

## 8.0 Air Quality

### 8.1 Climate and Meteorology

The McArthur River region experiences a tropical monsoonal climate with two seasons: the wet season which lasts from December to March; and the generally dry conditions which last for the remainder of the year. The main climatic hazard in the region is the occurrence of tropical cyclones which may produce flooding, wind damage and high seas. The El Nino Southern Oscillation phenomenon, a global system of atmospheric and oceanic interactions, can also have a significant effect on year-to-year weather variability, including the timing and amount of wet season rainfall.

#### 8.1.1 Long Term Climatic Records

Long-term climate data based on observations recorded by the meteorological station located at MRM are presented in Table 8.1. This includes information on temperature, humidity, rainfall, wind speeds, cloud cover and evaporation. Long-term climate data based on observations recorded by the Bureau of Meteorology (BoM) station located at Centre Island, the closest station to Bing Bong, are presented in Table 8.2.

##### ***Temperature***

Ambient temperature at MRM has an annual mean daily maximum of 34°C and daily minimum of 20°C. The mean annual temperatures for 9 am and 3 pm are 27°C and 34°C respectively. The maximum temperature recorded in 2002 was 43°C occurring at 3pm in October. June and July are the coldest months, however minimum temperatures are still mild with minimum 9 am and 3 pm temperatures of 16°C and 26°C respectively.

At Centre Island, the mean daily maximum temperature is 31°C and the mean daily minimum temperature is 24°C.

##### ***Rainfall***

As noted above, the wet season at McArthur River region occurs during December to March, with generally dry conditions for the remainder of the year. The mean annual rainfall is approximately 750 mm, however, for any given month, rainfall may vary markedly from year to year. For example total rainfall in January has ranged from 10 mm to 436 mm. Rainfall in the region is dominated by relatively short duration, high intensity events, often associated with afternoon and evening showers and thunderstorms.

Rainfall at Centre Island follows a similar pattern, however, there is a higher annual rainfall reported for this area of 1,038 mm.

**Table 8.1**

**Long-Term Climate Data - McArthur River Mine (1968 - 2001)**

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	No of years	Percent complete
Mean Daily Maximum Temperature (°C)	35.8	35.2	35	34.5	32.4	29.8	29.7	32	34.7	37.6	38.6	37.6	34.3	18.4	71
Mean No of Days where Max Temp 40°C	2.7	1.8	0.7	0	0	0	0	0	0	3.3	7	5.1	20.5	20.3	78
Mean No of Days where Max Temp 35°C	18.6	14.9	18	14.1	3.2	0.1	0	2.9	13.6	25.5	26.2	24.6	161.7	20.3	78
Mean No of Days where Max Temp 30°C	28.6	26	28.2	27.7	25.1	16	15.1	24.5	26.3	27.6	27.9	28.9	301.8	20.3	78
Highest Maximum Temperature (°C)	45	45.3	42.4	38	37.4	35.6	34.7	37.8	39.7	43.7	44.3	46	46	21.2	81
Mean Daily Minimum Temperature (°C)	24.8	24.7	23.1	20.2	16.5	12.6	12.2	13.5	16.6	20.7	24.1	24.8	19.7	18.2	70
Mean No of Days where Min Temp 2°C	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1	20.5	79
Mean No of Days where Min Temp 0°C	0	0	0	0	0	0	0	0	0	0	0	0	0	20.5	79
Lowest Minimum Temperature (°C)	16	17.5	15.6	7.5	3.2	1.6	2.8	2.7	6	9.3	15.6	16.5	1.6	21.2	73
Mean 9am Relative Humidity (%)	71	75	71	58	51	48	48	49	47	48	55	64	58	18.4	71
Mean 3pm Relative Humidity (%)	50	52	44	29	28	26	25	21	22	22	31	37	33	17.2	66
Mean 9am Wind Speed (km/h)	5.9	5	4.4	5.9	7.7	7.7	7.5	7.8	8.6	8.1	7	6	6.7	20.5	78
Mean 3pm Wind Speed (km/h)	9.1	8.5	9.2	9.5	9.2	9.6	10.3	10.7	12.2	12.4	11.6	10.1	10.1	18.5	71
Highest Recorded Wind Gust (km/h)	113	90.7	113	61.2	59.4	63	64.8	72.4	70.6	76	116.6	107.6	116.6	15.7	60
Mean Monthly Rainfall (mm)	176.6	181.4	146.1	31.3	9.1	1.7	3.5	0.1	6.7	15.6	55.4	120.8	748.4	29	88
Lowest Monthly Rainfall (mm)	10.1	5.2	13.4	0	0	0	0	0	0	0	4.4	22.4		29	87
Highest Monthly Rainfall (mm)	435.6	660.9	416.9	182.6	160.1	18.2	56.6	0.6	89.6	95.4	173.5	435.2		29	87
Highest Recorded Daily Rainfall (mm)	173.4	197.6	124.1	81.8	86.4	15	49	0.4	48.4	59.1	72.4	112.5	197.6	29.2	88
Mean No of Rain Days	13.2	13.1	11.1	3.6	1.3	0.6	0.4	0.1	0.9	2.1	5.9	9.7	61.7	28.9	88
Mean Daily Evaporation (mm)	7.4	6.9	6.7	7.2	6.3	5.8	6	7.2	8.7	9.9	10.3	9.1	7.5	13.6	70
Mean No of Clear Days	2.3	1.7	5.3	8.5	14.1	16.9	17.2	17	15.1	13.9	7.5	4.2	123.7	23.3	89
Mean No of Cloudy Days	12	12.5	9	4.1	2.5	1.8	1.7	0.8	1.2	1.8	4.1	6.5	58	23.3	89
Mean Daily Hours of Sunshine	6.9	6.6	7.6	8.7	8.8	9	9	9.7	9.4	9.4	9.2	8.2	8.4	13.9	54

**Table 8.2**

**Long-Term Climate Data - Centre Island (1968 - 2001)**

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	No of years	Percent complete
Mean Daily Maximum Temperature (°C)	33.7	32.8	32.8	32.0	29.6	26.7	26.1	27.7	30.3	32.8	34.4	34.4	31.2	23.8	91
Mean No of days where Max Temp 40°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	24.2	92
Mean No of days where Max Temp 35°C	9.1	4.8	3.8	0.6	0.1	0.0	0.0	0.0	0.1	2.8	10.2	12.3	43.9	24.2	92
Mean No of days where Max Temp 30°C	27.7	23.7	26.9	25.8	13.0	1.5	0.5	2.8	18.1	28.2	28.4	29.1	225.6	24.2	92
Highest Maximum Temperature (°C)	39.6	39.1	38.1	36.0	35.1	31.7	31.1	32.4	36.0	37.9	39.2	41.6	41.6	24.7	93
Mean Daily Minimum Temperature (°C)	26.8	26.5	26.3	25.2	22.5	19.3	18.4	19.5	22.1	24.8	26.8	27.3	23.9	23.9	91
Mean No of Days where Min Temp 2°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	92
Mean No of Days where Min Temp 0°C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	92
Lowest Minimum Temperature (°C)	21.0	21.5	22.0	18.8	15.5	13.8	12.0	12.4	14.5	14.5	20.0	22.3	12.0	24.7	92
Mean 9am Relative Humidity (%)	78	81	79	72	68	65	66	68	69	69	70	74	72	23.7	92
Mean 3pm Relative Humidity (%)	65	69	63	58	57	55	53	53	53	55	56	60	58	23.7	92
Mean 9am Wind Speed (km/h)	14.0	14.6	15.0	19.4	21.5	22.3	20.8	18.4	16.7	15.2	14.7	14.4	17.2	24.3	92
Mean 3pm Wind Speed (km/h)	16.6	16.2	17.0	19.1	18.8	18.3	18.1	19.9	20.9	21.1	20.8	18.0	18.7	23.8	90
Highest Recorded Wind Gust (km/h)	159.5	122.4	90.7	76.0	72.4	77.8	74.2	74.2	74.2	77.8	88.9	100.1	159.5	7.4	36
Mean Monthly Rainfall (mm)	215.9	285.8	280.3	84.5	15.7	6.8	1.9	1.6	1.8	8.6	33.9	101.1	1037.8	28.4	99
Lowest Monthly Rainfall (mm)	3.8	4.2	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2		28.4	99
Highest Monthly Rainfall (mm)	631.2	574.0	1214.0	66.9	201.4	140.0	14.4	12.4	23.0	63.2	249.5	371.6		28.4	99
Highest Recorded Daily Rainfall (mm)	198.6	197.2	383.5	328.4	74.2	63.5	14.0	11.8	20.0	45.2	68.6	115.4	383.5	28.4	99
Mean No of Rain Days	12.0	13.6	10.9	4.3	1.9	0.5	0.3	0.2	0.6	1.1	3.0	7.3	55.6	28.1	98
Mean Daily Evaporation (mm)	6.7	5.7	6.1	6.5	5.6	5.2	5.4	5.7	6.8	7.6	8.2	7.5	6.5	6.8	80
Mean No of Clear Days	2.6	2.1	6.1	9.0	14.0	15.3	16.0	16.3	17.4	13.8	9.6	4.7	127.0	21.9	100
Mean No of Cloudy Days	16.8	15.7	13.0	7.6	4.7	3.4	4.0	3.5	3.3	3.6	7.0	11.3	93.9	21.9	100
Mean Daily Hours of Sunshine	7.1	6.3	7.7	8.6	8.9	9.5	9.5	9.9	10.1	10.4	10.1	9.1	9.0	7.8	91

## **Evaporation**

Evaporation is highest during November and December, with averages of up to 10 mm/day recorded at McArthur River and 8 mm/day at Centre Island.

## **Humidity**

Humidity is highest during February, when the mean 9am value at McArthur River is 75% and the mean 3pm value is 52%. At Centre Island it is slightly higher at 81% and 69%.

### **8.1.2 Wind Direction and Speed**

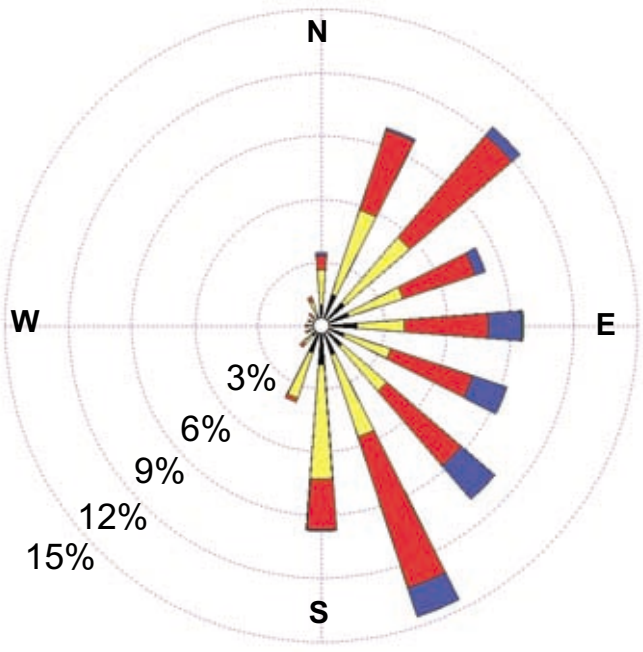
Wind roses for the McArthur River area have been compiled using the one year meteorological data file prepared for the modelling study. The wind speed and direction data collected at MRM are only recorded twice daily (9am and 3 pm) hence the CSIRO model TAPM (Hurley, 2000a-c) was used to prepare a complete file of hourly records for the McArthur River area suitable for modelling. The data file covers the 2002 year.

The wind roses given in Figure 8.1 show that the predominant wind patterns during 2002 were as follows:

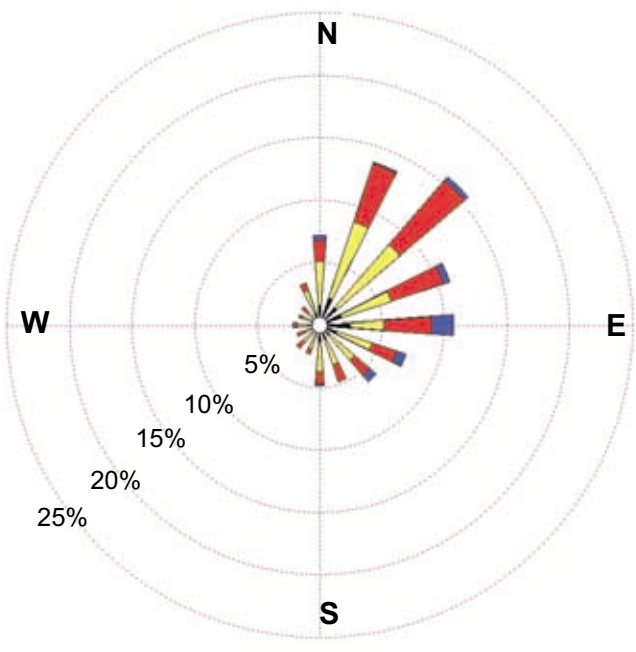
- **Annual:** Winds are typically fresh to moderate and predominantly from the north-east and south-east quadrants.
- **Dry Season (April to November):** The predominant winds during the dry season were light to moderate and from the north-east and south-east quadrants. During the day, winds blew mainly from the south-east quadrant. During the night, south south-east and north-east winds were predominant. Winds were stronger during the day than at night.
- **Wet Season (December to March):** Winds were light to moderate and blew predominantly from the north-east quadrant. During the day, the wind direction was variable, with a predominant easterly flow. During the night, north-east winds were predominant.

