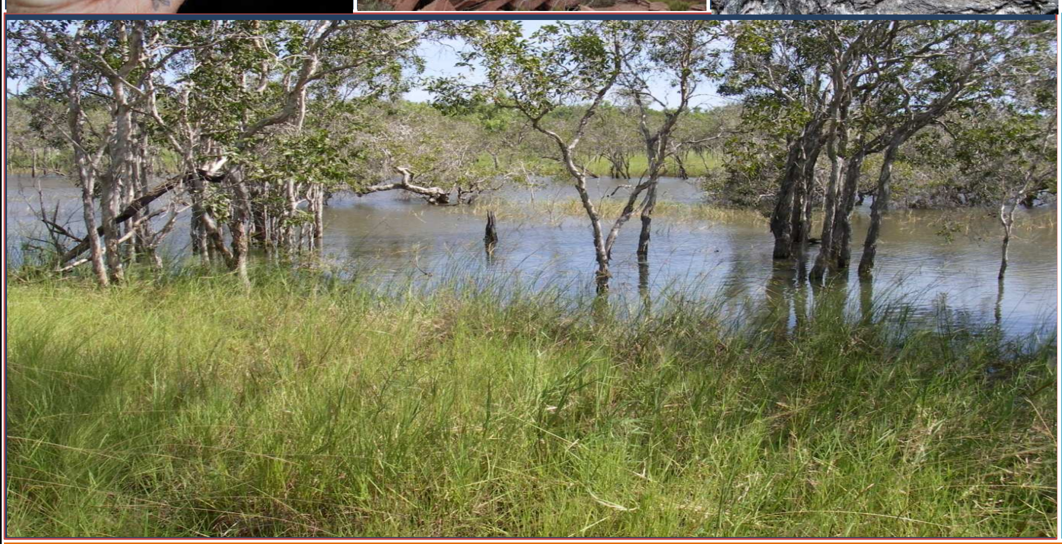
EcOz
Environmental
Services

# Draft EIS - Appendix R
# Draft Water Management Plan

Western Desert Resources Limited
Roper Bar Iron Ore Project



2012



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# 1 Introduction

## 1.1 Purpose and Scope

This Water Management Plan (WMP) outlines how environmental issues associated with surface and groundwater at the Roper Bar Iron Ore Project will be managed through all aspects of planned operations, clearly set out in the context of the overall framework of life of mine development.

The WMP also outlines how performance against the objectives and requirements of this plan will be measured, monitored and reported.

The WMP covers both the mine site and Bing Bong barge loading facility and given their geographical separation, are covered separately within document.

## 1.2 Objectives and Targets

### 1.2.1 Objectives

- No impacts on downstream water quality (both surface and groundwater) associated with mining activities.
- Manage water on site according to quality and minimise the volume of contaminated water generated and stored on site.
- Use water efficiently (i.e. reduce, re-use, re-cycle) to minimise the requirement for water abstraction and consequently, potential impacts on other water users (human and environmental).

### 1.2.2 Targets

- Water quality at downstream monitoring sites does not exceed trigger values.
- No increase in the volume of contaminated water stored on site.
- No decrease and if possible, increase the efficiency of water use.

# 2 Current Project Site Conditions

## 2.1 Climate

### 2.1.1 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 2-1). There are no weather stations within the project area, however Table 2-1 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.



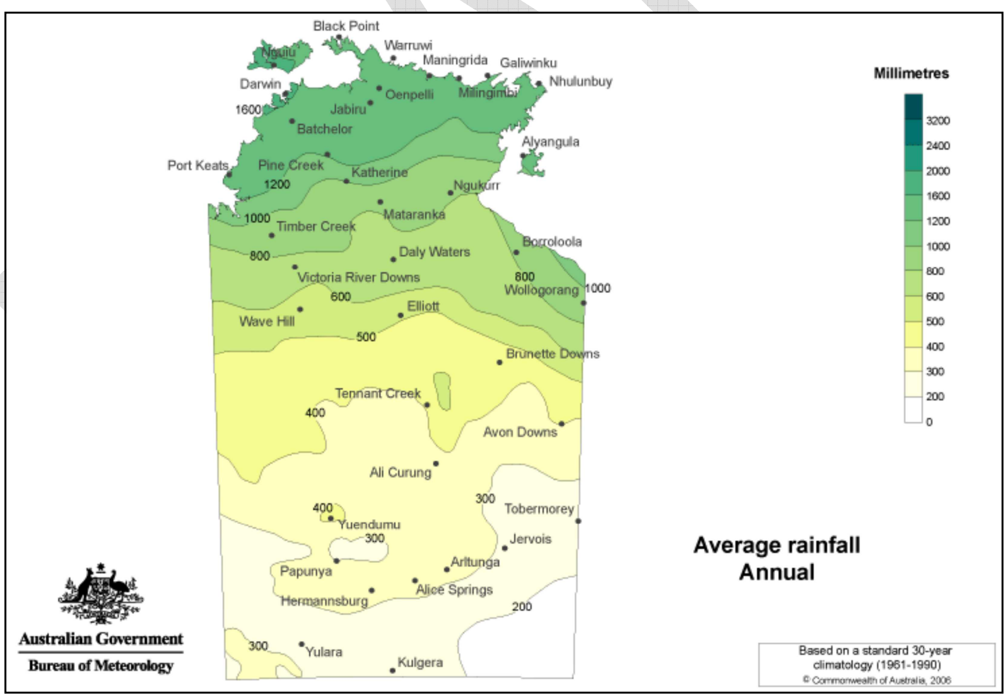



**Figure 2-1 – Average Annual Rainfall for the Northern Territory (BOM, 2012)**

**Table 2-1 – 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 2-2 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).

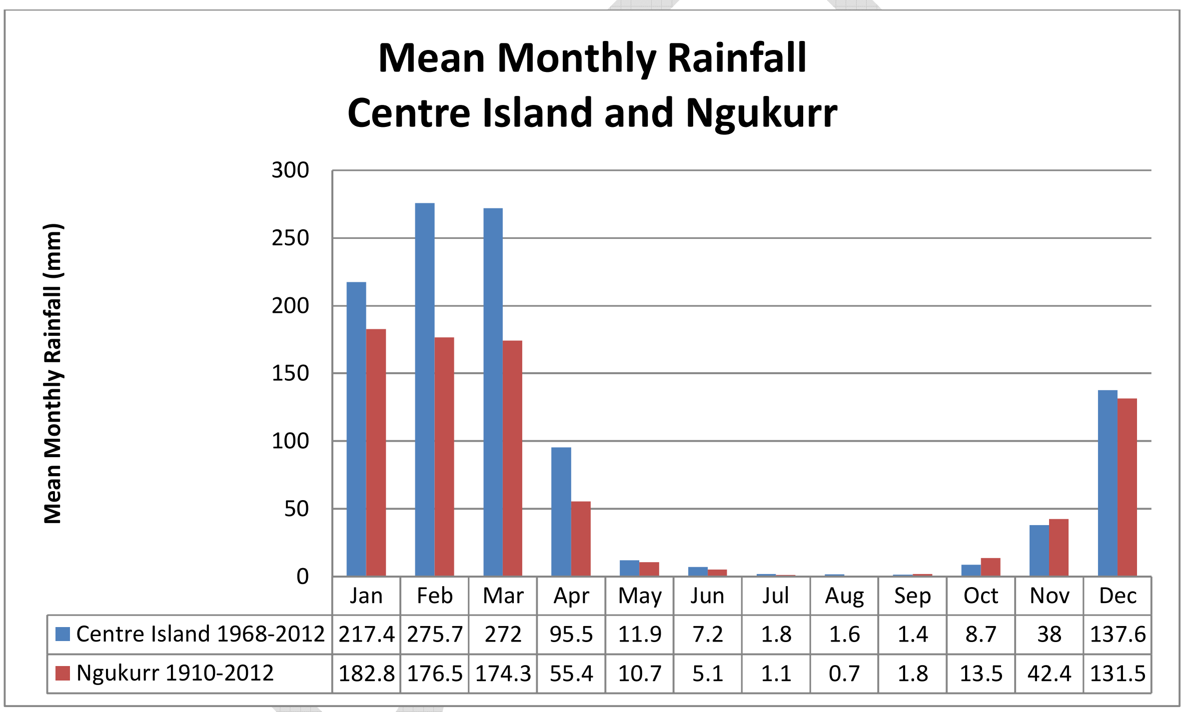
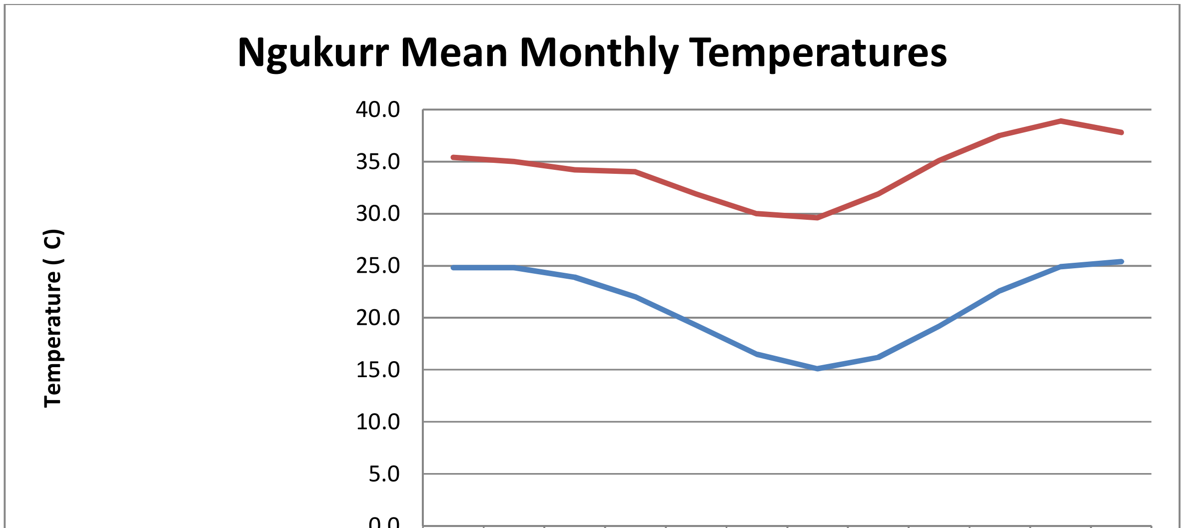



