



### 3. Climate, Natural Hazards and Climate Change

*This section provides a summary of climatic conditions and natural hazards that may affect management of potential impacts, in regards to the Project (Mine) during construction and operation. The assessment was undertaken in accordance with the requirements of the Terms of Reference (ToR) and a table cross-referencing these requirements is provided in Volume 4 Appendix C ToR Cross Reference Table. Flood plain management in particular is discussed further in Volume 4 Appendix P Hydrology Report.*

#### 3.1 Introduction

A climate and natural hazards assessment, inclusive of consideration of climate change risk has been undertaken. The assessment describes the climatic conditions experienced in the Project (Mine) area, and identifies the potential vulnerability of the Project (Mine) to these seasonal conditions and potential climatic extremes and natural or induced hazards. The assessment of climate, natural hazards and climate change draws on the result of several investigations undertaken for the Project (Mine) as well as desktop assessment of available literature. Specifically this section incorporates results from air quality baseline data collection, hazard and risk assessment and hydrology assessment.

#### 3.2 Description of Environmental Values

##### 3.2.1 Overview

The Project consists of:

- ▶ Mine (onsite), which includes both open cut and underground mining over EPC1690 and the eastern portion of EPC1080, on mine infrastructure and associated mine processing facilities
- ▶ Mine (offsite) infrastructure including:
  - A workers accommodation village and associated facilities
  - A permanent airport site
  - Water supply infrastructure

The operating life of the Mine is expected to be 90 years. Changes in climatic conditions and water availability over the design life have the potential to impact the Project's structures, processes, and supply chain logistics and therefore lifecycle maintenance costs and vulnerability to natural hazards.

Structures and processes are influenced by ambient air temperatures, precipitation, wind speeds and water availability. The frequency of extreme precipitation, flash flooding, wind and dust storms can interrupt mining operations and transport to and from the Project, and as such is an important design parameter for critical structures onsite.

In addition, reliability of water supply and avoiding excessive build-up of water inventory is essential for mining activities, necessitating a water management approach that can cope with periodic drought and flood conditions. The potential for extreme climatic events to impact environmental values is also considered in regard to flooding and uncontrolled releases of mine affected water.



### 3.2.2 Climatic Conditions

#### 3.2.2.1 Climate Stations

The Project (Mine) is located approximately 160 km north-west of Clermont. The nearest BoM stations to the Project (Mine) are the Carmichael, Twin Hills and Hughenden stations. The Carmichael station is closest, located approximately 12 km from the Project (Mine); the Twin Hills station is approximately 53 km east of the Project (Mine); and the Hughenden station is located approximately 239 km north-west of the Project (Mine) (refer to Figure 3-1).

The existing air shed environment, both locally and in a regional context, has been described by site-representative records of temperature, rainfall and wind speed and direction. The important air dispersion parameters of atmospheric stability and mixing depth are derived parameters best described by reported or calculated conditions over a larger regional context (inland central Queensland). The stations at Twin Hills and Hughenden were found to have sufficient data to describe the airshed environment, while data at Carmichael station was limited.

Climatically, the inland areas surrounding the Project (Mine) can be described as between a 'grassland' climate with a sub-classification of 'hot (winter drought)' such as found in Hughenden to the west and a 'subtropical' climate with a sub-classification of 'moderately dry winter' such as found at Twin Hills to the east (Stern et al, 2000).

The Hughenden Post Office has acted as a BoM climatic observing site (number 030024) since 1884 and remains operational. At the preparation of this report, the rainfall record at Hughenden spanned 117 years and the temperature record spanned 36 years.

The Twin Hills Post Office acted as a BoM climatic observing site (number 036047) between 1905 and 1985. At the preparation of this report, the rainfall record at Twin Hills spanned 80 years and the temperature record spanned 20 years.

The Carmichael meteorological station has acted as a BoM rainfall only observing site (number 036122) since January 2003. The station has the operational status of 'open', however, data records cease at 31 December 2010 with patchy data returns for all years except 2004-06 and 2008-09. There is also no temperature record at Carmichael meteorological station. Hence, this site cannot be used to classify the climate albeit the limited record can be compared to the nearby climatic sites of Hughenden (grassland – hot winter drought) and Twin Hills (subtropical – moderately dry winter).

#### 3.2.2.2 Carmichael AWS

An Automatic Weather Station (the Carmichael AWS, site number 333300) was commissioned by Adani on 27 October 2011. The Carmichael AWS is situated on the Project (Mine) and is intended to record the local climate with the following parameters.

- ▶ Temperature at 2 m and 10 m above ground level
- ▶ Solar radiation (in W/m<sup>2</sup>)
- ▶ Wind speed and direction
- ▶ Rainfall

Due to the short period of time in which the Carmichael AWS has been operating, the description of the meteorology of the Project (Mine) was primarily based on meteorological data collected at representative BoM sites across the region (refer to Section 3.2.1). Due to a solar panel fault, no data was recorded from 22 January to 3 May 2012.



**Plate 3-1 Carmichael AWS (Site number 333300)**

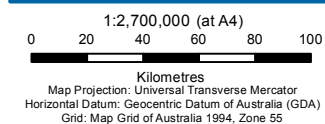




**LEGEND**

- ⚓ Major Port
- Key Centre / Locality
- ▲ Station
- State Road
- Existing Railway
- Local Government Area Boundary
- Rail (West)
- Rail (East)
- Project (Mine)
- Mine (Offsite)

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.



**Adani Mining Pty Ltd**  
Carmichael Coal Mine and Rail Project

Job Number | 41-25215  
Revision | A  
Date | 11-10-2012

Regional Study Area

Figure: 3-1



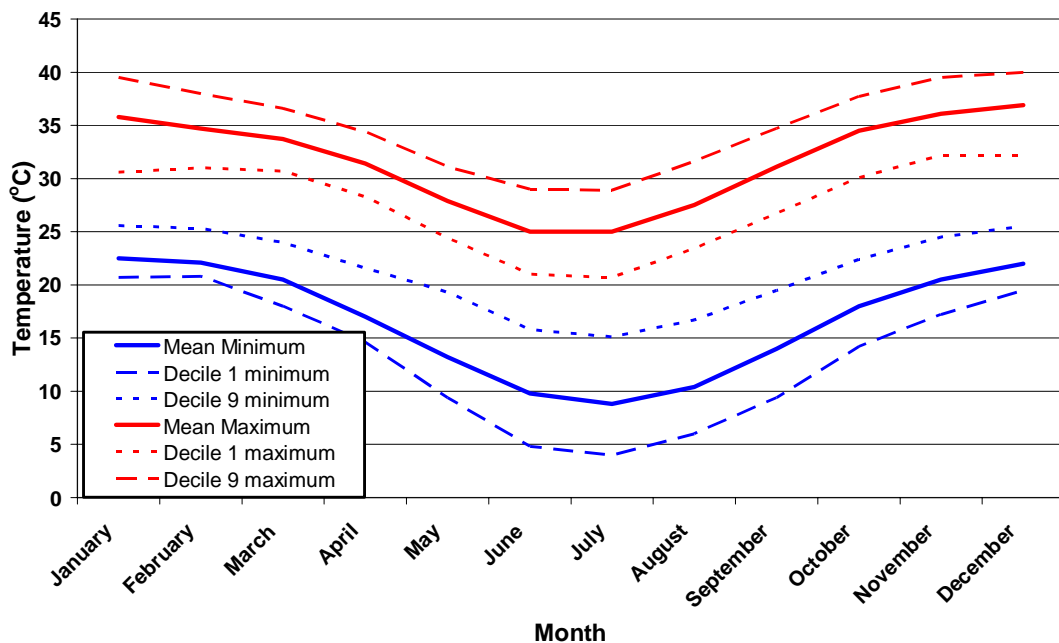
### 3.2.2.3 Air Temperature and Humidity

Monthly mean temperatures and humidity for Hughenden and Twin Hills are displayed in Figure 3-2 to Figure 3-5. These show the seasonal variation in the temperature range. Mean monthly minimums and associated upper and lower 10 percentiles (decile) are shown in blue and maximums are in red. Monthly mean relative humidity throughout the year is also displayed with both 9 am in the morning (red) and 3 pm in the afternoon (blue) observing times shown. These show both seasonal and diurnal patterns in humidity.

