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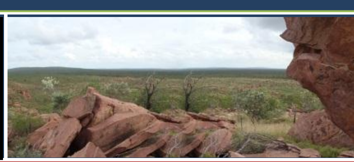
Chapter 7
Climate, Air, Noise and Vibration

Western Desert Resources Limited
Roper Bar Iron Ore Project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7.1 Background and Introduction

The following chapter assesses the potential impacts on air quality, including greenhouse gas emissions; terrestrial noise, and vibration which may arise as a result of the WDRL Roper Bar Iron Ore Project. This includes impacts to sensitive receptors in the community, mine personnel and the receiving environment. It should be noted that impacts of underwater noise on the marine environment are addressed separately in Chapter 5 (Marine).

The Australian Bureau of Meteorology maintains meteorological stations at several locations in the vicinity of the proposed mine. The most representative location is the Ngukurr meteorological station, located approximately 60 kilometres to the north of the project area. The records at this meteorological station are considered representative of the typical climatic conditions in the wider airshed in the vicinity of the proposed mine, and relevant meteorological information applicable to air quality and noise parameters are summarised in Section 7.2 below.

7.1.1 Objectives

The objectives of the Climate, Air, Noise and Vibration Chapter are as follows:

- Describe climate parameters which may influence the WDRL project including rainfall patterns, air temperatures, humidity, wind and other factors;
- Review of the potential impacts on air quality associated with the proposed stages of operation at the Roper Bar Iron Ore Project;
- Review of project energy requirements including power plant, energy infrastructure requirements (including type of equipment, fuel use, expected emissions to air), and calculation of associated greenhouse gas emissions for all stages of the project;
- Present baseline data for the existing noise amenity of the wider area around the Roper Bar Iron Ore Project;
- Assessment of the potential noise impacts from the proposed mining activities, considering the maximum extent of operational boundaries, the hours of operation, the type and number of plant and equipment and site topography. The noise assessment was carried out on the basis of:
    - Determination of the existing noise amenity at the nearest noise-sensitive places to the proposed mining activities; and
    - Determination of the operational noise impacts from proposed mining activities by detailed noise propagation modelling using SoundPLAN software;
- Review of the potential vibration sources associated with the proposed stages of operation at the Roper Bar Iron Ore Project and associated impacts; and
- Preparation of mitigation and control measures to inform the development of the Environmental Management Plan (EMP); and
- To ensure that operations are carried out in compliance with the *Northern Territory Waste Management and Pollution Control Act* and that there are no adverse impacts on sensitive receivers.

7.1.2 Description of Proposal

A detailed description of all proposed project operations and infrastructure is provided in Chapter 2. This section summarises components relevant to the generation of noise, air, and greenhouse gas emissions, and potential sources of vibration.

WDRL proposes to develop its open pit iron ore mine in 2013 with a series of open pits of varying depths between 20 vertical meters and 100 plus vertical meters. Mining will be by conventional open pit methods (including blasting) using selective mining techniques that are scheduled to extract ore and waste material.

WDRL intends to connect the Roper Bar Iron Ore Project with the Port of Bing Bong on the Gulf of Carpentaria, via a 165km long designated haul road. The haul road, with a grade not exceeding 7.5%, is anticipated to accommodate 380 tonne road trains at a frequency of up to 160 vehicles per day (20 vehicles making four round trips per day, or one vehicle every 9 minutes) during peak production. The proposed alignment of the haul road is presented in Figure 7-2.

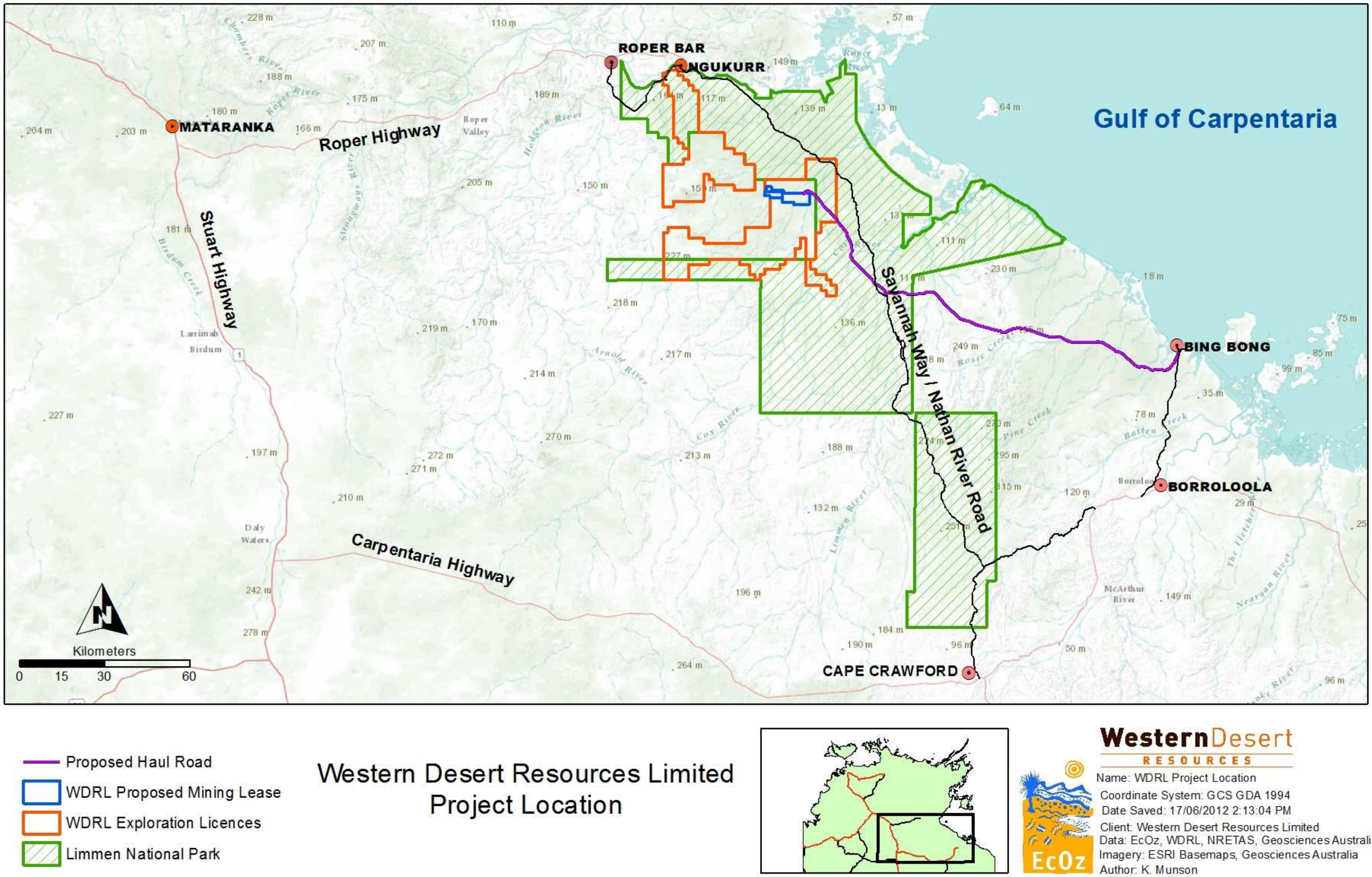

Figure 7-1 – Location of the WDRL Mining Lease

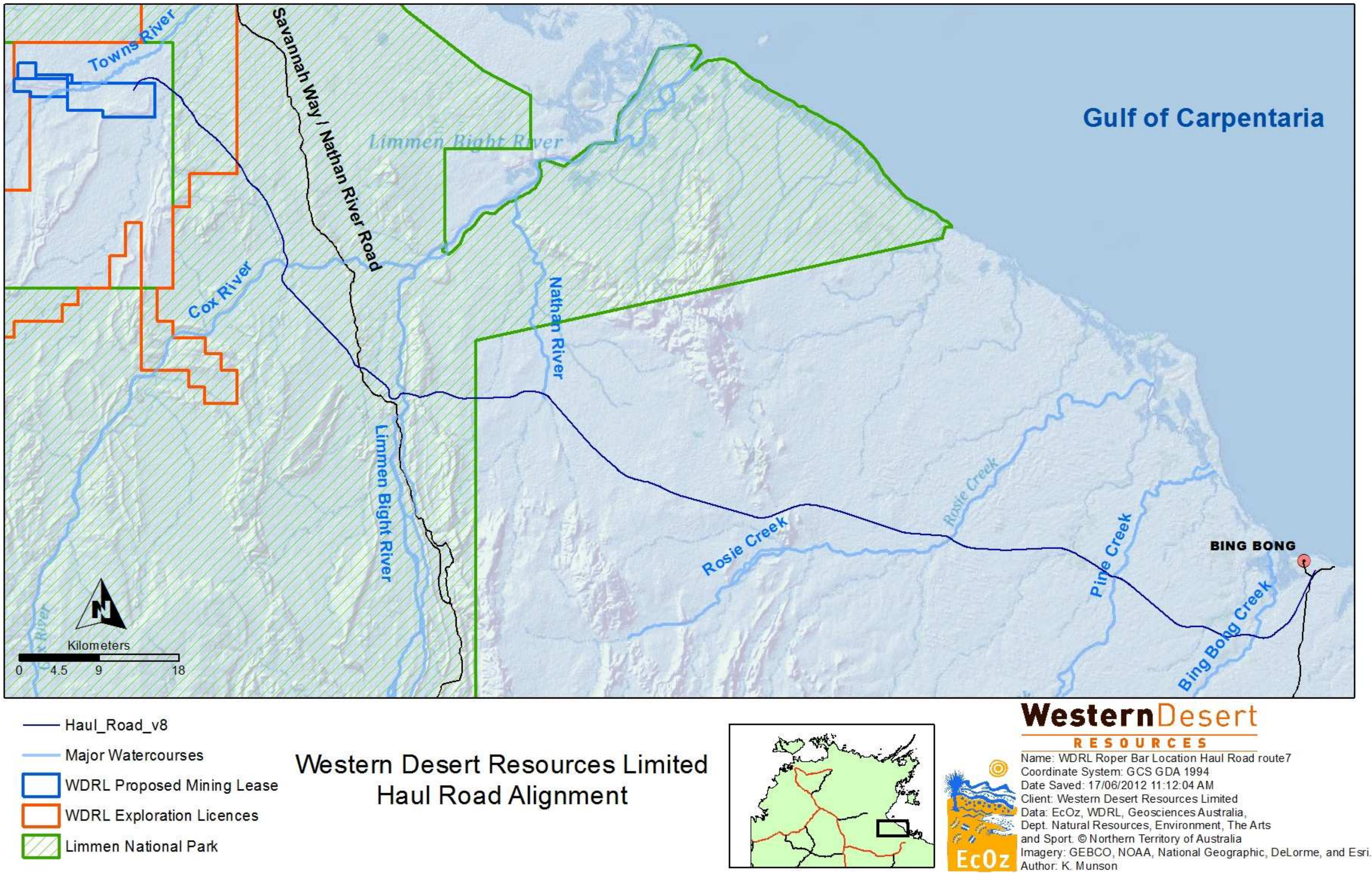

Figure 7-2 - Alignment of the Haul Road to the Port of Bing Bong

Construction and Operations will both be 24 hours per day for around 325 days a year utilising standard mining machinery and equipment. It is assumed that that up to 40 days production a year will be lost due to delays mainly attributable to high rainfall events.

Project ancillary infrastructure includes: process plant and ROM pad; access and haul roads; airstrip; administration building (mine services centre); truck service bays; fleet fuel and chemical storage and re-fuelling building, spares store, and an explosives magazine; potable water treatment plant and sewage treatment plant; mess with associated kitchen; nursing station; ablution block (shower/toilet); bar & entertainment area; laundry facilities; and fitness and recreation area. At the Port of Bing Bong, infrastructure will include the ore Stockyard and refuelling area, and Barge Loading Facility.

The project layout is shown in Figure 7-3 below.

Energy Infrastructure Requirements

Power will be provided by portable gensets. Power requirements are for transmission to borefield, camp and ROM pad. Power will also be made available to other areas as required. The following power generators will be required:

- Accommodation area (site camp): x 3 power generators (2 operational and 1 standby);
- Processing area: x 2 power generators (1 operational and 1 standby);
- Bing Bong: x 2 power generators (1 operational and 1 standby); and
- Conveyance system: x 2 power generators (1 operational and 1 standby).

A detailed description of plant (including mining fleet fuels and electricity demand, type of equipment, fuel use, and expected emissions to air) is included in Section 7.7 below.

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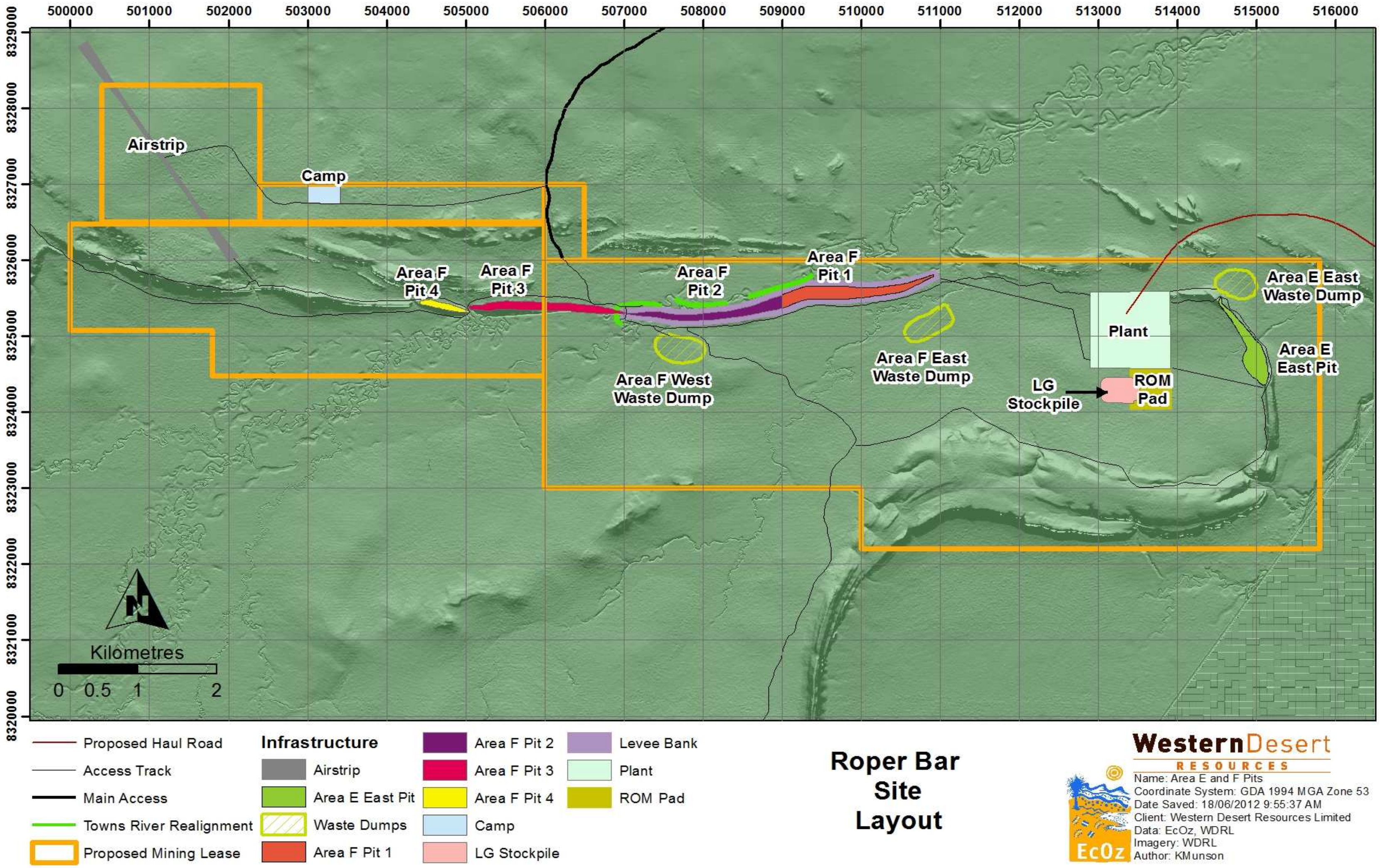


Figure 7-3 – Project Layout

7.2 Climate

The following section provides a description of the climate parameters with bearing on the WDRL project. Climate parameters include rainfall patterns, air temperatures, humidity, wind and other factors with potential to influence the project. Climate extremes such as drought, cyclone and floods are discussed with particular reference to the mine, processing plant and haul road. Detail on coastal specific climate parameters and extremes with potential to impact the loading and barge facility are discussed in detail in Chapter 5.

7.2.1 Meteorological Data

The project area experiences a tropical savannah climate with a distinct Wet and Dry season. The seasonal contrast between the Wet and the Dry has significant implications for water resources. The monsoon brings Wet season rain and during times of cyclones (including the lows before and after cyclones), the project area can experience significant rainfall. These rainfall events can cause flooding which is determined by the volume, duration and spatial distribution of the rainfall. It is these flooding events that provide the recharge to the aquifers. In contrast, the Dry season experiences negligible rain which results in many of the rivers ceasing to flow.