A meteorological dataset suitable for modelling has not been prepared for the Bing Bong area. However the original EIS for the McArthur River Mine (Hollingsworth Dames & Moore, 1992) reported that during the dry season the 9 am winds at Centre Island blow predominantly from south-east to south as at McArthur River. At 3pm the winds blow predominantly from east to north-east due to the development of the seabreeze during the day.

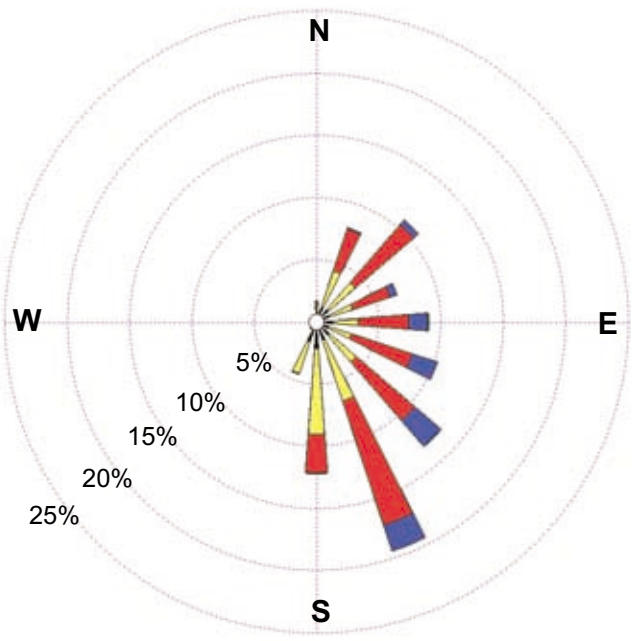
During the wet season, the 9am winds at Centre Island are more variable, while at 3pm the wind predominantly blows from the north-east quadrant. Winds tend to be stronger at Centre Island than McArthur River with fewer calms observed.



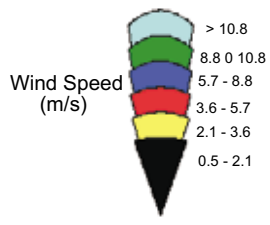
**ANNUAL**





**WET SEASON  
(December - March)**



**DRY SEASON  
(April - November)**



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 	McARTHUR RIVER MINE OPEN CUT PROJECT ENVIRONMENTAL IMPACT STATEMENT			<b>WIND ROSES 2002</b>	
	Drawn: VH Job No.: 42625552	Approved: CMP File No. 42625552-g-033.cdr	Date: 04-01-2005	Figure: <b>8.1</b>	Rev. A A4

### **8.1.3 Extreme Events**

#### ***Tropical Cyclones***

The cyclone season is generally from November to April with peak activity in January and February. The original MRM EIS (Hollingsworth Dames & Moore, 1992) estimated that there was a probability that the coast between Gove and Karumba would be affected by a cyclone once in about every 2.5 years. However, only 10% of the cyclones in the area have been described as notable by the Bureau of Meteorology. It was noted that due to the low population density in the area, smaller cyclones could in the past have passed between observing sites undetected, thus cyclone frequencies may be an underestimated.

#### ***Floods and Drought***

The occurrence of floods and drought in the Gulf Region is essentially an annual event, given the monsoonal nature of the climate. However, gross departures from the normal annual cycle are possible and such extreme events place additional levels of stress on the environment, particularly when wet season rains are significantly lower than average. Further information on flooding in the area of the mine site is given in Section 12.3.

#### ***Bushfire***

During the wet season there is little risk of bushfire in the region. In early June the number of fires begins to increase rapidly and generally remains high throughout the dry season. Fires are generally confined to understorey and grass cover and can generate smoke that leads to a marked reduction in visibility over very large areas. A large proportion of the fires that occur in the region are lit, usually on an annual basis, to reduce the potential for larger fires or to assist land management (e.g. by local aborigines in traditional hunting activities). Bush fires are generally of low intensity due to the regularity of burning.

The objectives of MRM's bush fire management plan are to reduce the risk of harm to environment, personnel and infrastructure from uncontrolled fires and to achieve a variety of fire-ages in the vegetation communities on the lease.

Strategies used in fire prevention include a network of fire breaks around the site, which is annually maintained. Controlled burns are undertaken approximately every three years in each area, however each area is visually inspected to determine annual burning requirements. A controlled burn will be undertaken after consideration is given to safety, environmental impact, fuel load, and available resources. Controlled burns are managed through a 'Permit to Burn' system. This permit ensures that all appropriate parties are notified of the date, time and location of the controlled burn. Appropriate parties include National Jet Systems, NT Bushfire Council, Community Relations/traditional owners, and the McArthur River Pastoral Lease Manager.

Fire management at the Bing Bong facility is based on the maintenance of suitable firebreaks around the lease area. This is assisted by the presence of the sea on one side, and the Mule Creek road on the other.

## 8.2 Relevant Emissions

### 8.2.1 Suspended Particulates

Suspended particulate matter is dust that stays suspended in the atmosphere for significant periods. The current nomenclature is to describe fractions of suspended particulate as:

- PM<sub>10</sub>: all particulate effectively less than 10 microns (µm) in diameter;
- PM<sub>2.5</sub>: all particulate effectively less than 2.5 µm in diameter; and
- TSP: total suspended particulate, generally less than 50 µm in diameter.

Within the range of suspended particulate, the group of particles which are sized 10 µm or less (PM<sub>10</sub>) have been associated with health effects. Particles that are larger than 10 µm, tend not to be able to penetrate the respiratory tract and do not appear to be significant with respect to potential health effects.

### 8.2.2 Deposited Particulates

Deposited particulate matter is dust that, because of its aerodynamic diameter and density, rapidly falls from the air. In general terms, deposited particulate has a diameter of greater than about 50 µm. However there is no sharp dividing line between these particles and the smaller particles of suspended matter that fall more slowly out of the air. Due to the size of the particulate matter, most of this material will not enter the body. Hence the effect of deposited particulate is primarily its nuisance effects, and may only affect health via annoyance reactions.

The dust deposition rate is measured as the amount of dust deposited on a horizontal surface as a result of gravitational settling over a specified time period. The unit for this parameter is grams per square metre per month (g/m<sup>2</sup>/month).

### 8.2.3 Oxides of Nitrogen

Oxides of nitrogen (NO<sub>x</sub>) are formed through a thermal process of combining oxygen and nitrogen. Typically this is from combustion of nitrogen in the presence in oxygen, such as in motor vehicles and thermal power generating plants, but also naturally in the nitrogen cycle. Oxides of nitrogen include nitrogen dioxide (NO<sub>2</sub>), nitric oxide (NO) and traces of nitrous oxide (N<sub>2</sub>O). The principal species of concern, in terms of human health effects, is NO<sub>2</sub>.

Nitrogen dioxide is soluble in water and excessive amounts in the atmosphere can result in “acid rain”. In the stratosphere, oxides of nitrogen play a crucial role in maintaining ozone levels. In the lower atmosphere, oxides of nitrogen play a major role in the formation of photochemical smog.

### **8.2.4 Carbon Monoxide**

Carbon monoxide (CO) occurs naturally in forest fires, volcanic ash and marsh gases. It is also sourced from incomplete combustion of fuels (particularly in motor vehicles), smoking cigarettes, burning wood and industrial plant exhaust.

### **8.2.5 Sulfur Dioxide**

Sulfur dioxide (SO<sub>2</sub>) is a colourless, pungent, irritating and reactive gas, which is soluble in water. SO<sub>2</sub> is generally removed from the atmosphere by rain. The main human activities that are sources of SO<sub>2</sub> include power generation from the burning of coal, oil or gas containing sulfur as well as other industrial activities. In urban areas, motor vehicles contribute about 10% to ambient SO<sub>2</sub> levels.

### **8.2.6 Trace Metals**

The main emissions of metals from the site will be lead and zinc which will be a component of the fugitive dust emissions from the mining and crushing operations.

Exposures to elevated levels of lead can give rise to a range of toxic effects. Zinc, however, is an essential trace element in the diet of all living organisms from bacteria to humans. However, either too little zinc or too much zinc can be harmful to human health.

### **8.2.7 Volatile Organic Compounds**

The World Health Organisation definition of Volatile Organic Compounds (VOCs) includes all organic compounds (substances made up of predominantly carbon and hydrogen) with boiling temperatures in the range of 50 to 260°C, excluding pesticides. VOCs are released from a wide range of industrial processes including the combustion of natural gas and from vehicle exhausts. The major environmental significance of VOCs is in relation to their role in the formation of photochemical smog. Other environmental and health effects depend on the composition of the VOCs, their concentration and the length of exposure.

### **8.2.8 Greenhouse Gases**

The existing mining operations produce greenhouse gases, predominantly from electricity generation and to a lesser extent from motor vehicle usage. Details of the greenhouse gas impacts from the existing and proposed operations are given in Section 8.14.

## **8.3 Existing Emissions**

The main fugitive emissions to air from the current mining activities are particulate matter from exposed areas, stockpiles and vehicle movements. There are also emissions of particulates from the ore crushing

and handling operations. Emissions of particulate results in suspended particulates and deposited particulates.

A 22 MW gas fired power station exists on site which burns approximately 2 million GJ of natural gas. It emits products of combustion of natural gas including carbon dioxide and carbon monoxide, oxides of nitrogen, small quantities of particulate, traces of sulfur dioxide and unburnt hydrocarbons.

Another point source is the vent shafts from the underground mine which vent dust from the mining operations and dust and fumes from explosions.

In addition, fuel consumed by the vehicles and machinery being operated around the mine generates emissions of carbon dioxide and carbon monoxide, oxides of nitrogen, sulfur dioxide and unburnt hydrocarbons.

Existing emissions from the site are reported the National Pollutant Inventory (NPI) and are publicly available on <http://www.npi.gov.au>. The NPI is an Australian database of pollutant emissions from various industrial facility sources and diffuse sources. All facilities triggering certain thresholds based primarily on fuel consumption must report to the NPI at the end of each financial year. McArthur River Mine triggers the thresholds and reports its emissions annually. Currently there are 90 substances reported to the NPI.

## 8.4 Existing Air Quality

### 8.4.1 McArthur River Mine

#### *Dust Deposition*

A network of 24 dust deposition gauges monitors the impact of MRM's mine site operations on air quality. The monitoring is undertaken in accordance with Australian Standard AS3580.10.1. The dust sampling locations are shown in Figure 8.2.

The dust deposition results (total solids) for sites D13 and D23 are given in Figure 8.3. These have been selected as typical sites to represent areas downwind of the tailings storage facility and process area respectively. While these results may be compared to the NSW EPA criterion for deposited dust (4 g/m<sup>2</sup>/month), it is important to note that the mine is in a remote area and hence nuisance dust issues are not particularly relevant to the site. Nevertheless, the results show that generally dust levels are low to moderate and normally below levels that would be expected to give rise to complaints in more populated areas. The only exception to this was in October 2002 when a number of the sites recorded high deposition levels.

Figure 8.4 presents the results of the analysis of zinc and lead levels in the dust for each monitoring site. There are no recommended guidelines for deposition rates of heavy metals, hence, these results can only be assessed in comparison with the history of results for each site or with other sites.



