9.1 Existing Conditions

9.1.1 Baseline information

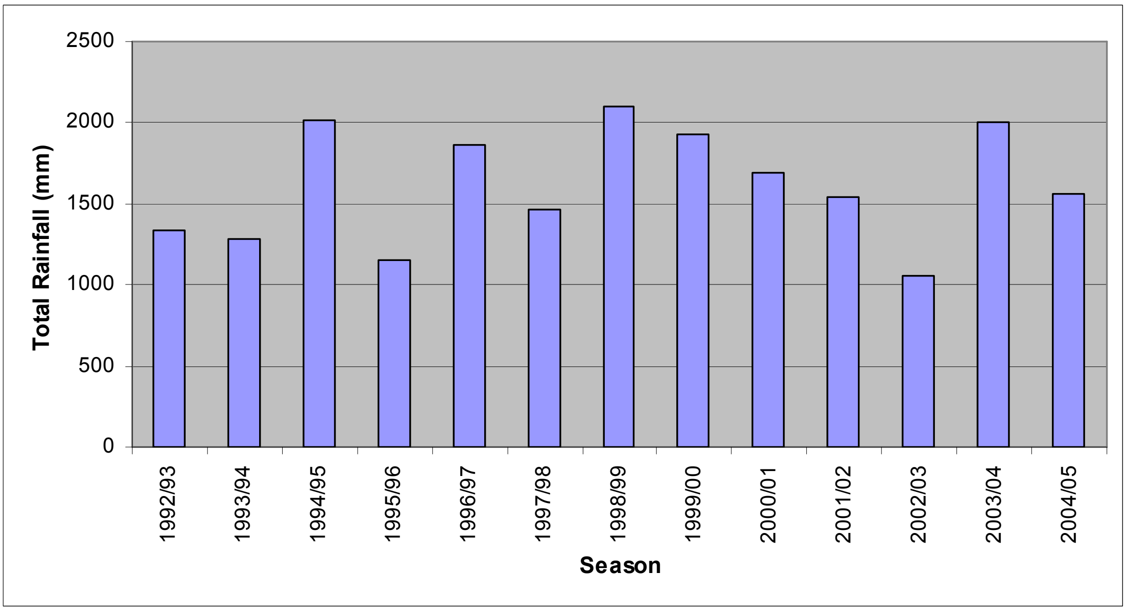
The nearest settlement to the proposed mine sites is Hayes Creek, which is located approximately twelve kilometres away. Due to the remote location of the sites, any risk of nuisance or potentially health-threatening effects of dust and noise to humans is minimal. However, appropriate measures will be taken to limit dust and noise impacts, to ensure site safety and prevent dust or noise nuisance.

Due to previous disturbance from mining and exploration activities the Princess Louise and North Point project area contains bare surfaces that may be sources of dust during dry, windy weather. Other than mining exploration, little mechanical activity currently occurs on the sites that could generate extra dust and noise. It is noted that Goldfields Tourist Drive and Grove Hill Road (Figure 1.2) attract tourist traffic, primarily during the dry season, and this is also a source of dust.

The surrounding flora and fauna may experience some impacts from dust, particularly during the tourist season, however these impacts are probably comparable to the effects of smoke and ash generated in bushfires. It is noted that wildfire is common in the region during the dry season.

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 data recorded at Brocks Creek Mine Site, approximately 95% of the total annual rainfall occurs during the wet season, and the mine areas can receive an average of about 1,400 mm/year, with variation from about 1,000 to 2,000 mm/year (Figure 9.1). The average evaporation rate is 3,360 mm/year.

Figure 9-1 Brocks Creek historic rainfall



Data obtained from the Bureau of Meteorology's (BOM) Mango Farm weather station, located approximately half way between Cosmo mine site and Pine Creek (Figure 9.2), indicates that the hottest month is October with mean maximum temperature of 37.3 ºC, and minimum of 22.3 ºC. The coolest month is July with a mean maximum of 31.5 ºC and minimum of 14.9 ºC. The average annual rainfall at Mango Farm is 1,328.5 mm/yr, and this rain mainly falls from November to March (BOM 2006).

