Section 12 Air Quality and Noise

12.1 Existing Condition

12.1.1 Baseline information

The Maud Creek mine site is located approximately 20 km away from the nearest town (Figure 12-1), the regional centre of Katherine. Circles of radius 2, 6 and 10 km are plotted on Figure 12-1 indicate the separation of the mine site in relation to populated areas. Due to the relatively remote location of the site, any risk of nuisance or potentially health-threatening effects of dust and noise to humans is minimal. However, appropriate measures will be taken to limit dust and noise impacts, to ensure site safety and prevent dust or noise nuisance.

Any historically disturbed areas at the Maud Creek site have naturally revegetated. Consequently, current dust levels at the site are expected to be similar to background conditions in the surrounding environment. Changes in dust emissions due to the Maud Creek Mine development are associated with construction and haulage on the unsealed access road to the mine rather than the underground mine. Any potential impact from dust on flora and fauna will be limited to within 20 to 30 m of the access road during the dry season.

The Katherine Town Council weather station, located approximately 17 km from the Maud Creek mine site (Figure 12-1) has the longest rainfall record in the vicinity of the mine (127 years). Annual rainfall statistics from the Bureau of Meteorology's (BOM) Katherine weather station are shown in Figure 12-2. The climate of the area is predominantly hot, humid and monsoonal during the wet season (October – April) with warm dry weather during the dry season (May – September).

Based on 127 years of data recorded at this weather station, the average annual rainfall in the vicinity of the Maud Creek site is 980.8 mm with 95% of the rainfall occurring during the wet season months from November to March (BOM 2007). The average annual rainfall for Katherine in the 26 years since 1971 was 1080.7 mm. The increasing rainfall trend is consistent with climate change predictions for northern Australia. The 90 percentile monthly rainfall statistic shown on Figure 12-2 indicates significant year to year variation in peak monthly rainfall rates (December – March). The hottest month is November with a mean maximum temperature of 39.5 ºC, and minimum of 25.2 ºC. The coolest month is July with a mean maximum of 28.7 ºC and minimum of 11.9 ºC.

Wind data from the Tindal RAAF weather station are shown in Table 12-1. The BOM Tindal Royal Australian Air Force (RAAF) weather station is located at the Tindal RAAF Base 10 km from Katherine town centre and 6 km from Maud Creek mine site (Figure 12-1). This is a more reliable wind record than the Katherine Aviation Museum weather station for the Maud Creek mine site due to proximity.

Table 12.1 indicates that during the dry season strong south-east winds dominate, and during the wet season winds are predominantly north-westerly. During the dry and wet seasons 80% of winds recorded were travelling at less than or equal to 15 km/hour (James Turnbull, Bureau of Meteorology, *pers. comm.*).