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 Job No: 42625552  
 Approved: CMP  
 File No: 42625552-g-034.wor  
 Date: 06-01-05

McARTHUR RIVER MINE  
 OPEN CUT PROJECT  
 ENVIRONMENTAL IMPACT STATEMENT

Figure: 8.2

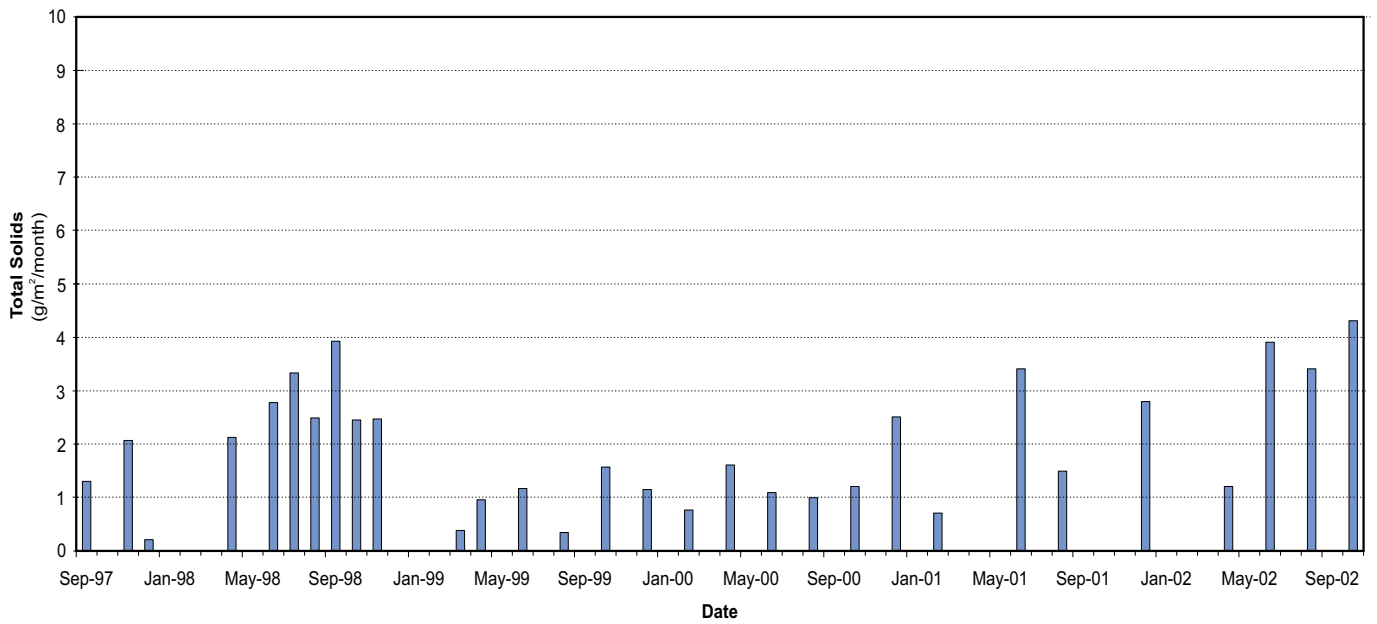
DUST MONITORING LOCATIONS



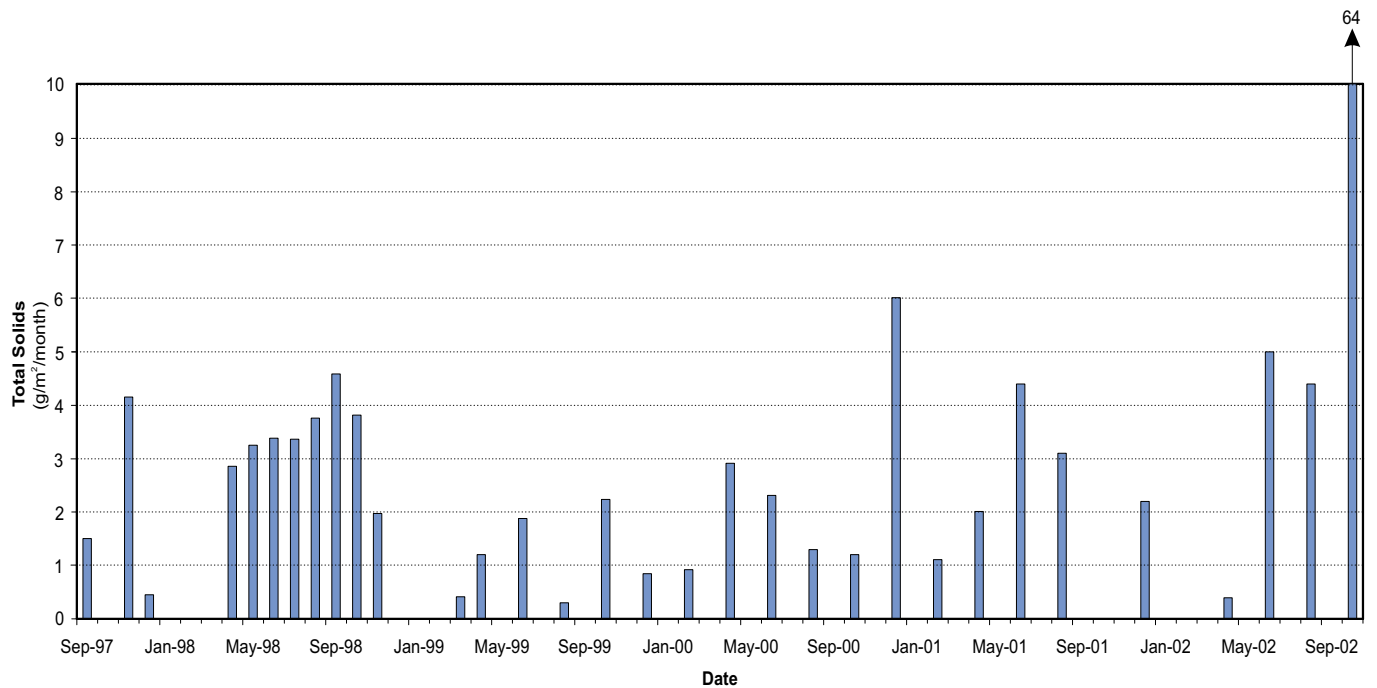
Scale 1:45 000 (A4)  
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 Date of Aerial Photography, 2001

D1 Dust Monitoring Location

Rev: A  
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**SITE D13**



**SITE D23**

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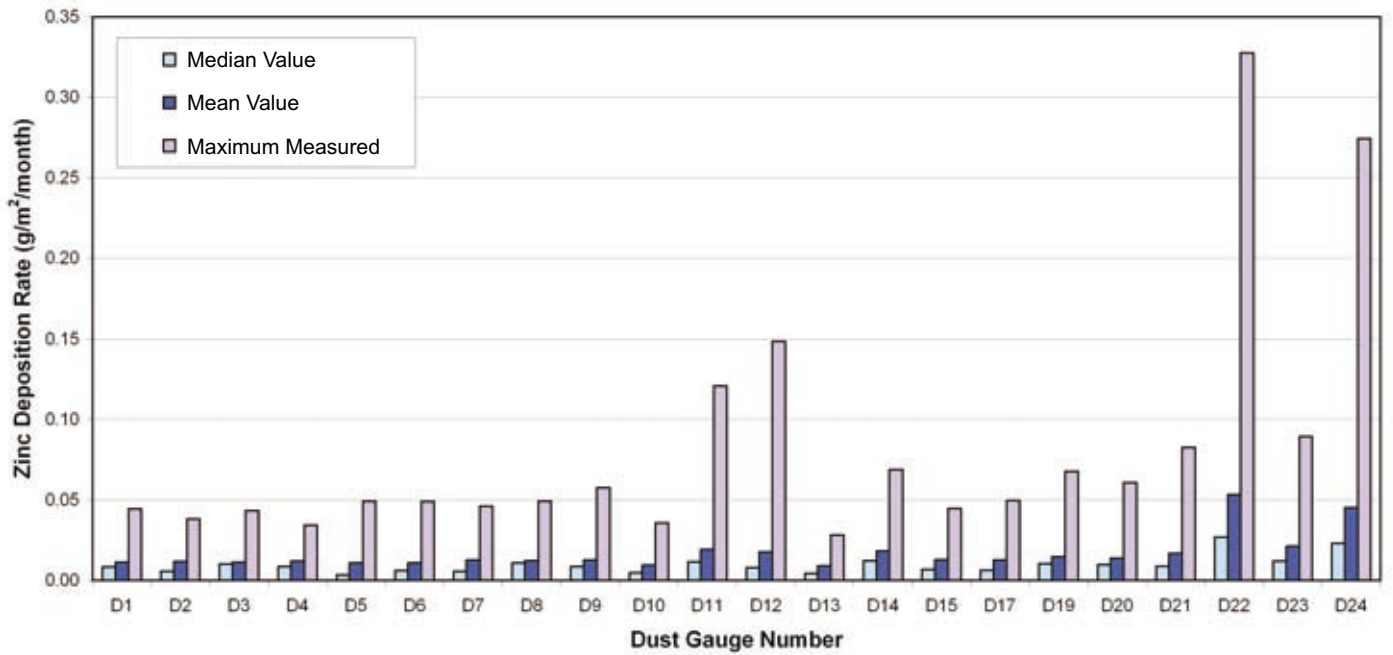
McARTHUR RIVER MINE  
OPEN CUT PROJECT  
ENVIRONMENTAL IMPACT STATEMENT

DUST DEPOSITION  
TOTAL SOLIDS  
SITES D13 AND D23

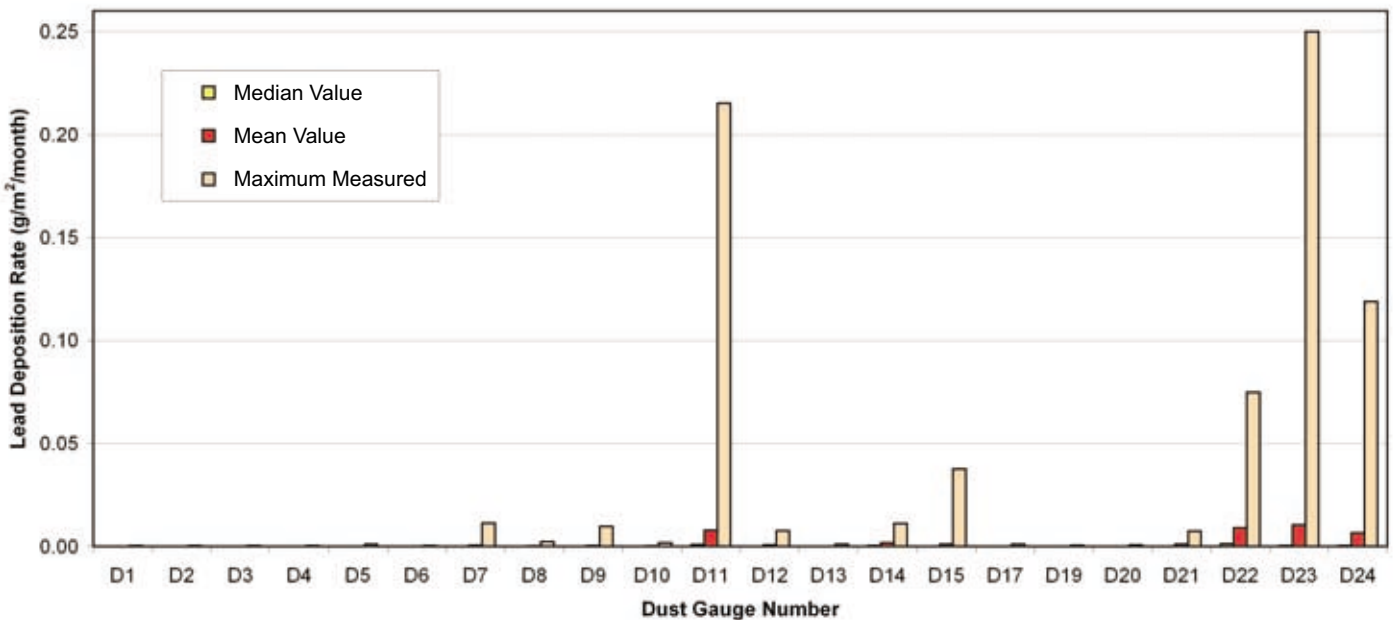
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Figure: **8.3**

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**SUMMARY OF ZINC DEPOSITION RESULTS (1995 - 2001)**



**SUMMARY OF LEAD DEPOSITION RESULTS (1995 - 2001)**

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McARTHUR RIVER MINE  
OPEN CUT PROJECT  
ENVIRONMENTAL IMPACT STATEMENT

**ZINC AND LEAD  
IN DUST DEPOSITION  
MINE SITE**

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Figure: **8.4**

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Higher levels of zinc deposition have been recorded by the gauges close to the Barney Hill area where the mine portal is currently located and where mineral processing occurs.

The lead deposition rates show similar characteristics to those of zinc in that the areas with highest historical deposition are around Barney Hill. However, the lead deposition levels on the northern side of Barney Hill are higher than those for zinc. This is likely to be because the two metals originate from different sources. Lead is likely to originate from a number of potential sources in that area which include two vent shafts from the underground mine and the pilot plant tailings dam. The lead deposition rates are also more variable than the zinc data.

### ***Metals in Soils***

Since 1992, an annual survey of base metals in soil has been conducted at MRM. The soil sampling sites are at the same locations as the dust deposition gauges to allow comparison between the measured rates of zinc and lead deposition and their accumulation in the soil.

The monitoring sites with the highest concentrations of metals in the soil are sites D5, D8, D22 and D24. Both zinc and lead concentrations are elevated at these locations, probably as a result of their proximity to geochemical anomalies. As the dust gauges at sites D5 and D8 did not show high deposition rates, it may be concluded that deposition from the mining activities has not contributed to the elevated metal concentrations in these soils. Sites D22 and D24 also exhibited high levels of metals in soil. These sites typically have elevated dust gauge metal concentrations and are in close proximity to Barney Hill. However, no background data were collected at these sites, thus it is not possible to confirm whether the metals in soil are from natural sources or are the result of dust fallout from mining operations.