Monthly mean temperatures for Hughenden Post Office (Site Number 036047) show daytime summer temperatures are mostly in the mid-30s with winter overnight temperatures most commonly between 7 and 12 degrees (see Figure 3-2). The temperature record of approximately 36 years shows values ranging from -2°C to 44°C. 'Hot days', with temperatures exceeding 35°C, can be expected up to 101 days per year. 'Frost days' with screen temperatures below 2°C can be expected up to 1.4 days per year. Relative humidity is highest in the mornings and during the February while the lowest is in the mid to late spring mornings and afternoons (see Figure 3-4).

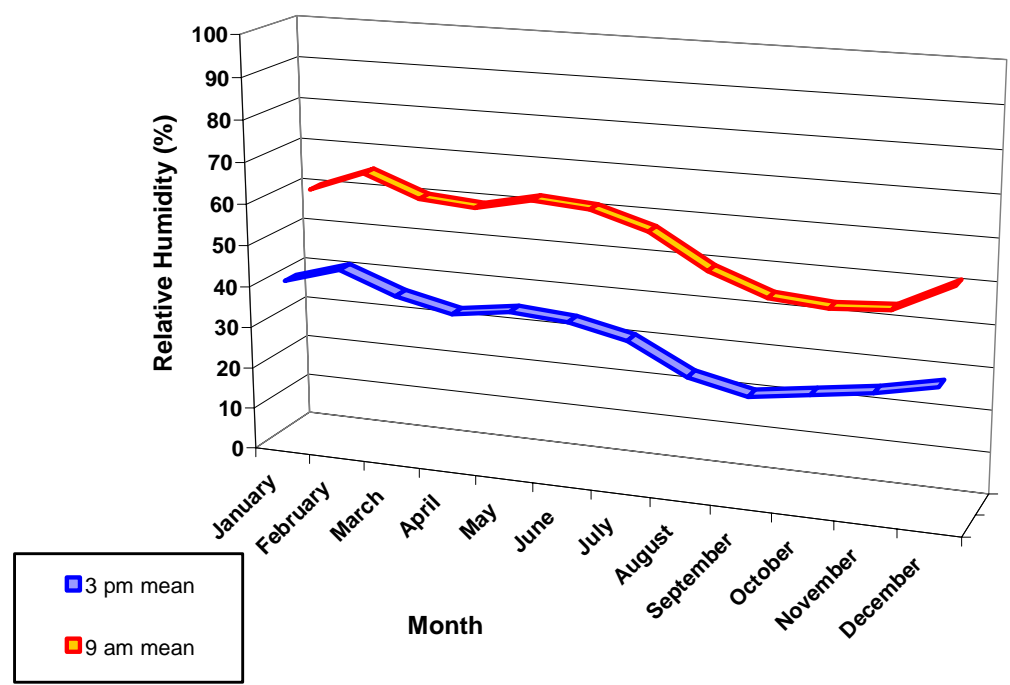
Monthly mean temperatures for Twin Hills Post Office (Site Number 036047) show daytime summer temperatures are mostly in the early to mid-30s with winter overnight temperatures dropping to between 5 and 10 degrees (see Figure 3-4). The temperature record of approximately 20 years shows values ranging from -3.2°C to 43.8°C. 'Hot days', with temperatures exceeding 35°C, can be expected up to 74.6 days per year. 'Frost days'; with screen temperatures below 2°C can be expected up to 10.4 days per year. Relative humidity is highest in the mornings and during the month of February and lowest in the late spring mornings and afternoons (see Figure 3-5).