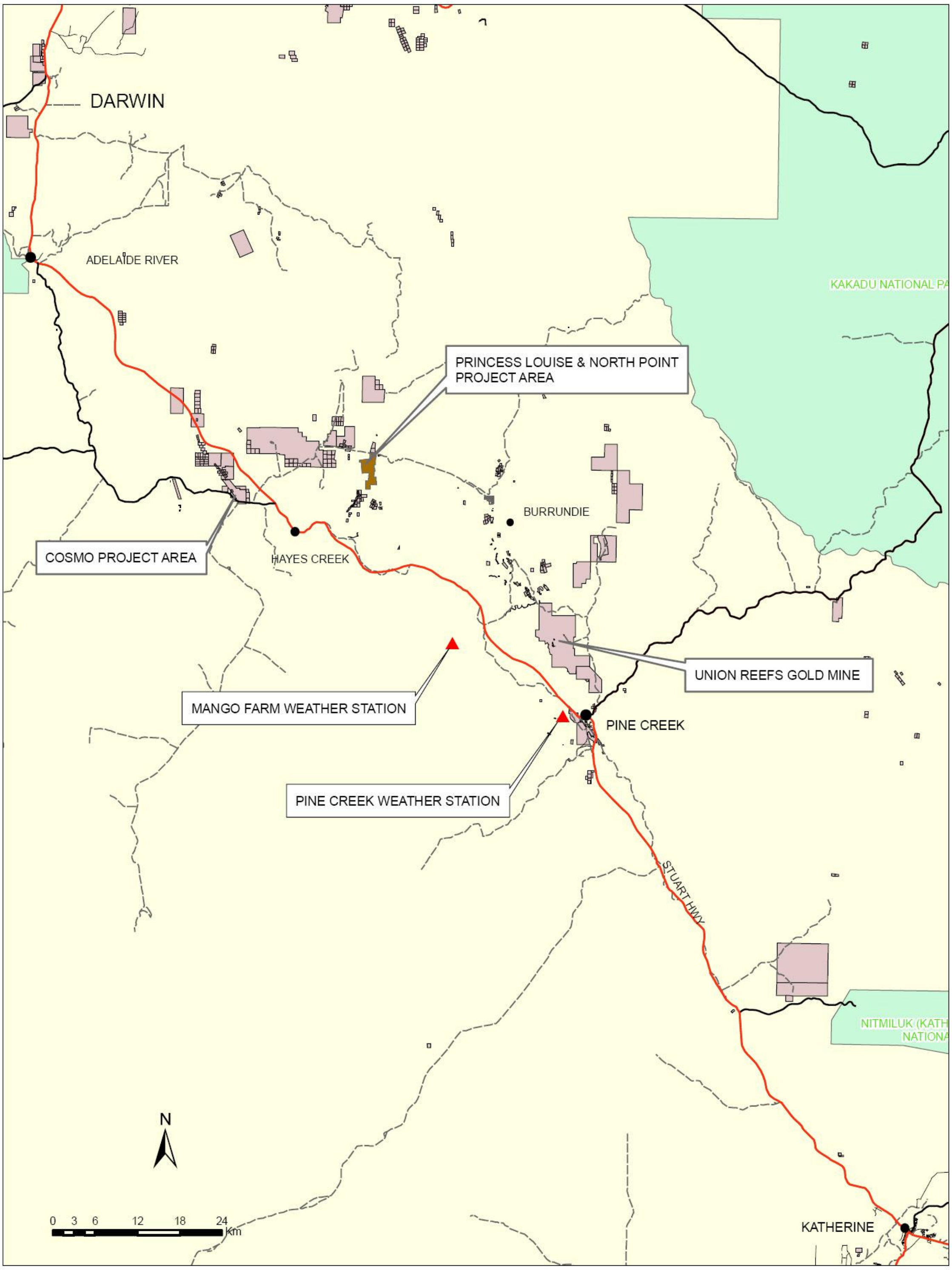
Data obtained from the BOM Pine Creek weather station, located in the Pine Creek town centre (Figure 9.2), indicates that during the dry season strong south-east winds dominate and during the wet season, winds are more variable, predominantly north-westerly.

During the dry and wet seasons 80% of winds recorded were travelling at less than or equal to 10 km/hour (James Turnbull, Bureau of Meteorology, *personal communication*). Wind data from the Pine Creek weather station are shown in Table 9.1.