Figure 12-1 Weather Station locations

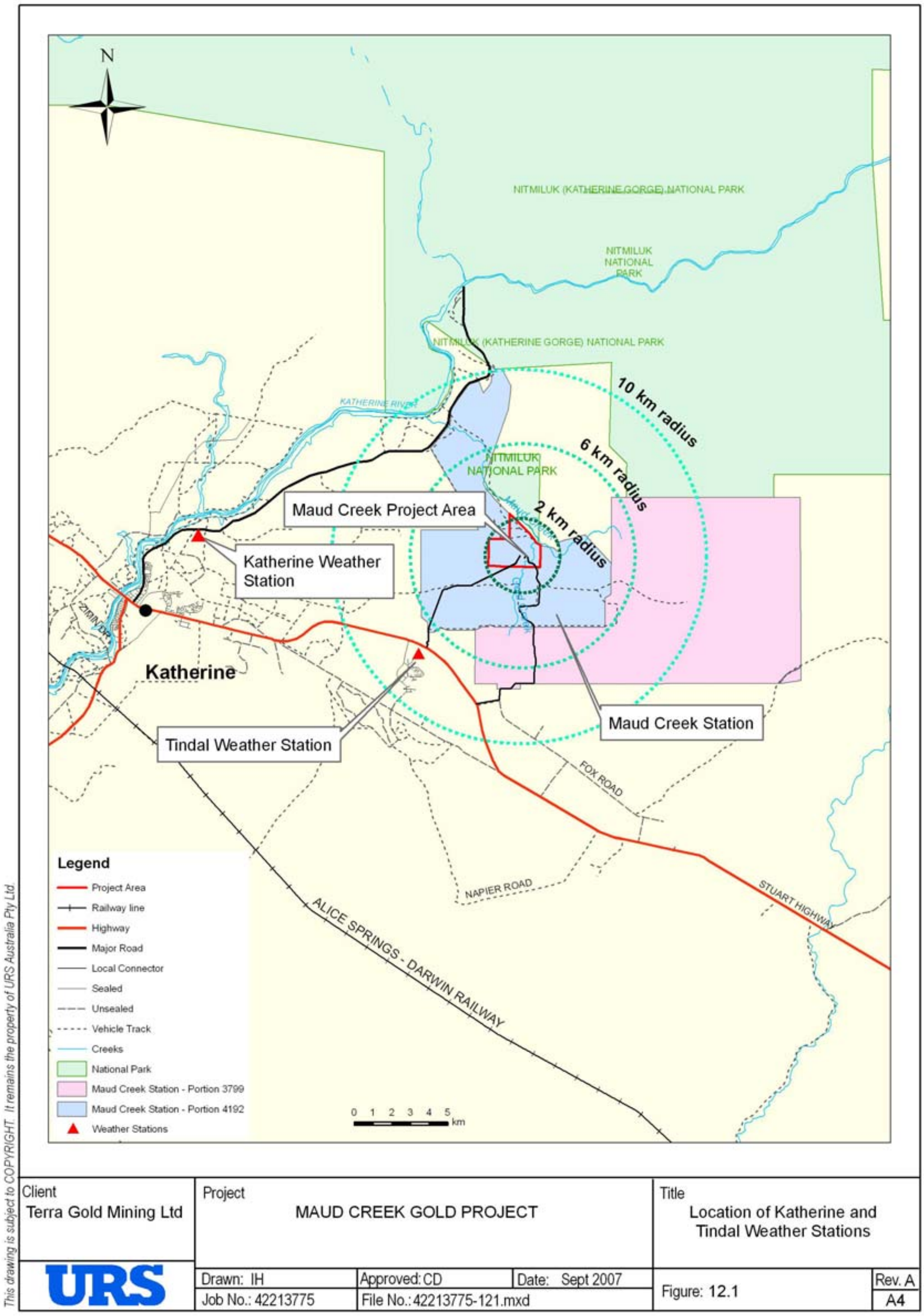
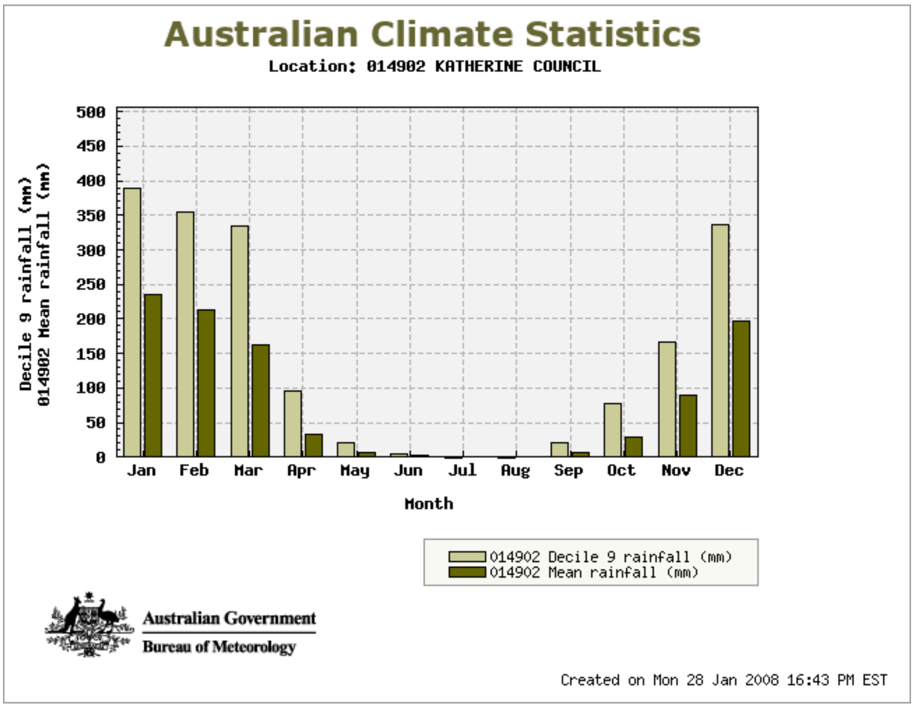


