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6. CLIMATE, NATURAL HAZARDS AND CLIMATE CHANGE

This Section describes the climatic conditions that may affect management of the South Galilee Coal Project (SGCP). **Sections 6.1.1** to **6.1.5** describe the local and regional climate. Extreme climate events are described in **Section 6.2**.

Detailed assessments of the potential air quality impacts and greenhouse gas (GHG) emissions associated with the SGCP are provided in **Section 10—Air Quality** and **Section 11—Greenhouse Gas Emissions**, respectively. Flooding and water management are described in **Section 9—Water Resources**.

6.1. CLIMATE

According to the Australian Bureau of Meteorology (BOM), the SGCP area is classified as 'Subtropical (Moderately Dry Winter)', based on the Köppen classification system.

Meteorological data has been obtained from the BOM weather station located at the Barcaldine Post Office (Station 036007), which has recorded climatic data from 1886 to present. This is the closest long-term synoptic weather station to the SGCP, located approximately 120 kilometres (km) to the west. Temperature, relative humidity, wind speed and rainfall data from the Barcaldine Post Office weather station has been obtained from the BOM to assess indicative regional weather patterns. Evaporation data was obtained from the Longreach Aero weather station (036031).

Data has also been obtained from a weather station installed at the Creek Farm property by the Proponent. This station was established to monitor local baseline climate data at the proposed SGCP site. Rainfall, temperature, wind speed and relative humidity data has been obtained from the Creek Farm weather station.

Rainfall data was also obtained from three nearby rainfall monitoring stations. These include:

- Alpha Post Office (Station 035000), located approximately 17 km east of the SGCP. The period of data collection from this station is 1886 to present.
- Betanga (Station 035087), located approximately 16 km west of the SGCP. The period of data collection from this station is 1899 to present.
- Rivington (Station 035236), located approximately 30 km south of the SGCP. The period of data collection from this station is 1984 to present.

6.1.1. Temperature

The average monthly climate data recorded at the Barcaldine Post Office weather station is provided in **Table 6-1** and **Figure 6-1**. Mean maximum temperatures at Barcaldine range from 22.6 to 35.7 degrees Celsius (°C) and mean minimum temperatures range from 7.9 to 23.1 °C. The lowest temperatures occur in July with an average minimum temperature of 7.9 °C. The highest temperatures have historically been recorded in January, with average maximum temperature of 23.1 °C.

The average monthly climate data recorded at the Creek Farm weather station is provided in **Table 6-2**.

Table 6-1 Climate Averages—Barcaldine Post Office Weather Station

Month	Temperature (°C)		Relative Humidity (%)		Wind Speed (km/hr)		Rainfall (mm)		
	Mean Max	Mean Min	9 am	3 pm	9 am	3 pm	Mean Monthly	Highest Daily	Highest Monthly
Jan	35.6	23.1	56.0	38.0	11.3	9.7	86.1	158.8	481.2
Feb	34.5	22.6	62.0	40.0	11.7	9.8	78.3	167.6	362.6
Mar	33.2	20.8	58.0	37.0	11.5	10.1	59.1	176.5	357.1
Apr	30.0	16.8	57.0	38.0	10.8	9.2	36.6	116.8	333.6
May	26.0	12.4	58.0	36.0	9.0	8.3	30.7	109.6	255.0
Jun	22.9	9.0	64.0	38.0	8.6	8.9	24.1	64.8	124.2
July	22.6	7.9	59.0	34.0	9.6	9.8	22.9	91.6	171.6
Aug	24.9	9.4	50.0	29.0	12.5	11.1	16.1	59.8	123.4
Sept	28.6	13.3	46.0	27.0	15.0	11.4	16.2	97.8	152.2
Oct	32.2	17.5	44.0	27.0	14.2	10.9	29.2	74.9	154.2
Nov	34.5	20.3	44.0	28.0	12.7	10.4	40.1	99.2	285.5
Dec	35.7	22.2	49.0	32.0	11.5	10.0	64.4	156.2	298.3
Annual Average	**30.1**	**16.3**	**54.0**	**34.0**	**11.5**	**10.0**	**503.9**	**176.5**	**1,304.2**

