BaT project

Chapter 7
Climate

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7. Climate

7.1 Introduction

The purpose of this chapter is to assess the vulnerability of the Project to seasonal conditions, extremes of climate and natural or human-induced hazards. It also assesses the greenhouse gas (GHG) emissions from construction and operation of the Project. A preliminary risk assessment detailing the potential threats from climate change to construction and operation of the Project is provided in **Appendix J**.

This chapter addresses section 9.11 of the Terms of Reference (ToR).

7.1.1 Methodology

This assessment focusses on the Environmental Impact Statement (EIS) as shown in **Chapter 1 – Introduction**, however, consideration has also been given to potential impacts outside of this area, where relevant.

A desktop review has been undertaken to describe and assess the potential impacts of the Project with regards to climate and GHG. This includes:

- policy and legislative overview
- description of climate patterns relevant to the Project
- description of the Project's anticipated energy consumption, fuel use and resulting GHG emissions
- determination of the potential impacts and benefits associated with the anticipated GHG emissions resulting from the Project.

Information provided by the Bureau of Meteorology (BoM) was gathered to develop an understanding of current climatic conditions, along with trend data to show observed changes over time. Where available, data on the frequency and timing of extreme weather events have been included. Climate change projections specific to the region were assessed as a basis for determining the vulnerability of the Project to future climate change. Where regional projections were not available, information has been supplemented by the most current national projections.

7.1.2 Legislative and policy framework

A number of legislative and policy instruments currently exist which relate to the accounting, reporting and management of GHG emissions. This section details the legislative framework applicable to this assessment.

Commonwealth government

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a national framework for Australian corporations to report GHG emissions, reductions, removals, offsets, energy consumption and production. The purpose of the NGER Act is to provide for a single, national system for the reporting of GHG emissions, abatement and energy consumption and production activities by corporations.

The NGER Act applies to corporation activities from 1 July 2008. Any activities undertaken within or after 2010 to 2011 are required to report if they exceed annual production of 50 kilotonnes in carbon dioxide equivalent (CO_2-e) of GHG emitted or if they consume or produce 200 terajoules of energy.

Under the requirements of the NGER Act, Queensland Rail is currently required to report on the activities it undertakes. Once the Project is operational, Queensland Rail as the rail operator would be required to incorporate the additional rail activities of the Project into its annual reporting.

Queensland government

Adverse weather has the potential to cause natural hazards such as floods, landslides, bushfires, coastal erosion and storm-tide inundation. In Queensland, the planning for these events is coordinated through instruments such as the Queensland State Planning Policy (SPP). Although the Project does not require approval under the Brisbane City Plan 2014, the principles of the Queensland SPP have been applied to the Project.

7.2 Climate

Records on weather within the study corridor were sourced from the BoM. The longest available time series were used for each variable to determine long-term averages and climate extremes. This included information collected at Toowong and Brisbane Aero weather stations. **Table 7-1** shows the location and commissioning dates of these stations.

Table 7-1 Weather stations

Variable	Station	Station location	Site commissioned
Rainfall	Toowong (40245)	4km west of study corridor	1889
Temperature, rainfall and wind conditions	Brisbane Aero (40223)	10km north-east of study corridor	1929

7.2.1 Rainfall

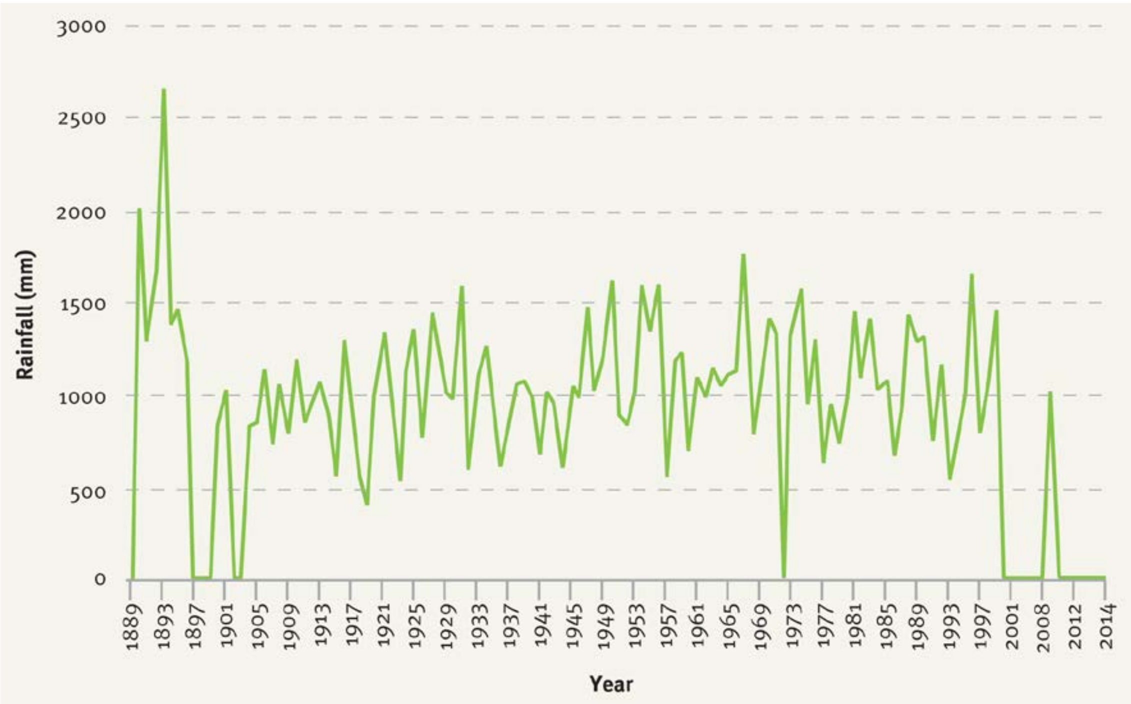
Figure 7-1 shows the mean and extreme rainfall (maximum and minimum) averages by month, measured at the Brisbane Aero weather station.