Figure 12-2 Katherine monthly rainfall averages



Source: BOM 2008 (Katherine Town Council weather station)

Rainfall in the region is predicted to change by about 5 per cent either side of existing averages in the wet season, and about 12 per cent either side of existing averages in the dry season, by 2030 (Hennessy et al. 2004).

In the Pine Creek region, evaporation rates are predicted to increase with increases in temperature, and the moisture balance (rainfall minus evaporation) is expected to fall by 10 – 80mm by 2030 (Hennessy et al. 2004). It is also anticipated that the intensity of cyclones is likely to increase due to global warming (Hennessy et al. 2004).

12.1.2 Climate change prediction

Present climate change modelling from worldwide greenhouse gas emissions suggests that daily temperatures in the Katherine region will increase by 0.3 – 1.8°C between 1990 and 2030, and the frequency of extremely hot periods will increase (Hennessy et al. 2004).

Table 12-1 Average wind direction and speed at Katherine

Month	Time	Wind Speed and Direction Interpretation
January	9am	70% of the wind speed was ≤ 15 km/h from a W to NW direction.
	3pm	75% of the wind speed was ≤ 15 km/h from a W to NW direction.
February	9am	70% of the wind speed was ≤ 15 km/h from a W to NW direction.
	3pm	75% of the wind speed was ≤ 15 km/h from a W to NW direction.
March	9am	72% of the wind speed was ≤ 15 km/h from a E to SE direction.
	3pm	75% of the wind speed was ≤ 15 km/h from a E to SE direction.
April	9am	72% of the wind speed was ≤ 15 km/h from a E to SE direction.
	3pm	75% of the wind speed was ≤ 20 km/h from a E to SE direction.
May	9am	75% of the wind speed was ≤ 15 km/h from a E to SE direction.
	3pm	70% of the wind speed was ≤ 20 km/h from a E to SE direction.
June	9am	72% of the wind speed was ≤ 15 km/h from a E to SE direction.
	3pm	70% of the wind speed was ≤ 20 km/h from a E to SE direction.
July	9am	75% of the wind speed was ≤ 15 km/h from a E to SE direction.
	3pm	72% of the wind speed was ≤ 20 km/h from a E to SE direction.
August	9am	70% of the wind speed was ≤ 15 km/h from a E to SE direction.
	3pm	70% of the wind speed was ≤ 15 km/h from a E to SE direction.
September	9am	72% of the wind speed was ≤ 15 km/h from a N to NW direction.
	3pm	72% of the wind speed was ≤ 15 km/h from a E to SE direction.
October	9am	80% of the wind speed was ≤ 15 km/h from a W to NW direction.
	3pm	82% of the wind speed was ≤ 15 km/h from a E to SE direction.
November	9am	80% of the wind speed was ≤ 15 km/h from a W to NW direction.
	3pm	60% of the wind speed was ≤ 10 km/h from a E to SE direction.
December	9am	77% of the wind speed was ≤ 15 km/h from a W to NW direction.
	3pm	80% of the wind speed was ≤ 15 km/h from a W to NW direction.

Source: BOM, 2007 - (January 1985 to March 2007, Tindal RAAF Base)

12.2 Impacts of Mining Operation

12.2.1 Dust generation

Potential dust generating activities include earthworks associated with clearing, levelling and grading for facility construction; decline construction; stockpiling and haulage/access operations. Mitigation will include minimising the disturbed area and use of water trucks to damp down exposed areas and roadways.

Dust generation will reduce during mining operations. Potential dust generating activities include: hauling ore from the underground; stockpiling and ore transport to the offsite processing plant at URGM. Offsite haulage is expected to generate dust impacts within 20 to 30 m of unsealed roads.

12.2.2 Noise and vibration

Noise will be generated from temporary generators, surface mine vehicles, machinery, explosives and haul trucks. Noise levels will be within acceptable occupational health and safety standards.

