Appendix F
Greenhouse gas emissions and management

Greenhouse gas emissions and management

1. Introduction

The material in this section has been prepared in accordance with the guide provided in Appendix 1 of the Northern Territory *Draft EIS Guidelines* for the project.

2. Greenhouse gas emissions estimates

The principal sources of greenhouse gas emissions are land clearing and fossil fuel (diesel) use. Thus reduction in the area cleared and high fuel use efficiency are important objectives for Matilda. Achievement of best practice in these areas will also result in minimum greenhouse gas emissions.

2.1 Greenhouse gases generated in the operation

Carbon dioxide (CO_2) is by far the most important greenhouse gas in this operation. It is the principal gas emitted as a consequence of fossil fuel use, land clearing, and as a consequence of energy use in the manufacture of building materials. Other greenhouse gases will arise in minor amounts, in particular there will be some methane emitted from waste materials and buried vegetation.

However, given that CO_2 emissions dominate total greenhouse gases in absolute terms, there will be little difference between emissions of CO_2 and emissions of CO_2 equivalent (CO_2^e). Thus in this report, CO_2 is reported directly as CO_2^e.

2.2 Mine development

Land clearing

Calculation of greenhouse gas emissions from land clearing and subsequent levels of carbon sequestration are determined using factors for emissions and carbon stores per hectare contained in a range of references (e.g. AGO 2004 workbook, Western Australian Greenhouse Taskforce 2004), and the planned areas to be cleared.

Assuming 50 t/ha of organic material (above and below ground) will be oxidised to CO_2 as a result of the clearing, this represents approximately 99 t of CO_2/ha that would be released as a result of land clearing. The total estimate of CO_2^e emissions from land clearing is 10,791 t and is summarised in Table 1.

Table 1: Greenhouse gas emissions from land clearing

Activity	Dimensions	Area of land cleared (ha)	CO_2 emissions (t)
Camp site at Lethridge Bay		2	198
Camp site at Andranagoo Creek		2	198
Haul road construction, Andranangoo	60 km track widened 2 m to 6 m	24	2,376
Haul road construction, Lethbridge	50 km track widened 2 m to 6 m	20	1,980
Surface to be cleared for mining at Lethbridge Bay		18	1,782
Surface to be cleared for mining at Andranagoo Creek		43	4,257
Total		**199**	**10,791**

Fuel use in construction of haul road

An estimated 4,312 L of diesel fuel will be used in haul road construction and in clearance of the camp and process sites. This is based on 5 weeks (25 working days@7.5 hr/day and a factor of 23 L/hr for grader use). Based on AGO standards, consumption of this fuel will release 3 kg CO_2^e/l of fuel (see explanation in later sections), or a total of 13 of CO_2^e.If this is added to the total in Table 1, the total emissions arising from land clearing activities are estimated to be 10,804 t of CO_2^e

Construction of infrastructure

The infrastructure needs for the operation will be modest, comprising the mine and haul roads, a processing plant, and associated camp facilities and offices. Based on Australian Greenhouse Office standards and other published material cited below, the 'embedded' CO_2^e content of construction materials can be calculated as the sum of emissions from energy use (indirect), and processes (direct). These are shown in Table 2.

Table 2: Greenhouse gas emissions 'embedded' in site infrastructure

Activity	Total materials	CO_2^e content of materials (per tonne)	Greenhouse gas emissions (tonne)
Plant construction – steel	65 t	Est. 10 t*	650
Camp construction – steel	3.5 t	Est. 10 t	35
Camp construction – wood	1.5 t	Nil – claimed in production	Nil
Camp construction – aluminum cladding	6 t	Est. 20 t*	120
Total	**76 t**		**805**

* based on energy consumption of 35 GJ (range 9-59)/ tonne of steel, with emissions of 290 kg CO_2^e GJ energy as electricity (AGO 2004 and Glover 2001).

** based on 991 kg CO_2^e emissions per tonne of alumina plus 1,479 MWh/tonne of refined aluminium (AGO 2004 and Australian Aluminium Council undated).