The Project Area falls within the Humid Zone which can experience an average rainfall between 600 – 1000mm per year (Figure 7-4). There are no weather stations within the project area, however Table 7-1 compares the data from two weather stations; Centre Island (Station 14703) near Bing Bong and Ngukurr (Station 14609). These stations are utilised due to their proximity to key project infrastructure. Bing Bong is the port facility used for exporting the ore and the final destination of the haul road. Ngukurr is located approximately 60 kilometres to the north of the mine, processing plant, airstrip and camp.

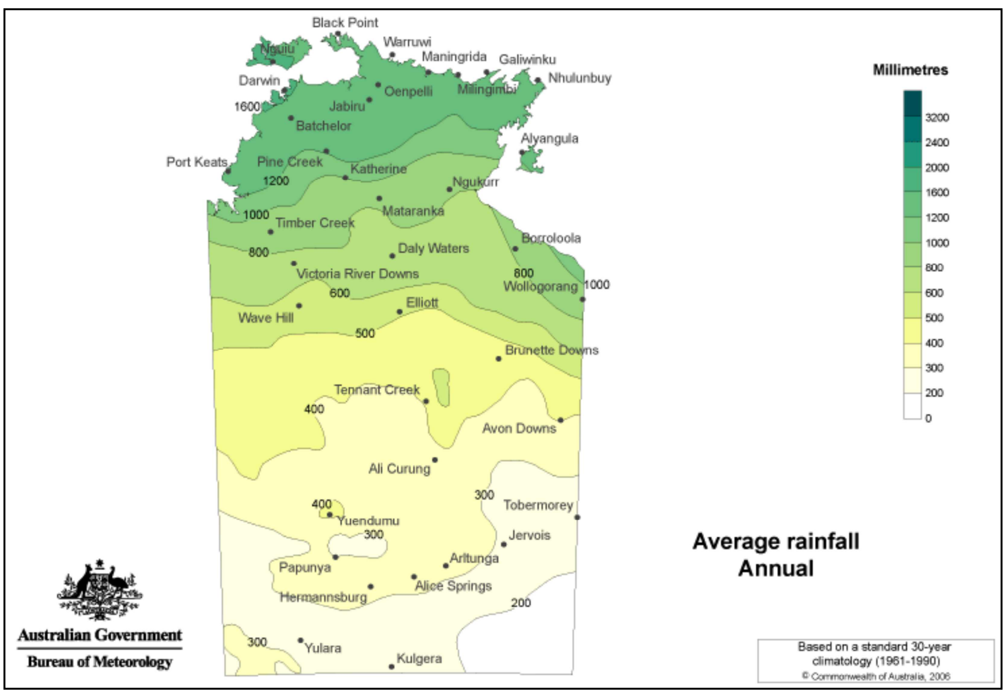


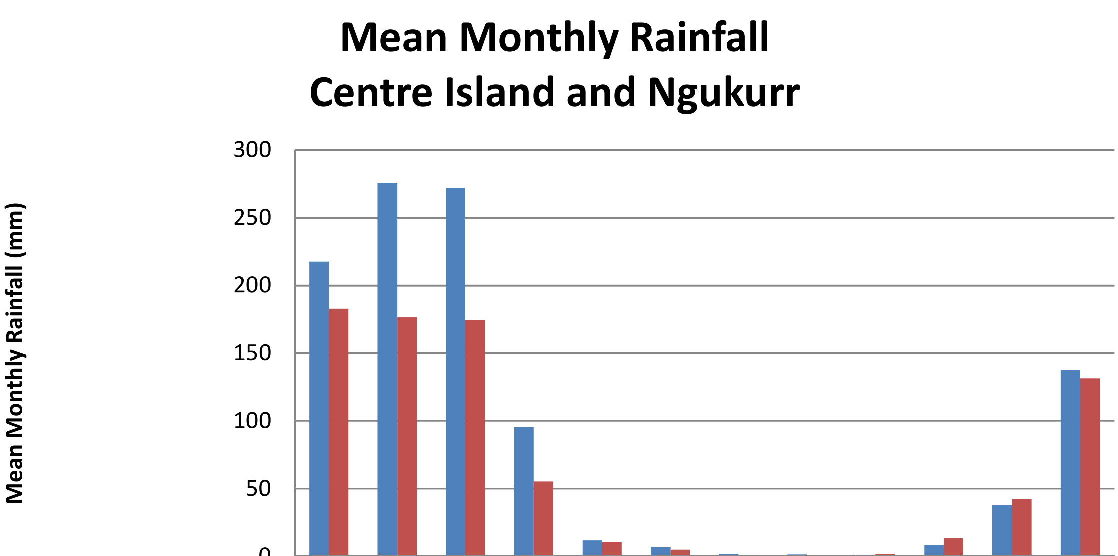
Figure 7-4 – Average Annual Rainfall for the Northern Territory (BOM, 2012)

Table 7-1 – Weather monitoring stations relevant to the WDRL project

SITE	SITE NUMBER	LATITUDE	LONGTITUDE	ELEVATION	DATA COLLECTION PERIOD	STATUS
Ngukurr	14609	14.73°S	134.73°E	34m	1910-2012	Open
Centre Island	14703	15.74°S	136.82°E	12m	1968-2012	O pen

Rainfall

The average annual rainfall for Centre Island is 1071.0mm (44 years data). Ngukurr has an average rainfall of 815.8mm (79 years data). Most of the rain falls during the Wet season between November and April, while the Dry season from May to October brings negligible rainfall. Figure 7-5 shows a mean maximum monthly rainfall ranging between 275.7 - 182.8 and a mean minimum monthly rainfall ranging between 1.4 – 0.7mm for Centre Island and Ngukurr respectively. Average annual evaporation is approximately 2,400mm for the region which, even in the wettest of years, exceeds the annual rainfall (NT Govt 2009).

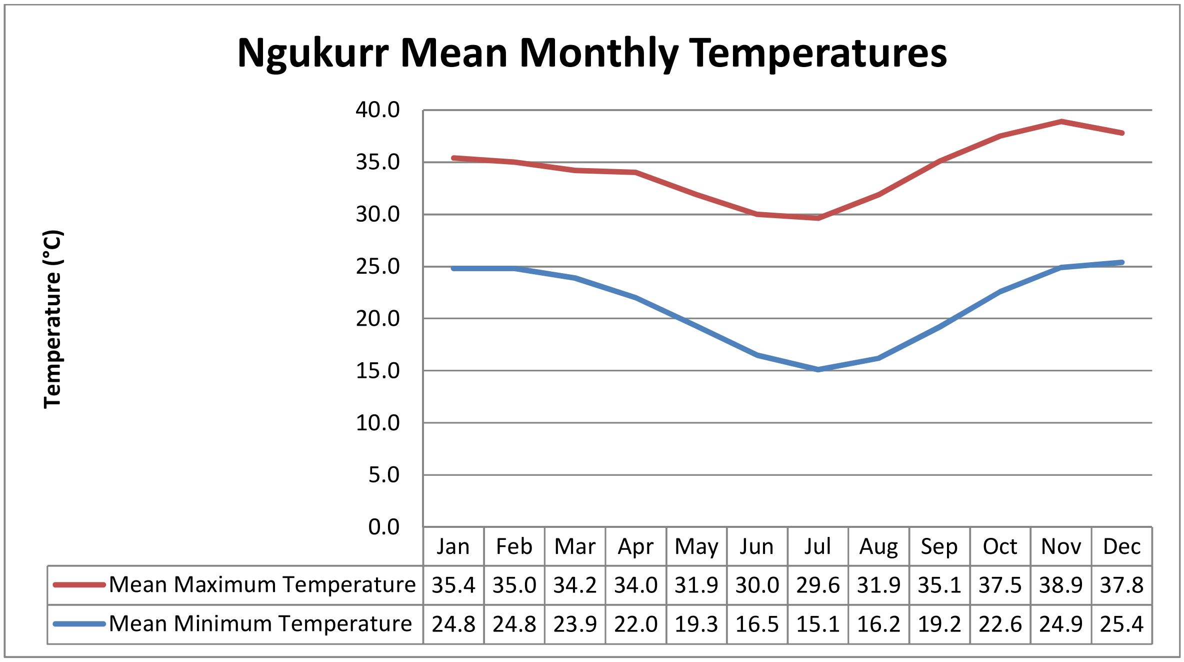


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Centre Island 1968-2012	217.4	275.7	272	95.5	11.9	7.2	1.8	1.6	1.4	8.7	38	137.6
Ngukurr 1910-2012	182.8	176.5	174.3	55.4	10.7	5.1	1.1	0.7	1.8	13.5	42.4	131.5

Figure 7-5 – Mean rainfall data for Centre Island (14703) and Ngukurr (14609) (BOM, 2012)

Temperature

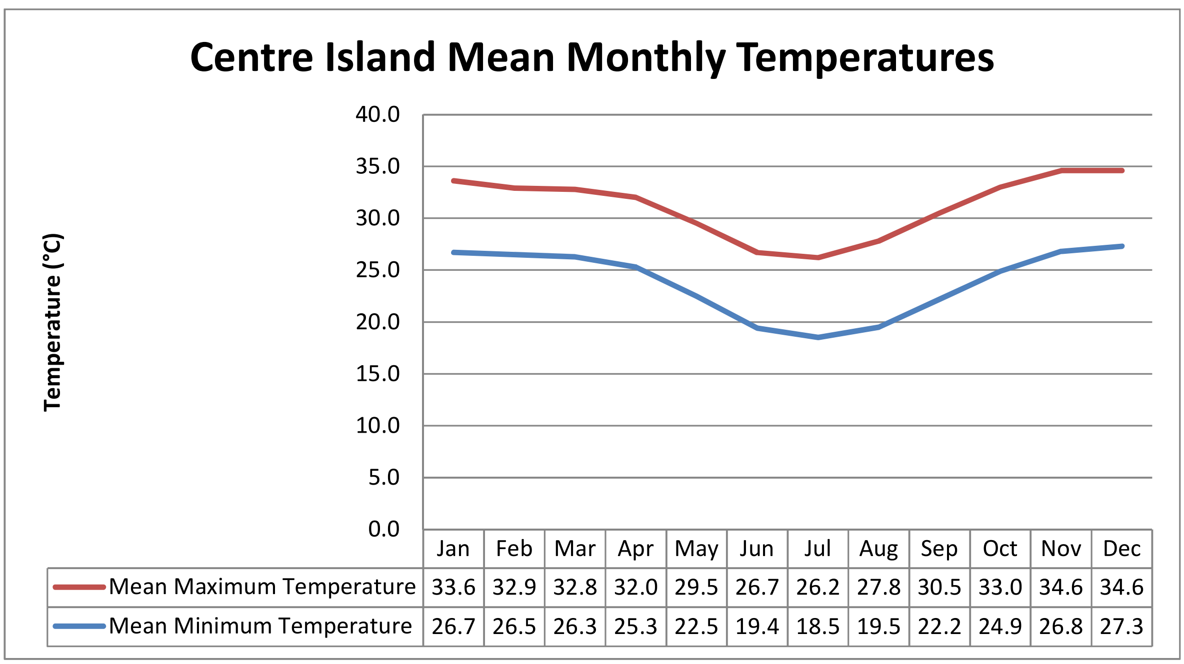
Air temperature data sourced from the BoM website at Ngukurr for mean minimum and mean maximum values for each month are presented in Figure 7-6. The highest average minimum temperatures were reported in December (25.4°C) and the average highest maximum temperatures were reported in November (38.9°C). The lowest average minimum and maximum temperatures occur during July (15.1 and 29.6°C respectively).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Maximum Temperature	35.4	35.0	34.2	34.0	31.9	30.0	29.6	31.9	35.1	37.5	38.9	37.8
Mean Minimum Temperature	24.8	24.8	23.9	22.0	19.3	16.5	15.1	16.2	19.2	22.6	24.9	25.4

Figure 7-6 – Mean monthly temperatures – Ngukurr 1962 to 2010 (BOM, 2012)

Air temperature data sourced from the BoM website at Centre Island for mean minimum and mean maximum values for each month are presented in Figure 7-7. The highest average minimum temperatures were reported in December (27.3°C) and the average highest maximum temperatures were reported in November and December (34.6°C). The lowest average minimum and maximum temperatures occur during July (18.5 and 26.2°C respectively).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Maximum Temperature	33.6	32.9	32.8	32.0	29.5	26.7	26.2	27.8	30.5	33.0	34.6	34.6
Mean Minimum Temperature	26.7	26.5	26.3	25.3	22.5	19.4	18.5	19.5	22.2	24.9	26.8	27.3

Figure 7-7 – Mean Monthly temperatures Centre Island 1974 to 2012 (BOM 2012)

Humidity

Relative humidity is typically presented as a percentage of the total moisture that could be contained within the air at a specific temperature. Relative humidity recordings are measured at 9am and 3pm.

The mean relative humidity at Ngukurr ranges from 25 to 78%. Higher relative humidity is observed during the wet season months; however, there is greater variance in minimum and maximum values during the dry season months (Figure 7-8).

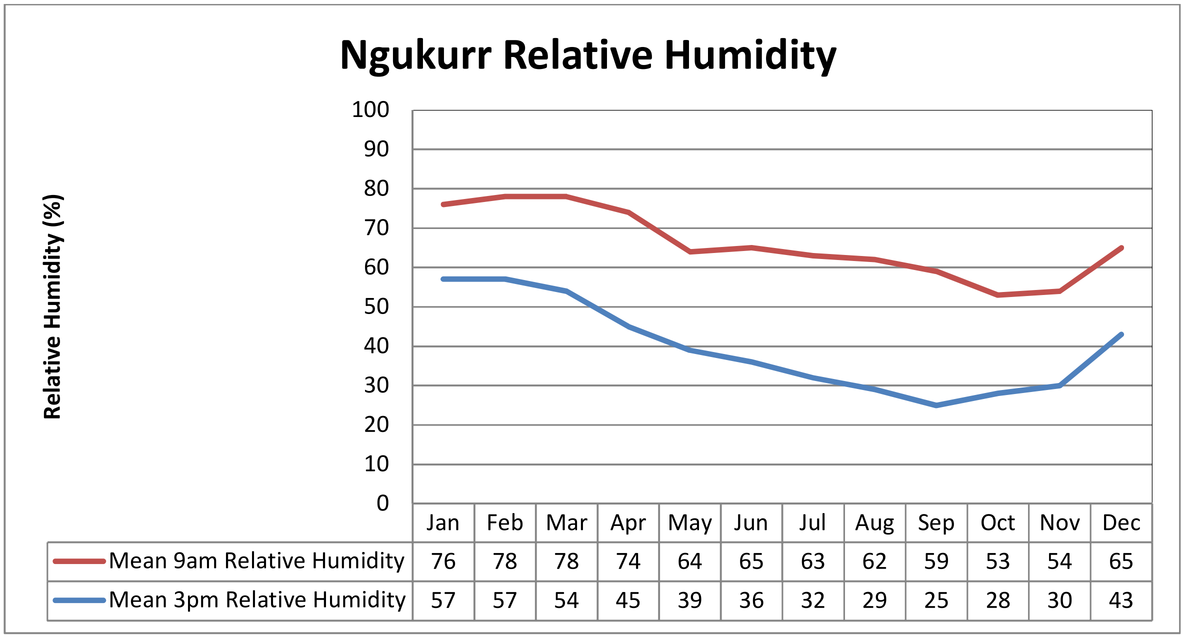
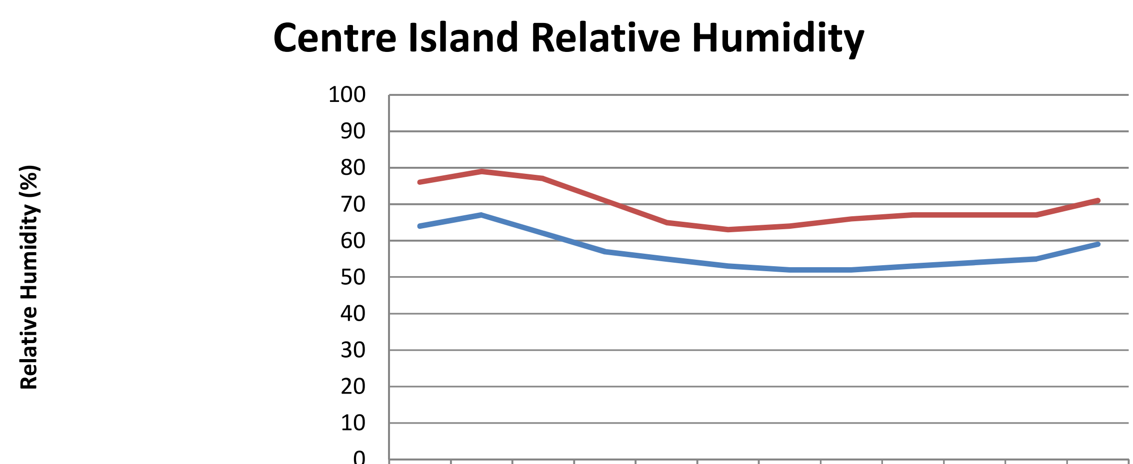


Figure 7-8 – Mean relative humidity Ngukurr 1962 – 2010 (BOM, 2012)

The mean relative humidity at Centre Island shows less variation when compared to the Ngukurr observations. Average relative humidity values at Centre Island range from 52 to 79%. Again, higher average relative humidity is observed during the wet season months with lower averages observed during the dry season months (Figure 7-8).