**Figure 3-2 Monthly Mean and Decile (10% and 90%) Maximum and Minimum Temperatures (°C) at Hughenden Post Office**

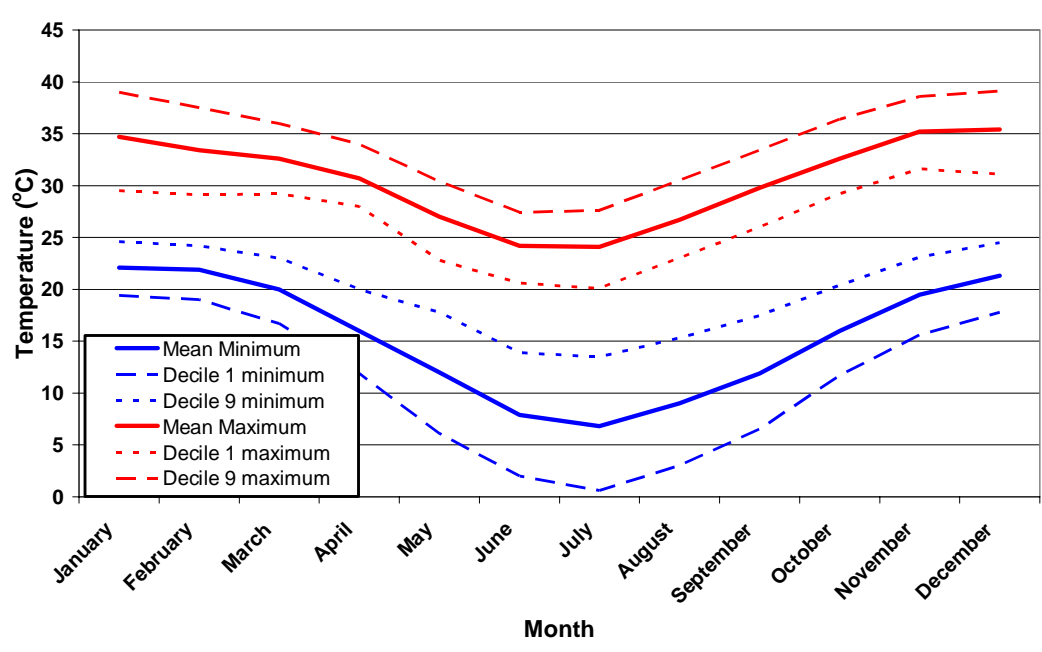




**Figure 3-3 Morning and Afternoon Monthly Mean Relative Humidity (%) at Hughenden Post Office**

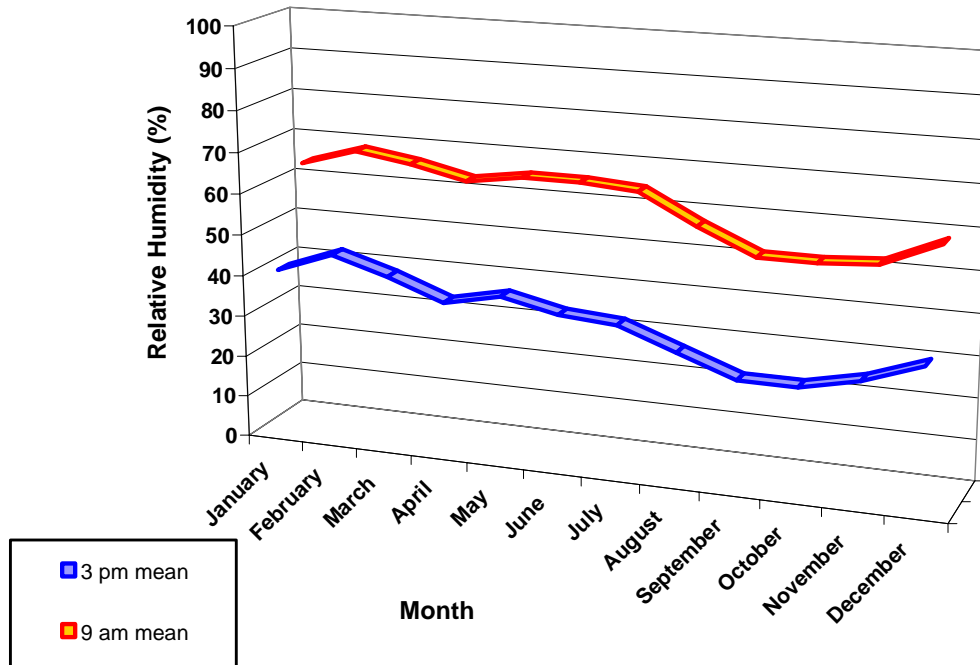


**Figure 3-4 Monthly Mean and Decile (10% and 90%) Maximum and Minimum Temperatures (°C) at Twin Hills Post Office**





**Figure 3-5 Morning and Afternoon Monthly Mean Relative Humidity (%) at Twin Hills Post Office**



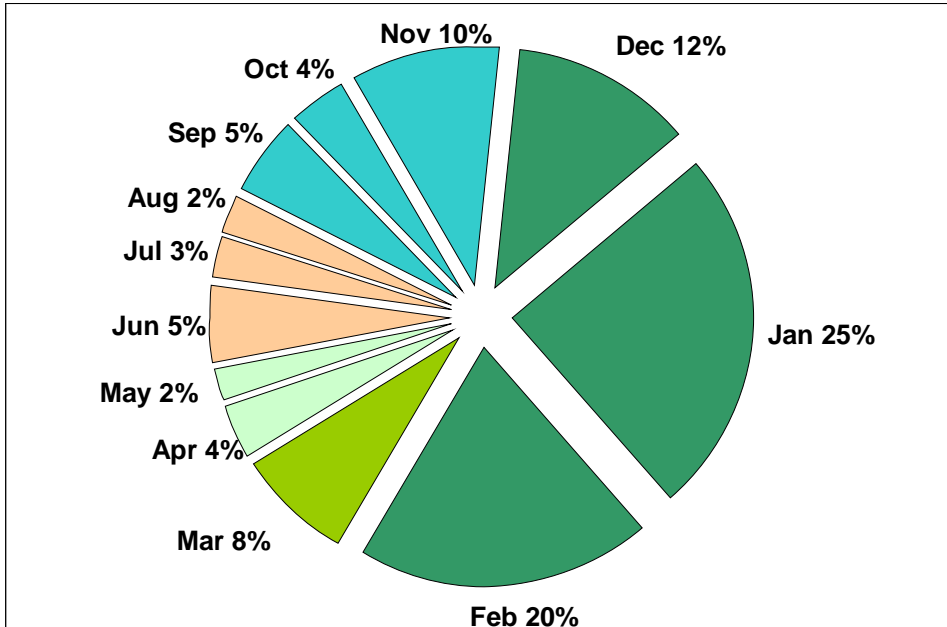
### 3.2.2.4 Rainfall

The annual rainfall record at Carmichael station ranges between 252 mm and 700 mm, with a mean of 524 mm, driven primarily by warm months producing convectively driven rainfall. Monthly mean rainfall proportions are shown in Figure 3-6. Rainfall in December through March accounts for 65 per cent of annual mean rainfall. The wettest month is January with a mean of 129.1 mm and the driest month is May with a mean of 11.2 mm.

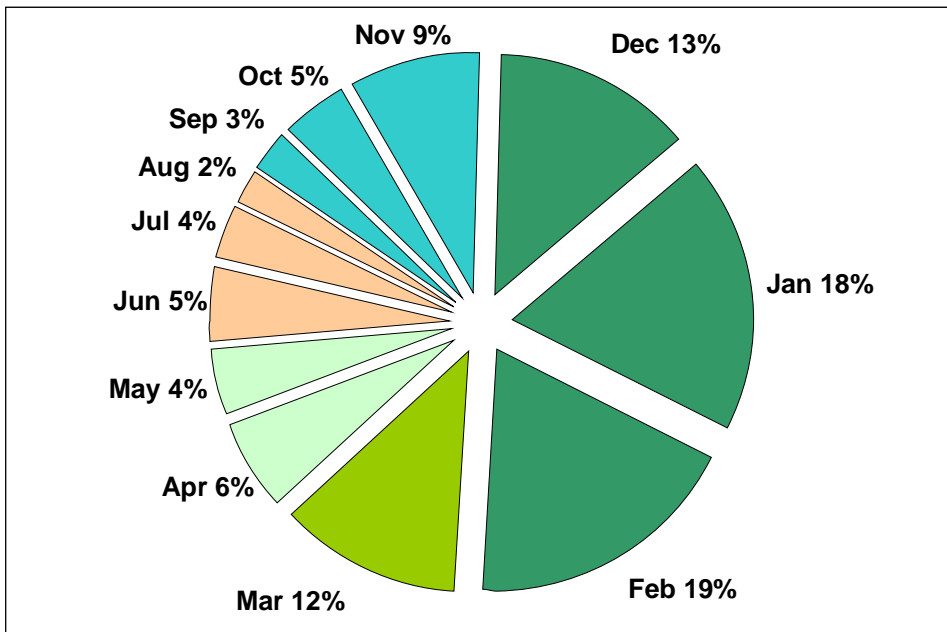
As the rain record at Carmichael station begins in 2003, the range of rainfall is not reliable at this stage, however similar rainfall patterns can be seen at Twin Hills and Hughenden. The annual rainfall record ranges between 218 mm to 1,477 mm at Twin Hills and 150 mm to 1,085 mm at Hughenden, with means of 610 mm and 492 mm respectively. Monthly mean rainfall proportions are shown in Figure 3-7 and Figure 3-8, with December through March inclusive accounting for the majority of the annual mean rainfall in the region. As would be expected, there is a clear pattern of rainfall decreasing inland with the mean number of rain days per year at 46 at Twin Hills and 43 at Hughenden.