These data show that on average, the driest months are in the spring season, followed by the winter months. The second highest daily rainfall event for the period between 1949 and 2000 occurred in the month of June, demonstrating that high rainfall can occur in winter. The wettest month on average in Brisbane is February.

Figure 7-2 shows the full time-series of annual total rainfall for the period between 1889 and February 2014 from the Toowong weather station.

Figure 7-1 Monthly rainfall averages (mm) for Brisbane Aero (1949 to 2000)

Figure 7-2 Annual rainfall totals for Toowong (1889 to 2014)



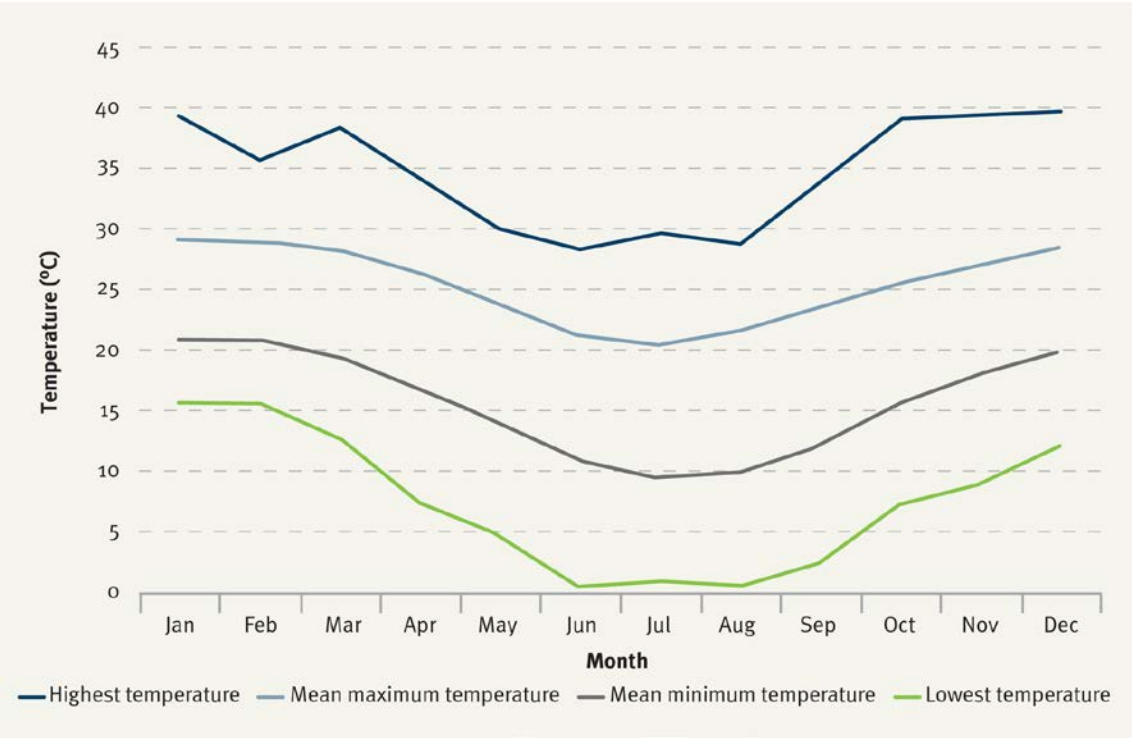
Note: Due to intermittent closure during 125 years of operation, the Toowong weather station data set is incomplete and shows zero annual rainfall totals for some years.