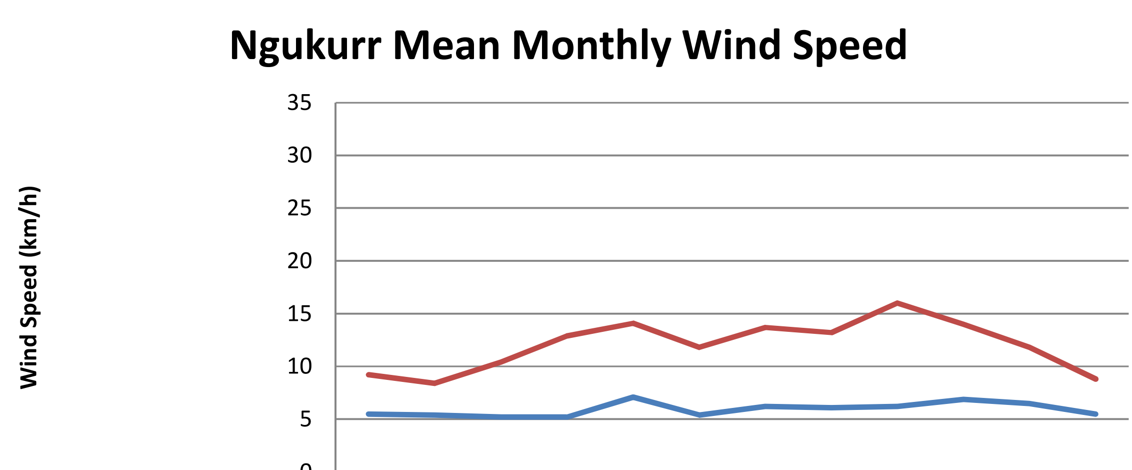
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean 9am Relative Humidity	76	79	77	71	65	63	64	66	67	67	67	71
Mean 3pm Relative Humidity	64	67	62	57	55	53	52	52	53	54	55	59

Figure 7-9 – Mean relative humidity Centre Island 1974 – 2010 (BOM, 2012)

Wind

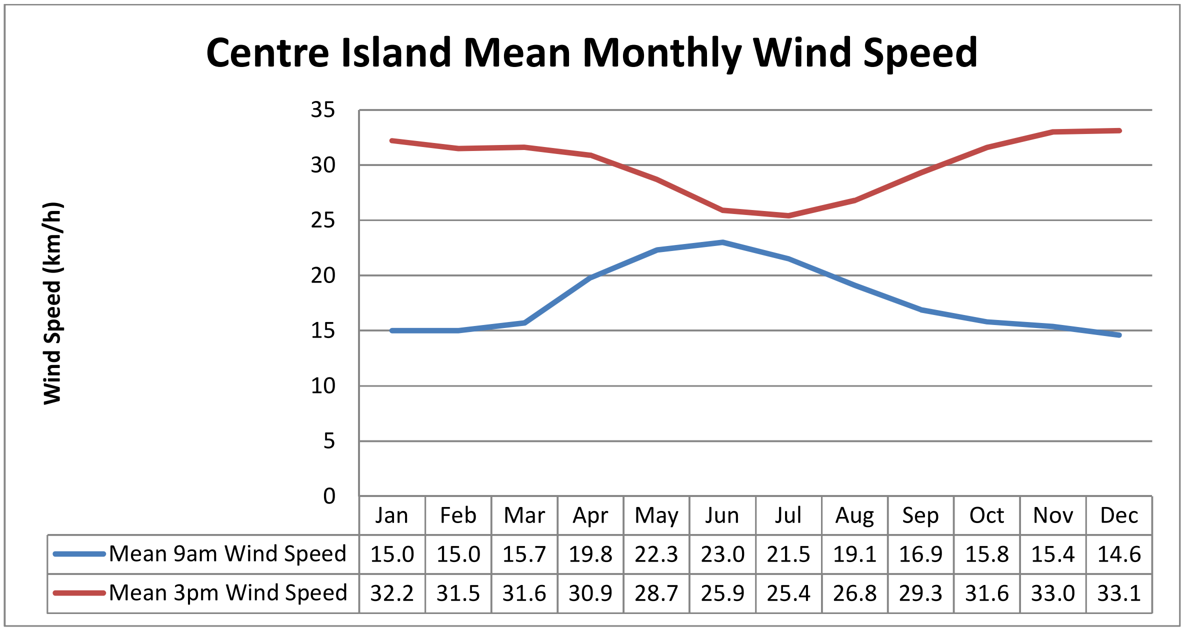
Wind speed and dominant direction plays an important role in the dispersion of dust particles. Mean monthly wind speed at Ngukurr ranges from 5.2 to 14.1km/h (Figure 7-10). Wind speeds generally display a higher maximum speed in the dry season months. Wind direction is predominantly South-East in the morning (Figure 7-12) and Easterly in the afternoon (Figure 7-13).

Centre Island is subject to greater average wind speeds with figures ranging from 14.6 to 33.0km/h (Figure 7-11). Greater variation in wind speeds between 9am and 3pm at Centre Island occur during the wet season months. Morning wind direction is generally South East (Figure 7-14) and changes to North East in the afternoon (Figure 7-15).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean 9am Wind Speed	5.5	5.4	5.2	5.2	7.1	5.4	6.2	6.1	6.2	6.9	6.5	5.5
Mean 3pm Wind Speed	9.2	8.4	10.4	12.9	14.1	11.8	13.7	13.2	16	14	11.8	8.8

Figure 7-10 – Mean monthly wind speed (km/h) Ngukurr 1962 – 2010 (BOM, 2012)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean 9am Wind Speed	15.0	15.0	15.7	19.8	22.3	23.0	21.5	19.1	16.9	15.8	15.4	14.6
Mean 3pm Wind Speed	32.2	31.5	31.6	30.9	28.7	25.9	25.4	26.8	29.3	31.6	33.0	33.1

Figure 7-11 – Mean monthly wind speed (km/h) Centre Island 1974 – 2010 (BOM, 2012)

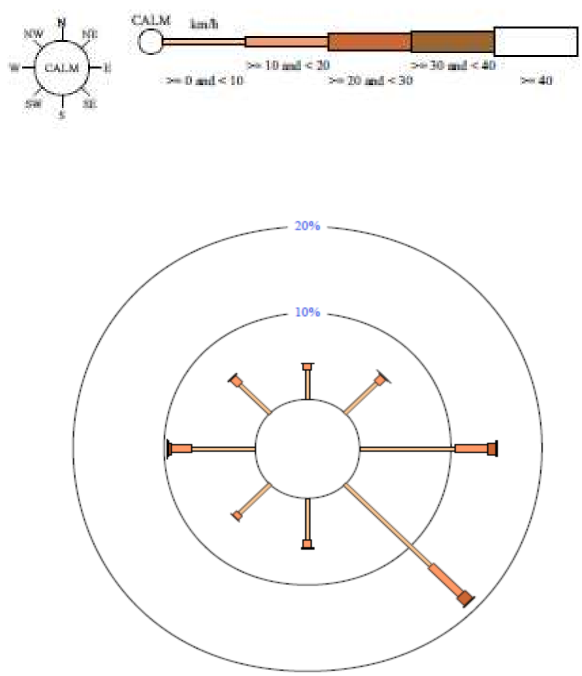


Figure 7-12 – Ngukurr 9am Rose of Direction versus Wind Speed in km/h (1962 to 2010)

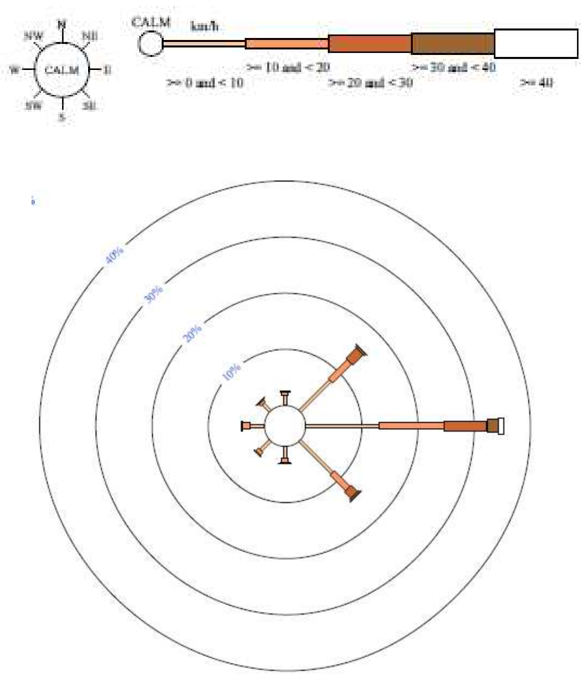


Figure 7-13 – Ngukurr 3pm Rose of Direction versus Wind Speed in km/h (1962 to 2010)

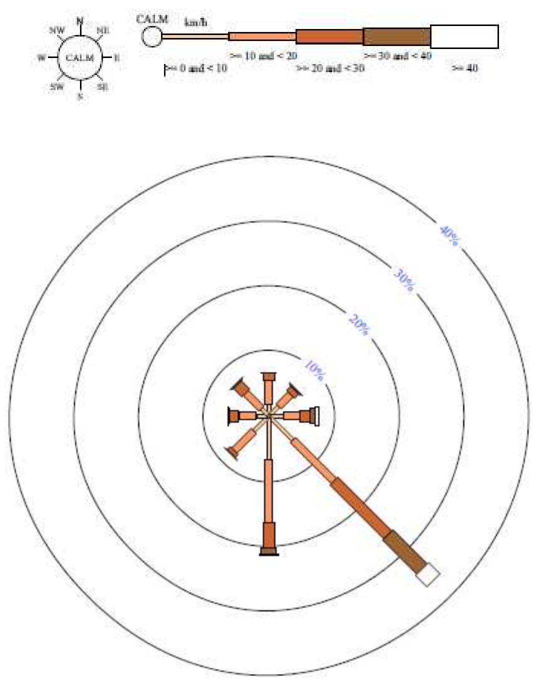


Figure 7-14 – Centre Island 9am Rose of Direction versus Wind Speed in km/h (1974 to 2010)

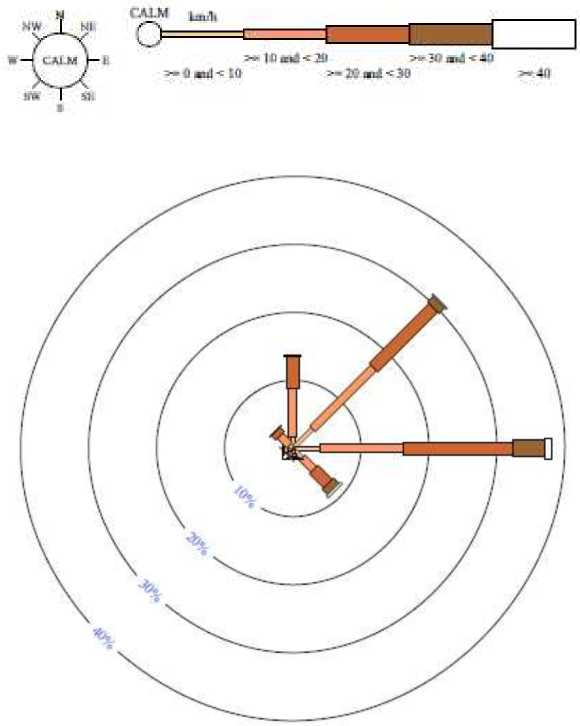


Figure 7-15 – Centre Island 3pm Rose of Direction versus Wind Speed in km/h (1974 to 2010)

7.2.2 Climate Extremes

Temperature Inversions

A temperature inversion is a layer of the atmosphere where temperature increases with height, rather than the normal temperature decrease with height. A temperature inversion creates a confining layer that prevents dissipation of particles into the atmosphere. As a result of temperature inversions, the air can become stiller, resulting in a build-up of dust and pollutants below the inversion. Significant dust levels resultant from WDRL's Roper Bar Iron Ore Project are not anticipated, however ongoing dust monitoring will be performed to monitor dust generation, and remedial action will be taken if required.

Flooding and Tropical Cyclones

The WDRL project occurs within areas subject to tropical cyclones. Typically the cyclone period occurs from November to April. BoM cyclone tracking indicates that there have been numerous tropical cyclones across the region in the period of 1970-2004 (Figure 7-16). Proximity of the project to the coastline, particularly with regard to the Bing Bong Barge Loading Facility and Stockyard, may result in increased likelihood of high rainfall events associated with cyclonic activity. The BoM predicts that the project area is likely to be exposed to between 0.2 and 0.4 tropical cyclones per year, using information gathered over a 36 year period (Figure 7-17).

Meteorological monitoring at Ngukurr and Centre Island indicates that the highest daily recorded rainfalls are 271.5mm (02/01/1976) and 383.5mm (25/03/1973) respectively. The potential impacts of flooding will be managed specifically for each component of the project, namely the mine site, haul road and loadout and stockyard facility.

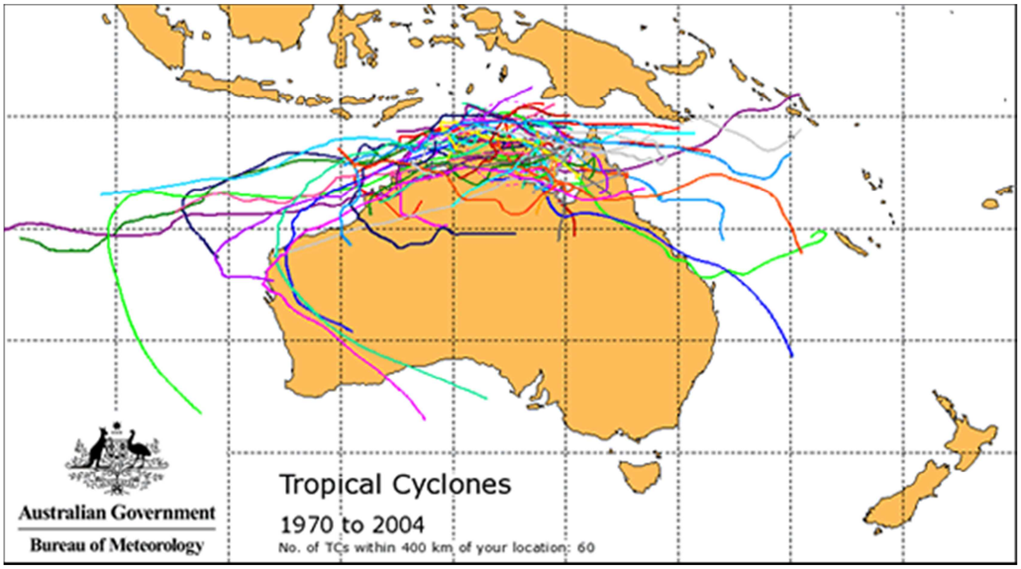


Figure 7-16 – Tropical cyclone tracks for the Northern region from 1970 – 2004

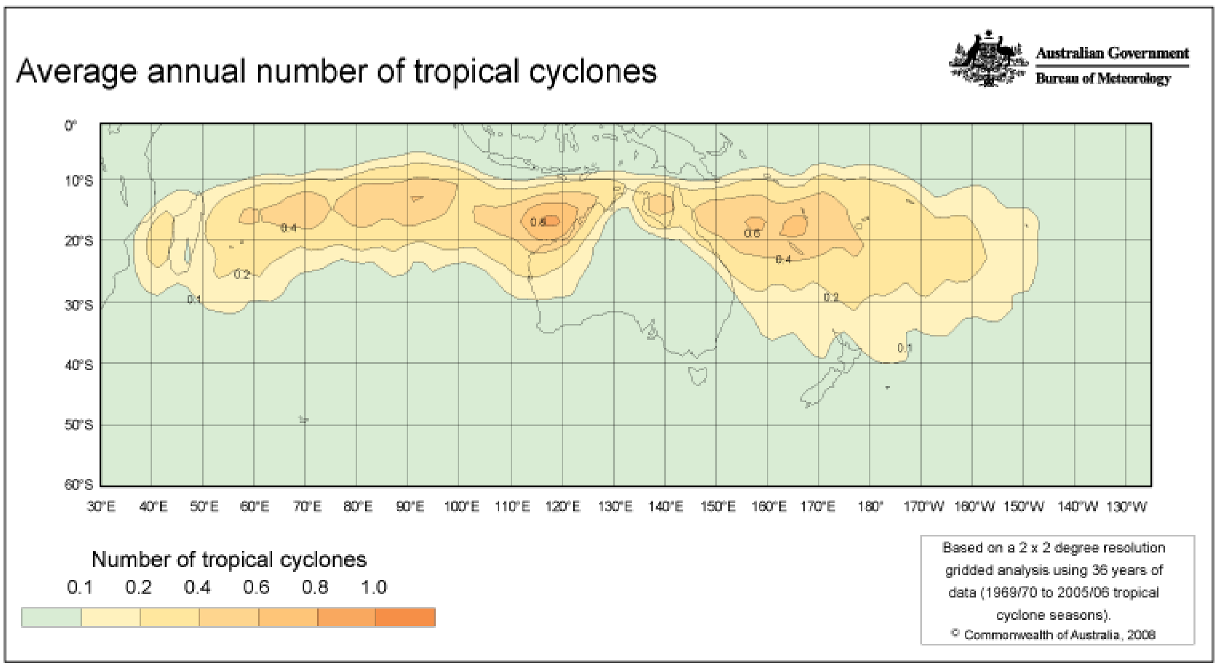


Figure 7-17 – Average annual number of tropical cyclones

Drought

The Commonwealth Department of Agriculture, Fisheries and Forests (DAFF) are responsible for assessing the impacts and severity of drought on rural and regional communities, the environment and the broader Australian economy. Exceptional circumstances (EC) events are declared for severe and rare events with prolonged impacts. EC events are declared when climate parameters including extreme temperatures are coupled with low rainfall and low soil moisture (DAFF, 2011). The wider area for the WDRL project does not occur within an EC defined area.