Source: BOM (2011a)

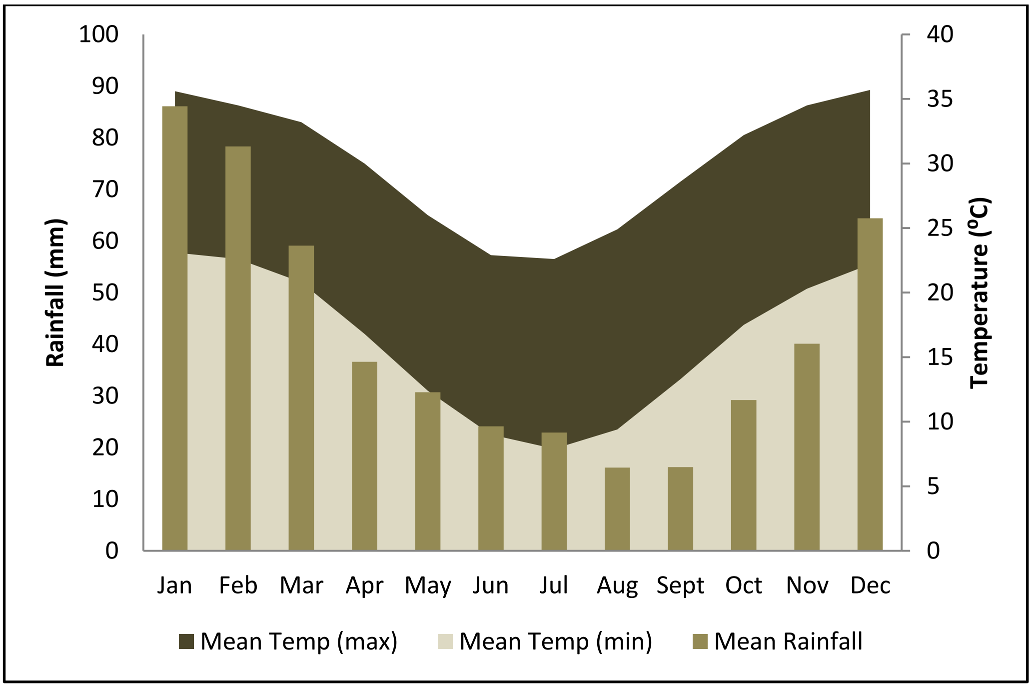


Figure 6-1 Average Monthly Rainfall and Temperature—Barcaldine Post Office (1886–present)

Table 6-2 Climate Averages – Creek Farm Weather Station

Month	Average Temperature (°C)	Average Relative Humidity (%)	Average Wind Speed (metres/second (m/s))
May 2010	16.7	65.2	0.8
Jun 2010	14.3	68.5	1.0
Jul 2010	14.8	68.9	1.1
Aug 2010	15.1	65.0	1.3
Sep 2010	19.9	74.2	1.2
Oct 2010	20.9	68.0	1.2
Nov 2010	21.9	75.6	1.2
Dec 2010	24.5	79.2	1.1
Jan 2011	26.4	69.2	1.0
Feb 2011	25.9	70.7	1.1
Mar 2011	23.8	77.5	1.2
Apr 2011	19.9	76.1	0.9
May 2011	14.9	69.3	1.0

Table 6-2 Climate Averages – Creek Farm Weather Station (cont)

Month	Average Temperature (°C)	Average Relative Humidity (%)	Average Wind Speed (m/s)
Jul 2011	12.5	64.5	1.0
Aug 2011	15.2	60.0	1.1
Sep 2011	18.1	52.9	1.2
Oct 2011	22.5	50.7	1.6
Nov 2011	26.6	54.5	1.4
Dec 2011	25.4	66.5	1.2

6.1.2. Rainfall

In addition to the data presented in **Section 6.1.1.**, rainfall data collected at the Alpha Post Office, Betanga and Rivington is presented in **Table 6-3** to provide an indication of local rainfall.