Blast noise will be highest during initial construction of the mine portal (approximately two weeks). Thereafter, underground blasting will have negligible effect on above ground noise levels. Vibration from blasting may be felt within 1 to 2 km of the underground mine.

Ore haulage during operations will generate traffic noise along the haul route. The proposed route for transporting ore, via an internal haul road connecting to the Stuart Highway through Katherine to URGM for processing is shown in Figure 15.1.

During the project, personnel will commute to and from the mine site daily, mainly from Katherine, which is located approximately 20 km west of the project site. The route taken by personnel will be via the Stuart Highway. Site supplies will also be transported from Katherine. Cars and minibuses will be used to commute between Katherine and the mine site for mine shift changes day and night, seven days a week, throughout the life of the mine. Traffic and transport is addressed in detail in Section 15.

12.2.3 Greenhouse gases

The principal sources of greenhouse gas emissions at the proposed Maud Creek mine site are land clearing, explosives, electricity use and fossil fuel (diesel) use. Less obvious sources are ‘embedded emissions’ used in the manufacture of site materials, and emissions resulting from any accidental fires that occur on the company’s tenements.

The most significant greenhouse gas impact from the proposed operation will be from carbon dioxide (CO_2) emissions. CO_2 will be emitted from electricity generation, fossil fuel use, land clearing, and as a consequence of energy use in the manufacture of building materials.

Other gases such as methane (CH_4) emitted from waste materials and buried vegetation, and amounts of the highly greenhouse active perfluorocarbons (PFCs) generated in aluminium manufacture (AGO, 2006a) are relatively minor contributors to greenhouse gas emissions. Consequently, the calculation for tonnes of CO_2 emitted is not significantly different from the calculation for combined greenhouse gas emissions in tonnes of carbon dioxide equivalents [1] (CO_2^e), only CO_2^e is reported in this section.

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[1] Carbon dioxide equivalents (CO_2^e) are used to express the total amount (tonnes) of greenhouse gases produced by a source; including not only CO_2, but others such as methane CH_4, nitrous oxide (N_2O), PFCs, and hydrofluorocarbons (HFCs). Each of these compounds varies in potency in its contribution to global warming, so each is compared back to the ‘standard’ global warming potential of CO_2, which is the weakest greenhouse gas. If a

Greenhouse gases in context

The following table is included to demonstrate the relativities of greenhouse gas emissions.

Table 12-2 Greenhouse gas emissions

Location (and date of data)	Total Kyoto emissions (including LULUCF*)	Greenhouse Gas Category Fuel combustion ($kt\ CO_2^e$)	 Mining, non-energy ($kt\ CO_2^e$)
Kyoto Annex 1 countries (2004)	18,190,224	4,404,775	not available
Kyoto Non-annex 1 countries (available data)	12,492,534	not available	not available
Australia (2005)	559,074	359,792	6,657
Northern Territory (2005)	13,503	5,133	232

*Land use, Land use change and forestry

Source: Australian Greenhouse Emissions Information System, Australian Greenhouse Office, Department of the Environment and Water Resources. (http://www.greenhouse.gov.au/inventory/index.html accessed July 02, 2007); http://unfccc.int/ghg_emissions_data/predefined_queries/items/3814.php (accessed July 02, 2007)

Emission from land clearing and construction of infrastructure

There are considerable areas at Maud Creek that are already cleared as a result of previous exploration, mining and farming activities. In this section, the assessment of emissions deals only with the areas that will be newly cleared for this project.

Greenhouse gas emissions from land clearing are determined for tropical savannahs using emission factors and estimates of carbon stored per hectare contained in a range of references (for example, Western Australian Greenhouse Taskforce 2004), and the FullCAM model developed by the Australian Greenhouse Office (AGO 2006b).

It can be assumed that 50 t/ha of organic material (above and below the ground) will be oxidised to CO_2 as a result of land clearing, and this will release approximately 147 tonnes of CO_2^e/ha to the atmosphere.

A total of 18.1 ha of land will be cleared for mining activities at the Maud Creek site, including stockpile areas and haul roads (refer Table 2-2).