Climate Change Implications

Climate change in Australia has the potential to have major impacts on human and natural systems. This includes an increase in average temperatures, frequency of hot days, changes to rainfall averages and global sea level rise. Greenhouse Gas Emissions have significant impact of climate change – GHG emissions and their offsets concerning this project are discussed further in Section 7.7. The proposed annual temperature changes for the Northern Territory by 2030 are presented in Figure 7-18. Given the short lifespan of the project (8 - 10 years) it is unlikely that climate change forces will have major negative impacts on the development.

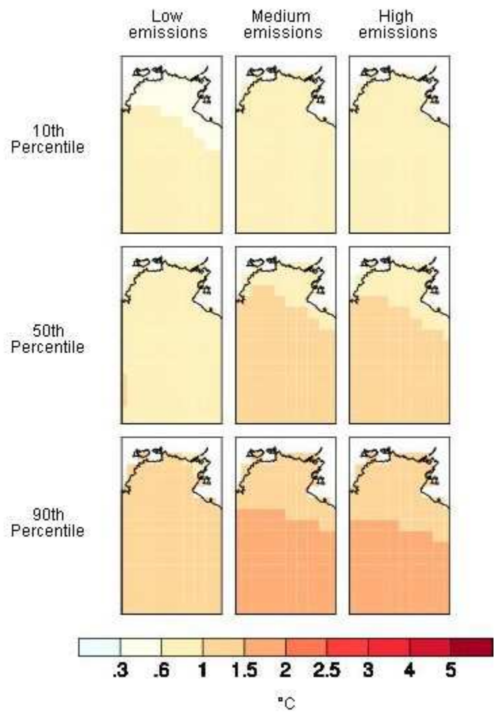


Figure 7-18 – Northern Territory Predicted Annual Temperature Change 2030.

7.3 Sensitive Receptors

The nearest sensitive areas with respect to the proposed operations of the Roper Bar Iron Ore Project are:

- The aboriginal community in Ngukurr (population of 900) located approximately 50km north-east from the mine operation area;
- An informal camping site at Towns River on Nathan River Road located approximately 15km north-east from the project area; and
- The Limmen River camp ground (within the proposed Limmen National Park), which is located near Savannah Way, approximately 2km from the proposed haul road.

The nearest sensitive receptors relative to the proposed mining areas are presented in Figure 7-19 and the nearest sensitive receptor to the haul road is presented in Figure 7-20.

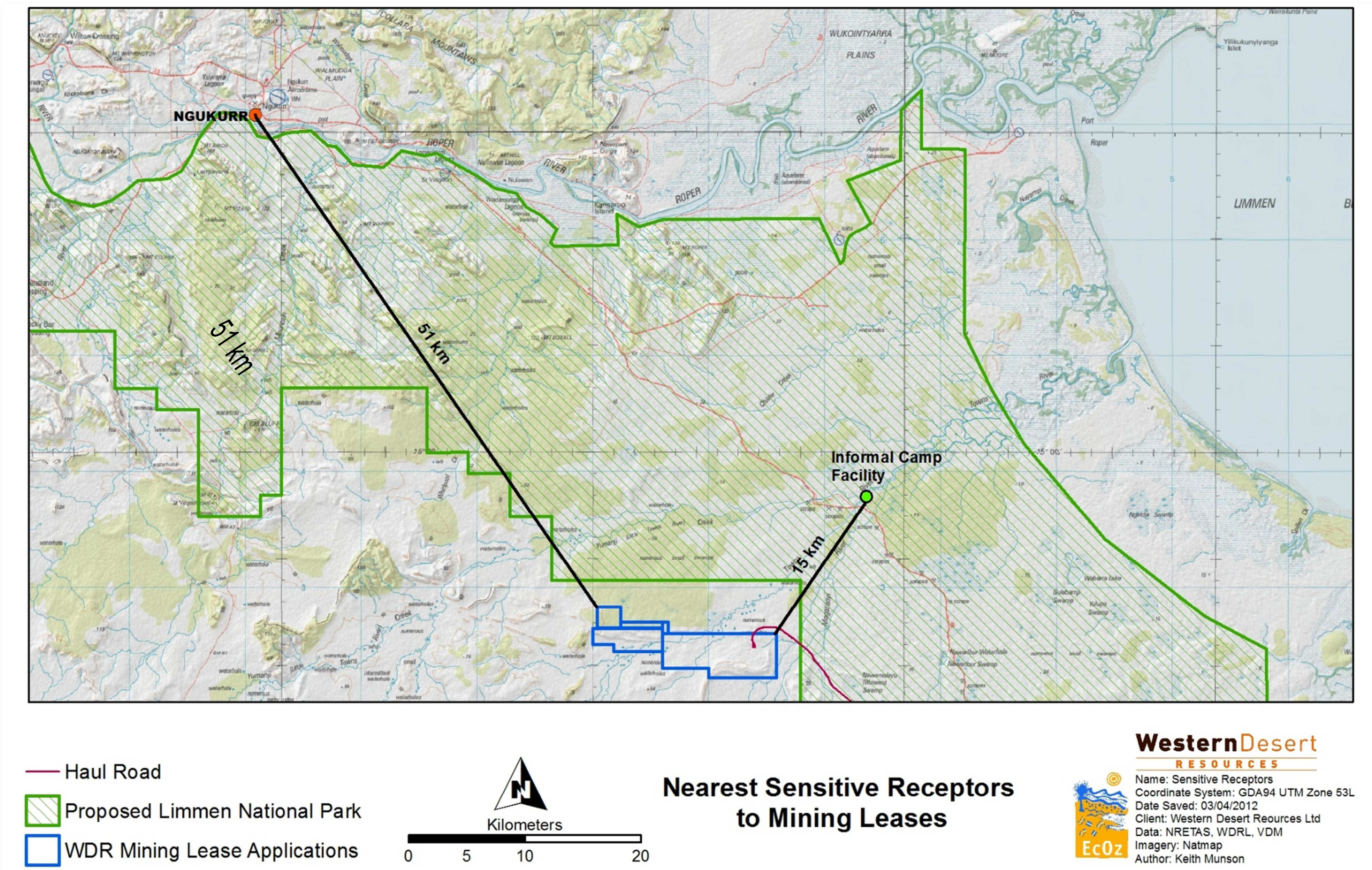


Figure 7-19 – Nearest Sensitive Receptors to Mine Site

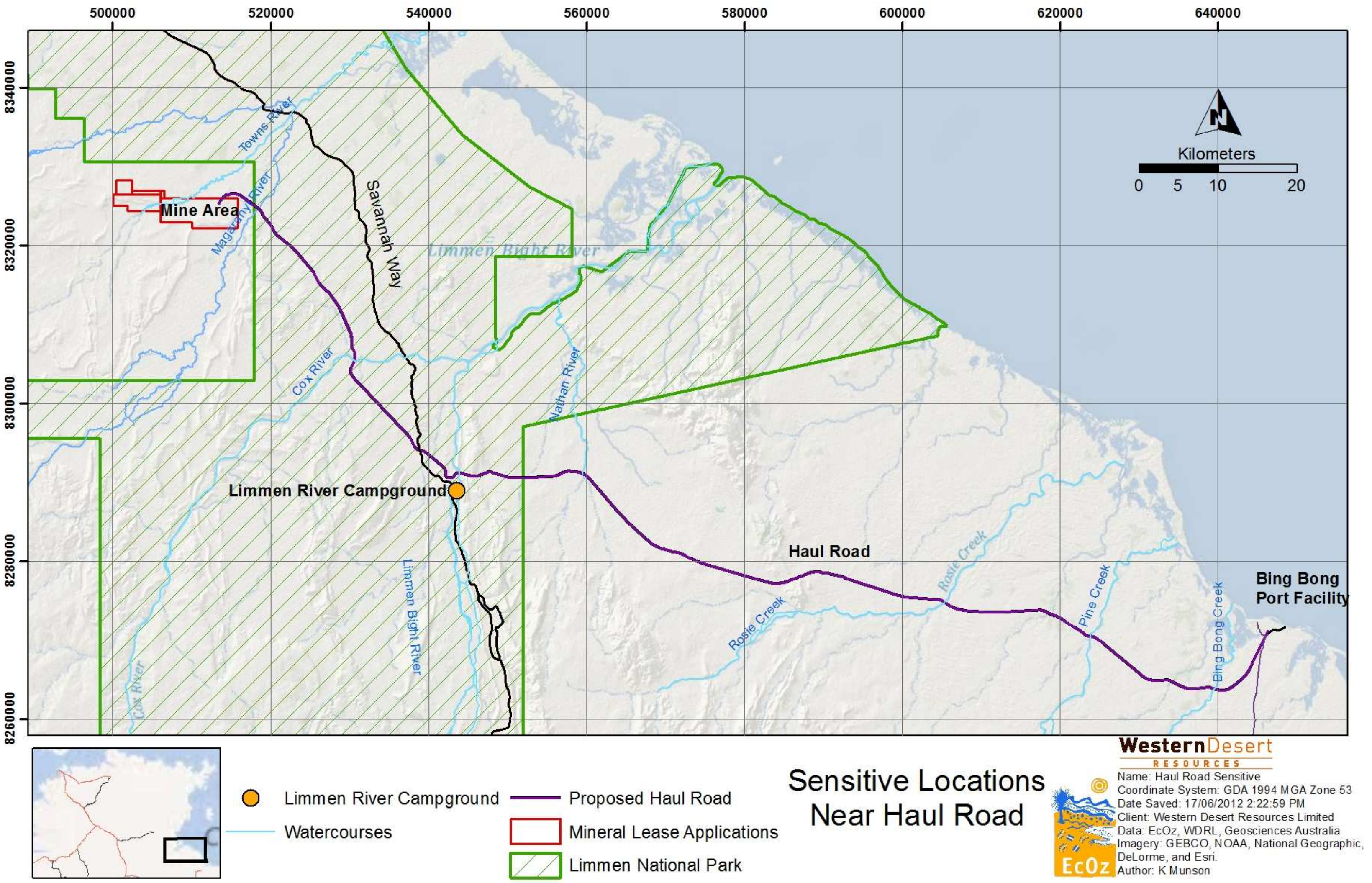


Figure 7-20 – Nearest Sensitive Places to Haul Road

7.4 Noise

Noise can be generated from a range of mining activities and machinery, including trucks, draglines, blasting, conveyors, crushing, screening and process plants. Careful management will be required to ensure that cumulative noise sources don’t impact upon nearby sensitive receptors, principally the mine camp accommodation and administration buildings.

7.4.1 Existing Noise Amenity

The existing noise amenity in the Roper Bar region is likely to be dominated by natural noise sources (e.g. birds and insects). The proposed mine is located at a minimum distance of approximately 50km from any residential areas (Ngukurr) and there are no urban, industrial or agricultural practices present that may influence the existing noise amenity.

To determine the existing noise amenity, site-specific noise measurements were carried out within the boundaries of the proposed mine site and near the Limmen River camp ground within the proposed Limmen National Park, near Savannah Way. The noise measurement locations are presented in Figure 7-21.

The noise measurement results from the proposed mine site are presented in Table 7-2 including the average or equivalent continuous sound level (L_{Aeq}) over 1 and 24 hour periods, and the L_{A90} (i.e. background noise levels).

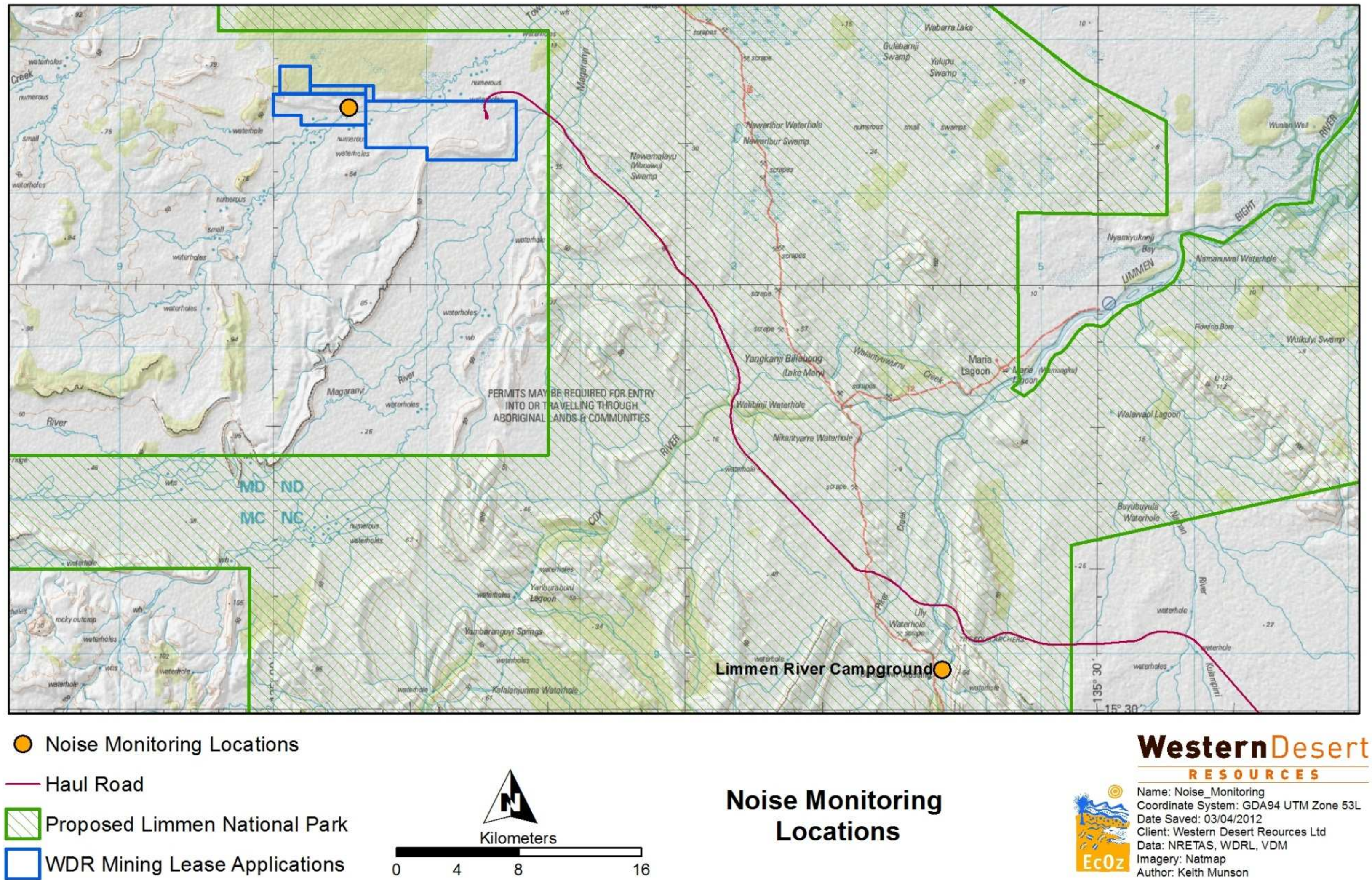


Figure 7-21 – Noise Survey Locations

Table 7-2 – Noise Measurements within the boundaries of the Mine Site

Date	L_{A90} (1-hour) [dB(A)]			L_{Aeq} (24-hour) [dB(A)]	L_{Aeq} (1-hour) [dB(A)]		
	Day	Evening	Night		Day	Evening	Night
Friday 24.02.2012	24	24	24	24	24	24	24
Saturday 25.02.2012	24	24	24	25	25	24	24
Sunday 26.02.2012	25	24	24	26	27	25	24
Median Level	**24**	**24**	**24**	**25**	**26**	**24**	**24**

L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.
L_{A90} - The noise level that is exceeded for 90% of the time under consideration (i.e. background noise level).

The results of the background noise measurements near the Limmen River camp ground at the proposed Limmen National Park are presented in Table 7-3 including the average or equivalent continuous sound level (L_{Aeq}) over 1 and 24 hour periods, and the L_{A90} (the noise levels that are exceeded for 90% of the time under consideration [i.e. background noise levels]). Note that these measurements were taken during the wet season, when the area is inaccessible and no visitors were present. However, given the small size of the campground, background levels are not expected to differ markedly during periods of visitation.

Table 7-3 – Noise Measurements – Limmen River Camp Ground (Limmen National Park)

Date	L_{A90} (1-hour) [dB(A)]			L_{Aeq} (24-hour) [dB(A)]	L_{Aeq} (1-hour) [dB(A)]		
	Day	Evening	Night		Day	Evening	Night
Thursday 8.03.2012	24	24	24	24	25	24	24
Friday 9.03.2012	24	-	-	25	25	-	-
Median Level	**24**	**24**	**24**	**25**	**25**	**24**	**24**

L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.
L_{A90} - The noise level that is exceeded for 90% of the time under consideration (i.e. background noise level).

The background noise measurement results are very low at both the proposed mining camp and Limmen River Camp Ground, indicating that the noise amenity of this remote outback area is unaffected by nearby development.

7.4.2 Noise Sources

The proposed Roper Bar Iron Ore Project will introduce a number of activities with a potential to generate significant noise emissions. The activities with the highest potential for noise generation are as follows:

- Iron ore extraction;
- Processing;
- Haulage;
- Operation of the airstrip and associated increased air traffic in the area; and

- Accommodation and recreation.