7.2.2 Temperature

Figure 7-3 shows the monthly variability of daily air temperature as measured by the Brisbane Aero weather station. This data represents the long-term seasonal variability in air temperature between 1949 and 2000.

This data shows the monthly variability in the highest and lowest daily air temperature, and the average daily maximum and minimum temperature, averaged over the period between 1949 and 2000.

Figure 7-3 Monthly temperature averages for Brisbane Aero (1949 to 2000)



7.2.3 Wind conditions

Figure 7-4 shows data of the maximum wind gusts by month for the period between 1952 and 2000 measured at Brisbane Aero weather station. This data shows that the strongest winds often occur in the month of January. These are commonly associated with tropical low pressure systems.

Figure 7-4 Monthly maximum wind gusts for Brisbane Aero (1952 to 2000)

7.2.4 Extremes of climate

Large variability in both extreme daily temperatures, and extended hot or cold periods need to be considered in the design (structural, mechanical and electrical), material selection and emergency management systems; especially with regards to fire safety. However, whilst within-tunnel temperatures do contribute to tunnel fire risk, the largest contributor to fire tunnel risk is associated with the condition, behaviour, number and type of vehicles (primarily buses and trains) using the tunnel.

Extreme instantaneous and seasonal rainfall has the ability to lead to increased flooding risk of both the tunnel, and enabling and supporting works, including surface infrastructure. Hence the management of surface and groundwater in the design should give consideration to future projected rainfall. Emergency management systems and plans must also consider flooding risks.

Sea level changes (both long-term and short-term) can influence groundwater levels, and the conveyance of overland and stormwater flows. Climate variability also has the potential to lead to construction delays. The Project reference design has factored in potential changes to rainfall and sea levels as a consequence of climate change. The reference design allows for sea level rises of 0.5m to 1.0m (refer to **Chapter 9 – Hydrology)**.

Project construction and operational risks associated with the extremes of climate are discussed in **Chapter 16 – Hazard and risk**. These climate risks primarily relate to:

- flooding and inundation from both surface and groundwater sources
- periods of warm and dry conditions potentially leading to spot fires at construction sites
- natural hazards and events (heat, strong wind, cyclones, etc.) resulting in construction delays.

These risks were identified as part of the preliminary risk assessment (refer to **Appendix J**) detailing the potential threats from climate to the construction and operation of the Project. A detailed discussion of the management of flood impacts to, and resulting from, the Project is provided in **Chapter 9 – Water quality and quantity**.

7.3 Greenhouse gas

GHG, such as carbon dioxide, is emitted into the earth's atmosphere as a result of natural processes (e.g. forest fires) and human activities (e.g. burning of fossil fuels). GHG absorbs and re-radiates heat from the sun, trapping heat in the atmosphere which then influences global temperatures. This section presents a high level assessment of GHG emissions for the most significant emissions sources during the construction and operation of the Project.

7.3.1 Greenhouse gas methodology

GHG emissions are reported as tonnes of carbon dioxide equivalent (t CO_2-e) and categorised as either Scope 1, 2 or 3 in accordance with the GHG Protocol (WBCSD & WRI, 2004), Intergovernmental Panel on Climate Change and Australian Government GHG accounting/ classification systems.

The emission scopes help delineate between 'direct emissions' from sources that are owned or controlled by the Project and 'indirect emissions' that are a consequence of Project activities but occur at sources owned or controlled by another entity. The three GHG scopes include:

- Scope 1 emissions, also called 'direct emissions'. These emissions are generated directly by the Project (e.g. emissions generated by the use of diesel fuel by construction equipment onsite)
- Scope 2 emissions, also referred to as 'indirect emissions'. Scope 2 emissions are generated outside of the Project's boundaries to provide energy to the Project (e.g. the use of purchased electricity from the grid)
- Scope 3 emissions are all indirect emissions (not included in Scope 2), due to upstream or downstream activities (e.g. indirect upstream emissions associated with the extraction, production and transport of purchased construction materials).

This assessment estimates the Scope 1 and Scope 2 emissions associated with the construction and operation of the Project, consistent with mandatory reporting under the NGER Act.

The most significant sources of GHG emissions identified for the construction and operation of the Project include:

- diesel consumption for Project owned and operated plant, equipment and construction vehicles (Scope 1)
- electricity consumption to power equipment for tunnelling activities and other construction electricity requirements (Scope 2)
- electricity consumption for the operation of the tunnel and underground stations, including tunnel ventilation (Scope 2).

The assessment of Scope 3 emissions is limited to an assessment of the potential reduction of indirect GHG emissions as a result of a shift from private vehicle use on roads to a use of buses and trains as a consequence of the Project.