Rainfall data indicates that although the region experiences rainfall all year round, it is highly seasonal, with distinct wet and dry seasons. The majority of rainfall occurs between December and March and the least rainfall falls between July and September. The mean annual rainfall recorded at the Barcaldine Post Office station is 503.9 mm. In comparison, the rainfall recorded at the Alpha Post Office and Betanga are slightly higher, with 559.2 mm and 556.5 mm recorded, respectively.

Table 6-3 Rainfall Data – Alpha Post Office, Betanga and Rivington

Month	Alpha Post Office[1] Rainfall			Betanga[2] Rainfall			Rivington[3] Rainfall		
	Mean Monthly (mm)	Lowest Monthly (mm)	Highest Monthly (mm)	Mean Monthly (mm)	Lowest Monthly (mm)	Highest Monthly (mm)	Mean Monthly (mm)[4]	Lowest Monthly (mm)	Highest Monthly (mm)
Jan	95.2	0.0	438.6	96.9	0.0	521.6	-	4.5	250.6
Feb	87.1	0.0	441.9	83.4	3.8	258.3	-	10.1	226.0
Mar	60.9	0.0	388.5	62.4	0.0	339.2	-	0.0	164.2
Apr	34.6	0.0	293.8	35.2	0.0	396.8	-	3.5	128.2
May	29.6	0.0	235.8	25.9	0.0	299.8	-	0.0	56.7
Jun	30.4	0.0	352.1	27.6	0.0	265.9	-	0.0	34.4

Table 6-3 Rainfall Data – Alpha Post Office, Betanga and Rivington (cont)

Month	Alpha Post Office[1] Rainfall			Betanga[2] Rainfall			Rivington[3] Rainfall		
	Mean Monthly (mm)	Lowest Monthly (mm)	Highest Monthly (mm)	Mean Monthly (mm)	Lowest Monthly (mm)	Highest Monthly (mm)	Mean Monthly (mm)[4]	Lowest Monthly (mm)	Highest Monthly (mm)
July	24.2	0.0	201.9	21.0	0.0	164.4	-	0.0	26.0
Aug	19.8	0.0	172.1	19.2	0.0	161.8	-	0.0	92.7
Sept	21.6	0.0	280.2	21.2	0.0	207.6	-	0.0	52.4
Oct	35.7	0.0	262.7	33.7	0.0	166.8	-	3.0	136.9
Nov	50.1	0.0	268.6	52.3	0.0	332.1	-	6.0	154.8
Dec	76.6	0.0	384.3	72.0	0.0	300.0	-	0.0	129.0
Annual Average	**559.2**	**205.4**	**1,576.8**	**556.5**	**196.8**	**1,318.3**	**-**	**467.8**	**713.8**

Source: BOM (2011b, 2011c, 2011d)