Table 9-1 Average wind direction and speed at Pine Creek (February 2000 to November 2006)

Month	Time	Wind Speed and Direction Interpretation
January	9am	72% of the wind speed was ≤ 10 km/h from a W to NW direction.
	3pm	80% of the wind speed was ≤ 10 km/h from a W to NW direction.
February	9am	65% of the wind speed was ≤ 10 km/h from a W to NW direction.
	3pm	80% of the wind speed was ≤ 10 km/h from a W to NW direction.
March	9am	70% of the wind speed was ≤ 10 km/h from a E to NE direction.
	3pm	80% of the wind speed was ≤ 10 km/h from a E to NE direction.
April	9am	80% of the wind speed was ≤ 10 km/h from a E to SE direction.
	3pm	70% of the wind speed was ≤ 10 km/h from a E to SE direction.
May	9am	75% of the wind speed was ≤ 10 km/h from a E to SE direction.
	3pm	75% of the wind speed was ≤ 10 km/h from a E to SE direction.
June	9am	85% of the wind speed was ≤ 10 km/h from a S to SE direction.
	3pm	80% of the wind speed was ≤ 10 km/h from a E to SE direction.
July	9am	85% of the wind speed was ≤ 10 km/h from a S to SE direction.
	3pm	80% of the wind speed was ≤ 10 km/h from a E to SE direction.
August	9am	85% of the wind speed was ≤ 10 km/h from a S to SE direction.
	3pm	70% of the wind speed was ≤ 10 km/h from a E to SE direction.
September	9am	90% of the wind speed was ≤ 10 km/h from a N to NW direction.
	3pm	80% of the wind speed was ≤ 10 km/h from a E to SE direction.
October	9am	90% of the wind speed was ≤ 10 km/h from a N to NW direction.
	3pm	85% of the wind speed was ≤ 10 km/h from a E to SE direction.
November	9am	90% of the wind speed was ≤ 10 km/h from a W to NW direction.
	3pm	90% of the wind speed was ≤ 10 km/h from a E to NE direction.
December	9am	85% of the wind speed was ≤ 10 km/h from a W to NW direction.
	3pm	80% of the wind speed was ≤ 10 km/h from a W to NW direction.

Source: James Turnbull, BOM, *pers comm.*



Client	Project			Title	
Burnside Operations Pty Ltd	PRINCESS LOUISE & NORTH POINT PROJECT AREA			Location of Pine Creek and Mango Farm Weather Stations	
URS	Drawn: BJ	Approved: PB	Date: 12 Dec 06	Figure 9.2	Rev. A
	Job No.: 42213760	File No.: 42213760-009-PL-NP.mxd			A4

9.1.2 Climate change predictions

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

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). Evaporation rates are predicted to increase with increases in temperature, and the moisture balance (rainfall minus evaporation) is expected to fall by 10 – 80mm in the Pine Creek region, 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).

9.2 Impacts of Mining Operations

9.2.1 Dust generation

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. Wherever possible, the quantities and areas of soils which are disturbed will be kept to a minimum.

During mining operations on-going rock excavation from the mine pits, deposition of rock on the waste dumps and ore stockpiles, and loading and unloading of trucks will be sources of dust emissions.

Dust created during transport will be minimal, owing to the nature and size of the material, and therefore will not pose a significant impact.

9.2.2 Noise generation

The major sources of noise anticipated from the mine sites are power generators, mine vehicles and machinery, use of explosives and haulage trucks.

Haulage from the mining sites to the URGM will occur over a full 24 hour period throughout the operational phase of the mine sites. The preferred route for transporting ore will be by road train via the existing Grove Hill Road, Stuart Highway and Ping Que Road to URGM (see Figure 11.1).

During the project, personnel and supplies will be driven daily between the mine sites and the Cosmo Village mine camp, which is located approximately 23 km west of the project site. The route taken will be the existing Grove Hill Road, Stuart Highway, Dorat Road and Douglas Road. Vehicles used will be cars and minibuses, and transport will occur across a 24 hour period throughout the life of the mine.

It is anticipated that the impact generated from haulage and commuting will be minimal, as vehicles will not be travelling past or through any populated areas.

As the mining duration is expected to be less than a year at both Princess Louise and North Point combined, disturbance to local wildlife should be considered temporary only.