Each of these activities can generate varying levels of noise, with the potential impacts mainly limited to any noise-sensitive areas in the vicinity of each of these activities. The other factors that influence the potential noise impact are the hours of operation, the number of plant and equipment and the sound power level of the dominant noise sources associated with each activity.

Based on the operational plan, mining activities at the Roper Bar Iron Ore Project will be conducted continuously 24 hours per day for around 325 days per year. Iron Ore will be transported along the 165km haul road to a load out facility (2-3km from the coast) at Bing Bong, where the mineral will be stockpiled.

It is anticipated that the duration of the project will be 8 to 10 years.

The dominant noise sources associated with the proposed Roper Bar Iron Ore Project are presented in Table 7-4.

Table 7-4 – Dominant Noise Sources

Activity	Noise Source Description	Quantity
Extraction	Excavator	2
	Dozer	2
	Dump trucks	10
	Graders	2
	Water Truck	2
	Service Truck	1
	Drill	6
	Light Vehicles	20
	Ancillary Equipment	10
Processing	Primary Crusher	1
	Secondary Crusher	1
	Screens	1
	Front end loaders	1
	Dump trucks	10
	Road Trains	3
	Power generator	1
	Pumps	5
	Parking Area	1
Haulage	Road Trains	10
Accommodation & Recreation	Power Generators	2
	Transformers	3
	Beer Garden	1
	Swimming Pool	1
	Sports Court	1
	Parking Area	1
Airstrip	Aircraft (Brasilia EMB 120)	1
	Aircraft (Brasilia M23)	1
	Aircraft (ERJ 170)	1

7.4.3 Noise Criteria

Under Northern Territory Government Legislation, environmental noise (inclusive of vibration) is considered a form of pollution and it is regulated under the *Waste Management and Pollution Control Act*.

The Act is not prescriptive in regards to the specific criteria to be used in the implementation of the Environmental Protection Objectives. Consequently, noise and vibration criteria from national or international standards or from environmental legislation from other states in Australia are used in specific acoustic investigations.

For the purposes of this EIS, the acoustic quality objectives from the Queensland *Environmental Protection (Noise) Policy 2008 (EPP [Noise])* is considered the most appropriate noise criteria. These criteria are well-established and tested on numerous environmental noise impact assessments for similar projects, therefore it is considered highly relevant to the proposed Roper Bar Iron Ore Project.

The purpose of the acoustic quality objectives as defined in the EPP (Noise) is to protect the amenity of an acoustic environment. In the case of dwellings, the indoor daytime and evening noise limits protect the ability to have a conversation while the indoor night-time noise limits address sleep disturbance and sleep awakening. The EPP (Noise) also states that acoustic quality objectives for protected habitats (i.e. those identified in a conservation plan under the *Nature Conservation Act 1992*) as a qualitative criteria, should be considered for the protection of health and biodiversity of ecosystems (mainly fauna protection).

Table 7-5 presents the relevant acoustic quality objectives for the Roper Bar Iron Ore mining project including the average or equivalent continuous sound level (L_{Aeq}) over a 1 hour period, and the L_{A10} and the L_{A1} (i.e. the noise levels that are exceeded for 1 and 10% over a specified 1 hour period).

Table 7-5 – Acoustic Quality Objectives

Location	Time of Day	Acoustic Quality Objectives (measured at the receptors) dB(A)			Environmental Value
		L_{Aeq} (1 hour)	L_{A10} (1 hour)	L_{A1} (1 hour)	
Dwelling (outdoors)	Day & Evening	50	55	65	Health and wellbeing for outside areas
Dwelling (indoors)	Day & Evening	35	40	45	Health and wellbeing for indoor areas
	Night	30	35	40	Health and wellbeing in relation to the ability to sleep

L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.
L_{A1} - The noise levels that are exceeded for 1% of each sample period.
L_{A10} - The noise levels that are exceeded for 10% of each sample period.

7.4.4 Sound Plan Noise Calculation Areas

The operational noise propagation modelling for the activities at the Roper Bar Iron Ore Project utilised the digital terrain model (DTM) developed for the mine site.

Considering the significant distance to the residences and areas of temporary human habitation at Ngukurr and Towns River respectively, the calculated noise levels at these noise-sensitive places external to the mine site are very low and fully compliant with the requirements of EPP (Noise).

To address more localised impacts on noise-sensitive areas within the boundaries of the mine site, detailed noise propagation modelling was undertaken focussing on three distinctive noise calculation areas as follows:

- Noise impacts within the accommodation area;
- Noise impacts from extraction activities on the accommodation area; and

- Noise impacts within the processing area.

The noise calculation area considered for the accommodation & recreation activities (accommodation area) is presented in Figure 7-22.

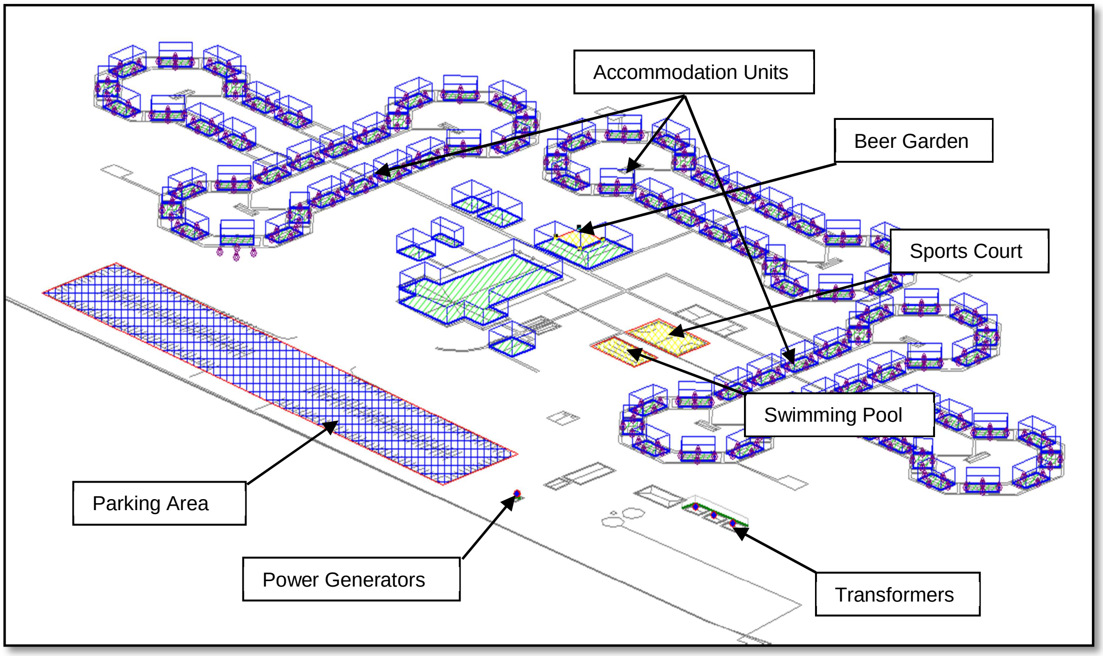


Figure 7-22 – Noise Propagation Model – Accommodation Area

The noise calculation area considered for the potential noise impact from the extraction activities on the residential camp is presented in Figure 7-23.

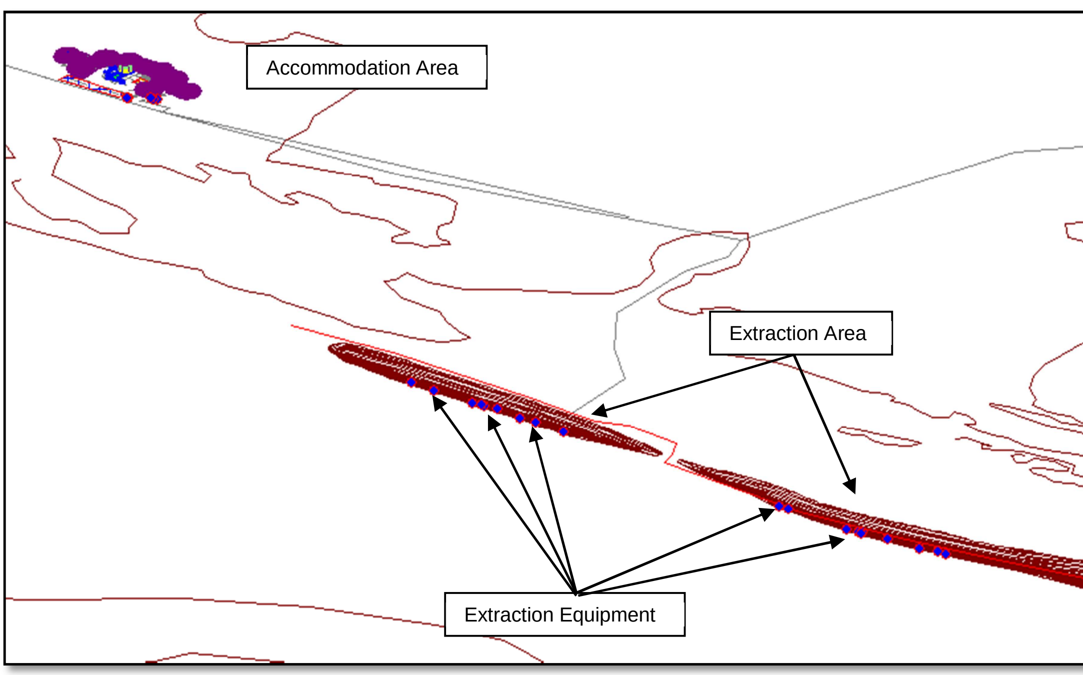


Figure 7-23 – Noise Propagation Model – Extraction Area Relative to Accommodation Area

The noise calculation model for the processing area is presented in Figure 7-24

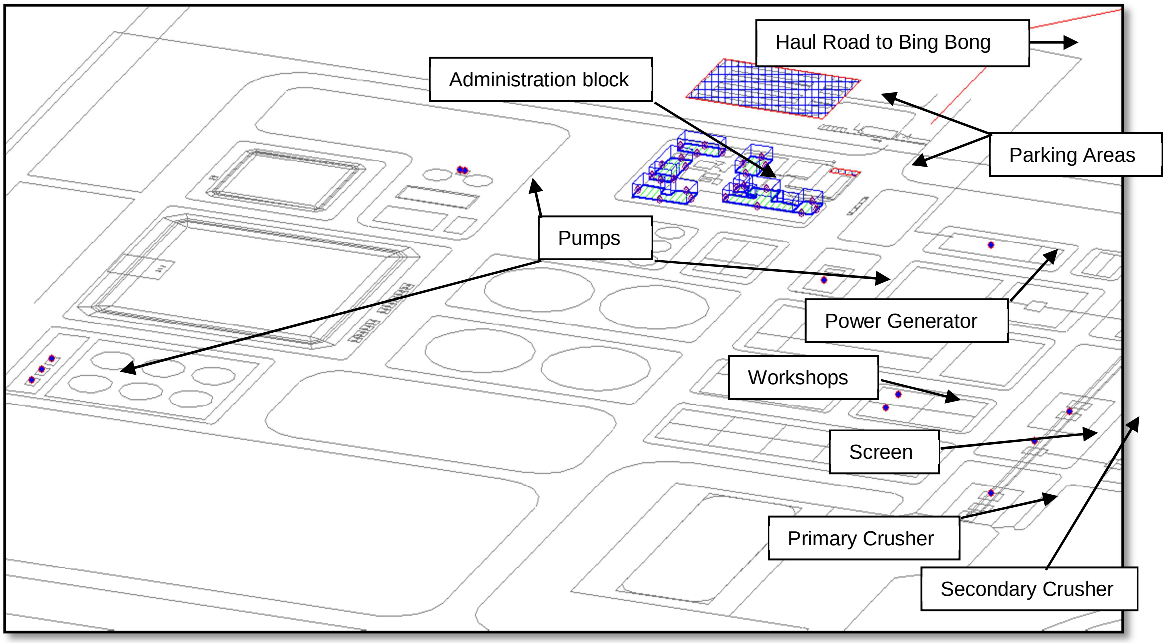


Figure 7-24 – Noise Propagation Model – Processing

Noise Calculation Results

The noise propagation modelling results for the most affected units within the accommodation area during day-time and evening are presented in Table 7-6 and in Appendix M (Noise and Vibration Technical Report).

Table 7-6 – Accommodation Area - Noise Modelling Results – Daytime/Evening

Unit	Calculated $L_{Aeq, 1\text{-}hour*}$ dB(A)	Indoors Noise Criteria $L_{Aeq, 1hour*}$ dB(A)	Recommended Noise Control
Unit 55 (South West)	41	35	Acoustic Design as per AS3671-1989
Unit 62 (East)	37		

**Façade adjusted to account for noise reflection from buildings.*
L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.

The noise propagation modelling results for the most affected units within the accommodation areas during night-time (before 7:00am and after 10:00pm) are presented in Table 7-7 and in Appendix M (Noise and Vibration Technical Report).

Table 7-7 – Accommodation Area - Noise Modelling Results – Night-time

Unit	Calculated $L_{Aeq, 1\text{-}hour*}$ dB(A)	Indoors Noise Criteria $L_{Aeq, 1hour*}$ dB(A)	Recommended Noise Control
Unit 55 (South West)	41	30	Acoustic Design as per AS3671-1989
Unit 56 (East)	33		
Unit 57 (South East)	32		
Unit 62 (East)	37		

**Façade adjusted to account for noise reflection from buildings.*
L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.

The noise propagation modelling results for the administration building located within the processing area is presented in Table 7-8 and in Appendix M (Noise and Vibration Technical Report).

Table 7-8 – Processing Areas - Noise Modelling Results – Daytime/Evening

Office Block	Calculated $L_{Aeq,\ 1\text{-}hour*}$ dB(A)	Recommended Noise Control
Admin Office (South)	66	Acoustic Design as per AS3671-1989 to comply with the internal noise criteria from AS2107-2000
Canteen (East)	63	
EHS Office (East)	62	
Engineering Office (west)	59	
Fire Station (East)	62	
Medical Centre (South)	61	
Metallurgical Laboratory (East)	65	
Training Room (South)	67	

**Free-field conditions (i.e. measurement is taken outside building).*
L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.

The noise propagation modelling results for the Limmen River camp ground within the Limmen National Park (near Savannah Way), located at a distance of 2km away from the haul road, during day-time and evening, are presented in Table 7-9 and in Appendix M (Noise and Vibration Technical Report).

Table 7-9 – Limmen River Camp Ground (Limmen National Park) – Daytime/Evening

Location	Calculated $L_{Aeq,\ 1\text{-}hour*}$ dB(A)	Indoors Noise Criteria $L_{Aeq,\ 1hour*}$ dB(A)	Recommended Noise Control
Camping Ground (Limmen National Park)	29	35	N/A

**Free-field conditions (i.e. measurement is taken outside building).*
L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.

The noise propagation modelling results for the same camping ground within the Limmen National Park, during night-time (before 7:00am), are presented in Table 7-10 and in Appendix M (Noise and Vibration Technical Report).

Table 7-10 – Limmen River Camp Ground (Limmen National Park) – Night-time

Location	Calculated $L_{Aeq,\ 1\text{-}hour*}$ dB(A)	Indoors Noise Criteria $L_{Aeq,\ 1hour*}$ dB(A)	Recommended Noise Control
Camping Area	29	30	N/A

**Free-field conditions (i.e. measurement is taken outside building).*
L_{Aeq} - A-weighted equivalent sound pressure level (or average noise measurement) for a given period.

Aircraft Noise Levels

The proposed runway is located within the boundary of the mine site at a distance of more than 1km from the nearest residential units at the accommodation area. The elevation difference between the proposed runway and the accommodation area is 5m. A land-height correction factor from Table 7-11 in AS2021 – 2000 was used to correct the coordinate distances.

Coordinate distances are distances from the relevant points on the alignment of the airport runway to the nearest point on the noise sensitive object (e.g. individual dwelling) or an area (e.g. layout of existing or proposed development, in this case the mine accommodation camp).

There are three (3) distance coordinates:

- DS - Distance in metres from the dwelling or area under investigation (noise sensitive area) to the extended runway centreline. It represents the lateral distance (or sideline projection) of the noise sensitive area relative to the alignment of the runway as an indication of the direction in which planes land and take-off;
- DL - Distance in metres from the closer end of the runway to the intersection of the extended runway centre-line and the location of the nearest point at the noise sensitive area. It represents the distance from the nearest end of the runway to the nearest dwelling or noise sensitive area. This indicates the distance from the point where the planes will land on arrival to the runway; and
- DT - Distance in metres from the further end of the runway to the intersection of the runway centre-line and the location of the nearest point at the noise sensitive area. It represents the distance from the furthest end of the runway to the nearest dwelling or noise sensitive area. This indicates the distance from the point where the planes will take-off on departure from the runway.

The nearest unit is located at a distance of 1,320m to the north-east relative to the centreline of the proposed runway (DS or lateral distance) (Refer to Figure 7-3). The alignment of the nearest unit in north to south direction is 902m from the southern end of the runway and (DL distance from the closest end of the runway) and at a distance of 2,503m (DT) from the northern end of the runway.

The Distance Coordinates are used to determine the noise level associated with different types of aircraft (Boeing, Airbus, British Airspace, SAAB, Fokker, Corporate Jets and Light Aircraft) depending on the type of planes arriving at the airport under investigation and the direction of take-off or landing on the runway.

Considering the lateral (DS) distance from the proposed runway relatively low aircraft noise levels are expected at the nearest residence.