### ***Other Pollutants***

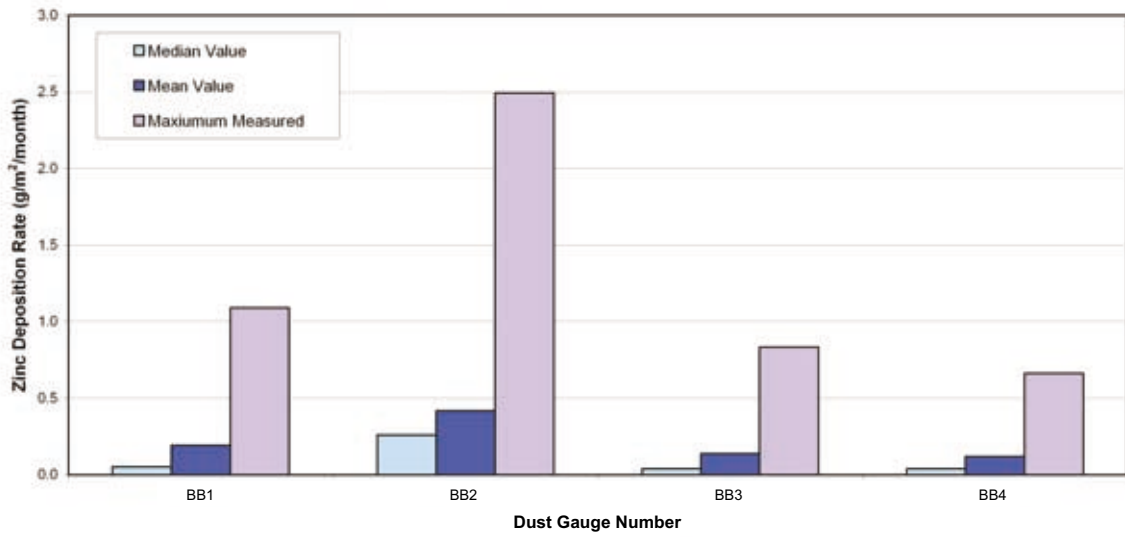
No other monitoring is currently undertaken for ambient air quality. While there are emissions from the power station and mine vehicles, there are no other industrial or urban developments in vicinity of the mine and therefore, background concentrations of pollutants such as SO<sub>2</sub>, NO<sub>x</sub>, O<sub>3</sub>, VOCs, CO and metals are expected to be minor and hence they have not been monitored.

## **8.4.2 Bing Bong**

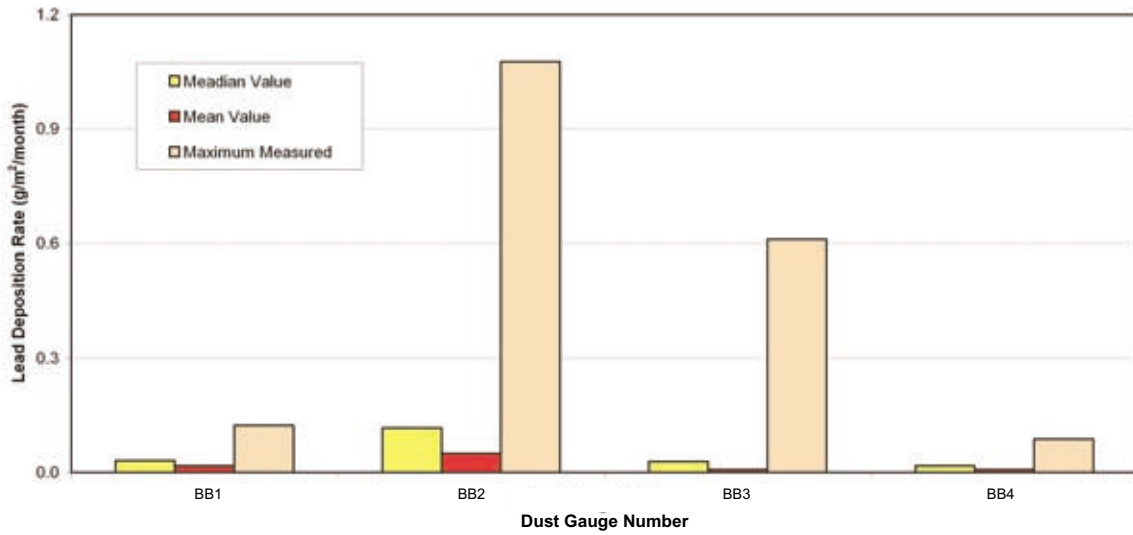
Dust deposition levels are monitored at Bing Bong, using four dust monitoring sites: one on either side of the wharf; and two at the dredge spoil emplacement area. The collected dust samples are analysed for zinc and lead concentrations as well as total and insoluble solids.

Generally, dust levels (total solids) are low to moderate and are normally below levels that would be expected to give rise to complaints in more populated areas.

The zinc and lead levels in dust at each of the monitoring sites are presented in Figure 8.5. The results indicate that metal deposition rates are generally low and not significant.



**Summary of Zinc Deposition Results (1995 - 2001)**



**Summary of Lead Deposition Results (1995 - 2001)**



**Dust Monitoring Locations**



McARTHUR RIVER MINE  
OPEN CUT PROJECT  
ENVIRONMENTAL IMPACT STATEMENT

**ZINC AND LEAD  
IN DUST DEPOSITION  
BING BONG**

Drawn: VH	Approved: CMP	Date: 04-01-2005
Job No.: 42625552	File No. 42625552-g-036.cdr	

Figure: **8.5**

Rev. A
A4

In addition to the monitoring of metal deposition rates at Bing Bong, soil base metal concentrations have been measured annually at the four dust monitoring sites. The purpose of this monitoring is as a long-term indicator of metal deposition. The results showed increases in zinc and lead concentrations recorded at Site BB2, peaking in 1999, which corresponded with the higher metal deposition results. To address this issue, better management practices were implemented at the site to reduce fugitive dust emissions from the operations. As a result, the soil metal concentrations have begun to decrease since 1999, mirroring the reductions in metal deposition being measured in the dust gauges.

No other monitoring is currently undertaken at Bing Bong for ambient air quality. As there are no other industrial or urban developments in vicinity of the mine, background concentrations of pollutants such as SO<sub>2</sub>, NO<sub>x</sub> and CO are expected to be negligible.

## 8.5 Emissions from Open Cut Operations

### 8.5.1 Fugitive Emissions

The main fugitive discharges to air from the open cut mine will be emissions of particulate matter from activities such as stripping, drilling and blasting, grading, crushing, stockpiling, exposure of areas, vehicle movements, and the loading and unloading of ore and overburden. Emissions of particulate matter will give rise to both suspended particulate and deposited particulate matter.

There will also be emissions of the products of fuel combustion from the vehicles and machinery being operated within the mine and from blasting activities. Products of fuel combustion include carbon dioxide and carbon monoxide, oxides of nitrogen and small quantities of sulfur dioxide and particulate.

Fugitive emissions of particulates have been estimated for the mining and processing activities using emission factors published by the National Pollutant Inventory (2001). The estimated fugitive emissions are given in Table 8.3. Table 8.3 also compares the predicted emissions with those that are currently reported for the existing underground operations.

**Table 8.3**

**Estimated Emissions to Air from Fugitive Sources**

	<b>TSP (kg/annum)</b>	<b>PM<sub>10</sub> (kg/annum)</b>	<b>PM<sub>2.5</sub> (kg/annum)</b>	<b>Zn (kg/annum)</b>	<b>Pb (kg/annum)</b>
Wind Erosion of Exposed Areas	49,892	24,946	7,234	1,587	410
Drilling & Blasting	18,820	9,787	2,838	1,036	448
Un/Loading Pit, ROM, Waste Dump	26,160	46,870	4,177	342	136
Primary & Secondary Crushing	15,981	2,188	634	1,665	729
Stockpiles, Plant Handling	10,800	5,400	1,566	1,125	492
Haul Roads	133,759	75,925	11,083	79	12
Vehicles	11,803	11,803	11,803	-	-
<b>Total</b>	<b>267,216</b>	<b>176,919</b>	<b>39,337</b>	<b>5,834</b>	<b>2,226</b>
<b>Existing NPI (2004)</b>	<b>nr<sup>1</sup></b>	<b>87,000</b>	<b>nr<sup>1</sup></b>	<b>3,600</b>	<b>1,300</b>

<sup>1</sup> not reported

## 8.5.2 Point Source Emissions

The only significant point source emissions from the expanded operations will be from the existing power station stack. No new point source emissions will occur as a result of the open cut mining operation.

The existing combined cycle gas turbine plant will be used to generate electricity for the open cut operations. Combined cycle gas turbines are widely used throughout the world as a response to abate greenhouse gas production from power generation and are the most greenhouse efficient gas fired power generation technology currently available. Gas fuel has the least carbon intensity of all the fossil fuels and the waste heat from the operation of the gas turbine can be used to raise steam and generate additional energy from the same fuel energy input. Details of the existing power station emissions are given in Tables 8.4 to 8.6.

**Table 8.4**

**Stack Data for Point Sources from the Open Cut Operations**

Emission Point	Stack Diameter (m)	Exhaust Temperature (°C)	Exit Velocity (m/s)	Moisture Content (% v/v)	Stack Height (m)	Exhaust Flowrate (Am <sup>3</sup> /hr)	Exhaust Flowrate (Nm <sup>3</sup> /hr)
Gas Power Station (existing)	3.5	605	16.7	5	23	578,150	170,690

**Table 8.5**

**Emission Data for Point Sources from the Open Cut Operations - Criteria Pollutants**

Emission Point	TSP		PM <sub>10</sub> <sup>A</sup>		PM <sub>2.5</sub> <sup>B</sup>		NO <sub>x</sub>		SO <sub>2</sub>	
	(mg/Nm <sup>3</sup> )	(kg/hr)	(mg/Nm <sup>3</sup> )	(kg/hr)	(mg/Nm <sup>3</sup> )	(kg/hr)	(mg/Nm <sup>3</sup> )	(kg/hr)	(mg/Nm <sup>3</sup> )	(kg/hr)
Power Station Stack (existing)	23.4	4.0	11.7	2.0	5.9	1.0	294.4	50.3	2.7	0.5

<sup>A</sup>: Presumed to be 50% of TSP values

<sup>B</sup>: Presumed to be 50% of PM<sub>10</sub> values

**Table 8.6**

**Emission Data for Point Sources from the Open Cut Operations - Other Pollutants**

Emission Point	CO		Zinc		Lead		Total VOCs	
	(mg/Nm <sup>3</sup> )	(kg/hr)	(mg/Nm <sup>3</sup> )	(kg/hr)	(mg/Nm <sup>3</sup> )	(kg/hr)	(mg/Nm <sup>3</sup> )	(kg/hr)
Power Station Stack (existing)	67.3	11.5	3.95E-04	6.75E-05	3.27E-07	5.58E-08	14.7	2.5

## 8.6 Assessment Criteria

Impact assessment criteria comprise ground level concentration limits, designed for use in conjunction with dispersion modelling. If maximum predicted ground level concentrations are less than the impact assessment criteria, then there should be no adverse impacts.

Impact assessment criteria apply downwind of a proposed facility. They are set to protect against adverse effects on human health. There are currently no nationally recognised impact assessment criteria nor are there any impact assessment criteria set by the NT Government.

The New South Wales Environment Protection Authority (NSW EPA) (now the Department of Environment Conservation) has published impact assessment criteria to be applied in the design stages of an activity to ensure that there will be no impact on public health or amenity values (NSW Environmental Protection Authority, 2001). NSW EPA impact assessment criteria relevant to the proposed development are given in Table 8.7. They have been used as the basis for this assessment and have been adopted as appropriate performance indicators for the open cut project.

**Table 8.7**

**NSW EPA Impact Assessment Criteria**

Pollutant	Criteria ( $\mu\text{g}/\text{m}^3$ )	Time Average
TSP	330	3-minutes
	90	annual
PM <sub>10</sub>	50	24-hours
	30	annual
Nitrogen Dioxide	246	1-hour
	62	annual
Carbon Monoxide	100,000	15-minutes
	30,000	1-hour
	10,000	8-hours
Sulfur Dioxide	712	10-minutes
	570	1-hour
	228	24-hours
	60	annual
Lead	0.5	Annual
Zinc Chloride fumes	33	3 minutes

In addition to the above, the NSW EPA has established criteria for dust deposition. These criteria are given in Table 8.8.

**Table 8.8**

**NSW EPA Impact Assessment Criteria for Deposited Dust**

Pollutant	Averaging Period	Maximum Increase	Maximum Total
Deposited Dust	Annual	2 g/m <sup>2</sup> /month	4 g/m <sup>2</sup> /month

## 8.7 Dispersion Model

### 8.7.1 Overview

Downwind concentrations from the mine and processing plant have been assessed using dispersion modelling techniques. The modelling has been used to calculate estimates of worst-case downwind ground-level concentrations of all relevant criteria pollutants (NO<sub>x</sub>, CO, SO<sub>2</sub> and PM<sub>10</sub>) for both normal and intermittent (start-up and emergency) operating conditions.

An assessment of potential off-site impacts during the construction phase has also been undertaken. Quantification and modelling of these dust emissions has not been performed. However, potential dust sources have been identified along with recommended management strategies.

Photochemical smog formation is not considered to be an issue, hence a quantitative assessment of the impact of NO<sub>2</sub> emissions from the development on regional ozone (O<sub>3</sub>) levels has not been undertaken.