9.2.3 Vibration

It is anticipated that vibration will result from open pit blasting as well as the movement of haul trucks along proposed access roads. However, the impacts generated from vibration is expected to be minimal as mining operations will only take place over a short period of time, and the project areas is not located near any populated area.

Vibration from mining activities could impact upon the ghost bat colony located adjacent to the North Point access road, as discussed in Section 8. Appropriate management strategies will be put in place to reduce the potential for vibration effects on the ghost bat colony during mining operations.

9.2.4 Greenhouse gas emissions

The principal sources of greenhouse gas emissions at the proposed Princess Louise and North Point mine sites are land clearing, 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.

Carbon dioxide (CO_2) is by far the most important greenhouse gas that will be produced by the proposed operations. It is the principal gas emitted as a consequence of electricity generation, fossil fuel use, land clearing, and as a consequence of energy use in the manufacture of building materials. Other gases occur in minor amounts; for example, there will be some methane (CH_4) emitted from waste materials and buried vegetation, and amounts of the highly greenhouse active perfluorocarbons (PFCs) are generated in aluminum manufacture (AGO, 2006a).

As CO_2 dominates in absolute terms, there is no need to distinguish between tonnes of CO_2 and tonnes of carbon dioxide equivalents (CO_2^e) emitted. Due to the small difference between the two numbers, only CO_2^e is reported in later sections of this chapter[1].

The components of the proposed Princess Louise and North Point mine project that may result in greenhouse gas impacts are described in Table 9.2.

[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 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 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 23 times stronger than CO_2, 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.

Emissions estimates from new land clearing

There are considerable areas at Princess Louise and North Point that are already cleared by exploration activities. In this section, the assessment of emissions deals only with the areas that will be newly cleared for the proposed operation.

Table 9-2 Components of the proposed mining operations and their associated greenhouse gas impact

Activity	Site	Description	Aspects to be considered in assessing net emissions
Mining	Princess Louise Open Pit	New open pit, generating 0.113 Mt ore and 0.361 Mt waste rock	Land clearing, rehabilitation of waste dump Electrical and fossil fuel energy use
	North Point Open Pit	New open pit, generating 0.323 Mt ore and 1.03 Mt waste rock	Land clearing, rehabilitation of waste dump Electrical and fossil fuel energy use
Infrastructure	Contractors yards	Located at both mines	Land clearing, land rehabilitation, materials used in construction, recycling, waste disposal
	Cosmo Village	Accommodation and administration site	Removal of buildings, services and other facilities Recycling of materials Land rehabilitation
Drill holes	Located across the whole area	47 exploration drill holes	Land clearing, rehabilitation of disturbed area
Electricity use	All activities	Electricity is obtained from the NT grid	Emissions calculated at standard rate for NT electricity
Fire management	2,800 km^2 in the vicinity of the mine	30 km radius around Brocks Creek	Reduced emissions as a result of improved fire management

Greenhouse gas emissions from land clearing are determined for tropical savannas using emissions 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 t of CO_2^e/ha to the atmosphere.

A total of 15.2 ha of new land clearing will be required for mining activities at Princess Louise and North Point mines, including requirements for waste dumps, haul roads and clearing for contractors' camps.

Areas of land to be cleared, and the associated greenhouse gas generation from this land clearing, are shown in Table 9.3.

Table 9-3 Greenhouse gas emissions from new land clearing

Domain	New land clearing (ha)	CO_2^e emissions (t)
Princess Louise: pit, sediment dam, waste rock dump, ROM pad, water tank and amenities	2.2	325
North Point	10.4	1529
Princess Louise access road	0.1	15
North Point access road	0.6	88
47 exploration drill holes*	1.9*	279
Total	**15.2**	**2,236**

*based on an estimated 400 m^2 disturbance per drill hole

Emissions estimates from construction of infrastructure

The infrastructure needs for the operation will be temporary and limited to:

- Portable site office and ablution facilities;
- Contractors laydown areas; and
- Power supply – portable generator to be used for the site office and lighting of the area at night.

Other facilities will include temporary waste storage areas, hydrocarbon storage facilities, explosives storage facility, and haulage and access roads.

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 Princess Louise and North Point Mine Sites are shown in Table 9.4.