**Figure 3-6 Monthly Mean Rainfall (mm) Proportions at Carmichael Site Number 036122 (January 2003 to December 2010)**



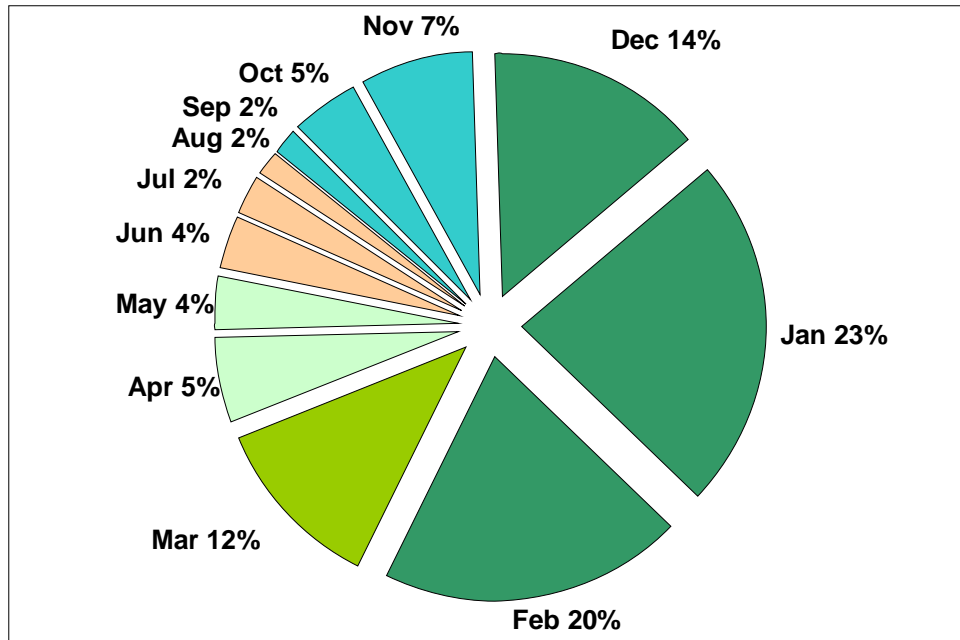
**Figure 3-7 Monthly Mean Rainfall (mm) Proportions at Twin Hills Post Office (1905 to 1985)**







**Figure 3-8 Monthly Mean Rainfall (mm) Hughenden Post Office (1884 – 2010)**



### 3.2.2.5 Wind Speed and Direction

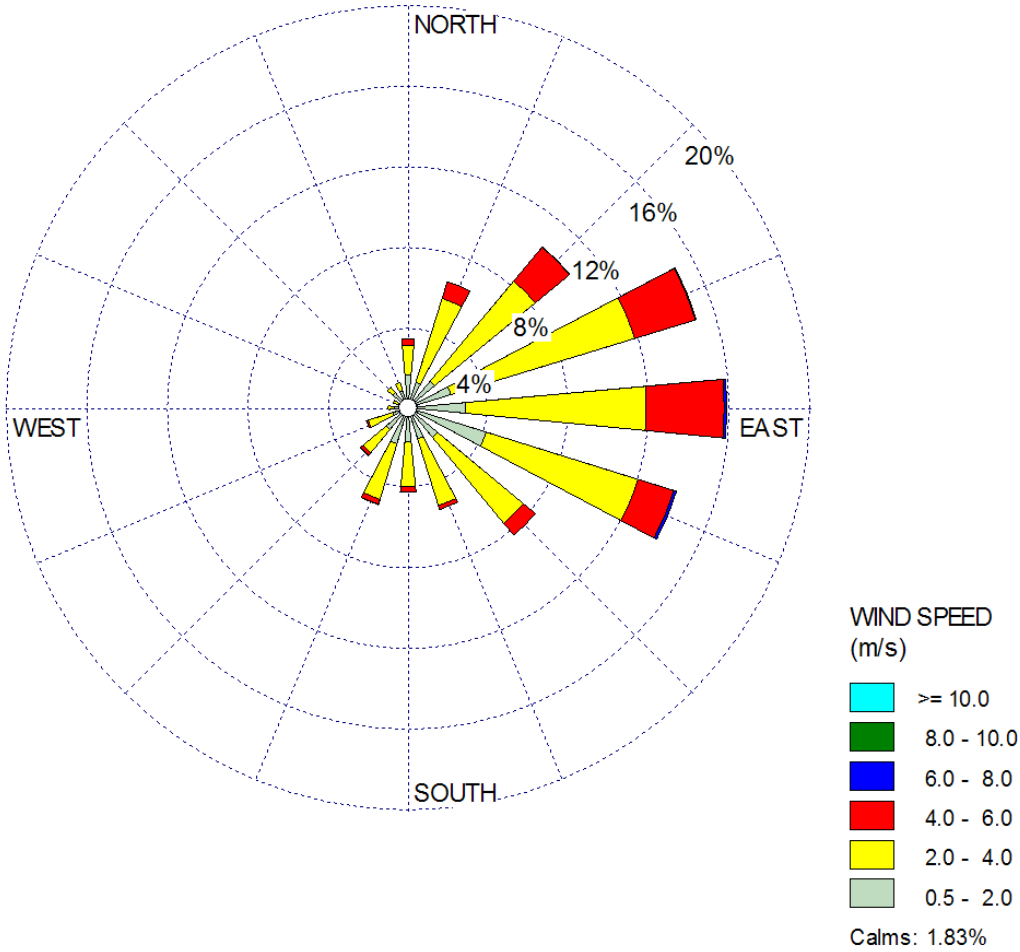
The annual wind rose for the Project (Mine) was derived using meteorological modelling tools (refer to Volume 2 Section 7 Air Quality). The prevailing wind directions have a strong easterly component. This is expected at this latitude of near 22° south, being dominated by the (south-east) southern hemisphere trade winds. The strongest winds, those above 4.0 m/s, continue the pattern of being mostly out of the east. The annual average wind speed for this dataset is 2.6 m/s. The modelled wind patterns were consistent with an inland sub-tropical climate, typical of the Bowen Galilee Basins. The dataset consistently shows the lack of westerly component winds and the south-easterly at times coming out of the north-east, mostly associated with wet season disruption to the prevailing trade winds.

To assess how well the modelling system represented the wind pattern, the derived annual wind rose for the Project (Mine) (refer to Figure 3-9) was compared with annual wind roses from Sonoma, Hughenden, Emerald (refer to Figure 3-10) and the Carmichael AWS (refer to Figure 3-11). Due to the absence of data from 22 January to 3 May 2012 at the Carmichael AWS, comparison was made for a November to January wet season and a May to August dry season. The comparison concluded that wind was been correctly modelled to be predominantly from the north-east sector during the wet season the south-east sector during the dry season, and that the model was consistent with regional and site observations for dispersion and modelling purposes.

Overall, the modelled wind speeds, were higher than the observed wind speeds at the Carmichael AWS. This can be attributed to the measurement site being well vegetated with a higher surface roughness than the corresponding roughness used in the whole-of-mine model assumptions. However, it was considered that the whole-of-mine model assumptions and derived wind data were suitable for dispersion and modelling purposes, due to the lack of significant terrain or substantive smaller scale terrain features that would influence or diverge the broader regional flows across the model domain.



**Figure 3-9 Derived Annual Wind Rose Project (Mine)**

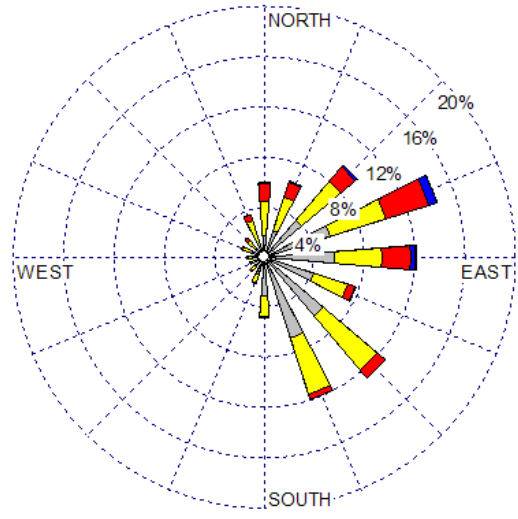
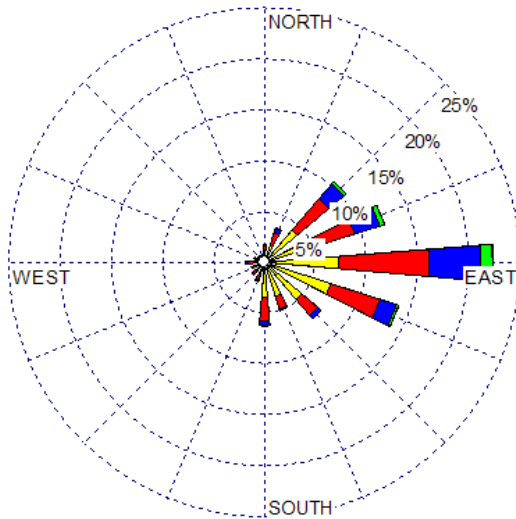