1 Based on rainfall data collected from 1886 to present.

2 Based on rainfall data collected from 1899 to present.

3 Based on rainfall data collected from 1984 to present.

4 Not recorded.

6.1.3. Wind Speed and Direction

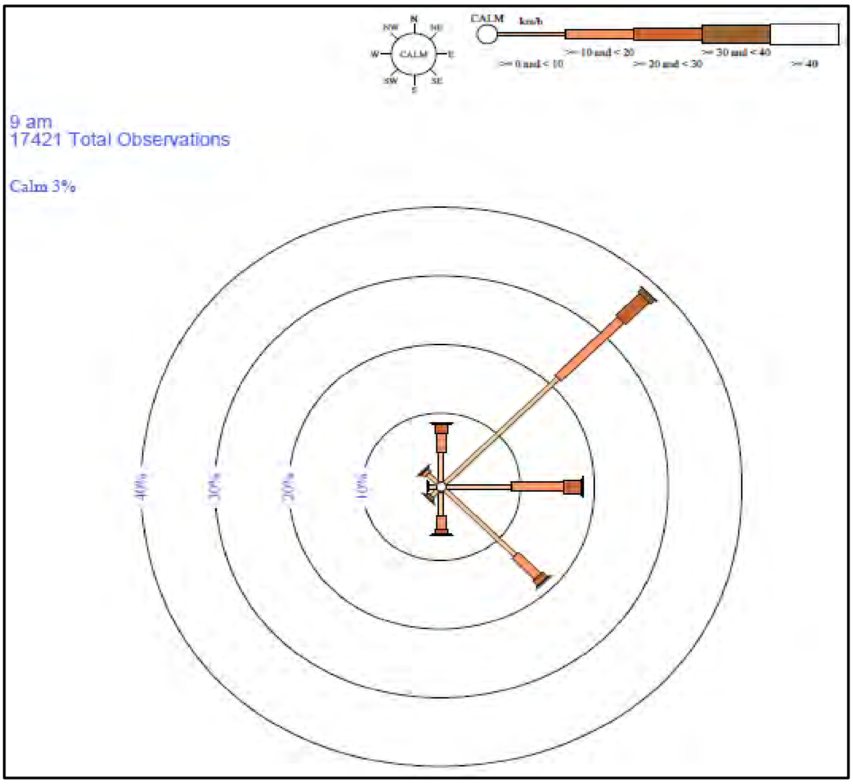
The region tends to have winds of low to moderate velocity (e.g. up to 15 km/hr) with the prevailing wind directions being from the north-east, south-east and east (refer to **Figure 6-2** and **Figure 6-3**). Further information on wind direction and speed, in reference to air quality, is provided in **Section 10—Air Quality**.

The Pasquil stability class frequency provided in **Table 6-4** indicates that the atmosphere around the SGCP is stable to slightly unstable for approximately 82 % of the time, therefore climatic conditions such as temperature inversions are possible.

Table 6-4 Frequency of Stability Classes at Site

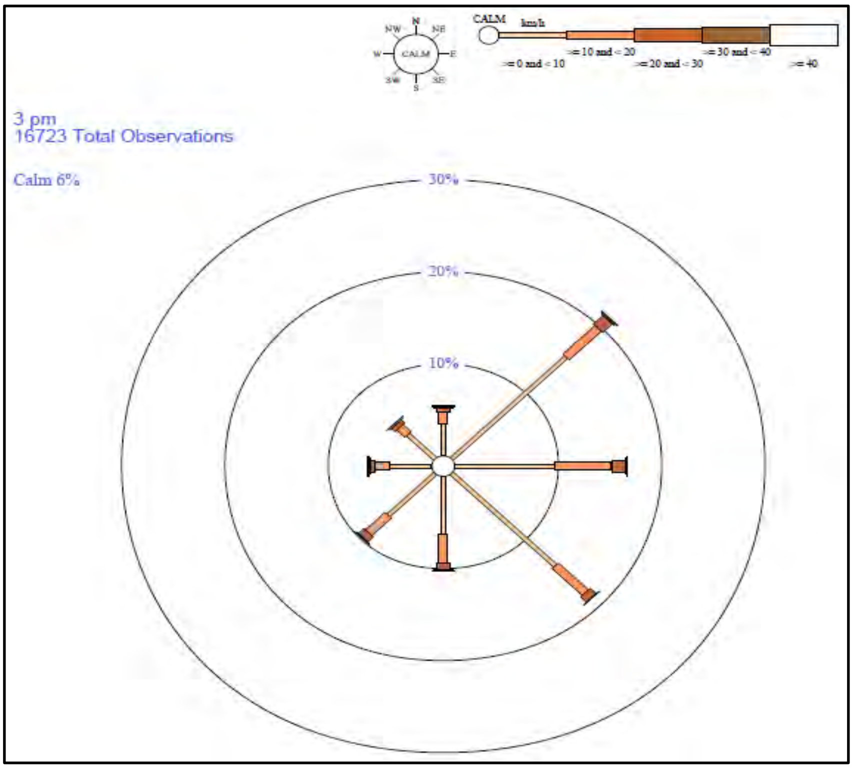
Stability Class	Description	Frequency of Occurrence (%)
A	Very unstable	4
B	Moderately unstable	14
C	Slightly unstable	16
D	Neutral	21
E	Slightly stable	10
F	Stable	35