2.3 Operation

Diesel fuel use for mining and transporting ore

The main source of greenhouse gas emissions in the operation phase will be from the burning of hydrocarbons for motive power and electricity generation. The AGO (2004) workbook for emissions from diesel fuel usage recommends a figure of 69.7 kg CO_2^e / Gj of energy. The Office of Energy (1999) in WA notes that diesel (distillate) contains 32 Mj/litre of energy. Using these data, an estimate of 2.23 kg CO_2/litre of fuel can be calculated. This figure ignores amounts of other greenhouse gases emitted when fuel is burned, and is also not a full fuel cycle figure. When these factors are included, the AGO workbook suggests a full fuel cycle figure of 3.0 kg CO_2^e/litre of fuel.

The energy usage and CO_2^e emissions are shown in Table 3. Approximately 58% of the emissions result from electricity generation, and 42% from the mining and haulage operations. Total emissions from fuel usage are estimated to be about 9,296 t CO_2^e per annum.

Table 3: CO_2e emissions from fuel used in normal operation

Activity	kL/anum	hrs/day/yr	L/unit activity	CO_2^e /L (kg)	CO_2^e tonnes/ annum
Electricity generation					
Generators, total 820 kW	1,796	24/7/365	.25 L/kWh	3	5,388
Mining					
Mining loader	330	24/7/365	38 L/hr	3	990
Concentrate loader	83	6/7/365	38 L/hr	3	249
Excavator	120	11/7/365	30 L/hr	3	360
Dump trucks x2	240	11/7/365	30 L/hr/each	3	720
Grader	92	11/7/365	23 L/hr	3	276
Road Train x 4 trips/24hr	432	24/7/300	1.5 L/km	3	1,296
Light vehicles	6	4/7/365	8 L/hr	3	18
Total for mining activity	**1,303**				**3,908**
Totals					
Total fuel/year	**3,099**				
Total CO_2^e tonnes/ annum					**9,296**

Over the life of the mining operation, estimated to be four years (three years at Andarnangoo and one year at Lethbridge – refer Section 1.4.1 of main report) it is estimated that a total of approximately 37,184 t of CO_2^e will be generated from this source over both Andranangoo and Lethbridge.

Assuming that 2,150,000 t of sands will be extracted and processed over the four years of mining (refer Section 1.4.2 of main report), this equates to approximately 17.3 kg of CO_2^e / t of sand processed.

2.4 Decommissioning and site rehabilitation

At the completion of mining operations, it is intended to remove and sell all infrastructure, however camp buildings may be left at the last mine site, depending on discussions with the TLC and traditional landowners. Any disturbed surfaces would be rehabilitated. The infrastructure is readily recyclable, with the energy 'costs' of recycling being of the order of 5 to 10 per cent of the original energy requirement for steel and aluminum manufacture/ smelting (Australian Aluminium Council, undated). However, some material will not be capable of recycling and will go to landfill as waste. The cost of removal from the site and delivery to a new user also needs to be added.

The embedded energy (and hence CO_2^e) 'lost' in these situations cannot be calculated with certainty, and an estimate of 10 per cent of the original energy requirement is used. In total, it is estimated that 80% of CO_2^e emissions included in the inventory as part of infrastructure construction will be 'recovered' through re-use/ recycling of steel, timber and aluminum by another party. Thus of the 805 tonnes of 'embedded CO_2^e' in construction materials shown as a greenhouse debit for the operation in

Table 2, it is estimated that 645 tonnes will be 'recovered' through recycling and reuse of the materials.

Land rehabilitation in the dry tropical woodlands will be effective, provided land preparation and surface water control is managed effectively (see other sections of this report). Based on modeling done in this environment, it is realistic to assume that revegetation with native species will result in sequestration of carbon vegetative and soil stores back to the level at the time of clearing (see WA Greenhouse Taskforce 2004).

However, this potentially carbon neutral result needs to be adjusted to allow for the energy involved in removing hard surfaces (haul roads and campsites), ripping of the disturbed sites, construction of surface water control structures to prevent erosion, seeding of the site and on-going monitoring. Estimation of the energy required to undertake these tasks is difficult, with an assumption being that these works will reduce by 20% the recovery of the original CO_2^e emissions. Given that 10,804 t of CO_2^e were emitted as a result of land clearing, the eventual amount sequestered from land rehabilitation will be approximately 8,643 t (80 per cent).