The location of the nearest residential unit at the accommodation area relative to the centreline of the proposed runway and the resulting maximum aircraft noise levels are presented in Table 7-11.

Table 7-11 – Distance Coordinates and Aircraft Noise Levels

Coordinates	Difference in Elevation	Aircraft Noise Level dB(A)	
DT = 2,503m	5m	Aircraft**	dB(A)*
DL = 902m		Light Aircraft – Take off (Due North)	59
DS = 1,320m			

**Table 3.23 of AS2021 – 2000*

7.4.5 Impact Assessment

The proposed mining activities will introduce additional noise from the plant and equipment at the mine site, processing plant and along the haul road. There will also be additional noise associated with increased aircraft traffic to the area.

Although the noise emissions from the mining equipment can be significant, the distance to the nearest residential areas will ensure inaudibility of the operational noise sources at the Roper Bar region and its surroundings.

With separation distances to the nearest residential areas exceeding 15km, it was expected that the operations at the Roper Bar Iron Ore Project will not cause impact on the existing noise amenity at residential areas.

It should be noted that all of the sensitive receptors are located significant distances from the mine site and are unlikely to be affected by noise, vibration or air quality emissions from the proposed Roper Bar Iron Ore Project. In this case, the localised impacts on sensitive areas (e.g. accommodation area and administration buildings) within the boundaries of the mine site are of primary concern because of the implications for the staff members who work and temporarily reside within the boundaries of the mine site.

The noise propagation modelling results indicate that the detailed design of the accommodation area has to consider the potential noise impact on individual accommodation buildings, to ensure compliance with the internal noise criterion of 35dB(A)$L_{eq(1\text{-hour})}$ for day-time and evening and 30dB(A)$L_{eq(1\text{-hour})}$ for night-time.

Of particular concern is the potential noise impact from the power generators located at the mine camp site. A number of management and mitigation measures have been proposed below to ensure that there are negative noise impacts on accommodation areas from generators are minimised.

The haul route noise emissions were modelled as a line source, with up to 10 road-train movements in 24 hours (during Phase 1 there will be 4 return trips or 80 total road-train movements in 24 hours). This is proposed to increase during Phase 2 (up to 160 movements per day). The proposed 165km haul road traverses uninhabited areas, with the only noise-sensitive place being the Limmen River camp ground within the proposed Limmen National Park.

The alignment of the proposed haul road passes at a distance of approximately 2km from the Limmen River Camp Ground. The noise propagation modelling results, considering a conservative number of road train movements, indicate full compliance with the Queensland *Environmental Protection (Noise) Policy 2008 (EPP [Noise])* criteria for the camping ground. Consequently, the haul road noise emissions are unlikely to cause nuisance to the people using the Limmen River camp ground in the proposed Limmen National Park.

The proposed runway is a potential noise source that has to be considered in the overall noise impact assessment. The primary concern with the aircraft arrival and departure on the proposed runway is the impact on the accommodation area.

The predicted maximum aircraft noise level at the nearest residential unit at the accommodation area is 59dB(A). The flight frequency will be low, with a maximum of one daily flight, during the day-time only. In context of the relevant criteria contained within Australian Standard AS2021-2000, predicted maximum aircraft noise levels less than 80dB(A) at the nearest residence. The accommodation area of the Roper Bar Iron Project is therefore considered 'acceptable' under AS2021-2000 and is unlikely to be affected by intrusive aircraft noise. Whilst audible in a quiet rural environment, the expected maximum aircraft noise levels are unlikely to be perceived as intrusive outside or inside the residential units. There will be no requirement for specific acoustic design to any of the units at the accommodation area to attenuate aircraft noise emissions.

Potential operational noise on fauna must also be considered. The haul road will not traverse any critical habitat for threatened or species of conservation significance. Whilst noise-sensitive species (particularly birds) are likely to suffer displacement as a result of the haul roads construction and operation, there is considered to be large areas of adjacent suitable habitat to which they may migrate to. Other less noise-sensitive species will likely remain in the haul road corridor.

The noise control measures to protect the noise amenity at the individual units within the accommodation area, the administration building at the processing area and the fauna habitats are included below and in the Environmental Management Plan (EMP) for Noise Amenity (Appendix C). These will be fully implemented in the detailed design and establishment of the facilities of the mine, so operational noise emissions will not impose any further constraints on the proposed Roper Bar Iron Mine Project.

7.4.6 Noise and Vibration Mitigation Measures

To protect the noise-sensitive areas within the boundaries of the accommodation area and administration building at the processing plant, noise control measures will be implemented, such as:

- Maintaining of maximum practicable distance between major noise sources (e.g. power generators, crushers, etc)and noise-sensitive areas;
- Use of non-sensitive (e.g. maintenance or storage) buildings as screens between power generators and accommodation units;
- Use of natural acoustic barriers (e.g. elevated terrain) between noise sources and the accommodation area;
- Utilising acoustically attenuated power-generators (i.e. use of soundproofing and/or noise abatement devices around the power generators);
- Installing of vibration dampening devices or materials around the primary sources of vibration; and
- Acoustic design of the building envelopes of the accommodation units as per the requirements of AS3671-1989 and AS2107-2000.

In addition to the above environmental noise control measures, all the operations at the Roper Bar Iron Ore Project will comply with the National Standard for Occupational Noise (NOHSC: 1007(2000)). Hearing protection equipment will be made available and utilised in areas where engineering noise control measures are deemed inappropriate or ineffective.

To minimise potential noise impact on fauna habitats the following noise control measures will be implemented, such as:

- Minimising the extent of the pit to reduce physical loss of habitat and noise impact beyond the boundary of the mining face;
- Minimise idle operation of any plant and equipment to reduce duration of noise emissions;
- Maintenance of the noise reduction systems (mufflers or attenuators) on any mobile or stationary plant to reduce noise emissions;
- Scheduling of operations to prevent concentration of mobile and stationary plant at the same location;
- Use of stockpiles as a form of noise attenuation barriers by locating any stationary plant behind the stockpiles; and
- Use of broadband reversing alarm systems to reduce extent of impulsive noise.

7.5 Vibration

Vibration associated with mining projects is of potential concern as it can cause disruption to existing residents/businesses, annoyance to humans, and possible structural damage to buildings. Effects of vibration are dependent on distance from the source, soil type, and susceptibility ratings of structures.

7.5.1 Vibration Criteria

As the Northern Territory *Waste Management and Pollution Control Act* does not prescribe specific noise & vibration limits, the criteria adopted for the Roper Bar Iron Ore Project are based on Queensland guidelines. In 2006, the Queensland Government issued guidelines specifying the recommended human comfort criteria for:

a) *Airblast overpressure level;*

  b) *Ground vibration peak particle velocity; and*

  c) *Times of blasting.*

These guidelines were specifically developed in order to set appropriate criteria in the development approval conditions for activities such as mines and quarries.

Airblast overpressure is the pressure resulting from the blast wave of the explosion, also known as a high energy impulse noise as a result of explosive detonations. Exposure to the blast waves can result in injury to hollow organ systems such as auditory, respiratory and gastrointestinal systems (Elsayed & Gorbunov 2006).

The following criteria are applicable to airblast overpressure:

  a) *The airblast overpressure must not be more than 115dB(linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and*

  b) *The airblast overpressure must not exceed 120dB(linear) peak for any blast.*

The following criteria are applicable to vibration:

  a) *The ground-borne vibration must not exceed a peak particle velocity of 5mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and*

  b) *The ground-borne vibration must not exceed a peak particle velocity of 10mm per second for any blast.*

Times of Blasting

Queensland blasting guidelines specifies blasting should generally only be permitted during the hours of 9:00am to 3:00pm, Monday to Friday, and from 9:00am to 1:00pm on Saturdays, and that blasting should not generally take place on Sundays or public holidays. However, given the remoteness of the project operation, these restrictions are not considered to be required.

7.5.2 Consideration of Potential Ground Vibration

The iron ore extraction will be mainly carried out by conventional truck and shovel equipment. A large portion of the ore body is classified as low strength to soft and will be removed by hydraulic excavators. Blasting will be applied for the removal of hard rock intervals or for rock conditioning, if required by surface mining machines. Any blasting will be conducted in accordance with the conditions of approval.

The operation of mobile mining equipment (e.g. bulldozers, excavators and trucks) and static plant (e.g. power generators, pumps, crushing and screening equipment) will create localised ground vibration. However, any ground vibration caused by the operation of the plant and equipment will be readily attenuated by the resilient properties of the soil.

It is difficult to predict impacts of blasting (airblast overpressure and ground vibration) due to the fact that every site has different characteristics. Considering the significant distance to the accommodation area (the only vibration-sensitive area within a distance of more than 2km from the extraction area) further investigation of ground vibration will not be required.

The ground vibration will have localised significance, similar to airborne noise, because of its potential to cause disturbance to ground-based fauna. The vibration from blasting has the potential to temporarily disrupt normal fauna behaviours, although there are other factors (e.g. land clearing) with more immediate pronounced effects than any occasional short duration localised vibration effects.

Considering the significant distance to any residential areas, the potential impact of ground vibration in the project area and its surroundings is not considered to be significant.

7.6 Air Quality

Dust, odour and other gaseous emissions which are generated on a mine site have the potential to affect air quality in the vicinity of the mine site and any nearby sensitive receptors.

It should be noted that at the time of compiling this document, no baseline air quality (dust monitoring) or impact assessments have been undertaken, given that such assessments will need to be undertaken during the dry season. The air quality impact assessment will be undertaken in the 2012 dry season, prior to the commencement of mining activities refer below for the proposed scope of works.

The following sections present expected baseline conditions, potential dust generation mechanisms, potential odour sources and other air quality indicators. Also presented is a planned program for future air quality impact assessment and preliminary monitoring and mitigation measures.

7.6.1.1 Baseline Air Quality

The ambient air quality in the vicinity of the project is anticipated to be excellent except for dust generation in the vicinity of unsealed roads and periodic impacts from bushfires.

There is no permanent air monitoring station in close proximity to the mining leases and no significant land uses within the region are expected to impact on the existing air quality, as there are no industrial or urban developments in the vicinity of the mine. Xstrata Zinc undertake air quality monitoring using depositional dust gauges at their McArthur River mine operations, including at the mine site and at the Port of Bing Bong (see below). There is no SO_2 and NO_2 monitoring data for the wider region. Monitoring at the McArthur River mine site indicates that generally, measured dust levels are within stated guidelines (McArthur River Mining 2012) and McArthur River mine operations are not expected to be having a measureable impact upon air quality in the vicinity of the proposed WDRL mine.

The potential mechanisms that may impact on air quality at the mine site and the Port of Bing Bong are reviewed below.

7.6.2 Review of Potential Air Quality Emissions

The following section reviews the potential for air quality emissions associated with the project.

Potential Mechanisms of Dust Generation

The main particulate emission associated with all phases of the Roper Bar Iron Ore Project will be dust. Dust emissions during establishment, operation and rehabilitation of the proposed Roper Bar Iron Ore Project are of primary concern in relation to potential air quality impacts.

The potential dust emissions from the proposed mine will be dependent on the total disturbed area subject to vegetation clearance, the area of active extraction (the pit), the total area of stockpiles and the length and frequency of use of unsealed tracks (the haul route is planned to be sealed).

The major sources of dust will be construction and operational activities such as earth moving; trenching; padding; backfill operations and open stockpiles. Dust emission sources are expected to include blasting, front-end loading of material to trucks, graders, scrapers, dozers, excavators, dumping of material from trucks to stockpiles, loading and unloading of stockpiles to conveyors, transport of material such as topsoil, cleared vegetation, and overburden, wind erosion from any recently cleared areas, ore and overburden stockpiles, and other sources.

There are two main mechanisms of fugitive dust generation associated with mining activities: pulverisation and abrasion of surface materials by application of mechanical force through implements (wheels, blades, etc.); and dislodgment and movement of dust particles by the action of turbulent air currents, such as wind erosion of an exposed surface by wind speed over 19km/hour (5.3m/s) (USEPA, 1995). The predominant wind direction during the dry season is the main transport mechanism for any fugitive material.

Dust has the potential to impact on several aspects of the environment, such as soil surface layers, vegetation, fauna and public amenity. These impacts include the loss of topsoil, the reduction of photosynthesis due to dust settlement, annoyance and reduced visual amenity.

From a human health perspective, research has shown that dust particles with a diameter less than 10µm (PM_{10}) and even finer particles with a diameter of less than 2.5µm ($PM_{2.5}$), are of particular concern. These small dust particles, referred to as respirable particles, can be carried deep into the lungs, where they can cause inflammation and a worsening of the condition of people with heart and lung diseases (CITEAIR, 2007). The dust emissions from extraction activities are dependent on the following factors:

- The physical characteristics of the materials handled or the surface of the operations site (e.g. the size of the area, the particulate distribution of the materials and the moisture content);
- The type and frequency of the physical activities that might result in surface disturbance (e.g. duration of the extraction activities);
- The prevailing weather conditions (such as wet or dry conditions, wind speed and direction); and
- The dust control measures implemented on the site (e.g. the implementation of an environmental management plan for fugitive dust control).

Other Particulate Emissions

Activities associated with the construction and operations of the Roper Bar Iron Ore Project are expected to result in emissions of low-levels of other air quality parameters from vehicles and equipment including:

- Carbon Monoxide (CO);
- Carbon Dioxide (CO2);
- Oxides of Nitrogen (NO_x);
- Oxides of Sulphur (SOx);
- Unburnt hydrocarbons; and
- Greenhouse gas (GHG) emissions.

The air quality indicators presented above are not commonly monitored at permanent air quality monitoring stations, as the background concentrations of these emissions are relatively low (sometimes below the sensitivity of the instruments). When more common indicators such as dust and SO_2 are found in concentrations within the acceptable limits, then other air quality indicators are generally well below the air quality objectives.

In this case, the hydrocarbons (mainly benzene) are considered minor emissions, because of the scale of activities and distance to any sensitive receivers. No further investigation of the hydrocarbon emissions is required considering the very limited potential for impact on the existing air quality at the nearest sensitive areas.

The GHG emissions are an important consideration for the proposed Roper Bar Iron Ore Project and are the subject of further investigation as part of the overall air quality impacts.

Emissions associated with specific project phases are reviewed in further detail below.

Emissions – Construction

The main particulate emission associated with all phases will be dust. The construction of the haul road is expected to take 40 weeks and other mining infrastructure and ancillary facilities are expected to be constructed within a 6-8 month period.

The major sources of dust will be trucks transporting material, plant and equipment, as well as the workers to the haul route corridor (along unsealed access routes) and construction activities involving vegetation clearing and soil removal, earth moving, and trenching. Road construction will consist of four crews working in different sections of the route. However, the impact of dust emissions on sensitive receptors is expected to be minimal, since the route passes almost entirely through remote areas. It is acknowledged however that significant amounts of dust which settle on vegetation can affect floristic health and subsequently the health of fauna that utilise vegetation for food or habitat. It is expected that these impacts will be minimal however given that vegetation within the infrastructure and mine footprint will be cleared prior to construction, and dust is expected to settle close to the source of origin.

Construction activities will not be confined to the dry season, due to the length of time required to construct both the haul road and ancillary facilities. However, the highest dust levels are likely to occur during the dry season; downwind under light wind conditions where the dust plumes are relatively undispersed, and re-suspension of dust from areas of construction activities can occur.

Dust can affect vegetation near to the construction corridor and access tracks, and result in loss of some topsoil which can increase the potential for wind erosion.

Other sources of emissions during the construction phase would be from vehicle and mobile plant and equipment exhausts, as well as combustion emissions from power generation at temporary accommodation camps.

Emissions – Operations

During operations, dust emissions are expected to be mostly associated with transport from extraction of material, transport of material from the process plant to the low grade storage facility, stockyard, loading and unloading processes from the stockyard to the overland conveyor and onto the barge loading facility, and wind erosion of the pit and overburden stockpiles.

Significant dust generation from the haul road or airstrip are not expected, as these will be sealed to allow all-weather access. Occasionally, dust may be generated during inspection and maintenance activities associated with vehicle movements and ground disturbance.

Other sources of emissions during mine operations would be from vehicle, plant and equipment exhausts as well as combustion emissions from power generation at accommodation camps. The operation of the mobile (bulldozers, excavators and trucks) and static (power generators, trommel screen, booster pumps) plant will be associated with combustion of diesel fuel with consequent emissions to air. The primary diesel fuel consumption emissions are sulphur dioxide (SO_2) and nitrous oxide (NO) which is rapidly oxidised to nitrogen dioxide (NO_2) by atmospheric photochemical processes.

Emissions – Decommissioning and Rehabilitation

Decommissioning and reclamation activities may produce fugitive dust emissions caused by vehicular and equipment emissions, demolition/breaking up of concrete foundations, traffic along unsealed roads, and from storage and use of fuels for plant and equipment. Dust associated with rehabilitation activities may include re-profiling, wind-borne movement of soil/topsoil from stockpiles and gaseous pollutants such as nitrous oxides, sulphur oxides, volatile organic compounds and particulate matter including but not limited to the burning of fossil fuel from vehicles and equipment.

Odour

Odours are a common source of air pollution complaints and may arise from a number of sources and processes. Specific to this project, odorous emissions are expected to be associated with fuel storage, dispensing and combustion, and potentially from onsite sewerage treatment plants at the mine camp. Odorous emissions for this project are considered minor emissions, because of the scale of activities and significant distance to any sensitive receivers, therefore no further investigation of odorous emissions is required.