### 8.7.2 Modelling

Modelling of the fugitive and point source emissions has been undertaken using the AUSPLUME dispersion model developed by the Environment Protection Authority of Victoria (EPAV) (Environmental Protection Authority Victoria, 2000). Version 5.4 of the model was used. This model was recently upgraded to improve its ability to simulate the dispersion of particulate matter from mining sources.

Terrain effects were taken into consideration in the AUSPLUME model using the Egan half-height method. A terrain data file suitable for use with the model was prepared for the area from the *National Topographic Map Series: Borrooloola, Sheet 6165 (scale 1:100,000)*.

Building dimensions were entered into the model using the Building Profile Input Program utility of the AUSPLUME model. Building downwash was simulated using the PRIME algorithm option.

### 8.7.3 Meteorological Data

The minimum data required by AUSPLUME is a list of hourly values (preferably hourly averages) of wind speed, wind direction, atmospheric stability class, and mixing depth. Stability class is a measure of the degree of vertical mixing in the atmosphere and hence its ability to disperse emissions. Hourly

temperatures are also required if the model is to be used to simulate stacks emitting at temperatures above ambient.

The TAPM model developed by the CSIRO was used to compile a meteorological file suitable for modelling. This was done rather than using the data collected by the BoM weather station located at the site due to its limited extent (only 9am and 3pm wind data is recorded). TAPM was run for the year 2002 to generate meteorological fields over the proposed development site. An AUSPLUME input file was then generated from the TAPM modelling at the McArthur River monitoring location.

The frequency of occurrence (%) of each stability class calculated for the AUSPLUME file is shown in Table 8.9.

**Table 8.9**

**Frequency of Atmospheric Stability Conditions**

Stability Class	A	B	C	D	E	F
Percentage (%)	8.4	12.8	15.0	22.4	30.1	11.2

## 8.8 Construction Impacts

Construction phase environmental management plans will be prepared which will identify potential dust sources and propose dust control strategies.

During construction, activities with the greatest potential for dust emissions include the excavation and stockpiling of soils, levelling and grading activities, and other earthworks operations. If required, water trucks/sprays may be used to suppress dust emission from these types of activities during dry or windy conditions. Wherever possible, the quantities and areas of soils which are disturbed will be kept to a minimum. Given the localised nature of construction activities, emissions from vehicle movements are expected to be minor.

The existing ambient monitoring programs at McArthur River and Bing Bong will provide feedback on the effectiveness of dust control strategies throughout the construction period.

## 8.9 Operations Impacts - Mine

The following assessment of potential impacts on air quality from the mine's operations has been undertaken using atmospheric dispersion modelling. While the modelling has been used to predict ground level pollutant concentrations over a wide area surrounding the site, the impact assessment has focussed on ground level concentrations predicted at the mine camp, where workers will spend their time between shifts. This location is considered to be the nearest sensitive receptor in terms of potential health impacts, although it is considered reasonable to assume that mine staff would be less sensitive to impacts on amenity values such as dust and odour compared to the general public.

The predicted results have been compared to the relevant criteria established by NSW EPA to assess the level of impact. For the majority of cases, the worst case meteorological conditions have been used in the assessment. Where averaging times are one hour or less, such as those specified for lead and zinc, the 99.9% frequency has been used to lessen the impact of a potentially extreme meteorological situation.

A summary of the predicted ground level concentrations at the mine camp and the relevant criteria is given in Table 8.10.

**Table 8.10**

**Air Quality Impacts at Mine Camp – Operations**

Emission and Averaging Period	Ground Level Concentration ( $\mu\text{g}/\text{m}^3$ )	
	Maximum Predicted At Mine Camp	NSW EPA Criteria
<b>TSP</b>		
3 Minute Average	303	330
Annual Average	3.0	90
<b>PM<sub>10</sub></b>		
24 Hour Average	20	50
Annual Average	2.0	30
<b>PM<sub>2.5</sub></b>		
24 Hour Average	4.2	25 <sup>1</sup>
Annual Average	0.45	8 <sup>1</sup>
<b>NO<sub>x</sub></b>		
1 Hour Average	10	246
Annual Average	0.08	62
<b>SO<sub>2</sub></b>		
10 Minute Average	0.03	712
1 Hour Average	0.007	570
24 Hour Average	0.01	228
Annual Average	0.0006	60
<b>CO</b>		
15 Minute Average	1.03	100,000
1 Hour Average	2.4	30,000
8 Hour Average	0.9	10,000
<b>Lead</b>		
Annual Average	0.05	0.5
<b>Zinc</b>		
3 Minute Average	13	33
<b>VOCs</b>		
3 Minute Average	0.28	100 (Benzene)
		50 (Formaldehyde)
		6,000 (n-Hexne)
		650 (Toluene)

<sup>1</sup> National Environment Protection Measure

### 8.9.1 Total Suspended Particulates

Predicted ground level concentrations of total suspended particulates (TSP) are shown in Table 8.10 and the dispersion modelling plots are shown in Figure 8.6.

The TSP emissions from the stack are considered negligible, with the bulk of the TSP impacts being attributed to the fugitive sources. The predicted maximum 3 minute ground level concentration at the mine camp is  $303 \mu\text{g}/\text{m}^3$ , which is below the relevant assessment criterion ( $330 \mu\text{g}/\text{m}^3$ ). This will not result in any significant impacts.

Maximum TSP concentrations will occur in the immediate vicinity of the mining operation and the overburden emplacement facility. Dust emissions from these sources will be managed in accordance with the requirements of the air quality management plan given in Section 21.

It is proposed to monitor TSP levels at the mine camp to provide relevant data should dust emissions ever become an amenity issue, despite the predicted concentration being within the NSW EPA criterion. This monitoring will continue throughout the life of the mine and will be used to ensure that the dust control measures keep ambient concentrations at acceptable levels.

### 8.9.2 PM<sub>10</sub> and PM<sub>2.5</sub>

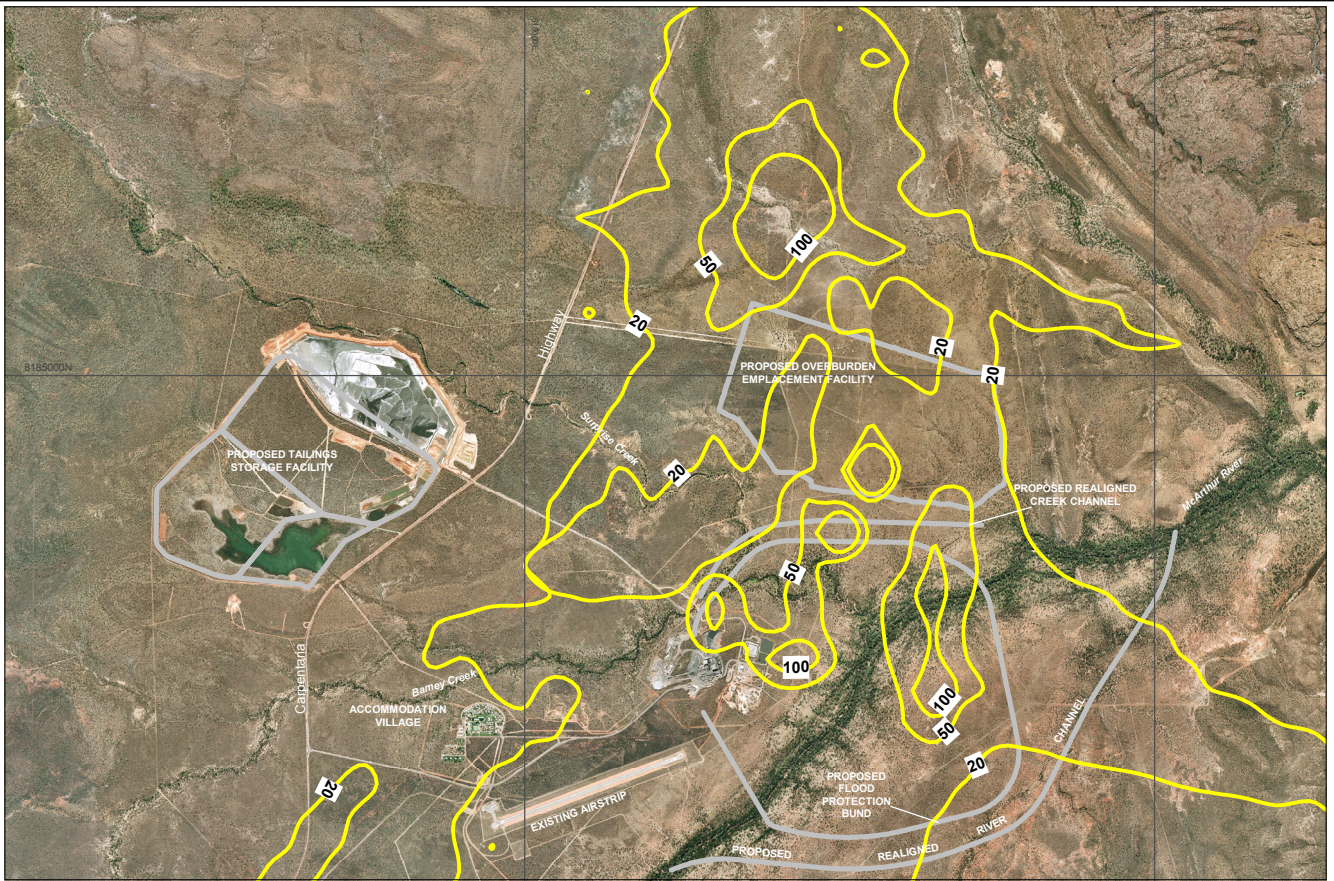
The predicted maximum PM<sub>10</sub> and PM<sub>2.5</sub> concentrations at the mine camp are well below the assessment criteria and background levels are expected to generally be low. Predicted PM<sub>10</sub> contours are shown on Figure 8.7. Based on the results presented in Table 8.10, it is concluded that particulate emissions from the development would not have a significantly adverse impact on ambient PM<sub>10</sub> and PM<sub>2.5</sub> concentrations at the mine camp.

Maximum PM<sub>10</sub> and PM<sub>2.5</sub> concentrations will occur in the immediate vicinity of the mining operation and the overburden emplacement facility. Dust emissions from these sources will be managed in accordance with the requirements of the air quality management plan given in Section 21.

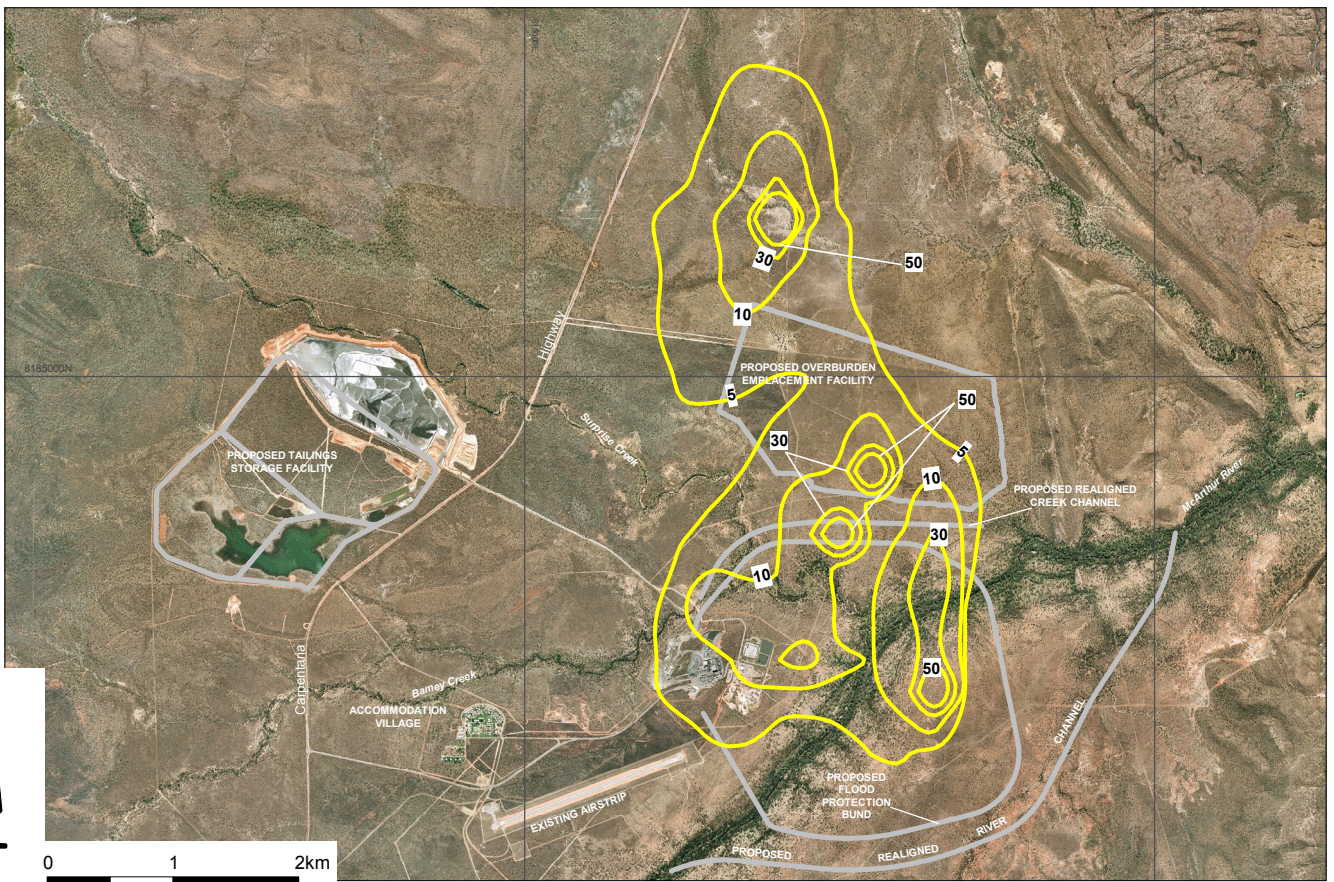
### 8.9.3 Oxides of Nitrogen

NO<sub>x</sub> emissions have been modelled and maximum downwind concentrations predicted. For the purposes of modelling, NO<sub>x</sub> emissions from the power station stacks were assumed to occur continuously. However, the modelling did not include NO<sub>x</sub> emissions from vehicle exhausts. These will occur at varying locations around the site and are minor compared to the power station emissions.