2.5 Net emissions over whole of mine life

The emissions and sequestration presented in the previous tables have been aggregated in Table 4 to show net emissions over the life of the mining operation. These numbers assume that the site 'boundary' is portside at the point where the material is shipped to the mainland.

This table shows that net emissions of CO_2^e over the life of the operation is estimated to be 39,505 t, which is equivalent to 18.4 kg/t of sand processed, assuming that 2,150,000 t of sand is processed.

Table 4: Net emissions from the mine over 'whole of life'

Activity	Net emissions (tonnes CO_2^e)		
	Mine development	Operations	Decommissioning and rehabilitation
Land clearing	10,804		
Built infrastructure	805		
Fuel use for operations		37,184	
Land rehabilitation			- 8,643 (80%)
Sale of built infrastructure			- 645 (80%)
Total for each phase	11,609	37,184	- 9,288
Net emissions over mine life	**39,505**		

3. Measures to minimise greenhouse gas emissions

Matilda will commit to 'stretch targets' for lower greenhouse gas emissions, using refinements of the calculated baseline estimates presented in this report as the point of departure.

The logical metric for the targets is the quantum of CO_2^e emitted per tonne of sand processed. An alternative metric is to use the quantum of CO_2^e emitted per tonne of HM sand produced, however this metric is affected by the HM grade of the sand being processed.

Given that reduced land clearing and fuel use generate 'win-win' outcomes for the company's economic performance and greenhouse emissions, company management will have in place a continuous improvement program that monitors these factors, while investigating options for increased efficiency through the life of the mine operation and during decommissioning.

4. Greenhouse gas emissions monitoring and reporting

4.1 Establishment of reporting system

The measurable sources of greenhouse gas emissions from the operation are land disturbance, construction and dismantling of infrastructure, including roads, work areas, buildings and plant, mining and initial processing and transport of ore to port-side. The company will put in place reporting systems to track estimates of CO_2^e emissions and sequestration.

Where available, standard AGO and NT government factors would be used in calculating emissions / sequestration. If these are not available, relevant factors will be taken from the available literature, with preference given to local research findings and calculations.

The following items would be accounted for in the greenhouse monitoring program:

1. Area of land disturbed (ha)
2. Area of land rehabilitated (ha)
3. Fuel use for electricity generation (L)
4. Fuel use for motive energy (L)
5. Materials imported to the site – approximate (by type and amount)
6. Materials disposed of to waste (amount and CO_2^e emissions/ tonne)
7. Materials removed from the site for recycling and reuse – approximate, based on item 5.

4.2 Baseline emissions calculation

The baseline emissions calculation in this section of the report shows that the anticipated net emissions from the total mining operation will be about 39,500 t of CO_2^e. This figure will be refined and recalculated during construction and the early phase of the operation.

4.3 On-going reporting

Matilda will produce an annual statement documenting greenhouse targets, and performance against those targets.

5. Preparedness for climate change

The available information on actual to date, and predicted climate change for the wet tropics of Australia is summarised in the following two sections. The principal reference is Hennessy *et al*. (2004).

Given the relatively short life of the operation (four years) many of the longer-term predictions will not affect operations during mine life, although they may affect the post-mine rehabilitation program.

5.1 Impacts of climate change

Actual changes to date

- Average surface temperatures across northern Australia have risen, with the minimum up by 0.96°C and the maximum has increased by 0.56°C.
- Rainfall in the Tiwi Islands has increased by about 30 mm per 10 years over the period from 1910 to 1999. The rate of rise has been faster since 1950, owing to an increased frequency of ‘big wet seasons’ in the mid-1970s and in late 1990s.

- The sea level around Australia has risen by between 12 to 16 cm over the last 100 years, and further increases are expected.
- The frequency of tropical cyclones has decreased slightly since 1969-70, but their intensity may have increased slightly. In the years 1967-1981, an average of 2.5 cyclones crossed land regions in the NT. This number fell to 1.7 in the years 1982-1996.