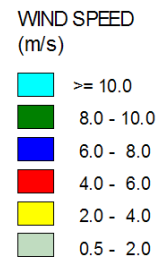
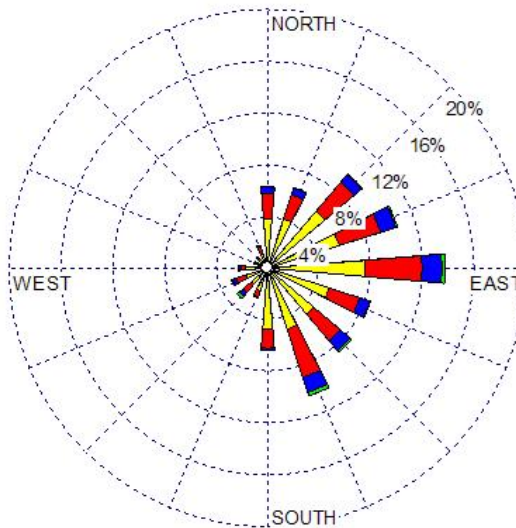
**Figure 3-10 Comparison Annual Wind Roses for Inland Central Queensland**

Hughenden (North-west)

Sonoma (North east)

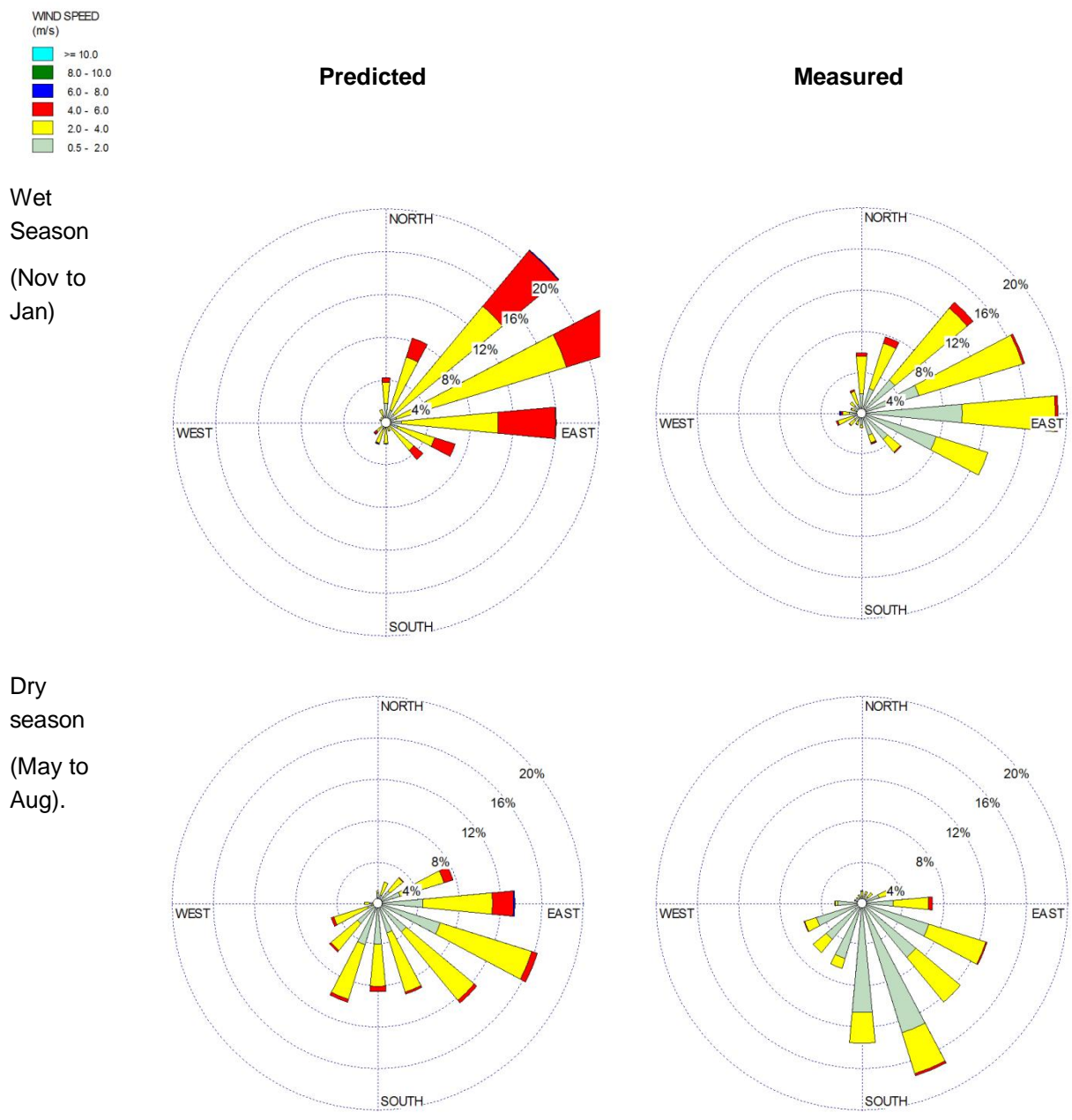


Emerald (South-east)





**Figure 3-11 Comparison of Derived and On-site Automated Weather Station Wind Roses**



**3.2.2.6 Solar Radiation**

Global solar exposure is the total amount of solar energy falling on a horizontal surface. The daily global solar exposure is the total solar energy for a day. Typical values for daily global solar exposure range from 1 to 35 MJ/m<sup>2</sup> (megajoules per square metre). The values are usually highest in clear sun conditions during the summer and lowest during winter or very cloudy days. The average daily solar exposure across the Project (Mine) is in the order of between 21 and 24 MJ/m<sup>2</sup>. The Project (Mine) experiences average daily sunshine hours (annually) of between 8 and 9 hours (BoM, 2011).



### 3.2.3 Natural or Induced Hazards

State Planning Policy 1/03 states that a natural hazard is a naturally occurring situation or condition with the potential for loss or harm to the community or environment. Natural disasters identified here as natural hazards include flooding, severe rainfall and tropical cyclones, earthquake, bushfire and climate change.