The maximum 1-hour and annual average NO<sub>x</sub> concentrations predicted by the model at the mine camp are summarised in Table 8.10 and compared to the relevant assessment criteria. Figure 8.8 also illustrates the locations of the maximum 1-hour and annual NO<sub>x</sub> predictions. Maximum ground level concentrations are predicted to occur on elevated land in an uninhabited area approximately 8 km north north-east of the plant site.



**MAXIMUM 24 HOUR**



**MAXIMUM ANNUAL**

— 10 — Ground Level Concentration ( $\mu\text{g}/\text{m}^3$ )

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0 1 2km  
Scale 1:60 000 (A3)  
Horizontal Datum: AGD84, Zone 53  
Date of Aerial Photography, 2001



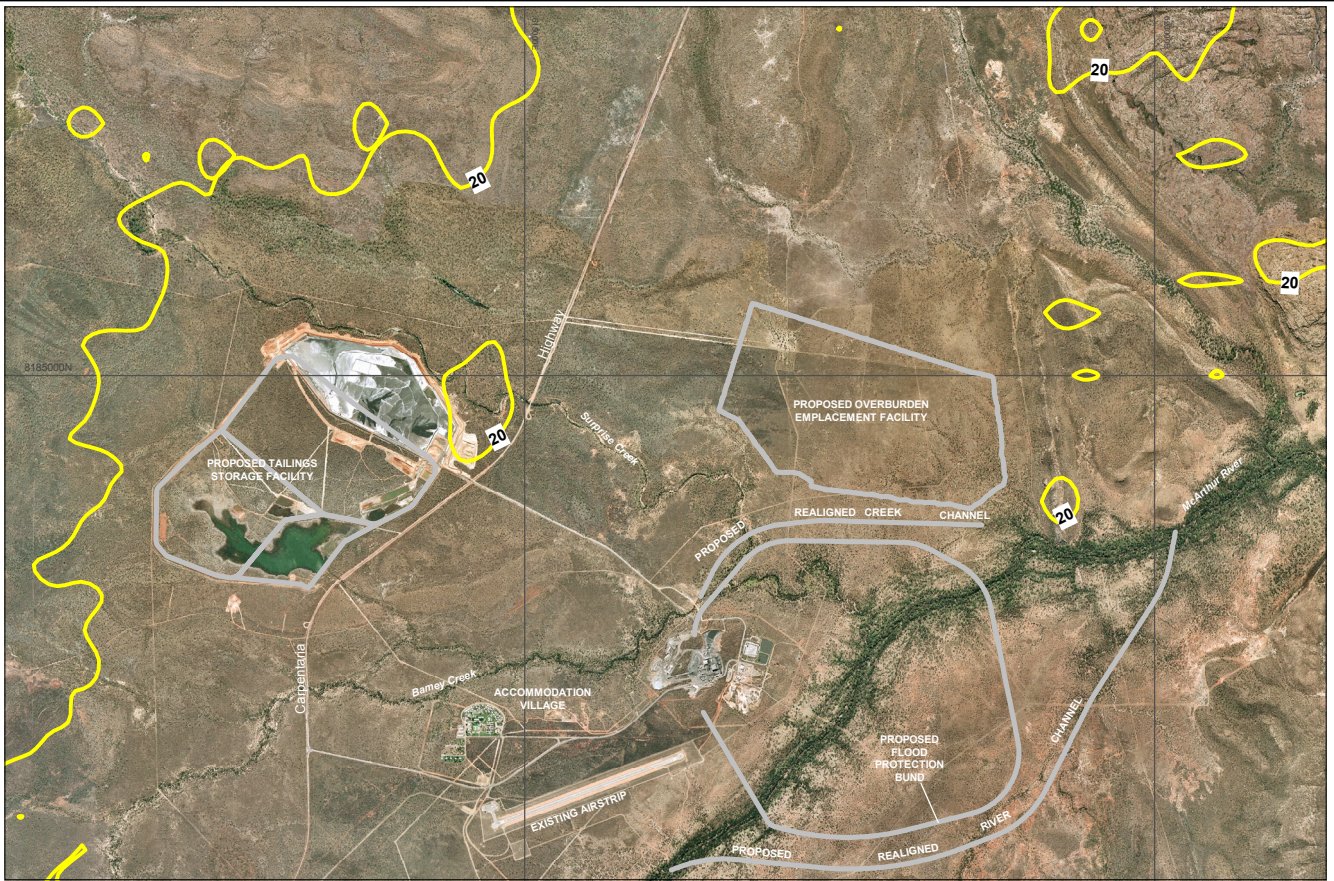
**MCARTHUR RIVER MINE  
OPEN CUT PROJECT  
ENVIRONMENTAL IMPACT STATEMENT**

**PM<sub>10</sub> PREDICTIONS**

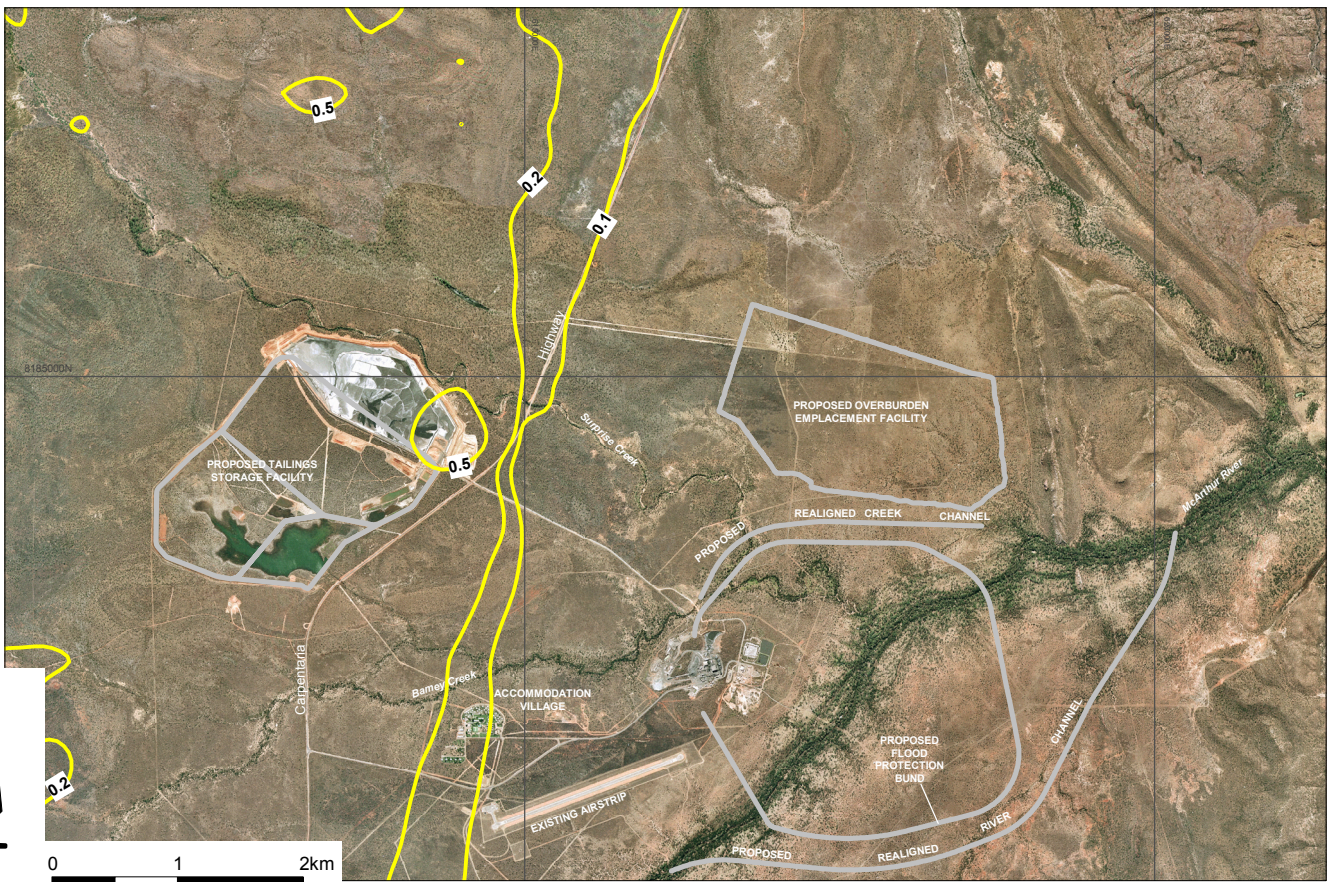
Drawn: VH	Approved: CMP	Date: 18-07-05
Job No: 42625552	File No: 42625552-g-038d.wor	

Figure: 8.7

Rev: D  
A4



**MAXIMUM 1 HOUR**



**MAXIMUM ANNUAL**

— 1 — Ground Level Concentration ( $\mu\text{g}/\text{m}^3$ )

0 1 2km

Scale 1:60 000 (A3)

Horizontal Datum: AGD84, Zone 53  
Date of Aerial Photography, 2001

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

**NO<sub>x</sub> PREDICTIONS**

Drawn: VH	Approved: CMP	Date: 18-07-05
Job No: 42625552	File No: 42625552-g-039c.wor	

Figure: 8.8

Rev: C  
A4

The predicted maximum NO<sub>x</sub> concentrations at the mine camp are well below the NO<sub>2</sub> assessment criteria. Given that NO<sub>2</sub> will represent only a portion of the total NO<sub>x</sub>, the risk of NO<sub>2</sub> assessment criteria being exceeded at the mine camp as a result of emissions from the expanded operations is extremely low.

#### **8.9.4 Sulfur Dioxide**

For the purposes of modelling, SO<sub>2</sub> emissions from the power station stacks were assumed to occur continuously. The modelling did not include SO<sub>2</sub> emissions from vehicle exhausts which are anticipated to be minor.

The maximum SO<sub>2</sub> concentrations predicted by the model at the mine camp are summarised in Table 8.10 and compared to the relevant assessment criteria. The predictions at all locations downwind of the mine are significantly less than the SO<sub>2</sub> assessment criteria, consequently, no dispersion modelling plots have been prepared.

Given that background levels are expected to be minimal, the risk of SO<sub>2</sub> assessment criteria being exceeded as a result of emissions from the expanded operation is extremely low.