**Figure 2-2 – Mean rainfall data for Centre Island (14703) and Ngukurr (14609) (BOM, 2012)**

***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 2-3. 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).

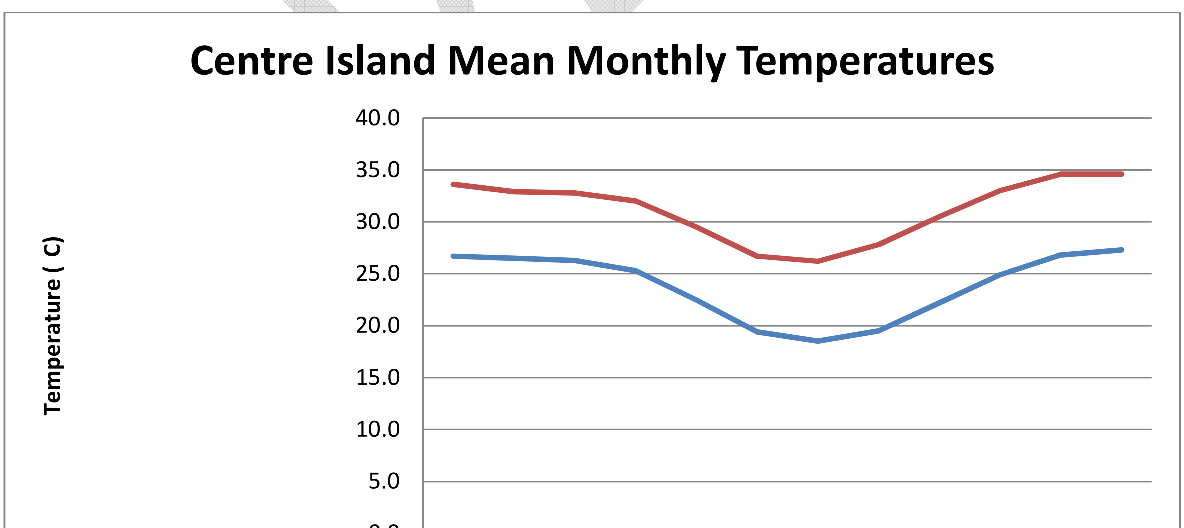



| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Maximum Temperature | 35.4 | 35.0 | 34.2 | 34.0 | 31.9 | 30.0 | 29.6 | 31.9 | 35.1 | 37.5 | 38.9 | 37.8 |
| Mean Minimum Temperature | 24.8 | 24.8 | 23.9 | 22.0 | 19.3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

**Figure 2-3 – 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 2-4. 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 2-4 – 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 2-5).

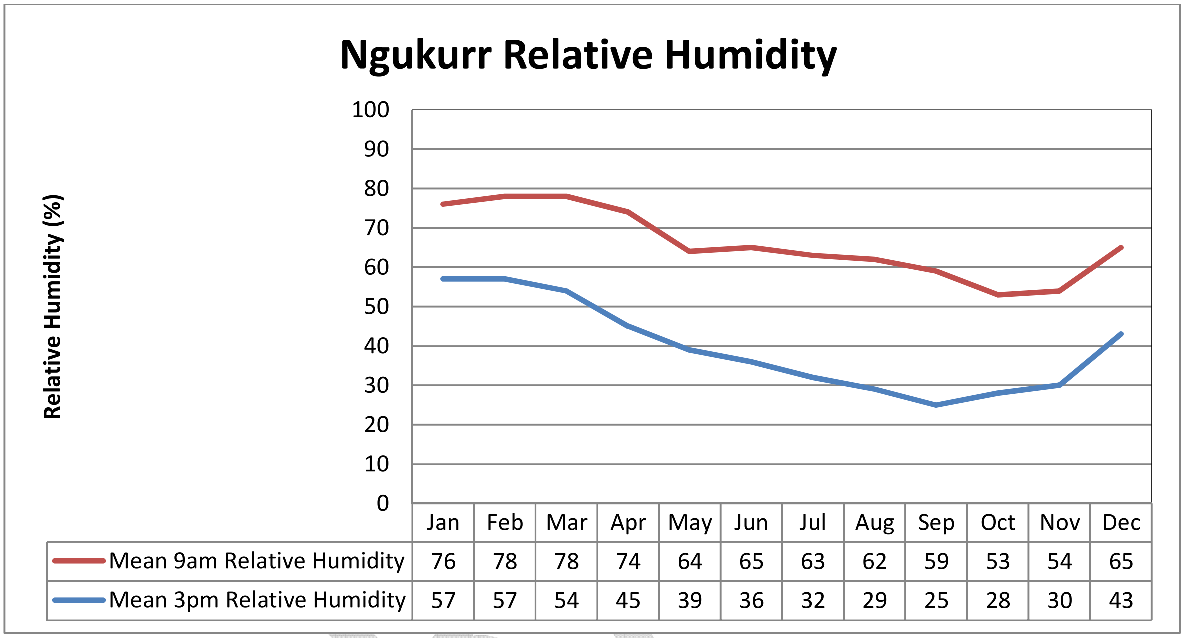
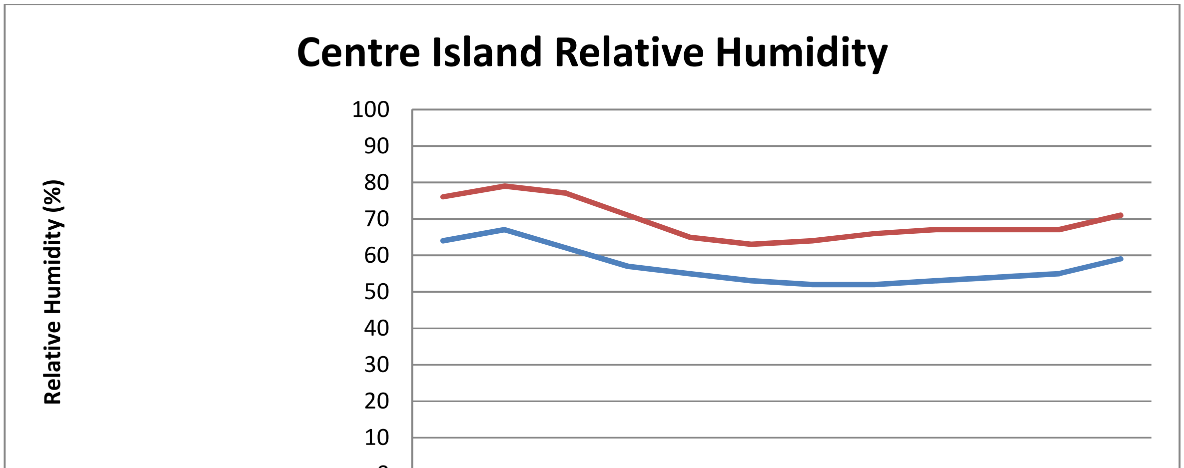



**Figure 2-5 – Mean relative humidity Ngukurr 1962 – 2010 (BOM, 2012)**

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 2-5).