#### 3.2.3.1 Flooding

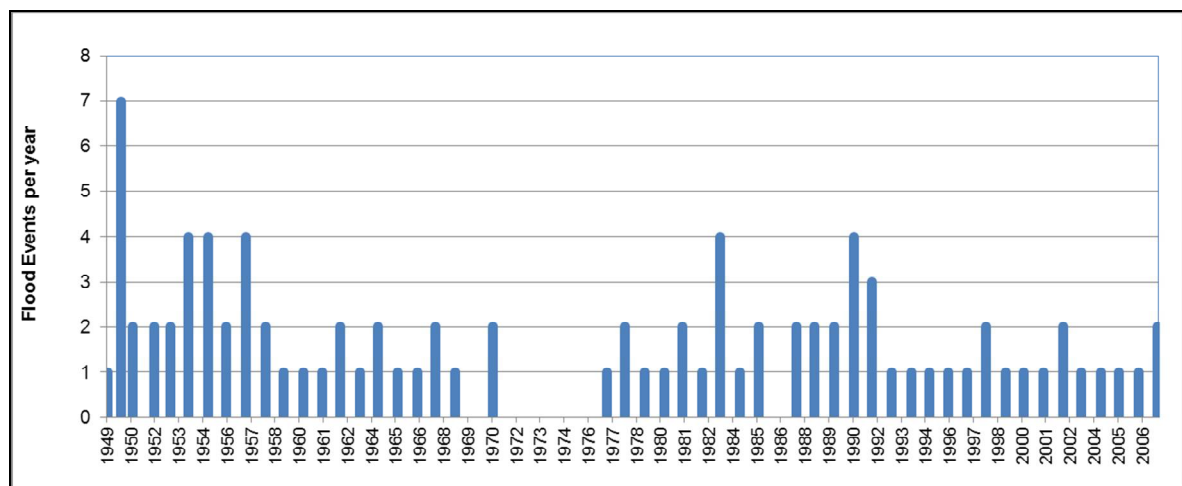
A detailed Hydrology assessment has been prepared for the Mine site (see Volume 2 Section 6 and Volume 4 Appendix P Mine Hydrology Report) which outlines surface water conditions in and around the Mine site and potential impacts of the Project (Mine) on these characteristics.

Flood data obtained from the BoM indicates at least one flood event per year (average) since 1949, with the frequency of flooding corresponding with the frequency of summer monsoonal and cyclonic rain events. The severity of each flood event is likely to be influenced by the rainfall amount and the preceding conditions such as the degree of soil cracking.

Almost all of the waterways within the Project (Mine) area are ephemeral. The closest gauging station to the Project (Mine) is at the Gregory Developmental Road crossing approximately 70 km to the northeast. The daily flow record of the Belyando River at the Gregory Developmental Road gauge 120301B shows a base flow of low to zero throughout the year. The flow regime at Gregory Developmental Road gauge is dominated by the wet season (January to May), during which flood events of short duration generally occur.

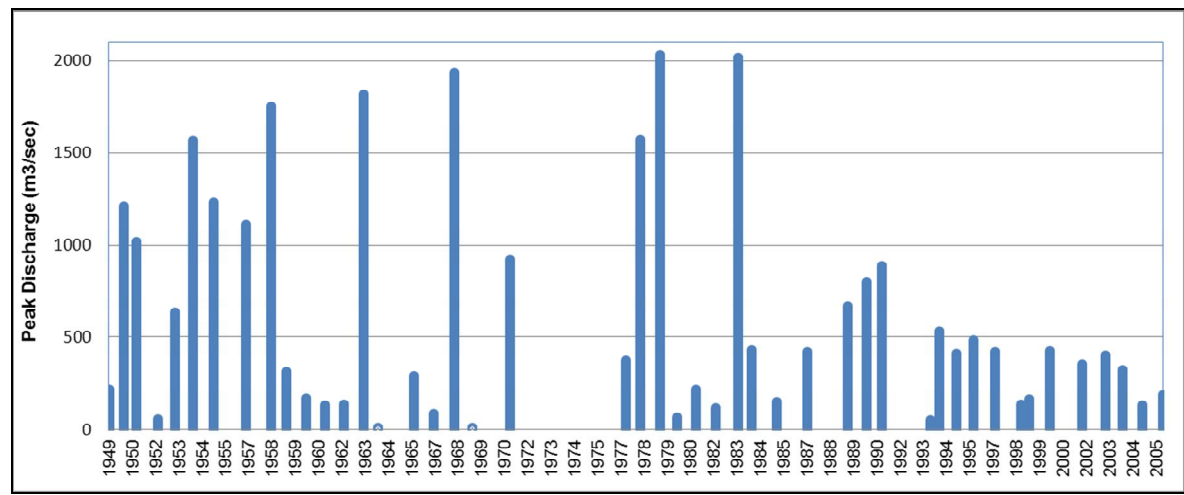
The frequency of flooding for the available record (excludes data from 1972 to 1976) at Gregory Developmental Road gage 120301B on the Belyando River is presented in Figure 3-12. A flood is defined here as when the Belyando River breaks its bank. The flood frequency in Figure 3-12 mirrors the frequency of summer monsoonal and cyclonic rain events. The severity of flooding is demonstrated by the annual maximum flood plotted in Figure 3-13. Severity of flood events depend both on the amount of rainfall and wetness prior to each rain event. Both Figure 3-12 and Figure 3-13 are charted at the month of being recorded.

**Figure 3-12 Flood Frequency on the Belyando River at Gregory Developmental Road Gauge (1949-2006)**





**Figure 3-13 Annual Maximum Flood recorded on the Belyando River at the Gregory Developmental Road Gauge**



**3.2.3.2 Severe Rainfall and Tropical Cyclones**

An average of ten tropical cyclones per year develop over Australian waters, of which six cross the coast, mostly over northwest Western Australia and northeast Queensland. Since 1959, when accurate radar based records commenced, 33 tropical cyclones have passed within 400 km Bygana Station in the Belyando River catchment. The inland location of the Project (Mine) reduces the likelihood of impacts from the strong winds accompanying cyclones, however cyclones can make intense, short term contributions during periods of summer maxima rainfall. Rainfall associated with monsoons and tropical cyclones in North Queensland is often of extreme intensity. While as much as 1,000 mm can fall in a few days at the coast, precipitation of 200 mm to 300 mm are more common inland.

Recorded rainfall totals surrounding the Project (Mine) during Cyclone Helen (January 2008) is consistent with this generalisation at 95 mm, 192 mm, 130 mm and 235 mm. The flow record on Belyando River at the Gregory Developmental Road gauge 120301B during this time equates to approximately a 1 in 100 year ARI event (9.9 m). The records do not indicate any significant flooding in the Carmichael River resulting from this event. The bulk of rainfall during Cyclone Yasi (February 2011) fell to the north of the Belyando River Catchment. The vicinity of the Study Area was affected by the wet weather in December 2010 and the Belyando River level reached a peak of 3.2 m on 27 December 2010 at the Gregory Development Road gauge.

**3.2.3.3 Earthquake**

Geoscience Australia defines significant earthquakes as all earthquakes above 3.5 on the Richter scale. A review of the data provided by Geoscience Australia (Geoscience Australia 2011) since 1955 found records of four nearest earthquakes to the Project (Mine) were of magnitude 1.2 to 3.1. Earthquake risk, as identified by the Commonwealth Government – Geoscience Australia report on the Mackay area, is assessed as low to moderate. Geoscience Australia also produces an Earthquake Hazard Risk Contour Map for Australia, based on earthquake measurements taken from the Geoscience Australia Earthquake Database. Peak ground acceleration is a dimensionless coefficient of acceleration that is used by civil engineers to estimate forces on structures. The Earthquake Hazard Risk Counter Map illustrated that there is a 90 per cent chance over the next 50 years that peak ground acceleration at the Project (Mine) will be less than 0.05. High values of this



calculation represent higher risk areas of earthquake occurrence. As such, earthquake risk is assessed to be low.

#### **3.2.3.4 Bushfire**

A Queensland Fire and Rescue Service (QFRS) Bushfire Risk Analysis map prepared for Isaac Regional Council in June 2008 indicates that bushfires have a low to medium risk of occurring within the Project (Mine).