Table 9-4 Greenhouse gas emissions 'embedded' in site 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	10	est. 4*	40
Camp construction – steel	10	est. 4*	40
Camp construction – wood	1	Nil – claimed in production	
Camp construction – aluminum cladding	2	est. 30**	60
Diesel to haul in above materials^			4
Total	23 t		144

* based on emissions of 2.4 t CO_2^e /t of raw steel (Bluescope 2006). Additional amount in total to account for transport and product manufacture.

** based on 0.76 t CO_2^e emissions per tonne of alumina plus 2.64 t CO_2^e emissions per tonne of smelted aluminium plus 14.70 t of CO_2^e indirect emissions per tonne of aluminium (AAC, 2005). Additional amount in total to account for transport and product manufacture

^ assuming 400 km round trip from Darwin for 6 heavy trucks (0.546 L diesel consumed/km) and 3 t CO_2/kL diesel full fuel cycle (AGO 2006a)

Emissions estimates from operations

The main source of greenhouse gas emissions in the mines' operational phase will be the hydrocarbons burnt for motive power. It is estimated that 0.52 L of diesel will be consumed per tonne of ore or waste rock extracted from the Princess Louise and North Point mines, prior to haulage to URGM. To estimate the diesel consumption in haulage from the mine sites to URGM, the AGO emissions factor for "heavy trucks" (0.546 L diesel/km) has been used.

One kL of diesel fuel releases 2.7 t of CO_2^e directly, when it is consumed in a vehicle (AGO 2006a). There are more 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 kilolitre of diesel (AGO 2006a). For the purposes of this PER, the full fuel cycle emissions from diesel use are presented here.

Estimates of CO_2^e for ore extraction and haulage are provided in Tables 9.5 and 9.6. Total fuel cycle emissions for diesel consumption due to motive power are in the order of 2,840 t of CO_2^e for extraction and 750 t of CO_2^e for haulage.

Table 9-5 CO_2^e emissions from diesel consumption in ore and waste rock extraction

Site	Ore to be mined (t)	Waste rock to be mined (t)	Diesel fuel use (at 0.52L/t of ore and waste rock)	Total full fuel cycle CO_2^e emissions (t)
Princess Louise	113,000	361,000	247,000	740
North Point	323,000	1,030,000	705,000	2100

Table 9-6 CO_2^e emissions from diesel consumption for haulage to URGM

Site	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)
Princess Louise	106	1100	64,000	190
North Point	106	3200	186,000	560

* Assuming 0.546 L/km as for "heavy trucks" in AGO (2006a)

Electricity supply to office buildings and contractor facilities at Princess Louise and North Point will be provided by diesel generators on site. There will be four 8 kVA generators for lighting towers and an additional 25 kVA generator. An estimated 27,000 L of diesel will be used to power these during the life of operations. Using standard emissions factors (AGO 2006a), this level of electricity production from diesel generators will produce a total of 82 t of CO_2^e at each mine site (Table 9.7).

Cosmo Village, which will be utilized by Princess Louise and North Point personnel, is powered by electricity from the NT grid. As the camp accommodates staff working on a variety of mining projects in the area, not all of the electricity consumed there can be attributable to the Princess Louise and North Point project. For the purposes of this PER, one fifth of the predicted electricity use at Cosmo Village over the project timeframe is assigned to Princess Louise and North Point (Table 9.7).

Based on the full fuel cycle (direct emissions at the power plant as well as emissions from gas or coal production from the source) CO_2^e emissions are produced at a rate of 0.716 kg per kWh of electricity, in the NT (AGO 2006a). Emissions from the electricity use at the mine sites and Cosmo Village are presented in Table 9.7.

Waste generation from the amenities is estimated to be three or four 240 L Sulo bins per week for the duration of the operation. According to AGO emissions factors for co-mingled waste, this equates to 1.6 t of CO_2^e, assuming 15 weeks of operation. Waste will be taken to the Brocks Creek landfill facility.

Table 9-7 CO_2^e emissions from electricity consumption at the mine sites and camp

Site	Electricity source	Diesel consumption (L)	Electricity consumption (GWh/year)	Total full fuel cycle CO_2^e emissions (t)
Princess Louise and North Point Mine Site	Diesel generator	27000	-	82
Cosmo Village	NT grid	-	0.26	10
Total				**92**

Greenhouse gas emissions in decommissioning and rehabilitation

At the completion of mining operations, it is intended to remove and either re-use or 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 PER. 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, timber and aluminum by another party. It is therefore estimated that 110 t of existing construction materials will be recycled.