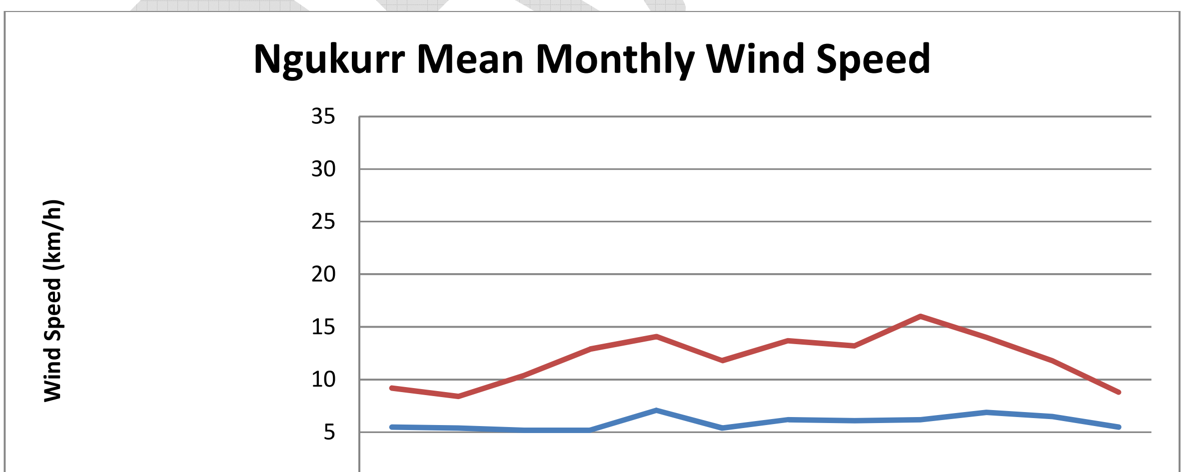

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean 9am Relative Humidity | 76 | 79 | 77 | 71 | 65 | 63 | 64 | 66 | 67 | 67 | 67 | 71 |
| Mean 3pm Relative Humidity | 64 | 67 | 62 | 57 | 55 | 53 | 52 | 52 | 53 | 54 |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

**Figure 2-6 – Mean relative humidity Centre Island 1974 – 2010 (BOM, 2012)**

### *Wind*

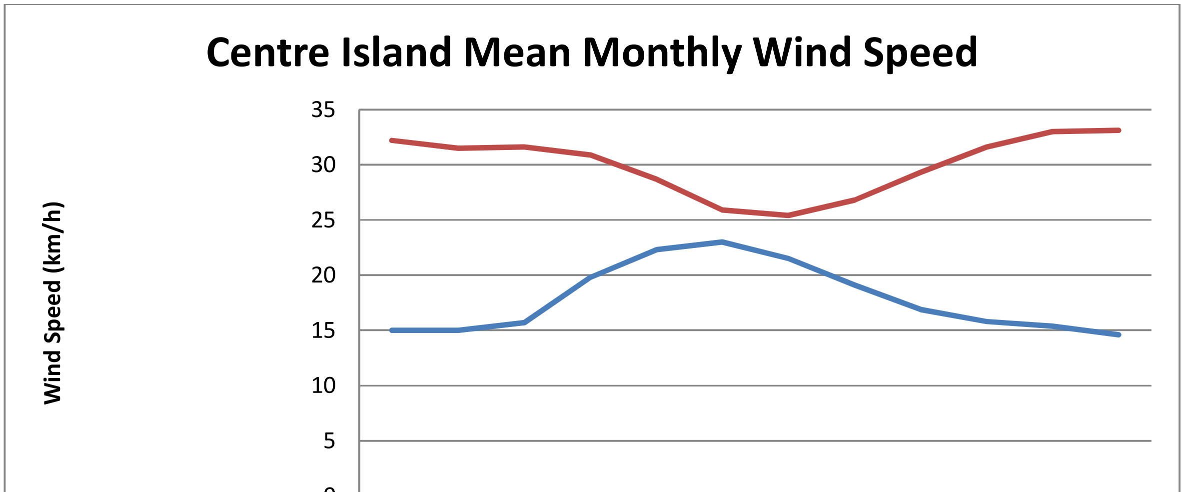
Wind speed and dominant direction plays an important role in the dispersion of dust particles. Mean monthly wind speed at Ngukurr ranges from 5.2 to 14.1km/h (Figure 2-7). Wind speeds generally display a higher maximum speed in the dry season months. Wind direction is predominantly South-East in the morning (Figure 2-9) and Easterly in the afternoon (Figure 2-10).

Centre Island is subject to greater average wind speeds with figures ranging from 14.6 to 33.0km/h (Figure 2-8). 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 2-11) and changes to North East in the afternoon (Figure 2-12).




| | 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 2-7 – 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 2-8 – Mean monthly wind speed (km/h) Centre Island 1974 – 2010 (BOM, 2012)**

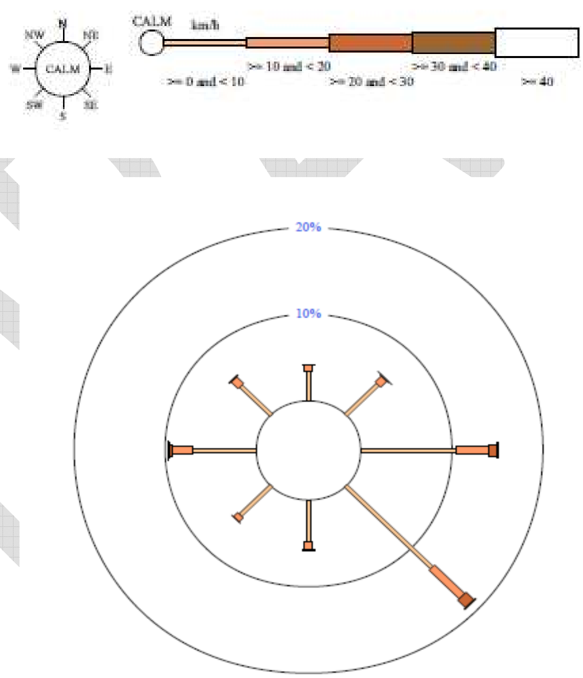



**Figure 2-9 – Ngukurr 9am Rose of Direction versus Wind Speed in km/h (1962 to 2010)**

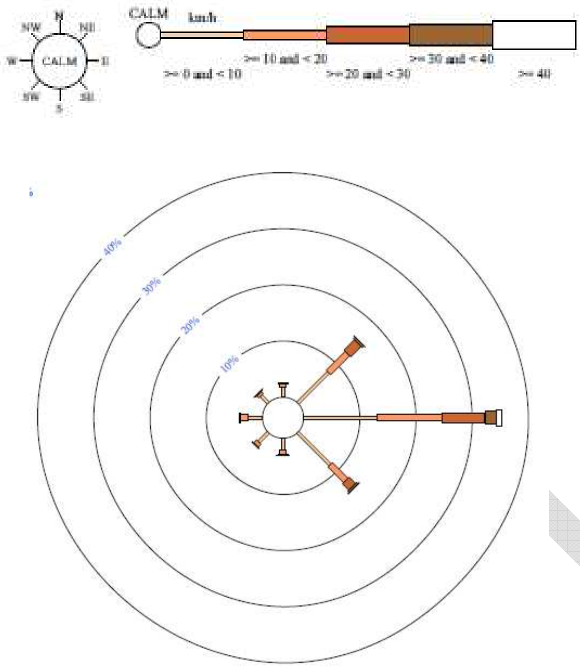



**Figure 2-10 – Ngukurr 3pm Rose of Direction versus Wind Speed in km/h (1962 to 2010)**

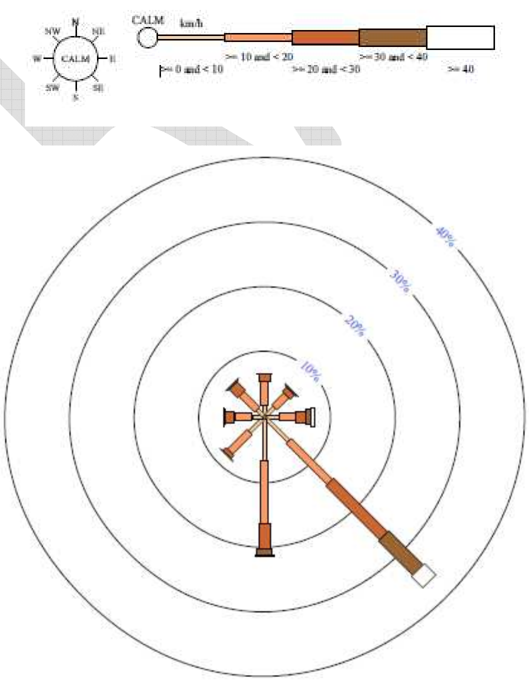



**Figure 2-11 – Centre Island 9am Rose of Direction versus Wind Speed in km/h (1974 to 2010)**

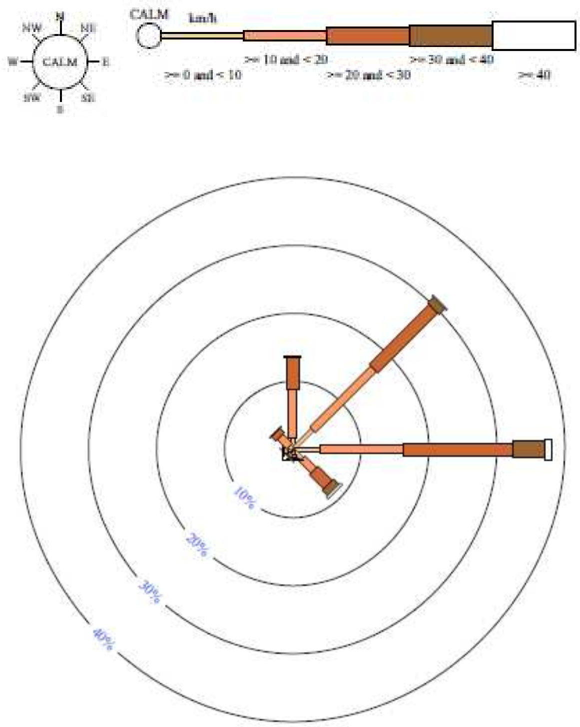



**Figure 2-12 – Centre Island 3pm Rose of Direction versus Wind Speed in km/h (1974 to 2010)**

## 2.2 Surface Water Catchments

### 2.2.1 Project Catchment Context

The area potentially affected by the proposed mine site, haul road and load out facility is located between the Roper and McArthur River drainage divisions, on the western side of the Gulf of Carpentaria (Figure 2-13). This area traverses the Towns River, Limmen River and Rosie Creek drainage divisions.