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source releases mostly CO_2 and very little else, then the emitted tonnes of CO_2 will be very close to the emitted tonnes of CO_2^e. If emissions contain some methane, which is 21 times stronger than CO_2 in terms of greenhouse effect, then the amount of CO_2^e could be significantly higher than the tonnes of CO_2 emitted by the source. It is important to gauge the total effects of all the greenhouse gases, not just CO_2.

Areas of land to be cleared, and the associated greenhouse gas generation from this land clearing, are shown in Table 12-3, and amount to a total of approximately 2,660 t of CO_2^e. Operational infrastructure will be temporary and consists of portable site office and ablution facilities; contractors laydown areas; power supply – from Northern Territory grid via new power line; and dewatering bores to lower the standing water table. Other facilities will include temporary waste storage areas, hydrocarbon storage facilities, explosives storage facility, and haulage and access roads.

Table 12-3 Additional land clearance and greenhouse gas emissions

Infrastructure	Total Additional Area of Disturbance (ha)	CO_2^e emissions (t)
Miscellaneous infrastructure (including bunding)	2.4	353
Existing open pit void	0	0
Portal Access Area (box cut)	0.7	103
Transport corridor		
Option 1. Preferred access route and power lines	15.0	2,205
Option 2. Alternative upgrade of existing access route[1]	(10.4)	(1,529)
Irrigation infrastructure	0	0
ROM pad	0	0
Totals	**18.1**	**2,661**

[1] Note: transport corridor option 2 is not included in totals

Based on AGO standards, the 'embedded' CO_2^e content of construction materials can be calculated as the sum of emissions from energy use (indirect), and processes (direct). The embedded CO_2^e emissions in infrastructure required at Maud Creek mine site are shown in Table 12-4, and amount to a total of approximately 685 t CO_2^e.

Table 12-4 Embedded CO_2^e emissions in infrastructure

Infrastructure	Materials (t)	CO_2^e content (t CO_2^e/t material)	Total CO_2^e emissions (t)
Construction of site office and other facilities			
Steel	20	est. 4	80
aluminium	6	est. 30	180
Workshop			
Steel	60	est. 4	240
aluminium	6	est. 30	180
Diesel to haul in above materials*			8
Total	**92**		**688**

* Assuming 650 km round trip from Darwin for 6 heavy trucks (0.725 L diesel consumed/km) and 3 tonnes CO_2/kL diesel full fuel cycle (AGO 2006a)

Emission estimates from the operation

Emissions over the ten year life of mine were estimated. One of the two main sources of greenhouse gas emissions in the mines' operational phase will be the hydrocarbons burnt for motive power. The proponent estimates average diesel consumption for haulage between the mine site and URGM and return to be 0.725 L diesel/km. This is higher than the AGO emissions factor for "heavy trucks" - 0.546 L diesel/km – which is to be expected given the size of the road trains.

One kilolitre of diesel fuel releases 2.7 t of CO_2^e directly, when it is consumed in a vehicle (AGO 2006a). There are additional greenhouse gases produced indirectly in this process, when the diesel fuel is extracted, produced and transported from its natural source to the point of consumption (AGO 2006a). This is known as the "full fuel cycle" and therefore, accounting for both the direct and indirect emissions, a total of 3.0 t of CO_2^e are produced per kL of diesel (AGO 2006a). For the purposes of this EIS, the full fuel cycle emissions from diesel use are presented here.

Total fuel cycle emissions for diesel consumption due to motive power are in the order of 6,880 t of CO_2^e for mine construction and ore extraction (from Terra Gold mine planning estimates shown in Table 12-4) and 30,000 t of CO_2^e for haulage (see Table 12-5).

Table 12-5 CO_2^e emissions from diesel consumption for haulage to URGM

Round trip to URGM (km)	Number of round trips (life of mine)#	Diesel fuel use (L)*	Total full fuel cycle CO_2^e emissions (t)
250	54,750	9,900,000	30,000

Assuming 15 round trips to URGM per day for the life of the operation
* Assuming 0.725 L/km average

Terra Gold estimates that 810,090 kg of ANFO (ammonium nitrate and fuel oil) explosive will be used in the construction and operational phases of the project. The AGO (2006a) listed emission factor for this is 0.167 t of CO_2^e per tonne of explosive which equates to approximately 135 t of CO_2^e.