Land rehabilitation in the dry 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 2,200 t of CO_2^e were emitted as a result of land clearing, the eventual amount sequestered from land rehabilitation will be 1,800 t CO_2^e (80%).

A comprehensive overview of BOPL'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 have been aggregated in Table 9.8 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 4,100 t, which is equivalent to 9.5 kg CO_2^e/t of ore produced.

Table 9-8 Net CO_2^e emissions from the mine over the life of operation

Activity	Net emissions (t CO_2^e) Mine development	Operations	Decommissioning and rehabilitation
Land clearing	2,200		
Built infrastructure		144	
Diesel use for mine vehicles		3,600	
Waste generated		1.6	
Electricity consumption		92	
Land rehabilitation			-1,800
Sale of built infrastructure			-110
Total for each phase	2,200	3,800	-1,900
Net emissions over mine life (t CO_2^e)	**4,100**		

9.3 Mitigation of Impacts to Air Quality

9.3.1 Dust management

Water trucks and sprayers will be used as required to suppress dust from mine excavation, stockpile deposition and haulage activities during dry or windy conditions. It is anticipated that excess water from pit dewatering will provide ample supply for dust suppression activities (Section 6.2).

A draft Dust and Noise Environmental Management Plan (EMP) has been developed to minimise impacts of dust on mine staff and the local environment. The draft Dust and Noise EMP is outlined in Section 18.6.

Any complaints received about the mine's impact on air quality will be documented and followed through using BOPL's incident reporting system, as described in the draft Dust and Noise EMP and BOPL's Environmental Management System (EMS) (Section 17).

9.3.2 Noise management

Due to the remoteness of the mine sites, 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 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 those areas of the operations where hearing protection is required to be worn.

As mentioned above, BOPL has developed a draft Dust and Noise EMP (Section 18.6), and complaints on noise generated at the mine or during haulage activities will be documented and followed through using BOPL's incident reporting system.

9.3.3 Vibration management

Due to the remoteness of the site, vibration will be managed primarily to minimise impact on fauna, in particular a ghost bat colony that is located adjacent to the North Point access road.

Appropriate blasting techniques will be implemented that will minimise vibration effects. The location of the access road into the North Point mine site will be positioned to ensure that no vibration effects from haul trucks to be felt by the ghost bat colony, as discussed in Section 8.

9.3.4 Greenhouse gas emissions management

BOPL 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, BOPL will develop a continuous improvement program that monitors fuel and electricity use on a monthly basis. BOPL will also investigate options for increased efficiency through the life of operations and during decommissioning.

Some examples of initiatives that BOPL are considering to reduce both operational energy costs and greenhouse gas emissions include:

- use of energy efficient machinery, appliances, and plant equipment;
- exploring the use of alternative fuels, such as LPG, CNG, and biodiesel;

- efficient vehicle use such as maintaining optimum tyre pressure, and minimising idling; 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); and
- mining and processing; and transport of ore to URGM.

BOPL will put in place reporting systems to track those sources of emissions, and calculate CO_2^e emissions and sequestration. Where possible, standard emissions factors from the AGO will be used in calculating CO_2^e emissions and sequestration. If these are not available, relevant factors will be taken from the available literature, with preference given to local research findings and calculations.

Preparedness for climate change

Impacts of climate change that could affect operations at the Princess Louise and North Point mine sites within the operational period may include slightly higher ambient temperatures, and 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 16, describes BOPL's considerations of these climate-related risks. BOPL will developed an Emergency Management Plan 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 BOPL'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 sites. 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.

9.4 Commitments

During mining, BOPL commits to the use of water trucks and sprayers to suppress dust emissions as necessary.

BOPL commits to the installation of soundproofing and/or noise abatement devices where necessary.

BOPL commits to hearing protection equipment being made available and utilised onsite where required.

BOPL commits to providing signs in areas of the operation where hearing protection is required to be worn.

BOPL commits to the implementation of appropriate blasting techniques to reduce the likelihood of noise and vibration impacting upon the ghost bat colony.

During mining, BOPL commits to monitoring fuel and electricity use on a monthly basis.

BOPL commits to investigating options for increased energy efficiency through the life of operations and during decommissioning.

During operations, BOPL commits to putting in place reporting systems to track greenhouse gas emissions.