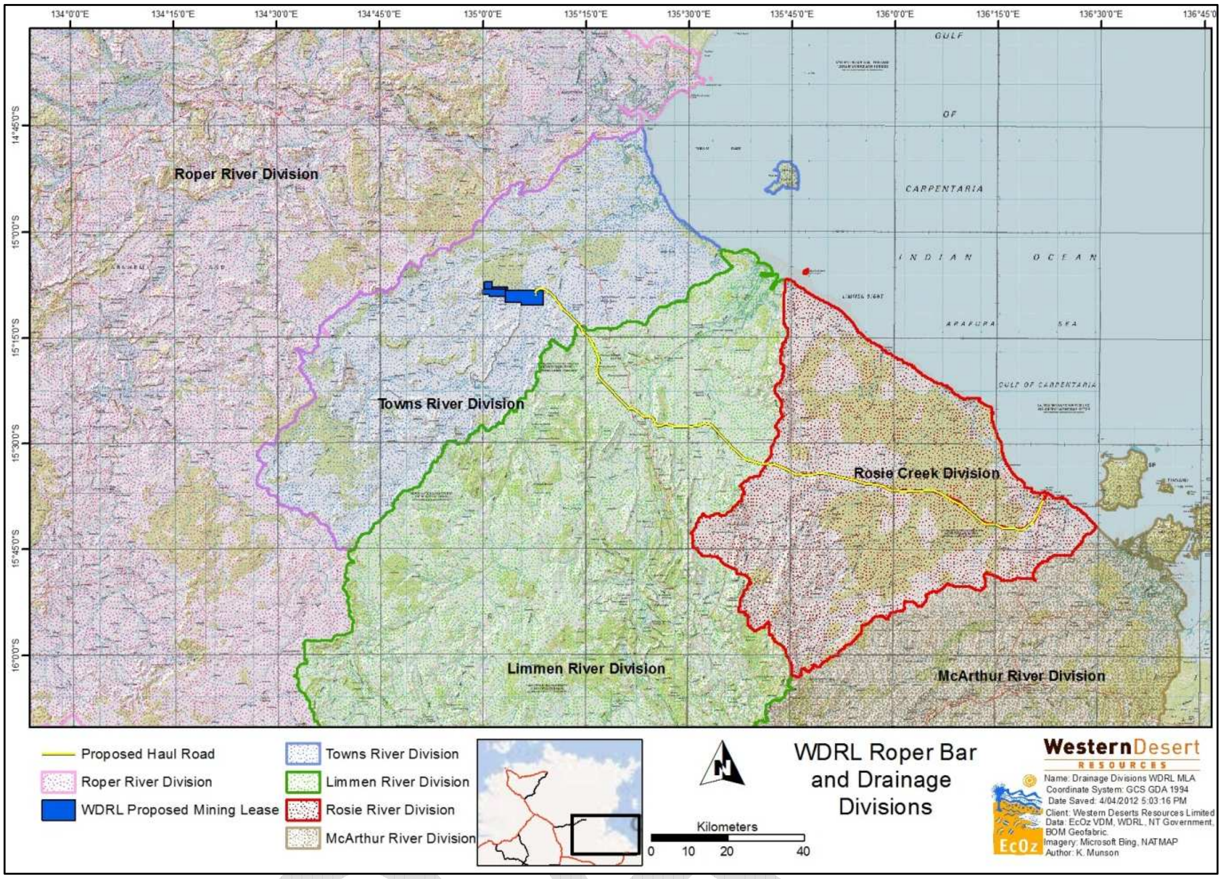



**Figure 2-13 - Location of mine site, haul road and Bing Bong loading facility in context of regional catchments.**

## 2.2.2 Mine Sub-catchments

### *Mine Site*

From its headwaters (approximately 30m AMSL), the Towns River catchment drains in a north-east direction for a total length of 130km, before it enters the Gulf of Carpentaria. The project area is located in the middle reaches of the Towns River.

The main Towns River channel passes through the centre of the project area, which is joined by two major tributaries about 20km downstream; Magaranyi River to the south-east and Yumanji Creek (Little Towns River) to the north (Figure 2-14). The catchment area of the main Towns River channel is relatively small ($503km^2$), compared to that of Magaranyi ($2068km^2$) and Yumanji ($1213km^2$) sub-catchments. Approximately $350km^2$ of the Towns River Catchment lies upstream of the project area.

Stream flows are restricted to during and just after the wet season (November to April) and surface waters are confined to remnant pools during the dry season (May to October). During the wet season, the Towns River has been observed to cease flowing for a week or more during periods of low rainfall. Although hydrographic data is not available for the Towns River or its tributaries, their catchment sizes and observations during baseline water quality surveys suggest that Magaranyi River contributes the highest flows, followed by the Towns River and Yumanji Creek.

The Towns River and its tributaries display a highly sinuous and meandering form, which alternate between well-defined channels and braided channel areas. The low-lying floodplain in the vicinity of the proposed mine is wide and flat and contains many non-active channel features, including ox-bow lakes and abandoned pools. During flood events, stream banks will overtop and flood waters may affect areas 1.0 to 1.5km from the stream channel. Maximum stream velocities are low (<2m/s).

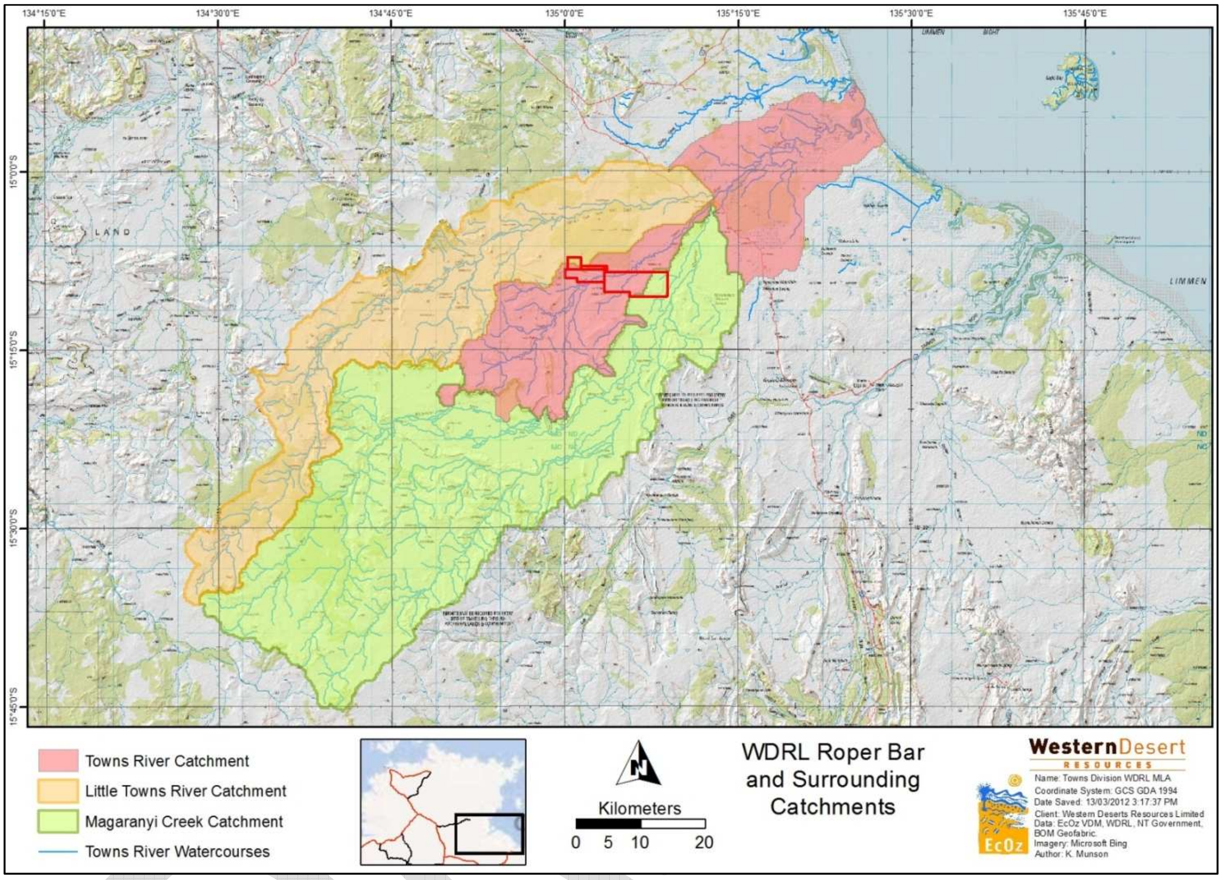



**Figure 2-14 - Location of project area within Towns River catchment.**

There are no other current uses or users of surface waters in the Towns River catchment

### 2.2.3 Bing Bong Sub-catchments

The Stockyard site is generally flat with an average elevation of approximately 3.0m AHD. The area of disturbance is approximately 22 hectares.