Source: **Appendix L—Air Quality Technical Report**



Source: BOM (2010a)

Figure 6-2 Annual Average 9 am Wind Rose – Barcaldine Post Office (1962–2010)



Source: BOM (2010a)

Figure 6-3 Annual Average 3 pm Wind Rose – Barcaldine Post Office (1962–2010)

6.1.4. Relative Humidity

Average relative humidity data is presented in **Table 6-1** and **Table 6-2**. At the Barcaldine Post Office, relative humidity is generally higher in late summer, autumn and winter and lower during the spring months. Relative humidity is higher in the morning than in the afternoon.

At the Creek Farm weather station, relative humidity was more consistent, with the highest humidity level recorded during summer and early autumn.

6.1.5. Evaporation

Evaporation data was obtained from the BOM Longreach Aero weather station (036031). The evaporation rate is highest in the summer months, with a mean daily rate of 12.0 mm in December, and lowest in the cooler months, with a mean daily rate of 4.4 mm in June (BOM, 2011e). The annual average evaporation is 8.4 mm (BOM, 2011e).

6.2. EXTREME EVENTS

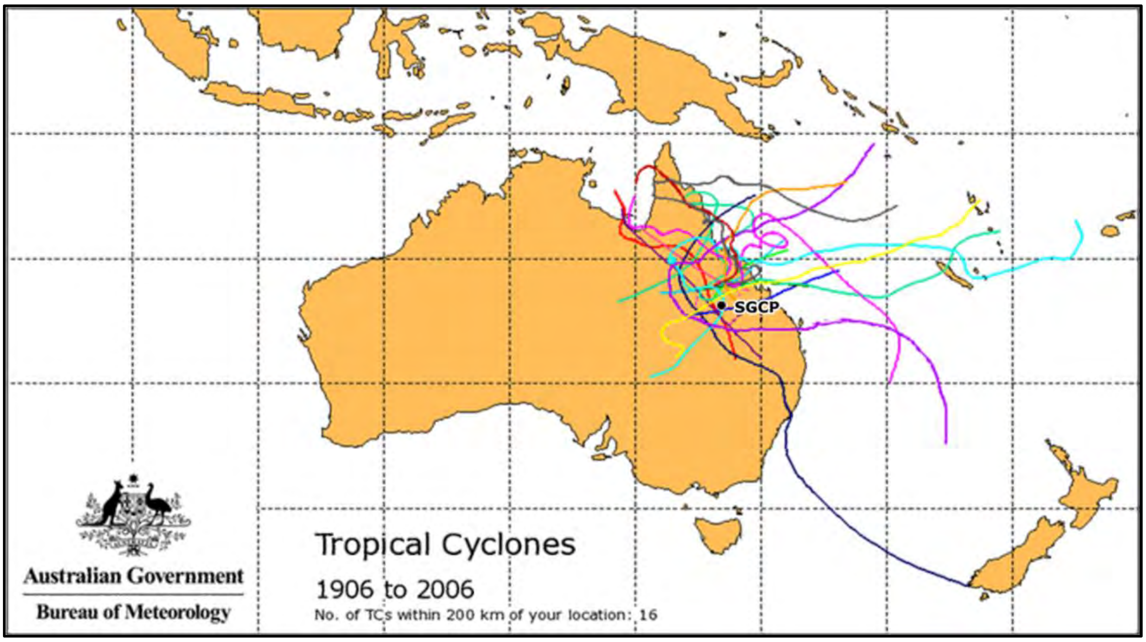
The following Section discusses potential extreme events such as flooding, cyclones, bushfires, landslides and earthquakes with regards to their likely magnitude and frequency at the SGCP. These are considered in reference to the *State Planning Policy 1/03 Mitigating the adverse impacts of flood, bushfire and landslide* (SPP 1/03).