7.6.3 Proposed Ambient Air Quality Assessment

An ambient air quality assessment (to be undertaken in the dry season) will focus on the generation of dust and other applicable ambient air quality parameters from mining. Investigations will focus on the nearest sensitive place (the proposed mining camp) and mine face. All other nearest sensitive receptors are considered to be at a sufficient distance from the mine to warrant no further investigations.

Dust

Ambient air quality data for the mine camp and mine face will focus on the background dust levels (expressed in terms of dust deposition as a descriptor of the potential for dust nuisance at the mine camp) and will provide a baseline against which expected and actual dust nuisance can be measured against.

Empirical models for estimation of fugitive dust emissions (Air Pollutant Emission Factors) from various industrial processes as developed by the USEPA will be used to determine the emission rate of dust in terms of total suspended particulate (TSP) concentrations, PM_{10} and $PM_{2.5}$. The USEPA emission factor for heavy construction operations, which relates the quantity of dust emissions (in Mg/ha/month) to the area disturbed and the duration of the activities, is proposed for this assessment.

This empirical formula was derived from field measurements of near large scale construction projects. The field studies used to derive the dust emission factor are based on TSP (which includes larger particles as well as fine dust such as PM_{10} and $PM_{2.5}$), therefore the use of this formula is considered to be highly conservative for estimation of dust emissions in terms of smaller particles such PM_{10} and $PM_{2.5}$ (USEPA, 1995).

The calculated particulate emission rates associated with the mine operations will be used to determine the ground level dust concentration (expressed as TSP, PM_{10} and $PM_{2.5}$) at the nearest sensitive place (the proposed mining camp).

The dispersion of the dust emissions (TSP, PM_{10} and $PM_{2.5}$) calculations will be carried out using the Gaussian Dispersion procedure for worst-case dispersion conditions, as follows:

- Light to moderate wind from the direction of the mine towards the nearest sensitive areas;
- Light to moderate wind from the direction of the Stockyard towards the nearest sensitive areas;
- Neutral atmosphere (Pasquil Stability Class ‘D’); and
- Conservative dispersion factors δy and δz corresponding to stability Class ‘D’.

The current Xstrata marine monitoring program includes the use of dust deposition gauges at the Port. This data will be reviewed to inform potential cumulative emissions at Bing Bong.

The potential deposition of the total suspended particulates emitted from the operation of the mine will be calculated using the DUSTCON model. DUSTCON calculates the dust loadings in grams per square metre per month (g/m^2/month) at various distances from a point source of dust. It allocates the annual dust load on the basis of wind correlation analysis.

Based on DUSTCON calculations for strong sunshine (worst case scenario), dust deposition contours will be developed to show all the dust depositions that are above the criteria of $120mg/m^2$-day (external contour) at the mine camp and Stockyard facility located approximately 2km from the Port of Bing Bong.

SO_2 and NO_2 Emissions

Background concentrations of pollutants such as SO_2, NO_x, CO and metals are expected to be minor. Furthermore, emissions are expected to be negligible and considering the distance to nearest sensitive receivers will not be monitored.

Greenhouse Gas Emissions

Greenhouse gas emissions have been calculated and are included in Section 7.7.

7.6.4 Air Quality Criteria

Under the Northern Territory Government Legislation air pollution is regulated under the *Waste Management and Pollution Control Act.*

The Act is not prescriptive in relation to any specific criteria to be used in the assessment of air quality. Consequently, air quality from national/international standards or from environmental legislation from other States in Australia is proposed to be utilised in the absence of specific NT criteria.

The air quality objectives presented below are based on the recommendations by the *National Environment Protection Council (NEPC)* which is a body responsible for the coordination of the standards for ambient air quality to be uniformly applied in every State and Territory of Australia.

The maximum allowable levels of the main air quality indicators proposed for this project are presented in Table 7-12.

Table 7-12 – Air Quality Objectives

Air Quality Indicator	Averaging Period	Maximum Concentration ($\mu g/m^3$)	Maximum allowable exceedances	Environmental Value
TSP	1 year	90	N/A	Health & Wellbeing
PM_{10}	24 hours	50	5 days each year	Health & Wellbeing
$PM_{2.5}$	24 hours	25	N/A	Health & Wellbeing
	1 year	8	N/A	
Dust Deposition	1 month	120 (mg/m^2/day)	N/A	Health & Wellbeing

7.6.5 Potential Impacts

From the perspective of potential impacts on the air quality, the project is not expected to impact on the nearest off-site sensitive receivers given the remote nature of the project and is unlikely to impact on the mine camp.

The potential air quality impacts are limited to local areas in the vicinity of the mining face and the crushed material stockpiles.

Dust emissions generated by extraction activities are expected to settle close to the mining face, with negligible dust deposition at the mining camp or further afield and high levels of dust deposition are only expected within an estimated 300m radius from the mining face given prevailing winds and other meteorological conditions. The nature of this dust deposition is highly dependent on the prevailing winds and atmospheric stability conditions, with maximum dust deposition in a north-westerly direction under calmer overcast conditions.

The dust deposited at close proximity to the mining face, or fugitive emissions from the Stockyard or conveyor are of potential concern, because of the potential to increase sediment loads in local waterways. The sediment control measures as presented in the Sediment and Erosion Control Plan (Appendix L of the EIS) are designed to control the surface runoff sediment as well as any additional sediment load due to dust fallout from the proposed mining activities. Impacts from fugitive dust emissions on marine ecology and associated mitigation measures are detailed in Chapter 5 (Existing Environment - Marine).

Baseline air quality monitoring focused on dust deposition will be carried out during the dry season, to ensure that future monitoring can detect any appreciable increase in the dust concentration above the background levels at the mine camp and Port of Bing Bong.

The project is unlikely to result in ground level concentrations of SO_2 and NO_2 which may harm existing ecosystems or human health, given the distance to the nearest sensitive receptors.

7.6.6 Mitigation Measures

Experience from large scale mines indicate that appropriate implementation of dust control measures can significantly reduce fugitive dust emissions. Research has shown that dust control measures, such as wet suppression during excavation, transport and handling of the excavated material, can achieve dust control efficiency of 56% to 81% (Buonicore & Davis1992).

Whilst significant impacts to sensitive receptors are not expected, impacts on air quality can also affect the receiving environment, in particular water quality of local waterways, as well as potential impacts on flora and fauna.

WDRL will employ stringent dust control measures to minimise the impact of its operations on the surrounding environment. This will include appropriate training for all personnel during site inductions.

Dust suppression water will be required for dust suppression for the mine, haul roads and stockpile. This includes spray water near mining faces, water tank trucks, product streams on conveyors and transfer stations, and spraying of un-worked stockpiles. Details of the source and quantity of water required for dust suppression purposes are presented in Chapter 6 (Existing Environment – Surface Water and Groundwater). Water will be recycled where possible. For example, treated sewage effluent will be utilised for dust suppression near the mine camp.

Management/control measures are summarised in Table 7-13 below, including those specified by Mintrex (2012):

Table 7-13 – Air Quality Mitigation Measures

Source	**Management Control/Mitigation Measure**
Construction Corridor and Transport Routes	• Haul route to be regularly watered whilst under construction; • Early reinstatement of the construction corridor to assist in soil stabilisation; • Speed of the vehicles while used on-site to be limited to 20 km/hr; • The haul route and roads within the stockyard facility used by the haul trucks would be sealed to reduce dust generation from material build up and air from the trucks' fans; • All haul trucks will have covered trailers to prevent fugitive dust emissions whilst travelling between the mine site and the stockyard; and • Unsealed roads within the stockyard area and maintenance roads beside the overland conveyor will be watered at regular intervals to minimise the dust generated from vehicular traffic.
Mine Pits	• Mine face spray watering; and • Daily visual inspection by Site Foreman to ensure no airborne dust is present beyond the boundary of the extraction site.
Truck Receival Hopper	• The truck receival hopper would have an enclosed dust containment hood fitted with curtains and dust suppression water sprays which operate whilst the trucks are tipping.
Stockpiles	• Where possible the amount of time that surfaces such as stockpiles and

	cleared areas are exposed will be minimised; • Ore at the mine will be conditioned to the Dust Extinction Moisture Level (DEM) prior to being loaded on trucks. The ore may be treated with a polymer additive that clumps very fine particles and reduces the DEM of the ore; • Once the ore is stockpiled at the stockyard, the stockpile would be maintained at the DEM for barge and shiploading; • Stockpile dust suppression water cannons would be installed on both sides of the stockpiles for control of dust within the stockyard area and to maintain the DEM of the stockpiled ore; • When rehandling of ore is required by mobile plant, a water truck would be used in conjunction with the stockyard cannons to control dust; • A wind break for the stockyard and stockpile area would be provided by the elevated haulage roadway above the truck receiver hoppers. This roadway also provides a visual break between Robinson Road and the stockyard; and • A green screen of trees would be planted on the perimeter of the stockyard area to provide wind/visual breaks for the operation.
Conveyor Transfers	• All of the conveyor transfers would be fully enclosed with and designed to minimise dust generation. The design would include: o head chute dust control curtains and dust suppression water sprays; o enclosed skirt sections with dust control curtains and dust suppression water; o sprays; and o flexi-seal skirts.
Stacker Discharge	• The discharge height of ore from the stacker to the stockpile will be controlled and maintained at less than 2 m during the construction of the stockpile and stacker discharge water sprays will be installed to surround the ore stream to reduce dust emissions, particularly during high winds.
Barge Loading	• The barge loader will be fitted with a telescopic loading chute that can be extended to the barge deck and the height between outlet of the chute and the stockpile will be maintained at less than 2 m during the loading of the barge; and • Chute discharge water sprays would be installed to reduce dust emissions.
Vehicle and Plant Emissions	• Preventative maintenance of all equipment and facilities would be carried out to reduce fugitive emissions; • Reduce to minimum idle operation of any diesel plant or diesel trucks; • Maintain the emission control systems on any plant and vehicles at full operational condition at all times; and • Regular maintenance of above ground facilities will be carried out to ensure that the control, safety and operating systems are functioning correctly and reliably.
Odour	• Waste food scraps will be kept contained and covered. • Sewage will be treated through an on-site treatment plant, with the effluent treated and used for dust suppression in the vicinity of the mining camp; and • Fuel storage areas to be fully sealed and bunded.

Monitoring

The majority of Roper Bar Iron Ore Project infrastructure is situated in a remote area and is not expected to be influenced from anthropogenic activities nor impact upon sensitive receptors (i.e. residential dwellings or businesses) due to the distance of any receptors from the mine. However, dust may impact upon the receiving environment and the mine camp.

Proposed monitoring will focus on the generation of dust arising from the WDRL operations. Depositional dust gauges are proposed to be strategically located in key areas based on prevailing wind directions, to detect fugitive dust emissions. These key areas include the mine site, mine camp, Stockyard Facility and Port of Bing Bong.

Dust monitoring is currently undertaken at the Port of Bing Bong by Xstrata. This includes dust deposition gauges in the vicinity of Port infrastructure, and marine sediment monitoring to detect fugitive emissions in the marine environment. Samples are analysed for Total Insoluble Matter (TIM) as well as lead and zinc concentrations (McArthur River Mining 2012).

Whilst total lead and zinc concentrations are not of interest with respect to WDRL operations, as part of the Port Marine Environment Monitoring program, WDRL propose to implement complementary environmental monitoring elements specific to its operations at the Port of Bing Bong Operations, in particular monitoring of TIM at additional sampling sites.

Specifically, WDRL propose to contribute to Xstrata's dust monitoring program, as well as installing additional dust deposition gauges as required. Specific locations of dust gauges will be confirmed as part of the Air Quality baseline assessment.

WDRL commit to undertaking a strategic assessment of the current Xstrata marine monitoring program to ensure that the cumulative impacts of both Xstrata's expansion and WDRL's proposal may be appropriately mitigated and monitored. The current Xstrata marine monitoring program will be reviewed in the context of both Xstrata and WDRL operations by relevant experts including Charles Darwin University Personnel and AIMS staff whom are currently undertaking monitoring activities.

Further information on the proposed scope of monitoring at the Port of Bing Bong is contained in Chapter 5 (Existing Environment - Marine).

Iron oxide levels are not proposed to be monitored due to the fact that iron oxides are poorly soluble near neutral pH and dust emissions are not expected to result in large quantities of iron becoming bioavailable for humans or other species of fauna or flora.

Whilst it is acknowledged the mine operations will result in emissions of other background pollutants, there are no other industrial or urban developments in close proximity to the mine, and therefore ambient background concentrations of pollutants such as SO_2, NO_x, CO and metals are expected to be low and are not proposed to be monitored.

Further details of the air pollution control measures to achieve compliance with air quality criteria and the chain of responsibility for implementation of these measures are included in Appendix C (Environmental Management Plan) for Air Quality.

7.7 Greenhouse Gas Emissions

The Northern Territory accounts for 2.8% of Australia's total greenhouse gas emissions (DCCEE 2011). The principal source of emissions in the Northern Territory is the burning of savannah woodlands. In 2008, the greenhouse gas emissions for the Northern Territory (excluding emissions and removals from land use, land use change and forestry) were 16.2 Mt (DCCEE, 2011). With allowance for additional emissions due to land use change and removal by forestry, the total greenhouse gas emissions are 16.3 Mt.

Greenhouse gas emissions, other than those associated with bushfires, are limited in the vicinity of the Roper Bar Iron Ore Project. The mine site is located in a remote area, with the only significant potential greenhouse gas emissions coming from other proposed mining ventures.

The potential GHG emissions from the Roper Bar Iron Ore Project were estimated using the National Greenhouse Accounts (NGA) Factors, as prepared by the Commonwealth Department of Climate Change and Energy Efficiency. The NGA Factors are based on the National Greenhouse and Energy Reporting (Measurement) Determination 2008, but allows estimation of a broader range of sources (Department of Climate Change and Energy Efficiency 2011).

The operations at the proposed Roper Bar Iron Ore Project are mainly associated with direct (point source) GHG emissions such as:

- Fuel (diesel) used in the stationary plant (mainly power generators); and
- Fuel (diesel) used in the mobile plant (excavators, bulldozers and trucks).

There are no indirect emissions of GHG, as the proposed mine will not purchase any electricity from external sources.

The GHG emissions from the disturbed (cleared) land as part of the mining activities are considered to be relatively minor and are likely to be partially offset by the CO_2 absorbed by the vegetation established as part of the progressive rehabilitation process.

The construction and operation of the project will increase the greenhouse gas emissions for the region. Of the main greenhouse gases, carbon dioxide (CO_2) and nitrous oxide (NO_2) are the most significant in relation to the project, since they are the main products of diesel combustion in heavy equipment and the processing plant. These sources will be present both during and after construction.

The GHG emission factors for calculating direct emissions are generally expressed in the form of a quantity of a given GHG emitted per unit of energy and cover broad range of greenhouse gases, such as:

- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- hydrofluorocarbons (HFCs);
- sulfurhexafloride (SF_6);
- tetrafluoromethane (CF_4); and
- hexafluoroethane (C_2F_6).

The relative global warming potential of the greenhouse gases is considered by expressing the factors as a carbon dioxide equivalent (CO_2-e).

The NGA factors for fuel emissions are developed for the three dominant greenhouse gases: - CO_2, CH_4 and N_2O. The estimate of the emissions from combustion of fuel is carried out by applying the following equation:

$$\boldsymbol{E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1,000}}$$

Where:

E_{ij}	=	Emissions of gas type (j), CO_2, CH_4 and N_2O, from the fuel type (i) (CO_2-e tonnes).
$\boldsymbol{Q_i}$	=	Quantity of fuel type (i) (kilolitres or gigajoules) combusted for transport energy purposes.
$\boldsymbol{EC_i}$	=	Energy content factor of fuel type (i) (gigajoules per kilolitre or per cubic metre) used for transport energy purposes (Note: If Q_i is measured in gigajoules, then *ECi* is 1).
$\boldsymbol{EF_{ijoxec}}$	=	Emission factor for each gas type (j) (which includes the effect of an oxidation factor) for fuel type (i) (kilograms of CO_2-e per gigajoule) used for transport energy purposes.

To obtain conservative results, the fuel combustion emission factors for stationary and transport energy purposes were used in the above equation. The emission factors for CH_4 and N_2O are higher for transport than for stationary energy purposes.

7.7.1 Greenhouse Gas Emission Thresholds

Division 1 - Part 2 of the *National Greenhouse and Energy Reporting Act* (2007) introduces a greenhouse gas emissions threshold that regulates the corporate responsibility in terms of reporting of GHG for inclusion in the National Greenhouse Gas Account (NGA). The greenhouse gas emissions threshold is defined as follows:

> *A controlling corporation's group meets a threshold for a financial year if in that year the total amount of greenhouse gases emitted from the operation of facilities under the operational control of entities that are members of the group has a carbon dioxide equivalence of (if the financial year is later than the one which starts on 1 July 2009) 50 kilotonnes or more.*

This means that any corporation, which generates more than 50 kilotonnes of GHG as a group has to provide annual report of the emissions to the NGA. The assessment of the potential GHG emissions from the operations of the proposed Roper Bar Iron Ore Project will be used to determine whether the company will be subject to annual NGA reporting.

7.7.2 Calculation of Emissions

The following section resents the CO_2 emission calculation results, considering the fuel consumption during each finite project stage.

Construction of Haul Road and Stock Yard Facility

A summary of CO_2 emission calculation results, considering the fuel consumption during the construction of the haul road and the stock yard facility, is presented in Table 7-14.