## 2.3 Groundwater Resources

Regional groundwater studies are limited. Recent studies to the north indicate that major aquifers in the Roper Region occur in the Tindall Limestone, Dook Creek Formation and Cretaceous sediments (Tickell 2009). These, particularly the Tindall aquifer, recharge in areas where the aquifer intercepts the surface through karstic conduit systems (e.g. sinkholes and caves), resulting from deep weathering (Knapton 2009).

The proposed mine site is located within the Towns River Catchment, whilst the proposed haul road crosses several catchments, of which the Limmen Bight is the largest. The Limmen Bight region hosts an aquifer system located in the north-east among shallow calcrete lithotypes (Northern Territory of Australia 2009) which is a likely source of base flow to the Nathan River.

### 2.3.1 Mine Site

The mine site is located in the middle reaches of the Towns River. The river has several waterholes along its course. These water bodies appear to be surface reflections of very shallow localised, and probably perched, groundwater systems which may be fed in some locations from exposed surface fracturing across higher lying ground.

A total of eleven investigative bores were constructed to ascertain the hydrogeological characteristics of the local aquifers and their variability around the proposed open pits. Bore drilling did not encounter any significant water bearing/yielding zones and there is no indication that any of the observed multiple water strikes are interconnected. Water was encountered predominantly in a) sandstones interbedded with siltstones and b) hematitic iron interbedded with silicified sandstones, mudstones and siltstones.

These bores are to be used for ongoing monitoring purposes.

### 2.3.2 Bing Bong

Although no groundwater data in the vicinity of the Bing Bong loading facility area were available during the preparation of this WMP, it is assumed that groundwaters are influenced by saline conditions, given the proximity to the coast.

# 3 Water Management System

## 3.1 Water Use in Operations

### 3.1.1 Mine Site

Water will be required at the mine site for the crushing/screening plant (331,128 kL/annum) and dust suppression of haul roads (113,029 kL/annum) and stockpiles (21,462 kL/annum). The total volume required for mining operations is therefore 465,619 kL/annum. An outline of the proposed water management system is provided in Figure 3-1.

Surface waters will not be extracted from the Towns River for mining. The major water source for mining will be from groundwater influx to the open pits (estimated at 2,365,200 kL/a) which will be contained in the primary storage facility of the mined out Pit 4. Water collected in sediment basins and from the Sewage Treatment Plant will also be recycled.

Potable water is required for human consumption and ablutions such as toilets, showers, bathroom, kitchens at the camps (both permanent mine camp and haul road construction camps), mine and administrative buildings and airport. Total potable water requirements have been estimated assuming a consumption of 300L per person per day. These are:

- 18,250 kL/annum at the camp site; and
- 3,650 kL /annum at the mine site.

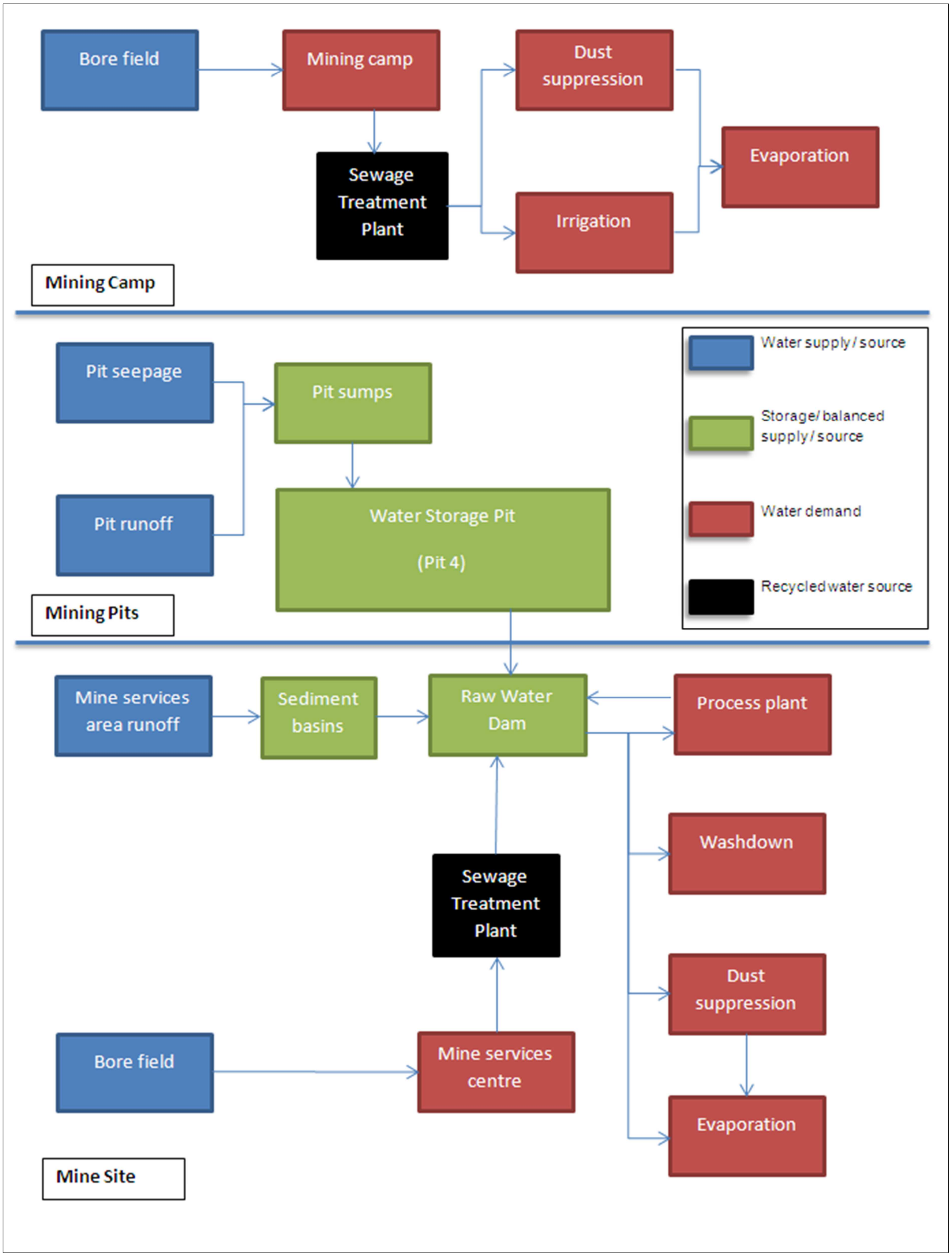



**Figure 3-1 Proposed Mine and Camp Water Management System**

### 3.1.2 Bing Bong

Water at the Bing Bong loading area will be sourced from bores at the facility. Since the site is within the seawater intrusion zone, a small reverse osmosis (RO) plant will be installed to treat bore water for potable supplies. Stormwater will be collected in settlement ponds and recycled for dust suppression. A total estimated volume of 175,696 kL/annum will be required for use at the Bing Bong Stockyard, primarily for dust suppression. An outline of the proposed water management system is provided in Figure 3-2.

Potable water is also required for Port of Bing Bong office facilities. Total potable water requirements are 3,285 kL/annum at the Bing Bong Stockyard loading facility, assuming a consumption of 300L per person per day.