#### **8.9.5 Carbon Monoxide**

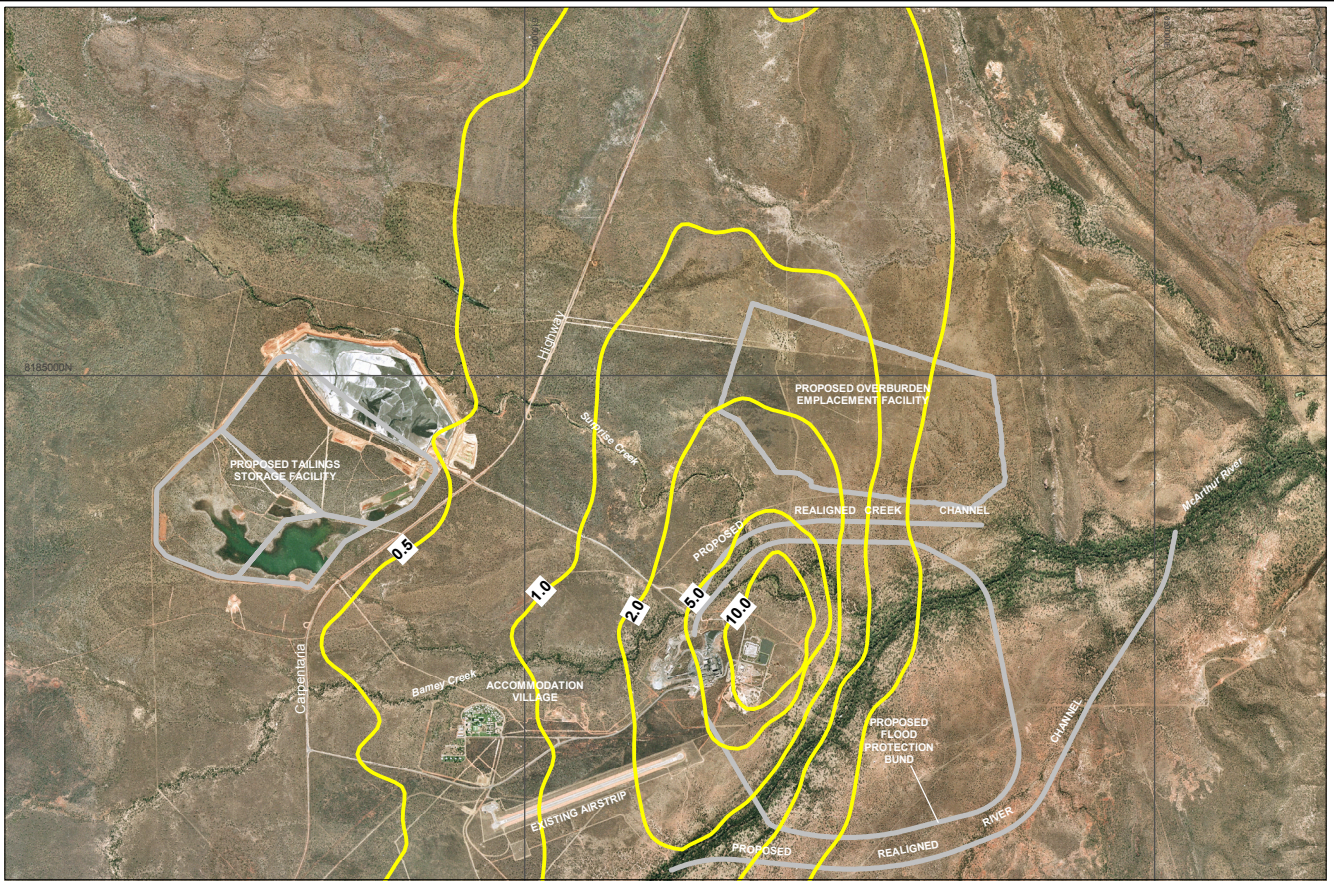
CO concentrations predicted downwind of the mine are far below the CO assessment criteria. The risk of CO assessment criteria being exceeded at the mine camp is extremely low. Because of this, CO dispersion model plots have not been provided due to the negligible predicted impact.

#### **8.9.6 Lead**

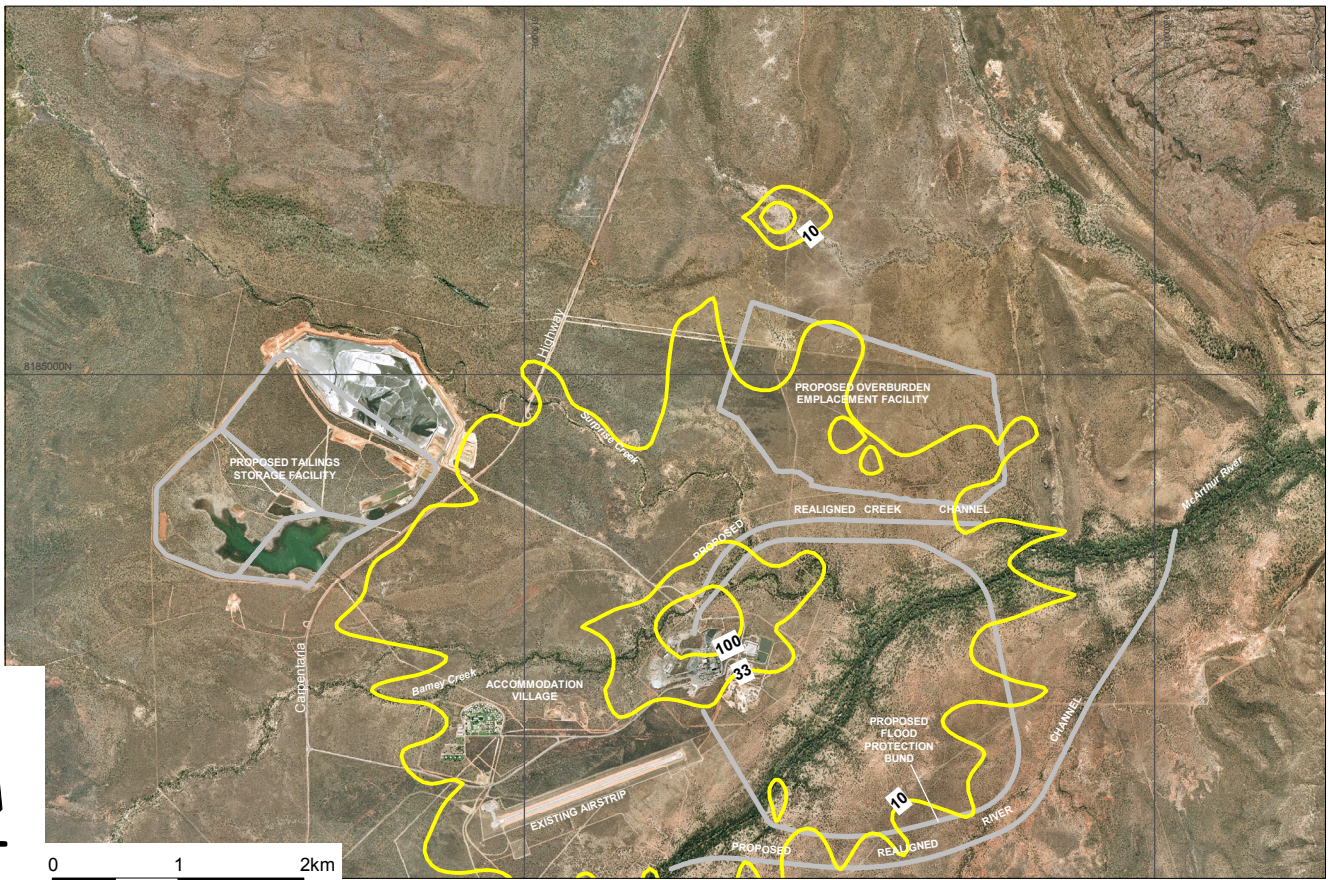
The lead component of the suspended particulates emitted from fugitive sources associated with the open-cut mine and processing facilities has been modelled and maximum downwind concentrations predicted. The maximum annual average concentration predicted by the model at the location of the mine camp is given in Table 8.10 and shown on Figure 8.9.

The predicted maximum annual average lead concentration at the mine camp does not exceed the NSW EPA assessment criterion. Furthermore, it should be noted that the National Occupational Health & Safety Commission (NOHSC, 2005) states that the time weighted average exposure standard for lead (as an inorganic dust or fume) is 150 µg/m<sup>3</sup>. Compared to the NOHSC concentration, the predicted lead concentration at the mine camp is shown as having no significant adverse impact.

Nevertheless, due to the health implications of lead in the environment, it is prudent to continue the existing lead deposition monitoring and to analyse the PM<sub>10</sub> filters at the mine camp for lead. This monitoring will continue at least throughout the initial stages of the expanded operations and the data will be used to verify the model results and to ensure that the dust control measures being put in place keep ambient concentrations at acceptable levels.



**MAXIMUM ANNUAL LEAD**



**MAXIMUM 3 MINUTE ZINC**

— 0.5 — Ground Level Concentration ( $\mu\text{g}/\text{m}^3$ )

Scale 1:60 000 (A3)  
Horizontal Datum: AGD84, Zone 53  
Date of Aerial Photography, 2001

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McARTHUR RIVER MINE  
OPEN CUT PROJECT  
ENVIRONMENTAL IMPACT STATEMENT

**PREDICTED ZINC AND LEAD  
IN SUSPENDED DUST**



Drawn: VH	Approved: CMP	Date: 18-07-05
Job No: 42625552	File No: 42625552-g-040c.wor	

Figure: 8.9

Rev: C  
A4

### 8.9.7 Zinc

The maximum 3-minute average zinc concentrations in suspended particulates predicted at the mine camp are summarised in Table 8.10 and compared to assessment criteria set for zinc. Figure 8.9 illustrates the locations of the maximum 3-minute average zinc predictions given by the modelling.

Zinc emissions associated with the open cut mining and processing activities will be in the form of sphalerite (zinc iron sulphide) rather than zinc chloride. There are no assessment criteria available for zinc in this form.

However, NOHSC (2005) states that the time weighted average exposure standard for zinc oxide (as a dust) is  $10 \text{ mg/m}^3$  ( $10,000 \text{ }\mu\text{g/m}^3$ ) and for zinc chloride (as a fume) is  $1 \text{ mg/m}^3$  ( $1,000 \text{ }\mu\text{g/m}^3$ ). By comparing the predicted concentrations to the NOHSC criteria, it is evident that the predicted zinc concentrations at the mine camp would have no significant adverse impact.

### 8.9.8 Volatile Organic Compounds

The proposed total VOC emissions from the power station have been modelled and maximum downwind concentrations predicted. For modelling purposes, the emissions were assumed to occur continuously.

The maximum 3-minute average concentrations predicted at the mine camp are summarised in Table 8.10 and compared to assessment criteria for a range of volatile organic compounds expected to be present in the emissions from natural gas combustion.

The predicted total VOC concentrations are far below the assessment criteria. Hence, emissions of VOCs from the expanded operations will have no potential for adverse impacts on air quality.

### 8.9.9 Seasonal Effects

The modelling results discussed above demonstrate that the maximum ground level concentrations predicted for the nearest sensitive receptor are well below the relevant guideline concentrations. All other seasonal ground level concentrations would be even less. Consequently it was not considered necessary to model seasonal variations in ground level concentrations.

### 8.9.10 Lighting

Apart from the mine, there are no significant ambient light sources in the vicinity. The main source of light from the existing operations is the lighting associated with the industrial facilities.

The open cut project will operate 24 hours per day and will be illuminated at night for safety reasons. Hence the sources of night-time illumination will include, not only the industrial area, but also the open cut, the haul roads and the overburden emplacement facility. The visibility of the lights in the open pit will reduce over time as the mine becomes deeper. Where possible, lights will be designed to shine downwards and to not spread laterally to minimise ambient light levels.

## 8.10 Operational Impacts – Bing Bong

No significant adverse impacts on local air quality at Bing Bong are anticipated as a result of the proposed open cut project. No new sources of air emissions will be introduced. Furthermore, there will be a slight decrease in truck and barge traffic and in the volume of concentrate being shipped (320,000 t/y compared to the existing rate of 330,000 t/y). Hence the existing dust controls will be adequate to ensure that there will be no additional air quality impacts at Bing Bong. Exhaust emissions from the delivery trucks and the barges will be minimised through appropriate tuning and maintenance and would not be expected to significantly impact on local air quality.

## 8.11 Abnormal Operations

Higher levels of NO<sub>x</sub>, CO and VOCs would occur during start-up and shut-down of the power station. Start-up normally takes up to 4 hours from cold conditions. The frequency of start-up and shut-down of the turbines will be limited, with the power station expected to operate 24-hours per day continuously. There will be limited shut-downs for maintenance requirements, most likely on an annual basis, and it is considered that the short-term and infrequent impacts on air quality from the start-up and shut-down operations would be minimal.

## 8.12 Mitigation and Monitoring Measures

### 8.12.1 Construction Phase Mitigation

The following environmental safeguards will be implemented during the construction phase:

- A construction environmental monitoring and management plan will be prepared and implemented to address air monitoring and management issues.
- Water sprays will be used (as required) across work zones and unsealed areas to suppress dust. The water will be applied by water cart across ground surfaces whenever the surface has the potential to generate excessive levels of dust.

### 8.12.2 Operational Phase Mitigation

The following environmental safeguards will be implemented during the operation phase:

- An environmental monitoring and management plan will be prepared and implemented to address air monitoring and management issues.
- Dust control equipment will be installed on all major plant and equipment generating significant point sources of dust. The conveyor belts will be covered to minimise dust emissions.

- Water sprays will be used (as required) across work zones and unsealed areas to suppress dust. The water will be applied by water cart across ground surfaces whenever the surface has the potential to generate excessive levels of dust.
- Other exposed surfaces and stockpiles will also be watered or sprayed as required.
- Any long-term stockpiles will be stabilised using fast-seeding, locally common grass or synthetic cover spray. Exposed areas will be minimised through progressive rehabilitation as soon as practicable.
- All major haul roads will be regularly watered and vehicle speeds on unsealed roads will be controlled to minimise dust.

### **8.12.3 Monitoring Program**

In addition to normal health and safety monitoring programs (which include monitoring the workers' exposures to dust, silica and lead), the following ambient air quality monitoring will be undertaken.

#### ***Dust Deposition Monitoring***

The existing dust deposition monitoring program will be reviewed prior to the commencement of the open cut operations to determine appropriate monitoring locations in light of the proposed changes in site activities. The dust collected will continue to be analysed for lead and zinc concentrations.