The potential threats to the construction and operation of the SGCP posed by climate and natural hazards are detailed in **Section 19—Hazard and Risk**.

6.2.1. Flooding/Cyclones

With regard to Australia's eastern states, tropical cyclones typically form in northern coastal Queensland and their intensity decreases as they move inland. Tropical cyclones in Queensland typically form from low pressure systems within the monsoon trough, between November and April (BOM, 2011f).

As shown on **Figure 6-4**, there have been 16 tropical cyclones within 200 km of Alpha between 1906 and 2006 (BOM, 2011f).



Source: BOM (2011f)

Figure 6-4 Tropical Cycles within 200 km of Alpha (1906–2006)

Meteorological monitoring has been conducted at the Barcaldine Post Office weather station since 1886. Since this time, the highest daily rainfall event recorded was 176.5 mm on 14 March 1936. Potential impacts from flooding and heavy rainfall events have been assessed for the SGCP area, and are detailed in **Section 9—Water Resources**. There is a potential risk of flooding and impact from strong winds in the SGCP area, with the subsequent potential for release of contaminants and sediments from site should appropriate surface water management measures not be implemented. This may occasionally, but infrequently necessitate halting of mining activities to prevent or minimise the release of contaminants during extreme meteorological conditions. The likelihood of flooding and chemical or wastewater spills is very low (refer to **Section 9—Water Resources** and **Section 19—Hazard and Risk**).

The potential impacts of flooding will be managed in accordance with the recommendations of SPP 1/03. Flood levees will be constructed progressively throughout the SGCP site as required to minimise impacts of flooding on mining activities and any potential for uncontrolled release of contaminants to the environment.

6.2.2. Bushfires

Bushfires and grassfires are an intrinsic component of Australia's environment. Natural ecosystems have evolved with fire and the landscape, along with its biological diversity, has been shaped both by historic and recent fires. Many of Australia's native plants are fire prone and very combustible while numerous species depend on fire to regenerate. Indigenous Australians have long used fire as a land management tool and it continues to be used to clear land for agricultural purposes and to protect properties from intense, uncontrolled fires.

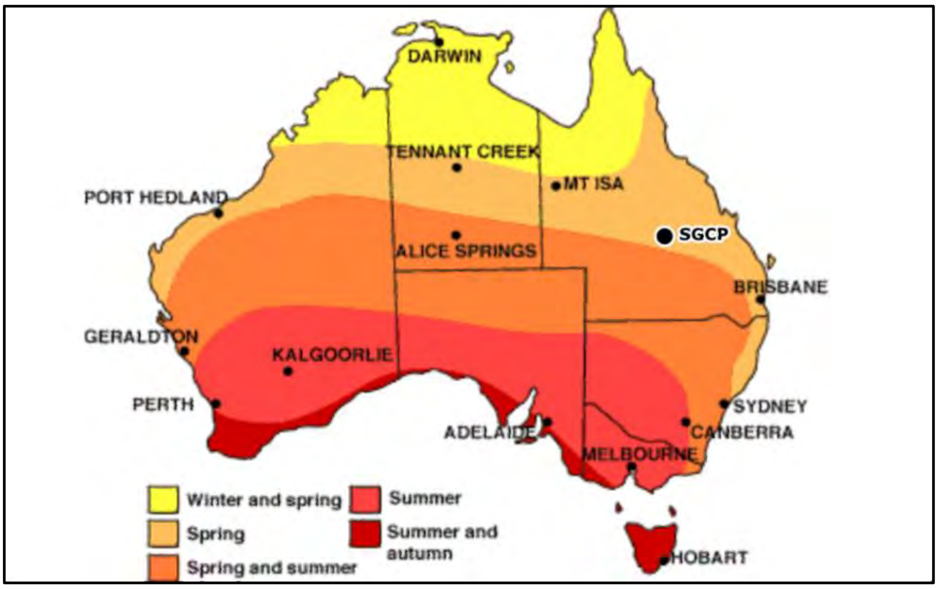
The risk associated with fire varies depending on the type of fire. Grassfires are fast moving and smoulder briefly. They have a low to medium intensity and primarily damage crops, livestock and farming infrastructure such as fences. Bushfires are generally slower moving but have a higher heat output and can smoulder for days. Fire in the crowns of the tree canopy can move rapidly.