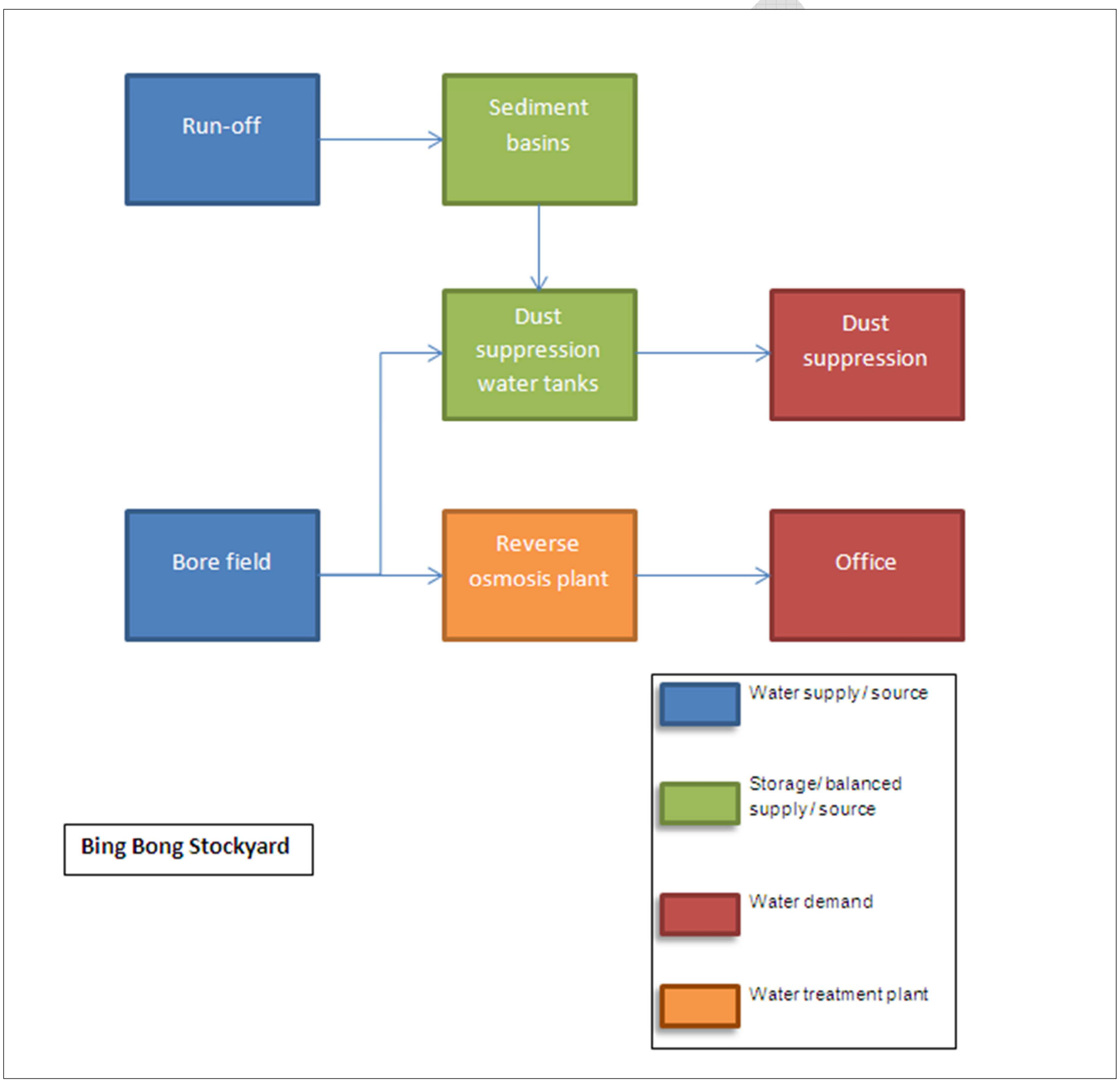



Figure 3-2 Proposed Bing Bong Stockyard Water Management System

## 3.2 Water Management Infrastructure

### 3.2.1 Mine Site

Initially, Area F West (Pit 4) will be mined. This is a small pit and after completion of mining, will provide the principal water storage for the mine. This Water Storage Pit (WSP) will potentially hold up to 956,000kL of water and will receive water from the sumps of other pits. Prior to the availability of the WSP for water storage, water required for initial mining development will be sourced from existing or to be developed groundwater bores within the project area.

Water from the WSP will transferred to the Raw Water Dam (RWD) at the mine site as necessary for the processing of ore through the gravity separation and crushing circuits. Water will be recovered from the processing circuits for reuse. Dust suppression around the mine site will utilise water from the WSP, RWD and sediment basin that have captured run-off from around the plant. The sediment basin to collect mine plant run-off is designed to have a water storage capacity of 3,886kL. Water from the ore stockpile sediment basin may also be utilised. This basin has a designed storage capacity of 8,276kL. Dust suppression will be achieved through water misters and sprays located throughout the plant, as well as on conveyors and stockpiles.

Erosion control measures are detailed in Appendix L. They consist or re-routing clean, external run-off around plant, airstrip and camp areas through a system of diversion channels and level spreaders. Uncontaminated run-off from disturbed areas will be collected in catch drains and channelled into sediment basins. Sediment basins will be constructed using the IECA Best Practice Erosion and Sediment Control guidelines with a minimum storage depth of 0.6 m. Implementation of these measures will ensure the integrity of receiving waters.

The current water treatment plant to provide potable water to the exploration camp consists of a softening filter (to remove carbonates), a 5 micron and 1 micron particle filter, a charcoal filter for taste and a UV light to kill any bacteria. Water treatment by RO plants (or similar) will be provided, where and if required, to treat bore water for potable supplies. The existing exploration camp obtains its potable water from a nearby bore, which produces water of a high quality with some elevated carbonates. It is envisaged that additional potable water requirements for the mine camp will be sourced from the existing camp bore and if required, additional bores will be constructed in the area.

The project requires construction of sewage treatment plants (STP) to treat the domestic stream generated from the mining camp and mine site. These systems will have the capacity to treat the entire domestic stream of both "black" and "grey" waste waters. The facilities will be Biological Nutrient Reduction (BNR) configurations, capable of treating daily volumes of waste water far in excess of those predicted. Two 'TransPAC Mega ISO Type 4' treatment systems will be utilised, each suitable to treat up to 50,000L per day. These systems provide secondary treatment to achieve final effluent quality with reduced nutrients, suitable for reuse via sub soil irrigation or evaporation irrigation.

The STPs will be installed and operated to treat water from the mine site and main camp to a high quality and will be recycled according to the Northern Territory Department of Health *Guidelines for Management of Recycled Water Systems* (2011). The end product from these STPs will also be validated and monitored to conform to the water quality set out in these guidelines before being recycled. Recycled water from the STPs will be used for irrigation and dust suppression around the mining camp and plant.

### 3.2.2 Bing Bong

Erosion control measures are detailed in Appendix L. They consist or re-routing clean, external run-off around the facility through a system of diversion channels and level spreaders. The run-off from the stockpile area will be collected in sediment basins. Sediment basins will be constructed using the IECA Best Practice Erosion and Sediment Control guidelines with a minimum storage depth of 0.6 m. Water from sediment basins will be used for dust suppression at the stockyard.

A small bore field will be established to provide additional make-up water for dust suppression after stored storm run-off has been used, and to provide potable water. Since the site is within the seawater intrusion zone, a small reverse osmosis (RO) plant will be installed to treat bore water for potable supplies.

## 3.3 Water Balance

A preliminary water balance for the mining operations and Bing Bong loading facility is provided in Table 3-1. In summary, it is evident that:

- Pit seepage or influx (i.e. pit dewatering) is the primary source of water;
- Processing is the primary user of water;
- Inputs from rainfall are relatively low and are greatly exceeded by modelled losses to evaporation, which renders a *water deficit* balance; and
- Owing to the generally small yields of bores and/or aquifers in proximity to WDRL, investigations into a supplementary bore field to the north of the Project Area are to be initiated.

**Table 3-1 Operational Water Requirements.**

| Water Source | Annual volume (kL) Dry (228mm - 1952) | Average (817mm) | Wet (1,449mm – 2011) |
|---|---|---|---|
| Pit Influx | 2,365,200 | 2,365,200 | 2,365,200 |
| Rain and Runoff | 790 | 2,823 | 5,013 |
| Potable bore water | 25,185 | 25,185 | 25,185 |
| ***Total*** | ***2,391,175*** | ***2,393,208*** | ***2,395,398*** |
| **Water Demand** | | | |
| Potable Water: Camp and Mine | 21,900 | 21,900 | 21,900 |
| Potable Water: Bing Bong | 3,285 | 3,285 | 3,285 |
| Process Water | 331,128 | 331,128 | 331,128 |
| Dust Suppression | 120,450 | 113,029 | 106,774 |
| Evaporation | 2,419,950 | 2,421,309 | 2,422,365 |
| ***Total*** | ***2,896,713*** | ***2,890,651*** | ***2,885,452*** |
| **Surplus/(Deficit)** | **(505,538)** | **(497,443)** | **(490,054)** |

# 4 Surface Water Management

## 4.1 Water Classes

For water management purposes, the surface runoff generated at the Roper Bar Iron Ore Project will be divided into three types, based on water quality:

1. **'Clean'** – surface runoff from areas of the site where water quality is unaffected by mining operations. Clean water includes runoff from undisturbed areas.
2. **'Dirty'** – surface runoff water and seepage from areas that are disturbed by mining operations, such as non-acid forming (NAF) waste rock dumps and roads. This runoff may contain silt and sediment, but is unlikely to contain contaminant concentrations in excess of ANZECC (2000) guidelines (95% Ecosystem Protection Level). However, any runoff to be discharged into receiving waters must be of suitable quality and will be managed according to the Erosion and Sediment Control Plans developed for the mine site and Bing Bong Stockyard facility (Appendix L), and this plan.
3. **'Contaminated'** – surface runoff water and seepage from areas affected by mining operations and potentially containing chemicals of various types generated by mining operations, where contaminant concentrations are (or are likely to be) in excess of ANZECC (2000) guidelines (95% Ecosystem Protection Level).