#### **3.2.4 Climate Change**

Over the 40 years since 1957, annual minimum temperatures have increased by 1.0°C for Queensland's pastoral/cropping zone and coastal sub-zone, winter minimum temperatures by 1.2°C for the pastoral/cropping zone (1.3°C for the coastal sub-zone), summer minimum temperatures by 0.7°C for the pastoral/cropping zone and coastal sub-zone, and May minimum temperatures by 2.8°C for the pastoral/cropping zone (3.0°C for the coastal sub-zone) (McKeon *et al* 2008).

Analysis of daily climate surfaces for Queensland's pastoral/cropping zone shows high variability in annual rainfall, which is influenced by the El Niño-Southern Oscillation (ENSO) phenomenon. However the relationship between ENSO and Queensland's rainfall has not been consistent throughout this century with the 1930-40s being a period of low correlation (McKeon *et al* 2008).

The Queensland Office of Climate Change predicts that in the future Queensland regions are likely to experience:

- ▶ increased temperatures of between 1.0 °C and 2.2 °C by 2050
- ▶ more hot days and warm nights
- ▶ increased frequency of heatwave events

Regional climate change summaries covering the whole of Queensland up to 2070 are produced by the Department of Environment and Heritage Protection (2012). As the Project (Mine) is positioned close to regional boundaries, a number of regional summaries are relevant. The regions of interest are the Whitsunday, Hinterland and Mackay Region; the Central Queensland Region; and the Central West Queensland Region. Annual mean temperature (the average temperature of all days within a given year) under a high emissions scenario is predicted to increase by 3.0 °C by 2070 in the Whitsunday, Hinterland and Mackay Region are, 3.2 °C in the Central Queensland Region, and 3.6 °C in the Central West Queensland Region. Annual rainfall is predicted to drop by 10 per cent in all three regions of interest. A greater proportion of intense and long-lived cyclones are also predicted, which have the potential to track further inland than cyclones under current climate conditions.

According to the Queensland Government Scientific Advisory Group (SAG) guidelines, predicted rainfall by the end of the Project (Mine) ranges between an increase of 20 per cent and a decrease of 20 per cent (DERM 2010). Hydrologic modelling for the Project (Mine) indicated that a 20 per cent increase in rainfall would result in an average 35 per cent increase in run-off for a 1000 year ARI event. This potential impact will be further investigated during detailed design of the Mine Plan.

### **3.3 Potential Impacts and Mitigation Measures**

The Proponent will prepare an Emergency Response Plan (ERP) for construction, operations and decommissioning phase, which will incorporate the requirements for workplace health and safety,



community and environmental hazard management. The ERP will include responses for natural events such as cyclones, flooding and earthquake.

### 3.3.1 Mine Affected Water

The three dominant influences on the volume of mine affected water (MAW) are as follows.

- ▶ Runoff (rain water)
- ▶ Groundwater inflows
- ▶ Process water requirements

Flooding of the underground mining area and open cut pits has the potential to produce mine affected water, while preventing the operation of the Project (Mine). Flooding and runoff may also lead to the release of MAW from sediment basins and MAW storages.

#### 3.3.1.1 Mitigation Measures

In accordance with design requirements, levees to protect the waste dumps should be constructed to a height equal to or exceeding the 100-year ARI flood level plus 600 mm. Runoff within open cut pits will be drained to sumps and be pumped to MAW storages. Runoff from spoil dumps and rehabilitation areas will be captured in sediment basins. Levees to protect underground mine access areas from either local or regional flooding will be designed when the location of these access areas is confirmed.

A preliminary hazard assessment of MAW storages and sediment basins has been undertaken in accordance with the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams. MAW storages have been designed with a design storage allowance (DSA) based on historic rainfall data. The DSA will accommodate for catchment runoff and direct rainfall with an annual exceedance probability of 1 per cent.

Post-development flood modelling indicates that the conceptual drainage scheme prevents flooding of the underground mining area and open cut pit areas.

The potential impacts identified in the Volume 4 Appendix P Mine Hydrology Report, and reproduced here, were identified from staged mine plans that are separated by up to 40 years. It should be noted that drainage and flooding issues that will occur in the intervening years cannot be identified or resolved at this time and must be considered during operational phases of the Project.

Further details and design criteria of the conceptual drainage scheme are provided in Volume 4 Appendix P Mine Hydrology Report. Further details and design criteria of the MAW storages and sediment basins are provided in Volume 2 Section 12 Hazard and Risk.

### 3.3.2 Flooding

The development of the Project (Mine) and conceptual drainage scheme is predicted to alter the hydrology of the Carmichael River and Project (Mine) site. Flooding during the 10, 50, 100 and 1000 year ARI events also has the potential to be affected upstream and downstream of the Project (Mine). This may cause afflux on existing infrastructure routes including roads.





### 3.3.2.1 Mitigation Measures

A conceptual drainage scheme has been developed to protect the Project (Mine) from flooding. The conceptual drainage scheme is staged over the life of the Project (Mine) and includes minor and major levees, diversion drains, culverts and waterway crossings.

Post-development flood modelling indicates that the proposed levees successfully prevent flooding of either the underground mining area or the open cut pit areas for the 10, 50, 100 and 1000 year ARI events. The haul road crossing at Carmichael River is immune to the 10 year or 50 year ARI events, but is overtopped by the 100 year and 1,000 year ARI events. There is a substantial head drop across the structure which may cause scour, particularly in combination with the relatively high velocities through the bridge. The waterway openings presented in the design are considered at the lower range of the recommended width and design refinements may lead to a larger waterway design to reduce the risk of scour damage in a flood.

For the 10 year ARI event, afflux is negligible at the western and eastern boundaries of the Project (Mine). For the 50 year ARI event, flood levels at Cabbage Tree Creek on the eastern boundary of the Project (Mine) increase by approximately 0.07 m, due to redirection of water by the Project (Mine). For the 100 year ARI event, a minor increase of 0.03 m is expected at the western boundary of the MLA, while the flood level at Cabbage Tree Creek is expected to increase by approximately 0.1 m at the eastern boundary of the MLA. More significant impacts are indicated for the 1000 year ARI event as the haul road is overtopped. An increase in flows of 0.2 m is expected at the western MLA boundary, and then to 0.03 m by 2 km upstream of the boundary. Flood levels at Carmichael River and Cabbage Tree Creek on the eastern boundary of the MLA are expected to increase by 0.07 and 0.2 m respectively.

As the Project (Mine) is relatively remote and undeveloped there are a limited number of roads or other infrastructure routes nearby which could be impacted by afflux. No significant change in existing flood extent or duration is predicted at any existing infrastructure corridors including the Moray-Carmichael Road or Shuttleworth Carmichael Road. The extent of afflux is local to the vicinity of the levees and unlikely to affect existing land use activities in the vicinity of the Project (Mine), including cattle grazing or homesteads.

Further details and design criteria of the conceptual drainage scheme, hydrologic modelling and flooding impacts are provided in Volume 4 Appendix P Mine Hydrology Report.

### 3.3.3 Bushfire

A QFRS Bushfire Risk Analysis map prepared for Isaac Regional Council in June 2008 indicates that bushfires have a low to medium risk of occurring on within the Project (Mine).

#### 3.3.3.1 Mitigation Measures

Vegetation will be cleared in all working areas and growth will be managed in other areas to prevent excessive fuel load accumulation. Fire breaks will be maintained around potential sources of bushfire risk.

Staff will be educated in relation to bushfire prevention, including possible ignition sources. Staff will also be trained in procedures for welding and any other activities with high risk of starting fires.

A fire management system for prevention, early detection and suppression of fires at the Project (Mine) and workers accommodation village will be implemented.