The assessment is based on the expected reduction in fuel consumption of vehicle traffic on aboveground roads, which has been used to calculate the potential reduction in GHG emissions as a result of the Project.

7.3.2 Construction and operation emissions

The Scope 1 and Scope 2 GHG emissions for construction and operation of the Project are presented in **Table 7-2**.

Table 7-2 Estimated GHG emissions – construction and operation

Emissions source	Scope 1 (t CO_2-e)	Scope 2 (t CO_2-e)	Total (t CO_2-e)	Percentage of total emissions (%)
Construction (total)				
Diesel consumption for Project plant, equipment and construction vehicles (transport)	17,799	-	17,799	3.4
Electricity consumption to power equipment for the excavation of the tunnel, stations and other construction electricity requirements	-	512,450	512,450	96.6
Total per year (tonnes)	**17,799**	**512,450**	**530,249**	**-**
Total per year (%)	**3.4**	**96.6**	**100**	**100**
Operation (per year)				
Annual electricity consumption for tunnel ventilation	-	19,754	19,754	44.4
Annual electricity consumption for the operation of bus and train stations	-	24,720	24,720	55.6
Total per year (tonnes)	**0**	**44,474**	**44,474**	**-**
Total per year (%)	**0**	**100**	**100**	**100**

The results illustrated in **Table 7-2** demonstrate that the majority of GHG emissions associated with the construction of the Project are attributed to the consumption of electricity purchased from the grid to power tunnel excavation equipment, such as the tunnel boring machine, and other electrical construction equipment.

Total estimated GHG emissions from construction of the Project are approximately 530,249 t CO2-e, which equates to 0.09 per cent of the Australian GHG inventory for the year 2010 to 2011 and 0.30 per cent of the Queensland GHG inventory for 2010 to 2011.

The annual GHG emissions footprint associated with operational electricity consumption for the tunnel ventilation system and train stations is approximately 44,474 t CO2-e per year, which equates to 0.01 per cent of the national GHG inventory for the year 2010 to 2011 and 0.03 per cent of the Queensland GHG inventory for 2010 to 2011.

The most recently published Australian National Greenhouse Accounts estimate Australian GHG emissions for 2011 to be 563.1 million t CO2-e as reported under the Kyoto Protocol (DIICCSRTE, 2013a). For the year 2010 to 2011, the annual Queensland GHG emissions totalled 155.5 million t CO2-e (DIICCSRTE, 2013b). The transport sector contributes approximately 14 per cent of Australia's total GHG emissions, with approximately 90 per cent of these emissions attributed to the combustion of fuel for road transport (Maddocks et al, 2010).

Reducing the future contribution of emissions from private vehicle road use as part of the Project would therefore contribute to an emissions reduction for the transport sector and Australia's overall emissions profile.

7.3.3 Reduction in GHG emissions resulting from the Project

The potential reduction in indirect Scope 3 emissions for the future year 2031, as a result of a shift from passenger vehicles to bus and train use as part of the Project, is provided in **Table 7-3**. The calculation of potential reduction in Scope 3 GHG emissions is a function of the reduction in future traffic volumes, expressed as vehicle kilometres travelled, resulting from the Project.

Table 7-3 Potential reduction in GHG emissions (2031)

Potential reduction in traffic volumes		Approximate fuel use equivalent (kL)			Reduction in GHG emissions per annum ($t\ CO_2$-e)
Per cent	Vehicle kilometres travelled	Petrol	Diesel	LPG	
0.3	252,000	7,383	2,942	792	28,817

Once commissioned, the Project would reduce the use of private motor vehicles for trips to and from the Brisbane Central Business District and inner city. With the operation of the Project, traffic forecasts indicate that this reduction would exceed 0.3 per cent of Average Annual Daily Traffic, the equivalent of 252,000km per weekday (2031 modelled year). Over the 100 year design life of the Project, the corresponding reduction in GHG emissions is estimated to be in excess of 2.5 million t CO_2-e. This reduction in GHG is likely to increase when the effects of road congestion, and the subsequent transport mode shift away from private vehicles, are also considered.

7.4 Summary

The Project is a long-term asset that is likely to experience a range of weather and climactic conditions. It is located in a sub-tropical climate that experiences irregular but often extreme weather events that result in floods and droughts. Measures to manage the effects of weather have been included in the Project's reference design and would provide the required level of service and immunity.

Sea level changes (both long-term and short-term) can influence groundwater levels and the conveyance of overland and stormwater flows. Measures to manage these effects have been included within the reference design, ensuring the necessary level of immunity over the life of the Project. As detailed in **Chapter 16 – Hazard and risk**, emergency management systems and plans would also be developed, providing contingency and ensuring safety during flood events.

This assessment has also determined that the Project would not contribute significantly to the Australian and Queensland GHG emissions inventories.