## 4.2 Potential Contaminants

The processing of ore in the plant will not use any chemicals and any water used in the processing circuit will be reused.

Mining of Area F will be conducted only in the dry season, and the depth of these pits will be relatively shallow. Accordingly, there should be minimal groundwater and the potential for any acid mine drainage within these pits is considered unlikely. If any Acid Mine Drainage is detected, it will remain in pit and be treated if necessary.

Areas where hazardous waste can potentially be generated include where ore is stockpiled, areas where PAF waste rock is encapsulated in NAF waste rock in a waste rock dump, open pits, and plant areas. Should there be evidence of PAF rock, run-off from these sources will be contained and treated.

## 4.3 Potential Impacts

Table 3-2 includes identified potential impacts on surface water during mining operations. Although the deterioration of water quality of Towns River can be considered a significant impact with wider environmental implications, the proposed management processes is likely to minimise any deterioration in both quantity and quality of river drained waters. Seepage containments in addition to sedimentation ponds and a constant monitoring of effluents directed into the River would be engineered and implemented to prevent any contaminated water influx into the wider surface water systems.

Groundwater surface expressions, including any identified GDE, are highly unlikely to be affected by mining operations as surface and ground water interaction is limited to underflows and minimal infiltration processes occurring mostly during wet season.

| Impacts on Surface Water During Mining and Operations |
|---|
| Deterioration of water quality in Towns River |
| Reduction in volume of surface water in Towns River |
| Impact on base flow, increase/decrease flow to/from GDEs, impact on biota |
| Impact on aquifer yields |
| Seepage from WRDs, stockpiles, surface impoundments |

## 4.4 Abstraction

Surface waters in the Towns River will not be used for mining. Surface run-off from disturbed areas will be collected and a proportion of these will be utilised for mining. The majority of water for mining operations will be sourced from groundwater influx to pits that will be collected in pit sumps. Make-up water will be sourced from groundwater.

## 4.5 Discharge

The mine will operate at a net water deficit. Make up water will need to be sourced from bore fields to balance the mine's water account. Water storage structures will ensure there is no need to discharge any contaminated water.

Dirty water will be allowed to discharge into surrounding water ways after passing through sediment basins to remove suspended particles. Artificial flocculation may need to be applied to the retained water in the sediment basins to assist with the settling process.

It is not expected that any contaminated water will be generated from the mine in its first year of operation. If PAF material in waste or low grade stockpiles produce contaminated run-off / seepage at a later date, this water will be collected, treated and reused within the mine. There will not be any requirement to discharge contaminated waters.

## 4.6 Contingency Planning and Mitigation Measures

| Issue | Actions |
|---|---|
| AMD effects on the environment | a) Implement response to limit environmental impact<br>b) Identify source of issue<br>c) Review knowledge base to identify shortcoming<br>d) Review current strategy<br>e) Update planning and implementation |
| Function or biota affected by stream realignment. | a) Implement response to limit environmental impact<br>b) Identify source of issue<br>c) Review knowledge base to identify shortcoming<br>d) Review current strategy<br>e) Update planning and implementation |

| Issue | Actions |
| --- | --- |
| Evidence of erosion and sedimentation within the WDRL footprint | a) Document the erosion and/or sedimentation as an environmental incident (take photos)<br>b) Determine what is causing erosion and/or sedimentation<br>c) Review ESCP and mitigation structures – fix any areas which are not working effectively<br>d) Report in the MMP |
| Uncontrolled discharge incident | a) Record as environmental incident and ensure reported within the MMP<br>b) Determine reasons for uncontrolled discharge and develop strategy to mitigate<br>c) Improve site diversion, ESCP structures as necessary<br>d) Determine if contamination event has occurred and report as necessary |
| Reduced water quality downstream | a) Record as environmental incident and ensure reported within the MMP<br>b) Determine reasons and develop strategy to mitigate<br>c) Improve site diversion, ESCP structures as necessary<br>d) Report as environmental incident in MMP |

### 4.6.1 Flood Mitigation – Mine Site

The mine plant site and camp areas are located on high ground above the 100-year ARI flood level.

The design philosophy for realignment of the Towns River (Option C) entails:

- Mining Area F West Pit 3 during the dry and allow the pit to permanently flood during the wet season.
- Construct an inlet at the western end of Pit 3 and provide an inlet and outlet at the eastern end.
- Construct channels between oxbows on the northern side of Pit 2 where pit infrastructure are to be constructed across existing flow channels.
- Construct the final outlet into the existing stream channel between the Exclusion Zone and Pit 2.

Option C has been designed to contain the 20-year ARI within the realignment since the existing streams only convey incidental flows within the banks. This rationale facilitates maintaining sinuosity, imitation of existing channel morphology and meander pattern as far as practicable within engineering risk constraints. Option C requires the least disturbance and alteration of catchments, stream realignment and other flood protection infrastructure.

In addition to the above the Towns River at the western end of Pit 3 will be allowed to flow into the pit by means of an additional excavation of a top flitch in the southern wall. This flitch will vary in depth below natural surface between 1.2m at the channel end to a maximum of 3.2m at the pit wall and will be protected by rock armouring where required. The open pit will be constructed with the two upper benches at $40^{o}$, some 10m high separated by a berm 5m wide.

The open pits and WRDs would be protected by bunds set at minimum required heights assuming a minimum freeboard requirement of between 30% and 50%:

| Location Name | HEC-RAS Cross-Section | Estimated Water Surface Elevation (m) | Notes |
|---|---|---|---|
| Operating pit - south wall - east end | 2699 | 19.6 | Unlikely to be affected by 20 year ARI flooding |
| Operating pit - south wall - nr Wades Crossing | 324 | 23.0 | Freeboard - +50% of the height from ground level to 20 year ARI flood level |
| Operating pit - north wall - nr Wades Crossing | 8282 | 22.9 | Freeboard - +50% of the height from ground level to 20 year ARI flood level |
| Operating pit - north wall - east end | 3994 | 20.6 | Freeboard - +50% of the height from ground level to 20 year ARI flood level |
| Eastern Waste Dump | 2699 | 19.6 | Toe of dump unlikely to be affected by 20 year ARI flooding |
| Western Waste Dump | 324 | 23.0 | Toe of dump unlikely to be affected by 20 year ARI flooding |

Erosion protection by means of rock armouring is to be provided where the flow velocity exceeds 2m/s. Since HECRAS modelling indicated that the velocities adjacent to the pit bund and waste dumps will be well below this level, erosion protection measures are not required for the pit bund and waste dump facilities therefore.

### 4.6.2 Flood Mitigation – Bing Bong

The stockyard is to be constructed on an earthen pad to elevate infrastructure above the natural topography and storm surges. Stormwater management controls are to be implemented:

- Upstream diversion bunds to divert clean storm runoff around the site;
- Catchment bunds to divert storm runoff into sediment basins; and
- Sediment basins with mulch bunds at the downstream perimeter of the site to settle and discharge treated storm runoff.

# 5 Groundwater Management

## 5.1 Potential Contaminants

No chemicals are used in the preparation of the shipping ore and the ore stockpiles do not present a potential source of contamination to groundwater.

Bulk fuel tanks will be located at the Bing Bong loading facility, Mine Site, Camp and will later be installed at the Airstrip. These tanks will be self-bunded and should not pose a contaminant threat to groundwater, except in the event of a catastrophic failure. Fuel spillages during refuelling will be cleaned up immediately and is therefore unlikely to affect groundwater.

Seepage of poor quality water associated with AMD is possibly the main potential source of contamination to ground waters.

## 5.2 Potential Impacts

There is the likelihood of the depletion of groundwater resources in the immediate area (less than 1.2km from the edges of the open pits) surrounding the mine pits. The groundwater modelling identifies this area. There is limited potential for impacts on GDE's: only one potential GDE has been identified. There are currently no other users of the groundwater in the region and with the establishment of a National Park, new users are unlikely.

## 5.3 Groundwater Management Infrastructure

Groundwater management infrastructure pertains to small-scale abstraction and treatment for potable supplies at the camp and plant and possibly the Stockyard and loading facility.

Pit dewatering systems will discharge to Storage Pit 4 in the western portion of Area F; the primary source for processing and dust suppression.

## 5.4 Abstraction

### 5.4.1 Mine site

Water requirements for the mining and processing operation will be sourced from groundwater influx into mining pits and run-off water collected in sediment basins. Although water balance calculations show an overall water deficit, the Water Storage Pit 4 will provide a sufficiently large reservoir available to meet the needs of the mine without the extraction of additional bore water. This storage capacity will also assist in containing mine waters and obviates the need for discharge into the Towns River.