As shown on **Figure 6-5**, the peak fire season for the SGCP is during spring. At this time of year, the temperature begins to increase (refer to **Table 6-1** and **Figure 6-1**) and vegetation is generally dry due to low rainfall over winter. These factors may be amplified by natural climatic cycles such as El Niño, which result in periods of increased temperature and reduced rainfall and humidity.

Bushfire hazard mapping provided in the Jericho Shire Planning Scheme (Campbell Higginson Town Planning, 2006) has been reviewed for the SGCP. The SGCP area is primarily classified as having a low bushfire risk, however there are small areas of medium fire risk. The modelling examined factors such as slope, vegetation and aspect.

As a bushfire mitigation measure, areas surrounding the SGCP infrastructure will be managed to meet the requirements of SPP 1/03. As mining construction and operations progress, fire breaks will be maintained to minimise the risk of bushfire. Areas subjected to increased risk of bushfire will undergo regular inspection to maintain them clear of vegetation and other combustible materials.

The SGCP will follow the Queensland Fire and Rescue Service (QFRS) regulations and procedures and will have access to a dedicated, fully trained SGCP Mines Rescue Team. Employees/contractors who form the team will have full senior and occupational first aid qualifications.



Source: BOM (1997)

Figure 6-5 Distribution Map for Australian Fire Seasons

6.2.3. Landslides

Landslides can be caused by earthquakes, volcanoes, soil saturation from rainfall, seepage or by human activity (e.g. vegetation removal, construction on steep terrain). Landslides usually involve the movement of large amounts of earth, rock, sand or mud, or a combination of these materials.

Considering the topography of the SGCP area, landslides resulting from natural causes are unlikely. Disturbance to waterways has the potential to create land slippage and mining activities also have the potential to create localised land slippages within the mine ramps, pits and waste emplacements.

Slumping may occur from the settlement of overburden materials. Such risk is reduced with the design and creation of stable landforms, though ongoing stability monitoring will occur.

Despite the low risk of occurrence, should a landslide/slippage occur at the SGCP that meets the definition in SPP 1/03, the Proponent will manage the impacts in accordance with SPP 1/03 and in consultation with the Queensland Government State Disaster Management Group. The site Emergency Response Plan will also be implemented.

6.2.4. Earthquakes

The majority of the world's earthquakes occur at tectonic plate boundaries (i.e. interpolate seismicity). Australia is located centrally within the Indo-Australian tectonic plate and consequently experiences minor intraplate seismicity compared with locations on the plate boundaries.

A search of the Geoscience Australia database indicated that no earthquakes have been recorded within a close proximity to the SGCP from 1955 to November 2011. The closest earthquakes included a 3.0 magnitude earthquake near Clermont on 17 September 1992 and a 2.9 magnitude earthquake near Anakie on 9 June 1990 (Geoscience Australia, 2011).

In the unlikely event of an earthquake, the SGCP will follow the site Emergency Response Plan.

6.3. CLIMATE CHANGE IMPACT ASSESSMENT

Climate change predictions and a risk assessment of how changing climate patterns may affect the viability and environmental management of the SGCP are provided in **Section 11—Greenhouse Gas Emissions**. The proposed adaptation strategies and mitigation measures are also described in this Section.