Electricity supply to the site at Maud Creek will be via the Northern Territory grid. Electricity use is estimated at 0.92 GWh per month for the life of operations. Using standard emissions factors (AGO 2006a), this level of electricity consumption will produce approximately 78,800 t of CO_2^e based on the full fuel cycle.

In the order of ten domestic air conditioning units will be used on site while no large scale chilling other than water chillers will be used. Assuming a charge of 0.99 kg for each unit and using the default loss rates provided in AGO (2006a) this equates to approximately 3,860 t of CO_2^e emissions due to leakage.

Waste generation from the amenities is estimated to be 15 m^3 per month for the duration of the operation. According to AGO emissions factors for co-mingled waste, this equates to approximately 200 t of CO_2^e over the ten year life of the operation. Waste will be taken to the landfill facility in Katherine by a contractor.

Emissions that result from the milling of the ore at URGM have not been taken into account in this EIS as it falls outside the boundary of the proposed Maud Creek project. No emissions due to liquid petroleum gas usage or electrical switch gear are anticipated.

Greenhouse gas emissions in decommissioning and rehabilitation

At the completion of mining operations, it is intended to remove and sell all infrastructure, and to rehabilitate disturbed surfaces. The infrastructure will be readily recyclable, with the energy 'costs' of recycling being in the order of five to ten per cent of the original energy requirements for steel and aluminum manufacture and smelting (AAC 2005). However, some material will not be suitable for recycling and will go to landfill waste.

The cost of removal from the site and delivery to a new user also needs to be added to assessments. The embedded energy (and hence CO_2^e) 'lost' in both situations cannot be calculated with certainty, and an estimate of ten per cent of the original energy requirement is used for the purposes of this EIS.

In total, an estimated 80 per cent of CO_2^e emissions included in the inventory as part of infrastructure construction will be 'recovered' through re-use or recycling of steel and aluminum by another party. It is therefore estimated that 550 tonnes of CO_2^e will be "recovered" through recycling of existing construction materials.

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

However, this potentially carbon neutral result needs to be adjusted to allow for the energy involved in removing hard surfaces such as haul roads, 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 per cent the recovery of the original CO_2^e emissions. Given that the 9.3 ha (operational area of 12 ha less pit void area of 2.7 ha – Table 2-2) to be rehabilitated will have generated 1,370 tonnes of CO_2^e as a result of land clearing, the eventual amount sequestered from land rehabilitation will be 1,090 tonnes CO_2^e (80%).

A comprehensive overview of Terra Golds's rehabilitation and decommissioning strategies is included in Section 3.

Net emissions over whole of mine life

The emissions and sequestration presented in the previous tables and text have been aggregated in Table 12-6 to show net emissions over the life of the mining operation. This table shows that net emissions of CO_2^e over the life of the operation will be approximately 122,000 t, which is equivalent to 24.3 kg CO_2^e/t of ore produced.

Table 12-6 Net CO_2^e emissions from the mine over the life of operation

Activity	Net emissions (tonnes CO_2^e)		
	Mine development	Operations	Decommissioning and rehabilitation
Land clearing	2,660		
Built infrastructure		685	
Diesel use for mine vehicles		6,880	
Diesel use for haulage vehicles	8	30,000	
Explosives		135	
Electricity consumption		78,800	
Air conditioning		3,860	
Waste generated		200	
Sale of built infrastructure			-550
Land rehabilitation			-1,090
Total for each phase	2,668	120,560	-1,640
Net emissions over mine life		**121,588**	

12.3 Mitigation of Impacts

12.3.1 Dust management

Any complaints received about the mine's impact on air quality will be documented and managed in accordance with Terra Gold's incident reporting system, as described in the Air Quality and Noise EMP and Terra Gold's Environmental Management System (Section 18).

Water trucks and sprayers will be used as required to suppress dust from mine vehicles/haul trucks, stockpile deposition and haulage activities during dry or windy conditions. The truck trailers will be covered using fitted steel covers or tarpaulins, as appropriate, for transport of ore to URGM.

The mine water dam for ensuring zero discharge from the site to the surface water environment will be used to supply water for dust suppression activities on site. Also, to minimise dust, the gazetted section of the access road will be bituminised. An Air Quality and Noise Environmental Management Plan (EMP) has been developed to minimise impacts of dust on mine staff and the local environment. The Air Quality and Noise EMP is presented in Section 19.