### 5.4.2 Bing Bong

Sediment basins will collect all surface runoff from the Stockyard and this water will be used for dust suppression at the stockyard. However, this will be insufficient for the entire dry season and make up water will be required from a nearby bore field. The volume of required groundwater is dependent upon the size and duration of the preceding Wet season.

## 5.5 Contingency Planning and Mitigation Measures

| Non-compliance | Action |
|---|---|
| Groundwater quality has declined | a) Report as environmental incident – report within MMP<br>b) Identify corrective actions and implementation strategies<br>c) If necessary, consult with regulatory authorities to determine appropriate management<br>d) Review ESCP if necessary<br>e) Check all bunding and spill containment structures to ensure no breach is evident<br>f) Check all storage containers/basins to ensure no breaches are evident |
| Groundwater Dependent Ecosystems are showing signs of deterioration or change | a) Report as environmental incident – report within MMP<br>b) Identify corrective actions and implementation strategies<br>c) If necessary, consult with regulatory authorities to determine appropriate management |
| Contamination incidents occurring at unacceptable levels | a) Report as environmental incident – report within MMP<br>b) Identify corrective actions and implementation strategies<br>c) If necessary, consult with regulatory authorities to determine appropriate management<br>d) Review ESCP if necessary<br>e) Review spill containment procedures and infrastructure<br>f) Review chemical storage procedures and infrastructure<br>g) Update procedures and equipment as necessary |

# 6 Monitoring

## 6.1 Monitoring Programs

Monitoring will be undertaken to verify compliance with environmental conditions and commitments, satisfy regulatory and reporting requirements, track environmental performance and measure the effectiveness of environmental management measures.

WDRL will establish an environment monitoring program specific to its operations at Bing Bong. WDRL will also participate in the relevant environmental monitoring programs currently run by Xstrata and expand these programs if necessary for the WDRL operation.

Results from any monitoring undertaken will be presented within the MMP, with an assessment of compliance against commitments made in the EMP.

Provision will be made for changes in monitoring requirements throughout the proposal including those following the implementation of the Rehabilitation and Closure Plan. Changes will be captured within the MMP.

### 6.1.1 Surface Water

| Management Objective | Performance Indicators | Monitoring Methods | Reporting |
|---|---|---|---|
| No AMD affects to the environment | A comprehensive AMDMP completed and implemented | To be developed as part of AMDMP but will include water quality | MMP |
| Stream realignment will not affect river function or biota | No evidence of erosion as a consequence of increased velocity | Part of ESCP | MMP |
| | No changes in water quality | Part of surface water monitoring program | |
| Maintain baseline water quality | No evidence of erosion or sedimentation outside the mining footprint | Visual inspection and permanent monitoring points in susceptible areas | MMP |
| | Water quality upstream and downstream of bridges the same | Chemical and dissolved solids assessment | Monthly initially, six monthly afterwards |
| | Water quality parameters upstream and downstream of mine in accordance with baseline quality | In situ and laboratory testing in accordance with this plan | Annually through MMP |
| | No spills of any environmentally harming products | Incident reporting | Through MMP |
| | Installation of sewage systems to code and no reports of incidents | Incident reporting | Through MMP audit |

### 6.1.2 Groundwater

| Management Objective | Performance Indicators | Monitoring Methods | Reporting |
|---|---|---|---|
| To ensure that groundwater quantity is retained | Construction bore management plan written and implemented | Monitoring of water levels | MMP |
| | No impact on important GDE | Condition of important GDE | |
| To ensure that groundwater quality is retained | No changes in water quality due to AMD | As part of groundwater monitoring plan | MMP |

### 6.1.3 Biological

| Management Objective | Performance Indicators | Monitoring Method | Reporting |
|---|---|---|---|
| Protect flora and fauna species, and significant habitat types, from negative impact | No evidence of impact outside mining footprint e.g. no sedimentation or erosion | Visual inspection post wet season to determine areas at risk/showing evidence of erosion and/or sedimentation | Keep a record of areas showing signs of erosion and/or sedimentation so that measures of success can be made on mitigation strategies – e.g. photo monitoring |
| | | Condition inspection of sensitive habitats | Any evidence of impact on significant habitats should be documented and reported within the MMP |
| | No change in species and community composition downstream of mine compared to upstream and baseline data | Macroinvertebrate surveys | Any evidence of impact on macroinvertebrate communities should be documented and reported within the MMP |
| | | Fish surveys | Any evidence of impact on fish communities should be documented and reported within the MMP |

## 6.2 Sampling Methods and Quality Control

### 6.2.1 Surface Water

Surface water quality will be monitored on a regular basis at sites that are located both upstream and downstream of inputs from the mine site, in order to assess potential impacts of mining operations on downstream surface water quality. A preliminary surface water monitoring program is presented in Table 6-1 below, including baseline monitoring locations. The monitoring program will be finalised prior to commencement of mining activities, in consultation with relevant regulatory agencies (i.e. DoR, NRETAS).

**Table 6-1 Proposed Surface Water Monitoring Program.**

| Monitoring Sites | Frequency | Analytes |
|---|---|---|
| Mine Area: RBSW01 – RBSW14 | Monthly (during periods of flow) | In-situ pH, electrical conductivity (EC), turbidity.<br>Total dissolved solids (TDS) and total suspended solids (TSS).<br>Total acidity and total alkalinity.<br>Major anions (Cl, $SO_4$, $CO_3$/$HCO_3$, $NO_3$) and cations (Ca, Mg, Na and K) and fluoride.<br>Dissolved metals: As, Cd, Cr, Cu, Mn, Ni, Pb, Zn, Fe<br>Ammonia and nutrients (total N and total P) |
| Haul Road: RBSW15 – RBSW21, both upstream and downstream of haul road | Weekly during construction | In-situ pH, electrical conductivity (EC), turbidity.<br>Total suspended solids (TSS). |

### 6.2.2 Groundwater

Groundwater levels and field water quality will be surveyed monthly whilst samples for laboratory analysis of water quality will be obtained quarterly, from all monitoring bores located both upstream and downstream of the mine site. The data and information gathered from these monitoring programs will be used to assess potential impacts of mining operations on downstream water qualities. A preliminary groundwater monitoring program is presented below, including baseline monitoring locations (Table 6-2). The monitoring program will be finalised prior to commencement of mining activities, in consultation with relevant regulatory agencies (i.e. DoR, NRETAS) including additional monitoring locations for shallow and deep groundwater monitoring bores in the vicinity of specific infrastructure locations (i.e. WRDs, plant, ore stockpiles, etc).

**Table 6-2 Proposed Groundwater Monitoring Program for the Mine Site.**

| Monitoring Sites/Action | Frequency | Analytes |
|---|---|---|
| RBGW01 to RBGW11<br>Additional shallow and deep bores up- and downstream of specific infrastructure locations i.e. WRDs, tailings dam, plant, ore stockpiles, etc, | Monthly | Groundwater level.<br>Field water quality: in-situ pH and electrical conductivity (EC). |
| RBGW01 to RBGW11<br>Additional shallow and deep bores up- and downstream of specific infrastructure locations i.e. WRDs, tailings dam, plant, ore stockpiles, etc, | Quarterly | Groundwater level.<br>Field water quality: in-situ pH and electrical conductivity (EC).<br>Laboratory:<br>Total acidity and total alkalinity.<br>Major anions (Cl, $SO_4$, $CO_3$/$HCO_3$, $NO_3$) and cations (Ca, Mg, Na and K) and fluoride.<br>Sulphide S.<br>Dissolved metals: As, Cd, Cr, Cu, Mn, Ni, Pb, Zn, Fe |
| Reporting | Monthly and quarterly | Tabulations and trend diagrams.<br>Mass transport model. |
| Response | Monthly and quarterly | Variations by more than 10% trigger further assessment, re-sampling and site investigations to ascertain cause, impact, remediation and preventative action. |

### 6.2.3 Biological

Baseline surveys of aquatic macroinvertebrates will be conducted during the 2012 post-wet season recessional flow period, in accordance with the NT manual for the national AUSRIVAS monitoring methodology (Lamche 2007). Importantly, this sampling will be conducted prior to the commencement of any construction/mining activities. Sites will be sampled on major streams draining the mine project area (i.e. Towns River, Magaranyi River) and upstream/downstream of proposed haul road crossings.

## 6.3 Water Quality Trigger Values

### 6.3.1 Surface Water

It is proposed that initially, the default ANZECC (2000) guidelines for 95% aquatic ecosystem protection (hardness modified) will be adopted as maximum trigger values for surface water monitoring. It is envisaged that site-specific trigger values will be developed when there is sufficient data available from baseline monitoring and upstream reference sites.

### 6.3.2 Groundwater

It is proposed that site-specific (and possibly individual monitoring location-specific) trigger values be developed using ambient water qualities from baseline monitoring and reference sites.

# 7 Reporting

## 7.1 Monitoring Data and Interpretation

A complete data set and analysis will be presented annually as part of the Water Management Plan component of the Mining Management Plan.

## 7.2 Incidents

Incidents associated with water or that may impact water or water resources will be reported immediately to the Department of Resources and other Departments if the incident is of a nature that requires that level of reporting.