The Project (Mine) will aim to ensure the safety of personnel and assets for all structures within the Project including buildings at the mine site, accommodation village and airstrip for event like fire or hazardous material spills/emergencies. Building fire safety will be incorporated into the design of Project (Mine) infrastructure, including adherence to QFRS guidelines and provision of a water supply, water reticulation and hydrant system. Details of building fire safety and the fire management system are provided in Volume 2 Section 12 Hazard and Risk.

### **3.3.4 Wind**

Wind associated with inland tracking cyclones or storm conditions may result in dust emissions or compromise surface infrastructure in relation to the Project (Mine).

#### **3.3.4.1 Mitigation Measures**

All non-active OCM pit and waste dumps identified as being under rehabilitation in the Mine plan will be revegetated as rapidly as possible to minimise dust emissions due to wind. Revegetation is expected to result in a 90 per cent dust reduction factor.

No controls have been applied to wind erosion from exposed surfaces in active OCM pits, waste dumps and the MIA. The MIA includes a large stockpile of coal for loading onto trains for export.

Mitigation and monitoring measures will be employed to identify and control emissions over the relevant Environmental Protection (Air) Policy 2008 objectives (refer to Volume 4 Appendix S Mine Air Quality Report).

### **3.3.5 Water Supply**

Periodic flood and drought may present a risk to Project (Mine), as a surplus or deficit of water.

#### **3.3.5.1 Mitigation Measures**

A preliminary water balance (PWB) for the Project (Mine) was conducted for common (90th percentile) and rare (10th percentile) rainfall and evaporation conditions. These conditions were based on long term historical climate data (1890 – 2010). The PWB sets minimum MAW storage dam sizes to handle surplus water, and predicts deficits when external water supply will be required.

The PWB is provided in Volume 4 Appendix P Mine Hydrology Report.

### **3.3.6 Climate Change**

Table 3-1 provides a summary of potential climate change impacts.

**Table 3-1 Summary of Potential Climate Change Impacts**

Climate Parameter	Project Components Most Likely Affected	Potential Impacts	Design and Procurement Considerations
Higher temperature extremes	Equipment	Possible malfunctioning of any temperature sensitive equipment	<p>Consider appropriate temperature ranges in selection of plant and equipment</p> <p>Undertake adequate preventative maintenance of plant, pumps, generators etc. as part of standard procedures</p> <p>Monitor plant and equipment on days of extreme weather conditions and adopt alarm warning systems for equipment in the event of failure</p>
	Power and Gas Supply/Critical Structures/equipment	Warping of infrastructure and building materials	Appropriate design of structures, in particular materials selection, to ensure these can withstand temperature extremes and durability is suited for changes in climatic conditions
	Project (Mine) surface infrastructure (buildings) and underground mine (UGM)	Unsuitable atmosphere for workers leading to heat stress.	<p>Implement a UGM atmosphere management plan.</p> <p>Provide centralised UGM atmosphere monitoring from the control room.</p> <p>Design and provide adequate UGM ventilation system.</p> <p>Maintenance on UGM ventilation fans.</p> <p>Intake air cooling when required.</p>

Climate Parameter	Project Components Most Likely Affected	Potential Impacts	Design and Procurement Considerations
	Explosives and chemical storage	Combustion or explosion	<p>Consider appropriate temperature suitability of stored chemicals and explosives</p> <p>Design, storage and handling requirements of diesel and ANFO (refer to Volume 2 Section 12 Hazard and Risk) are expected to be adequate under a climate change scenario.</p> <p>Design and construction of tanks will comply with AS 1692-2006 Steel tanks for flammable and combustible liquids. The storage and handling will comply with the requirements of AS 1940 – The storage and handling of flammable and combustible liquids. All diesel storage tanks will be installed on impervious surfaces and fully bunded.</p> <p>Fire fighting systems will be provided at major storage and handling areas and in the event of fire, emergency response will include the use of carbon dioxide, dry chemical or foam.</p>

Climate Parameter	Project Components Most Likely Affected	Potential Impacts	Design and Procurement Considerations
Increased severity of flooding	Project (Mine) conceptual drainage scheme, haul road and conveyor crossing, open cut pits and UGM	Climate change scenario flood modelling was undertaken in line with Queensland Government SAG predictions (refer to Section 3.2.4). As such, a 20 per cent increase in rainfall over the Project (Mine) life was adopted, producing an average 35 per cent modelled increase in runoff for a 1000 year ARI event (refer to Volume 4 Appendix P Mine Hydrology Report).	<p>Modelling of the proposed levees under climate change-affected hydrology for the 1000 year ARI event showed that the southern levee will overtop upstream of the haul road and conveyor crossing but not downstream, thereby keeping the open cut pit areas dry. On the northern side, overtopping occurs along the first two-thirds (from the east) of the levee alignment. Overtopping ceases downstream of the natural hill in the topography at approximately eight kilometres chainage.</p> <p>Levees or other measures to protect UGM access areas from flooding will be designed once these areas are confirmed.</p> <p>Under a non-climate change affected hydrology, the haul road and conveyor crossing are expected to be overtopped by the 100 year ARI event. Detailed design will consider that the structure can be overtopped.</p> <p>Design of MAW storages and sediment basins is in accordance with the DERM Manual and is considered appropriate for flood mitigation.</p> <p>Refer to Volume 4 Appendix P Mine Hydrology Report for more information on Project (Mine) flood immunity.</p>

Climate Parameter	Project Components Most Likely Affected	Potential Impacts	Design and Procurement Considerations
<p>Reduced annual rainfall and increased evaporation</p>	<p>Raw water dams Project (Mine) water supply</p>	<p>Potential effects on the water balance, loss of water to evaporation, resulting in insufficient water for mine operations, e.g. dust suppression and an increased demand on import of water from external sources</p> <p>May lead to changes in water chemistry, evaporation and concentration of contaminants</p>	<p>Dam and water storage will be designed and constructed to accommodate future water needs and adequate capacity</p> <p>Process water plant will be designed to design considers both dry and wet periods, including the provisions of adequate supply reserves. For example, tailings thickening agents may be considered during dry periods.</p> <p>A preliminary water balance was conducted for the Project (Mine) to take into account annual fluctuations rainfall (refer to Section 3.3.5).</p>
<p>Increased wind speed due to inland tracking of cyclones</p>	<p>Coal and overburden dumps Conveyors On-site structures</p>	<p>Dust from coal stockpiles, overburden dumps or cleared areas in windy conditions can result in deposition of dust on plants or surface water bodies.</p> <p>Stability of on-site structures, in particular those housing hazardous materials may be compromised in high wind conditions.</p>	<p>The proposed dust control measures are considered appropriate mitigation for dust emissions due to wind (refer to Section 3.3.4).</p> <p>Appropriate design standards will be adopted to ensure that all structures are designed to withstand wind speeds characteristic of the region.</p>
<p>Increased risk of bushfire</p>	<p>Project (Mine) infrastructure</p>	<p>Bushfires may result in impaired visibility resulting in reduced speeds and subsequent delays</p> <p>Damage to Project (Mine) infrastructure</p>	<p>The proposed bushfire prevention and control measures will be employed (refer to Section 3.3.3.1).</p>



### **3.4 Summary**

The Project (Mine) has the potential to increase the severity or frequency of natural hazards. Moreover, natural hazards may present a risk to the operation of the Project (Mine). Climate change predictions such as an increase in temperature, severe flooding, evaporation and wind speed associated with cyclone, may exacerbate this relationship between the Project (Mine) and natural hazards. The management and mitigation measures employed through the construction, operational and decommissioning of the Project (Mine) adequately safeguard against risks associated with natural hazards and climate change. See Volume 2 Section 13 Environmental Management Plan for further detail.



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