The magnitude of changes to date will not require any separate climatic mitigation strategies, beyond those already planned to address cyclone risk with attendant wind damage, storm surge and flooding impacts.

Predicted changes over the next 25 years (relative to 1990 data)

- Further warming of the climate is predicted to occur as a result of increased (and increasing) CO_2^e levels in the atmosphere. The best available estimate for the Tiwi Islands is an increase in average annual surface temperature of about 1.3^{o}C by 2030, with most of the increase occurring in minimum temperatures. There will also be an increase in the frequency of extremely hot periods. The average number of days over 35^{o}C is predicted to increase by an average of 17 days in coastal locations. This rate of change is too slow to have any material impact on the mining operation, as the mine life is presumed to be four years.
- The trend in annual rainfall in the Tiwi Islands is not predicted to vary by more than about 5 per cent either side of the existing average during the wet season, with a small increase in non-wet season rainfall (20 per cent increase). However predicted evaporation rates will rise because of the predicted higher temperatures, with an estimate moisture deficit of between 30 and 50 mm compared to the present, depending on season. This will impose some stresses on native vegetation to be established on mined areas, but again the this rate of change is too slow to have any material impact on the mining operation as the mine life is presumed to be four years.
- Further sea level rise is predicted, within the range of 5 to 15 cm by 2030 and 10 to 50 cm by 2070.
- On average, the NT is affected by 2.0 cyclones per year, with a slight decrease in incidence since 1967. While, the frequency is too low to allow for any statistically significant trends in frequency to be detected, it is anticipated that the intensity of cyclones is likely to increase due to greenhouse warming.
- The predicted increases in cyclone intensity and higher sea levels will increase storm surge frequency and severity. This represents a significant risk to coastal areas in the Tiwi Islands, and to vegetative cover and built infrastructure, particularly coastal infrastructure including port facilities. Some specific environmental impacts may include mangrove recession and increased coastal erosion. Although there have been no NT studies, research done for Cairns found that a 1-in-100 storm surge under current climatic events became a 1-in-40 year event in 2050, when projected increases in cyclone intensity and sea level rise were incorporated. The management of storm surge risk is addressed in the main report (Section 6).

6. References

Australian Aluminium Council (undated). *Submission to the Review of the operation of the Renewable Energy (Electricity) Act 2000*. Available on www.mretreview-gov.au/pubs/mret-submission156.pdf

Australian Greenhouse Office (2004). *AGO factors and Methods Workbook*. Australian Government.

Australian State of the Environment Committee (2001). *Australia State of the Environment 2001*, Independent Report to the Commonwealth Minister for the Environment and Heritage, CSIRO Publishing on behalf of the Department of the Environment and Heritage.

Glover, J. (2001). *Which is better? Steel, Concrete or Wood: A comparison of Assessments on Three Building Materials in the Housing Sector*. Unpublished fourth year thesis. Department of Chemical Engineering, University of Sydney. Available on www.boralgreen.shares.net.au

Hennessy, K., Page, C., Bathols, J., McInnes, K., Pttock, B., Suppiah, R. and Walsh, K. (2004). *Climate change in the Northern Territory*. Consultancy Report for the Northern Territory Department of Infrastructure, Planning and Climate Impact Group, CSIRO Atmospheric Research, School of Earth Sciences, Melbourne University.

Landcare Council of the Northern Territory (2005). *Sustaining our resources – people, country and enterprises*. Maps and Appendices. Supplementary Information for the Integrated Natural Resource Management Plan for the Northern Territory. Northern Territory Government.

Office of Energy (1999). *Energy Western Australia 99*. Government of Western Australia

Western Australian Greenhouse Taskforce (2004). *Opportunities for the Western Australian land management sector arising from greenhouse gas abatement*. Report prepared by CRC Greenhouse Accounting and Tony Beck Consulting Services Pty Ltd. Government of WA

7. Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Matilda Minerals Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in exchanged correspondence.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between August and October 2005 and is based on the conditions encountered and reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.