The results of the monitoring program will be used to provide an indication of the effectiveness of the dust control measures being implemented and to monitor the PM<sub>10</sub> concentrations that mine staff are exposed to.

#### ***Suspended Particulate***

A PM<sub>10</sub> monitor will be installed at the eastern side of the mine camp to monitor for ambient concentrations of suspended particulates. The monitoring will be undertaken in accordance with Australian Standards AS/NZS 3580.9.6:2003, AS/NZS 3580.10.1:2003 or AS3580.9.7:1990. The filters collected from the monitor will be analysed for lead and zinc content to provide suitable data on emissions.

#### ***Meteorology***

Monitoring of wind speed, wind direction, rainfall and temperature will continue to be undertaken at the airfield. The anemometer will be regularly calibrated and maintained to ensure acceptable data quality.

### **8.13 Management Plan**

Strategies for the management and monitoring of air quality effects for both construction and operations are outlined in the strategic management plan given in Sections 22.3 and 22.4 respectively.

## 8.14 Greenhouse Gas

### 8.14.1 Greenhouse Management Strategies

#### ***MRM Strategy***

Xstrata is proposing to become a signatory to the Australian Government's Greenhouse Challenge Program. This program was launched in 1995 and is a joint voluntary initiative between the Australian Government and industry to reduce greenhouse gas emissions. It requires participating organisations to sign agreements with the Government. The agreements detail a process for undertaking and reporting on actions to reduce greenhouse gas emissions from their operations.

#### ***Northern Territory Government's Greenhouse Strategy***

The Greenhouse Policy Framework (Northern Territory Government, 2002) provides guidance for the development of a Northern Territory Strategy for Greenhouse Action. The Strategy will build on the 1993 NT Greenhouse Strategy and the 2000 NT National Greenhouse Strategy Implementation Plan. The Strategy will provide a Territory based response to greenhouse gas emissions and adaptations to climate change.

In accordance with the requirements of the NT Greenhouse Policy Framework, the NT government recently released the paper "Developing a Strategy for NT Greenhouse Action" which seeks input from community, government and non-government stakeholders to develop a comprehensive strategy for greenhouse action for the NT.

#### ***National Greenhouse Strategy***

The 1998 National Greenhouse Strategy (Australian Greenhouse Office, 1998) extends the program of action launched by governments in Australia through the 1992 National Greenhouse Response Strategy. This approach is based on voluntary action. The strategy contains measures that different governments are pursuing through a variety of policy approaches. As a result, the Australian, state and territory governments have prepared implementation plans (<http://ngs.greenhouse.gov.au/index.html>). The latest NGS progress report indicates the following:

- The Australian Government has committed to implement measures including:
  - Legislation to require that, by 2010, Australia sources an additional 9,500 gigawatt hours (GWh) of electricity from renewable sources;
  - Minimum energy performance standards for equipment and appliances, as well as pursuing the incorporation of energy efficiency measures into the Building Code of Australia;
  - New power station energy efficiency standards; and
  - Innovative Bush for Greenhouse Program and Plantations-2020 Vision Program.

- State and Territory Governments have implemented a variety of measures. The Northern Territory's initiatives are detailed in the Northern Territory Greenhouse Policy Framework, the 1993 Northern Territory Greenhouse Strategy, and the 2000 Northern Territory National Greenhouse Strategy Implementation Plan.

### ***Securing Australia's Energy Future White Paper***

In June 2004, the Australian Government released a white paper titled *Securing Australia's Energy Future* (Department of the Prime Minister and Cabinet, 2004). The objective of the paper was to establish a comprehensive long-term policy framework for Australian energy. The paper establishes an integrated policy framework for:

- developing Australia's energy resources;
- improving stationary (electricity and gas) and transport energy markets;
- overhauling Australia's fuel excise system;
- improving energy efficiency;
- enhancing energy security;
- lowering Australia's long term greenhouse emissions signature; and
- improving air quality and managing the environmental impact of large projects.

The white paper includes a range of major new initiatives such as:

- Driving investment of at least \$1.5 billion to demonstrate break through technologies with significant long term greenhouse gas reduction potential through the establishment of a \$500 million fund to leverage private sector investment of at least \$1 billion in the demonstration of low emission technologies.
- A requirement that Australia's largest energy users undertake regular energy efficiency assessments, with firms using more than 0.5 petajoules of energy a year undertaking mandatory energy assessments every 5 years and reporting publicly on the outcomes.
- A requirement that large energy projects and recipients of more than \$3 million in excise credits to manage their emissions through membership of the Greenhouse Challenge Program.

The White Paper builds on the nearly \$1 billion the Government has invested in a range of climate change measures across the economy.

### ***International Greenhouse Strategies***

The Kyoto Protocol is an international treaty designed to limit global greenhouse gas emissions. Many parties to the United Nations Framework Convention on Climate Change (UNFCCC), including Australia, have signed the Protocol since negotiations were concluded at the third Conference of the Parties to the UNFCCC (COP3). The Kyoto Protocol was developed at COP3, held in Kyoto, Japan, in December 1997.

Following the decision by the Russian Government to ratify the Kyoto Protocol in 2005, the conditions have now been met for the Kyoto Protocol to come into force.

Annex B of the Kyoto Protocol lists the greenhouse gas emission reduction commitments for the developed countries. Commitments are expressed as a percentage of the base year emissions (in most cases the base year is 1990). They are a target for average annual emissions during the commitment period from 2008-2012, termed the First Commitment Period. At COP3, Australia accepted a target of 108% of its 1990 emissions, one of the only nations in the developed world to be allowed an increase in greenhouse gas emissions. This was in recognition by the international community of the fact that many Australian industries are energy intensive and that the global greenhouse benefit from using Australian products often occurs in other countries.

While Australia has not ratified the Kyoto Protocol, there has been commitment both nationally and at the state and territory level to a reduction of greenhouse gas emissions in line with the Kyoto Protocol commitments. The June 2004 White Paper states that Australia is on track to achieving its Kyoto target.

### 8.14.2 Existing MRM Greenhouse Gas Inventory

MRM has compiled an annual Greenhouse Gas (GHG) inventory for the McArthur River mine since 1998 on a financial year basis. That inventory identifies energy use on the site and provides a baseline emissions report using generic GHG emission factors. Table 8.11 shows the contributions to that GHG inventory. The GHG inventory for earlier years used different emission factors from those currently used and prior to 2002/03 emissions associated with dedicated air travel were not included.

**Table 8.11**

#### Existing MRM Greenhouse Gas Inventory

	Units	2000/01	2001/02	2002/03
<b>Production/Consumption Data</b>				
Concentrate produced	tonnes	367,680	352,431	371,383
Percent of zinc and lead in concentrate	%	47.0	46.6	51.5
Zinc and lead in concentrate	tonnes/y	172,800	164,200	191,300
Electricity consumption	MWh/y	126,500	135,300	143,800
Diesel for mining and transport	kL/y	3,760	4,380	3,810
LPG and petrol	kL/y	34	36	40
Aviation fuel	KL/y	-	-	855
Explosives use	tonnes/y	778	874	743
<b>Greenhouse Emissions Data</b>				
CO <sub>2</sub> -e from power generation	tonnes/y	108,100	115,600	103,100
CO <sub>2</sub> -e from diesel use	tonnes/y	12,000	13,900	11,500
CO <sub>2</sub> -e from other transport use	tonnes/y	69	72	2,540
CO <sub>2</sub> -e from explosives use	tonnes/y	127	143	124
Total CO <sub>2</sub> -e	tonnes/y	120,200	129,700	117,300
CO <sub>2</sub> -e/tonne of zinc and lead in concentrate	tonnes/tonne	0.696	0.790	0.613

The above inventory data show that the equivalent CO<sub>2</sub> emissions (CO<sub>2</sub>-e) attributable to the production of the concentrate are dominated by emissions resulting from electricity generation. However natural gas which is one of the most GHG efficient fuels for the generation of base-load electricity is used.

Comparison of the inventory data for 2000/01 with that for 2001/02 indicates that there was a reduction in the net yield of zinc and lead in the concentrate, an increase in electricity consumption, and an increase in diesel use. These factors combined to increase the specific greenhouse gas emissions per tonne of metal exported in concentrate from 2000/01 to 2001/02. However, there was a significant improvement in 2002/03 due to an increased percentage of metals in the concentrate and increased concentrate production.

The key assumptions underlying the GHG inventory are:

- Emission factors for energy use are on the full fuel cycle basis, which takes account of the energy used in production of market-ready fuel. In addition, the full fuel cycle basis takes account of the GHG impacts of the minor amounts of methane and nitrous oxide discharged with the products of combustion of fuels.
- Other than minor emissions with products of combustion of fuels, there are no emissions of non-CO<sub>2</sub> Kyoto GHGs from the MRM site. The greenhouse gases that are reportable under the Kyoto Protocol comprise CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, hydrofluorocarbons, perfluorocarbons and SF<sub>6</sub>. It is assumed that there are no methane emissions from the mining operations. There is no use of fluorinated compounds in the MRM operation.
- All electricity is generated by the on-site power plant comprising an open-cycle gas turbine generator running on natural gas.
- The boundaries of the MRM operation for the purpose of the GHG inventory are defined as including dedicated transport. This includes the trucking of concentrate from the mine to the port at Bing Bong, the use of vehicles on-site, and the dedicated flights for staff to and from Darwin.

### 8.14.3 Projected GHG Inventory to 2012

Table 8.12 shows the projected GHG inventory through the period of the expansion of the MRM operation and the expected steady state GHG emissions during the first Kyoto Accounting Period from 2008 to 2012.

**Table 8.12**

**Projected GHG Inventory to 2012**

	Units	2004	2005	2006	2007	2008/12
<b>Production/Consumption Data</b>						
Zinc and lead in concentrate	tonnes/y	157,000	190,340	190,700	180,393	177,980
Electricity consumption	MWh/y	144,700	152,500	152,600	151,500	150,800
Diesel for mining and transport	kL/y	3810	4,644	3,000	3,500	4,300
LPG and petrol	kL/y	40	43	40	40	40

	Units	2004	2005	2006	2007	2008/12
Aviation fuel	kL/y	855	855	855	855	855
Explosives use	tonnes/y	743	750	1700	2700	3000
<b>Greenhouse Emissions Data</b>						
CO <sub>2</sub> -e from power generation	tonnes/y	103,700	109,290	109,362	108,573	108,072
CO <sub>2</sub> -e from diesel use	tonnes/y	11,500	14,017	9,055	10,564	12,979
CO <sub>2</sub> -e from other transport use	tonnes/y	2,540	2,549	2,540	2,540	2,540
CO <sub>2</sub> -e from explosives use	tonnes/y	124	125	284	451	501
Total CO <sub>2</sub> -e	tonnes/y	117,900	126,000	121,200	122,100	124,100
CO <sub>2</sub> -e/tonne of zinc and lead in concentrate	tonnes/tonne	0.751	0.662	0.636	0.677	0.697

It can be seen from Table 8.12 that the annual GHG emissions from MRM will increase marginally from 117,900 t CO<sub>2</sub>-e/y in 2004 to 124,100 t CO<sub>2</sub>-e /y in 2008. This is not considered to be a significant increase and is within the range of GHG emissions since 2000/01 which have varied from 117,300 to 129,7000 t CO<sub>2</sub>-e/y (Table 8.11).

Table 8.12 shows that the GHG emissions per tonne of metal in 2008/12 will be approximately 7% lower than in 2004 (on a per-tonne product basis), demonstrating an improvement in net greenhouse efficiency of mine operations.

Approximately 0.9% of the most recent GHG emissions inventory for the Northern Territory (total of 14.4 million t/y CO<sub>2</sub>-e for the year 2000) would be attributable to the MRM open cut project assuming 2008 GHG emissions. Taking into account the projected increase in NT GHG emissions from a number of current development proposals (NT Government <http://www.ipe.nt.gov.au/whatwedo/greenhouse/emissions/index.html#howmuch>) emissions from the MRM open cut project would constitute approximately 0.6% of the total projected future NT annual emissions inventory of 20 million tonnes of CO<sub>2</sub>-e (which includes emissions of proposed projects including Phillips 10 MTPA LNG, Alcan Alumina Refinery expansion, and gas extraction from the Sunrise gas fields).

#### 8.14.4 Management of Greenhouse Gas Emissions

MRM will manage its GHG emissions in the following manner:

- MRM will become a signatory to the Greenhouse Challenge Program. It will continue to quantify GHG emissions and will submit annual reports to the Australian Greenhouse Office on performance against emission management targets.
- Natural gas will continue to be used as the energy source for electricity generation. This results in significantly reduced GHG emissions compared to the alternative energy sources of coal or oil.
- Energy efficiency will be a major consideration for the design and selection of equipment for the open cut operation. In addition, consideration will also be given to opportunities for ongoing energy efficiency programs at the existing plant. This will have the dual benefit of reducing GHG emissions as well as reducing operating costs.

- MRM has assessed the opportunities for the provision of GHG offsets. However as McArthur River mine is an existing operation and the change from underground to open cut mining will have no significant change to its GHG emissions, it was concluded that an offsets program was not warranted.