Table 7-14 – Fuel Consumption and CO_2 emissions - Construction of haul road and stock yard

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CO_2) CO_2-eTonnes
Dozers	4	352.8	1,800**	38.6	69.2	942.37
Graders	12	816.48				2,180.92
Earthmovers	12	583.2				1,557.80
Water Carts	12	518.4				1,384.71
Sealing Trucks	4	151.2				403.87
Light Vehicles	12	72.36				193.28
Cranes	4	108				288.48
Concrete Agitator Trucks	4	108				288.48
Compaction Rollers	12	181.44				484.65
Side Tippers	4	162				432.72
End Tippers	8	324				865.44
Front End Loaders	12	583.2				1,557.80
Excavators	8	388.8				1,038.53
Total (tonnes/construction period)						**11,619.05**

Calculations based on hours of operation and fuel burn rates provided by Western Desert Resources
*** Based on five months construction period.*

A summary of CH_4 emission calculation results, considering the fuel consumption during the construction of the haul road and the stock yard facility, is presented in Table 7-15.

Table 7-15 – Fuel Consumption and CH_4 emissions - Construction of haul road and stock yard

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CH_4) CO_2-eTonnes
Dozers	4	352.8	1,800**	38.6	0.2	2.72
Graders	12	816.48			0..2	6.30
Earthmovers	12	583.2			0.2	4.50
Water Carts	12	518.4			0.2	4.00
Sealing Trucks	4	151.2			0.2	1.17
Light Vehicles	12	72.36			0.2	0.56
Cranes	4	108			0.1	0.42
Concrete Agitator Trucks	4	108			0.1	0.42
Compaction Rollers	12	181.44			0.2	1.40
Side Tippers	4	162			0.2	1.25
End Tippers	8	324			0.2	2.50
Front End Loaders	12	583.2			0.2	4.50
Excavators	8	388.8			0.2	3.00
Total (tonnes/construction period)						**32.74**

Calculations based on hours of operation and fuel burn rates provided by Western Desert Resources
*** Based on five months construction period.*

A summary of N_2O emission calculation results, considering the fuel consumption during the construction of the haul road and the stock yard facility, is presented in Table 7-16.

Table 7-16 – Fuel Consumption and N_2O emissions - Construction of haul road and stock yard

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (N_2O) CO_2-eTonnes
Dozers	4	352.8	1,800**	38.6	0.5	6.81
Graders	12	816.48			0.5	15.76
Earthmovers	12	583.2			0.5	11.26
Water Carts	12	518.4			0.5	10.01
Sealing Trucks	4	151.2			0.5	2.92
Light Vehicles	12	72.36			0.5	1.4
Cranes	4	108			0.2	0.83
Concrete Agitator Trucks	4	108			0.2	0.83
Compaction Rollers	12	181.44			0.5	3.5
Side Tippers	4	162			0.5	3.13
End Tippers	8	324			0.5	6.25
Front End Loaders	12	583.2			0.5	11.26
Excavators	8	388.8			0.5	7.5
Total (tonnes/construction period)						**81.46**

Calculations based on hours of operation and fuel burn rates provided by Western Desert Resources
*** Based on five months construction period.*

Mine Camp Operations

A summary of total GHG (CO_2, CH_4 and N_2O) emission calculation results, considering the fuel consumption during the operation of the mine camp, is presented in Table 7-17.

Table 7-17 – Fuel Consumption and GHG emissions – Mine Camp Operations

Source	GHG	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CO_2) CO_2-eTonnes
CAMP	CO_2	475	8,800**	38.6	69.2	1,269.32
	CH_4				0.1	1.83
	N_2O				0.2	3.67
Total (tonnes/year)						**1,274.82**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

Extraction Area Operations

A summary of CO_2 emission calculation results, considering the fuel consumption associated with the operations at the extraction area, is presented in Table 7-18.

Table 7-18 – Fuel Consumption and CO_2 emissions – Extractions Area Operations

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CO_2) CO_2-eTonnes
Excavators	2	1,235	7,560**	38.6	69.2	3,298.83
Trucks	10	4,475				11,953.26
Dozers	2	776				2,072.79
Graders	2	358				956.26
Water Carts	2	239				638.40
Service Truck	1	60				160.27
Drills	6	1,691				4,516.86
Light Vehicles	20	56				149.58
Ancillary Equipment	10	106				283.14
Generators	1	302.4				807.75
Front End Loaders	1	204.12				545.23
Total (tonnes/year)						**25,382.37**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

A summary of CH_4 emission calculation results, considering the fuel consumption associated with the operations at the extraction area, is presented in Table 7-19.

Table 7-19 – Fuel Consumption and CH_4 emissions – Extractions Area Operations

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CH_4) CO_2-eTonnes
Excavators	2	1,235	7,560*	38.6	0.2	9.53
Trucks	10	4,475			0..2	34.55
Dozers	2	776			0.2	5.99
Graders	2	358			0.2	2.76
Water Carts	2	239			0.2	1.85
Service Truck	1	60			0.2	0.46
Drills	6	1,691			0.1	6.53
Light Vehicles	20	56			0.2	0.43
Ancillary Equipment	10	106			0.1	0.41
Generators	1	302.4			0.1	1.17
Front End Loaders	1	204.12			0.2	1.58
Total (tonnes/year)						**65.26**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

A summary of N_2O emission calculation results, considering the fuel consumption associated with the operations at the extraction area, is presented in Table 7-20.

Table 7-20 – Fuel Consumption and N_20 emissions – Extractions Area Operations

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (N_2O) CO_2-eTonnes
Excavators	2	1,235	7,560*	38.6	0.5	23.84
Trucks	10	4,475			0.5	86.37
Dozers	2	776			0.5	14.98
Graders	2	358			0.5	6.91
Water Carts	2	239			0.5	4.61
Service Truck	1	60			0.5	1.16
Drills	6	1,691			0.2	13.05
Light Vehicles	20	56			0.5	1.08
Ancillary Equipment	10	106			0.2	0.82
Generators	1	302.4			0.2	2.33
Front End Loaders	1	204.12			0.5	3.94
Total (tonnes/year)						**159.09**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

Processing Operations

A summary of CO_2 emission calculation results, considering the fuel consumption associated with the processing operations, is presented in Table 7-21.

Table 7-21 – Fuel Consumption and CO_2 emissions – Processing Operations

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CO_2) CO_2-eTonnes
Crushing Plant	1	1,367	6,600	38.6	69.2	3,651.82
FEL Crusher Feed	1	360	4,000			961.60
FEL Haul Truck Loading	1	238	2,640			634.66
Office and Workshop	1	149	4,400			396.66
Total (tonnes/year)						**5,644.74**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

A summary of CH_4 emission calculation results, considering the fuel consumption associated with the processing operations, is presented in Table 7-22.

Table 7-22 – Fuel Consumption and CH_4 emissions – Processing Operations

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CH_4) CO_2-eTonnes
Crushing Plant	1	1,367	6,600	38.6	0.1	5.28
FEL Crusher Feed	1	360	4,000		0.1	1.39
FEL Haul Truck Loading	1	238	2,640		0.2	1.83
Office and Workshop	1	149	4,400		0.1	0.57
Total (tonnes/year)						**9.07**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

A summary of N_2O emission calculation results, considering the fuel consumption associated with the processing operations, is presented in Table 7-23.

Table 7-23 – Fuel Consumption and N_2O emissions – Processing Operations

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (N_2O) CO_2-eTonnes
Crushing Plant	1	1,367	6,600	38.6	0.2	10.55
FEL Crusher Feed	1	360	4,000		0.2	2.78
FEL Haul Truck Loading	1	238	2,640		0.5	4.59
Office and Workshop	1	149	4,400		0.2	1.15
					Total (tonnes/year)	**19.07**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

Haulage to Bing Bong Port

A summary of total GHG (CO_2, CH_4 and N_2O) emissions for the haulage of iron ore from Roper Bar Iron Mine to the Bing Bong Port, is presented in Table 7-24.

Table 7-24 – Fuel Consumption and GHG emissions – Haulage to Bing Bong Port

Source	GHG	Consumption (kL/year)	Duration (Hours)	Energy Content	Emissio n Factor	Annual Emissions (CO_2) CO_2-eTonnes
Haulage	CO2	9,360	7,800*	38.6	69.2	25,001.68
	CH4				0.2	72.26
	N2O				0.5	180.65
				Total (tonnes/year)		**25,254.59**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

Stock Yard and Barge Loading Facility (Port of Bing Bong)

A summary of CO_2 emission calculation results, for the operations of the stock yard at the Bing Bong port, is presented in Table 7-25.

Table 7-25 – Fuel Consumption and CO_2 emissions – Stock Yard

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CO_2) CO_2-eTonnes
Port Barge Loading System	1	446	2,000*	38.6	69.2	1,189.98
Port Office and Workshop	1	89	4,400			238
Barge	3	1,610				4,300.55
Port FEL and stacking	1	238	2,640			634.66
Port FEL reclaim	2	360	2,000			961.60
					Total (tonnes/year)	**7,324.79**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

A summary of CH_4 emission calculation results, for the operations of the stock yard at the Bing Bong port, is presented in Table 7-26.

Table 7-26 – Fuel Consumption and CH_4 emissions – Stock Yard

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (CH_4) CO_2-eTonnes
Port Barge Loading System	1	446	2,000*	38.6	0.1	1.72
Port Office and Workshop	1	89	4,400		0.1	0.34
Barge	3	1,610			0.2	12.43
Port FEL and stacking	1	238	2,640		0.1	0.92
Port FEL reclaim	2	360	2,000		0.1	1.39
Total (tonnes/year)						**16.8**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

A summary of N_2O emission calculation results, for the operations of the stock yard at the Bing Bong port, is presented in Table 7-27.

Table 7-27 – Fuel Consumption and N_2O emissions – Stock Yard

Source	Quantity	Consumption (kL/year)	Duration (Hours)	Energy Content	Emission Factor	Annual Emissions (N_2O) CO_2-eTonnes
Port Barge Loading System	1	446	2,000*	38.6	0.2	3.44
Port Office and Workshop	1	89	4,400		0.2	0.69
Barge	3	1,610			0.5	31.07
Port FEL and stacking	1	238	2,640		0.2	1.83
Port FEL reclaim	2	360	2,000		0.2	2.78
Total (tonnes/year)						**39.81**

Calculations based on fuel consumption as provided by Western Desert Resources
*** Based on one year operation period.*

Airstrip

A summary of total GHG (CO_2, CH_4 and N_2O) emission calculation results, for the transport of staff form Darwin to the mine site using Brasilia EMB 120 aircraft, is presented in Table 7-28.

Table 7-28 – Fuel Consumption and GHG emissions – Airstrip

Source	GHG	Consumption (kL/year)	Operation (trips/ day)	Energy Content	Emission Factor	Annual Emissions (CO_2) CO_2-eTonnes
Brasilia EMB 120 aircraft	CO2	250.32	1	33.1	66.3	640.62
	CH4				0.04	0.39
	N2O				0.7	6.76
Total (tonnes/year)						**647.77**

*** Based on one year operation period.*

Total Emissions

The total fuel consumption and GHG emissions for the operation of the Roper Bar Iron Ore Mine are presented in Table 7-29.

Table 7-29 – Roper Bar Iron Ore Total Fuel Consumption and GHG emissions

Source	Consumption (KL/pa)	Emission Rates CO_2-eTones			Combined Total CO_2-eTonnes
		CO_2	CH_4	N_2O	
CONSTRUCTION SUBTOTALS	4,349.88	11,619.05	32.74	81.46	11,733.25
CAMP SUBTOTALS	475.20	1,269.32	1.83	3.67	1,274.82
EXTRACTION AREA SUBTOTALS	9,502.52	25,382.37	65.26	159.09	25,606.72
PROCESSING AREA SUBTOTALS	2,113.25	5,644.74	9.07	19.07	5,672.88
HAULAGE SUBTOTALS	9,360.00	25,001.68	72.26	180.65	25,254.59
STOCK YARD OPERATIONS SUBTOTALS	2,742.22	7,324.79	16.80	39.81	7,381.40
AIRSTRIP SUBTOTAL	250.32	640.62	0.39	6.76	647.77
TOTAL EMISSIONS					
FIRST YEAR	28,793.39	76,882.57	198.35	490.51	**77,571.43**
FOLOWING YEARS	24,443.51	65,263.52	165.61	409.05	**65,838.18**
WHOLE PROJECT (10 YEARS)	-	664,254.25	1,688.84	4,171.96	**670,115.05**

The total emissions for the first year of operation are higher than the emissions for the following years, due to fuel consumption associated with the construction of the haul road and stock yard.

Overall, the annual greenhouse gas emissions from the operation of the Roper Bar Iron Ore Project will exceed the 50 kilotonnes threshold specified in the *National Greenhouse and Energy Reporting Act* (2007). WDRL will therefore be required to report greenhouse gas emissions on an annual basis to the National Greenhouse Gas Account (NGA).

7.7.3 Greenhouse Gas Mitigation Strategies

As part of the overall greenhouse reduction strategy on a national level, there have been a number of research projects aimed at reduction of fuel consumption and improvement of processes and equipment. Following is an overview of some of the potential strategies for greenhouse gas emissions which can be implemented as part of the design and operation of facilities at the Roper bar Iron Ore Project.

Design, Machinery and Equipment

In order to reduce fuel consumption and GHG emissions, the following are examples of strategies for machines and equipment that will be considered:

- **Maintenance Practices:** - Machines, equipment and light vehicles should be maintained regularly as per manufacturer's specifications. The aim of this practice is to improve machine performance, increase engine life, reduce machine and tyre wear, reduce costs and improve the overall efficiency of the machines.
- **Tyres Pressure Management:** - The running efficiency of trucks and machines greatly impacts on their fuel consumption. It has been demonstrated that the implementation of a tyre pressure management system is one method for improving their running efficiency and therefore their fuel energy consumption.
- **Payloads Capacity**: - In order to maximize the haulage rate trucks should be loaded at their maximum carrying capacity. Review of fuel usage revealed that increasing the weight carried by trucks did not significantly increase their fuel consumption, resulting in a greater rate of production per fuel consumption.

On-site Vehicle Movement

Analysis of trucks and machines movements within the mine site will reveal opportunities to reduce traveling distances and improve the production efficiency and reduce fuel consumption. For example the use an in-pit refuelling truck will allow for the machine and trucks to remain working within the pit area and will reduce their travelling time to the refuelling facility.

Heating, Ventilation and Cooling (HVAC)

Solar thermal HVAC units can be utilised in place of conventional inverter technologies at the site. The units are different to conventional split units and present the following characteristics:

- The only addition is a solar collector panel next to the condenser;
- The solar panel works in the shade using ambient heat to reduce the electricity used by the condenser and even stores up to 24 hours of energy to help run the condenser at night;
- The compressor size is reduced due to the solar panel;
- The condenser efficiency is greatly improved by pre-heating the refrigerant in the solar panel;
- Electrical wiring requirements are reduced; and
- Savings of up to 80% on cooling energy costs and up to 60% on heating energy costs.

A typical configuration of solar thermal HVAC unit is presented in Figure 7-25.

Figure 7-25 – Solar Thermal HVAC

Lighting

Lighting design throughout the mine site should consist of best-practice quad-phosphor T5 fluorescent lamps and reflectors combined with LED halogen downlights.

LED and single bank quad phosphor T5 fluorescent lamps with reflectors present many advantages over incandescent light sources including lower energy consumption by up to 80% over standard T8 tubing and incandescent lamps, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability.

Conventional metal halide high bay lighting can be discouraged in favour of a 4 x 54w T5 fluorescent fitting which will provide the lighting lux levels needed while producing a better quality and wider proportion of light than conventional high bays and produce a lot less heat. As the control gears in these fittings are electronic as well it will provide even more energy savings. High bay fittings such as these present an operating cost saving of 50% over conventional metal halide fittings.

Water Heating

Roof mounted solar hot water systems with electric boost are desired in favour of conventional electric storage tanks.

The use of solar hot water systems can save over 80% in energy costs for water heating.

Plug-in Appliances

Plug-in appliances such as microwaves, computers, televisions, stereo players etc. consume a significant level of power during standby periods. These 'phantom loads' can be eliminated at the accommodation area and offices through the use of radio frequency controlled standby power elimination units which will enable occupants to switch off all plug in appliances at the source via one main switch located in each unit or office upon exit.

Insulation

The installation of adequate insulation in the ceiling cavity and external walls can dramatically reduce the requirements of mechanical heating and cooling in the buildings. Adequate insulation is essential to balance heat loss and gain in order to achieve the minimum possible energy consumption from HVAC systems.

High performance window glazing is desired and can be incorporated into the design to ensure there is minimum thermal gain/loss through windows at the development. High performance glazing allows maximum daylight penetration into work spaces while taking load off the HVAC system.

Water Efficient Fittings

The installations of 6 Star WELS Rated water efficient taps, showers and toilets within the accommodation area and offices can attribute to water saving of over 75% over conventional units.

7.7.4 Commitments

To ensure long-term compliance with the requirements for environmental and occupational noise control, WDRL is committed to undertaking periodic noise surveys to evaluate and ensure compliance with the environmental and occupational health and safety legislation.

WDRL commit to undertake baseline surveys of air quality at the mine site and mine camp using dust deposition gauges during the dry season in order to provide a baseline against which expected and actual dust nuisance can be measured against. WDRL also commit to contributions toward Xstrata's existing dust monitoring program at Bing Bong Port, including monetary contributions and personnel as required.