12.3.2 Noise management

Due to the relative remoteness of the mine site, noise will be primarily managed from a personnel health and safety perspective, and efforts will be made to reduce the effects of noise on staff. Noise from equipment will be reduced by installing soundproofing and/or noise abatement devices, where practicable.

Hearing protection equipment will be made available and utilised onsite in areas where engineering controls are deemed ineffective or inappropriate. Signs will be provided that indicate the areas of the operations where hearing protection is required to be worn.

As mentioned above, Terra Gold has developed a draft Air Quality and Noise EMP (see Section 19.7), and complaints on noise generated at the mine or during haulage activities will be documented and managed in accordance with Terra Gold's incident reporting system.

12.3.3 Greenhouse gas emission management

Terra Gold will aim to limit net greenhouse gas emissions through efficient energy use, recycling of construction materials, rehabilitation of disturbed sites (resulting in carbon sequestration), and fire management practices to prevent accidental fires and therefore reduce emissions from wildfires.

Given that reduced land clearing, electricity use and fuel use generate 'win-win' outcomes for the company's economic performance and greenhouse emissions, Terra Gold will develop a program that monitors fuel and electricity use on a monthly basis. Terra Gold will also investigate options for increased efficiency through the life of the operation and during decommissioning.

Some examples of initiatives that Terra Gold is considering to reduce both operational energy costs and greenhouse gas emissions include:

- use of energy efficient machinery, appliances, and plant equipment;
- the use of alternative fuels, such as LPG, CNG, and biodiesel;
- efficient vehicle use such as maintaining optimum tyre pressure, and operating a bus to reduce car usage; and
- energy-conservative use of equipment by personnel, for example, turning lights and appliances off when not in use.

The measurable sources of greenhouse gas emissions associated with the proposed operations are:

- land disturbance;
- construction and dismantling of infrastructure (including roads, work areas, buildings and plant);
- mining and processing; and
- transport of ore to URGM.

Terra Gold will track emissions so as to comply with National Pollutant Inventory (NPI) reporting guidelines, which will also be used as the greenhouse gas emissions reporting and public disclosure mechanism.

12.3.4 Preparedness for climate change

Impacts of climate change that could affect operations at the Maud Creek mine site within the operational period may include slightly higher ambient temperatures and more frequent cyclones during the wet seasons, which could be more intense than those experienced in previous years. However, owing to the short operational period, these potential impacts are minimal.

Preliminary risk assessment planning, documented in Section 17, describes Terra Gold's considerations of these climate-related risks. Terra Gold has developed an Emergency Management Plan (Section 17) for a range of extreme events such as flooding, electrical storms, strong winds and bushfires, to protect mine personnel, equipment and the surrounding environment.

The impacts of working in extreme heat conditions are managed from a health and safety perspective through Terra Gold's Safety Management Plan. Procedures include use of personal protective equipment to prevent sunburn, management of dehydration and heat stress, and first aid training.

In the longer term, the increased temperatures and evaporation rates predicted for the NT may affect the growth of replanted vegetation on the mine site. This will be considered during planning and implementation of mine rehabilitation programs; for example, it may result in selection of more drought-tolerant plant species, or contouring to retain surface water in areas targeted for establishing vegetation.

12.4 Commitments

Terra Gold commits to documenting and managing any complaints received about the mine's impact on air quality, noise and vibration using Terra Gold's incident reporting system.

Terra Gold commits to using water trucks and sprayers as required during dry or windy conditions to suppress dust from mine vehicles/haul trucks, stockpile deposition and haulage activities.

Terra Gold commits to covering the truck trailers for ore transport to URGM.

Terra Gold commits to bituminising the gazetted section of the access road.

Terra Gold commits to installing soundproofing and/or noise abatement devices, where practicable.

Terra Gold commits to making hearing protection equipment available onsite in areas where noise reduction engineering controls are deemed ineffective or inappropriate.

Terra Gold commits to providing signage indicating areas of the operations where hearing protection is required to be worn.

Terra Gold commits to developing a program that monitors fuel and electricity use on a monthly basis.

Terra Gold commits to investigating options for increased energy efficiency through the life of operation of the project and during decommissioning.