has been set at 6 m to provide sufficient width for construction plant to operate and a vehicle access road for safety and maintenance during operations. The temporary bund will be constructed from clayey earthfill sourced from the initial excavation for the test pit. The earthfill will be placed in thin layers, watered and compacted to achieve the required level of watertightness. A 1 m thick layer of durable rock sourced from the test pit will be placed over the outer batter of the temporary bund to provide protection against erosion and scouring of flood waters.

Bund Construction Management

The bund will be constructed in accordance with an approved quality management plan in accordance with best engineering practice. The key factors will include:

- Identifying suitable materials capable of meeting the required specifications;
- Selecting suitable equipment and placement techniques consistent with the requirements;
- Providing clear instruction and project management; and
- Regular quality control testing on as-built constructions.

All earthworks will be carried out in accordance with the requirements of AS3798 “Guidelines on Earthworks for Commercial and Residential Developments”. Quality control testing will be undertaken by an independent NATA certified laboratory and will include compaction tests every 1,000 m³ and material quality tests (plasticity, grading and dispersion) every 5,000 m³.

4.6.4 Bund and Channel Construction Schedule

During the 2005 dry season a temporary bund is being constructed around the Test Pit to allow initial mining. This is part of the already approved Test Pit project. The temporary bund is on the western side of the McArthur River and will not affect the McArthur River channel.

It is proposed to undertake the construction of the flood protection bund and channel realignments for the open cut project over the 2006 and 2007 dry seasons. The construction works have been staged to achieve the following goals:

- Efficient use of materials from the realigned channels and Test Pit in the levee.
- Optimisation of haul distances and equipment useage using the proposed construction equipment.
- Normal flood flows will be able to be passed without erosion to the partially completed levees and channels and channel sections will be free draining.

At the commencement of the 2006 dry season it is proposed to commence construction of sections of the main flood protection bund and realigned drainage channels that will not impede flood flows during the 2006/2007 wet season. During the 2006 dry season the following construction is proposed:

- Barney Creek realigned channel: constructed for full length and depth including erosion protection works.
- McArthur River realigned channel: upper section constructed between chainage 800 and 1880 and full depth constructed between chainage 4600 and end of channel.
- Main flood protection bund to full height: constructed between chainages 0 and 1800 and between 3200 and 5800.
- Main flood protection bund: foundation works constructed in the McArthur River. This work will not impede flow in the McArthur River and will be protected from erosion by rock protection.
- Temporary bund around Test Pit: extended to the north to connect with the main bund (chainage 1800) and to the south to connect with Barney Hill to provide flood protection during the 2006-07 wet season to the expanded open pit area and to the future mine infrastructure (hardstand, workshop, offices, etc.) and the temporary haul road crossings of the McArthur River.

Earthfill for the construction of the main flood protection bund and the temporary bund will be sourced from the Barney Creek and McArthur River realigned channels and the Test Pit. Rockfill and rock protection material will be sourced from the Test Pit.

During the 2007 dry season, the remainder of the main flood protection bund (chainages 1800 to 3200 and 5800 to 7450) will be constructed using earthfill and rockfill sourced from the remainder of the McArthur River realigned channel. Additional rockfill will be sourced from the open pit operations while sandy material from the realigned channel that is not suitable for the bund construction will be used to flatten the inner batter of the main flood protection bund to prepare for rehabilitation.

A summary of earthwork quantities for the construction of the main flood protection bund, together with the source of these materials (Test Pit or channel realignment) is provided in Table 4.11. The table indicates that 52% of the bund is constructed and 37% of the total channel volumes are excavated in the first year (2006).

Table 4.11

Summary of Main Flood Protection Bund Quantities and Sources (m³)

Material	2006		2007	
	Test Pit	Channels	Test Pit	Channels
Earthfill	0	1,429,300	0	1,302,800
Weathered Rockfill	0	67,800	0	125,000
Fresh Rockfill	305,900	0	0	222,500
Spoil (Rehabilitation)	0	0	0	935,900
TOTAL	305,900	1,497,100	0	2,586,200

To achieve the construction program, it is estimated that the following equipment will be required each year.

- Cat 631 scrapers; 5 No. for core placement.
- Cat 651 scrapers; 4 No. for general earthfill placement and removal.
- Cat 777 haul trucks; 3 No for rockfill placement and removal.
- Dozers; 3 No. D11 for pushing and ripping, 2 No. D9 for conditioning and spreading.
- Excavators; 1 No. EX1800 for loading haul trucks, 2 No. EX300 for batter trimming /rock armour
- Rollers, 4 No. Cat 825 for earthfill and 1 No. 16t drawn flat drum for rockfill.
- Graders; 2 No. Cat 16G for spreading fill and trimming haul roads.
- Water Trucks; 10 No. for conditioning fill materials and watering haul roads.
- Support Vehicles; refuelling, maintenance, supervision, management and operator transport.

4.6.5 Construction Workforce

The construction phase will extend over a two year period and the construction workforce will peak at approximately 150 during the 2006 and 2007 dry seasons. This workforce will include construction labour, suppliers, consultants, and other contractors.

The construction workforce will be accommodated in a purpose-built construction camp to be located adjacent to existing accommodation village. The buildings and infrastructure at the construction camp will be constructed using conventional demountable components. All necessary infrastructure will be

installed including water, sewerage, drainage and electricity. The construction workers will use the facilities of the existing accommodation village including:

- Dining;
- Wet canteen;
- Recreation/entertainment;
- Medical/first aid; and
- Laundry.

The camp will provide single status accommodation only. The residents will work under fly-in fly-out arrangements.

4.6.6 Construction Wastes

A discussion of the wastes likely to be generated during the construction phase is given in Section 7.6. Details of the construction phase waste management plan are given in Section 21.3.1.

4.6.7 Construction Phase Environmental Management

Due to the distinct differences in construction and operational activities, an environmental management plan will be prepared to specifically address the activities to be undertaken during the construction phase.

The construction phase Environmental Management Plan (EMP) will be prepared by the construction contractor to establish the specific criteria and general management strategies to be adopted during construction with respect to:

- Vegetation management;
- Erosion and sediment control;
- Waste management;
- Storage of hazardous goods;
- Air and noise aspects; and
- Mosquitos.

Strategic EMPs for the above aspects of the construction phase are given in Section 22.3.

4.7 Operational Workforce

MRM currently employees 330 people on site. This includes wages employees, salaried staff and contractors. Efficiencies to be obtained in changing from an underground to an open cut mining operation

will result in the total on-site workforce reducing to 270 following the expansion. Further details of the operational workforce are given in Section 15.5.2.

The proposed organisation structure of the operational workforce for the open cut operation is given below.

