19.0 Sustainability and Climate Change

19.1 Introduction

This chapter has been structured to present three separate assessments relating to:

- Greenhouse gas emissions
- Climate change
- Sustainability.

The assessments provide an introduction to the topic under consideration, the legislation and policy that underpins the assessments, the potential impacts to the Project and environmental values, and mitigation to minimise or avoid potential impacts.

19.2 Greenhouse Gas emissions

19.2.1 Introduction and approach

A strengthening scientific position, heightened public interest and expectations, and an increasing focus on national and international policy mean that managing greenhouse gas emissions at the corporate and national level is likely to become standard practice in the future. The business environment now includes a cost on greenhouse gas emissions as a direct result of government action, and businesses will see adapting to climate change as a risk adverse and cost effective position long-term.

Wind electricity is one of the most technically advanced sources of renewable energy. Wind power is recognised as a clean energy source that can meet a percentage of Australia's electricity requirements with no operational greenhouse gas emissions. Renewable energy technology is seen as essential in the transition to a sustainable, low carbon economy, with associated benefits such as displacing equivalent megawatts in fossil fuel based electricity, new jobs and investment, and energy supply for rural and regional areas.

Renewable energy accounts for approximately 6% of the total installed generating capacity in Queensland (Department of Employment, Economic Development and Innovation, 2009). Renewable energy from wind accounted for approximately 1.4% (12.45 megawatts) of this capacity. Successful implementation of the Project is anticipated to significantly increase the amount of energy generated from wind in Queensland.

This section provides an assessment of the potential greenhouse gas emissions that will be produced as a result of the construction and operational phases of the Project and to highlight potential measures by which these greenhouse gas emissions could be reduced.

19.2.2 Legislative Context

National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act) requires Australian corporations exceeding the corporation or facility thresholds to publicly report their greenhouse emissions, energy consumption and energy production each financial year. The object of the Act is to introduce a single national reporting framework to inform government policy, meet reporting obligations and underpin the introduction of an emissions trading scheme in the future.

From 2011 reporting year onwards, the corporation threshold for reporting is 50,000 tonnes (t) of carbon dioxide equivalent (CO_2-e) of greenhouse gases emitted and 200 terajoules (TJ) of energy consumed or produced (Figure 19.1). The current facility threshold is 25,000 t of CO_2-e of greenhouse gases emitted and 100 TJ of energy consumed or produced. These will be the thresholds for subsequent years.

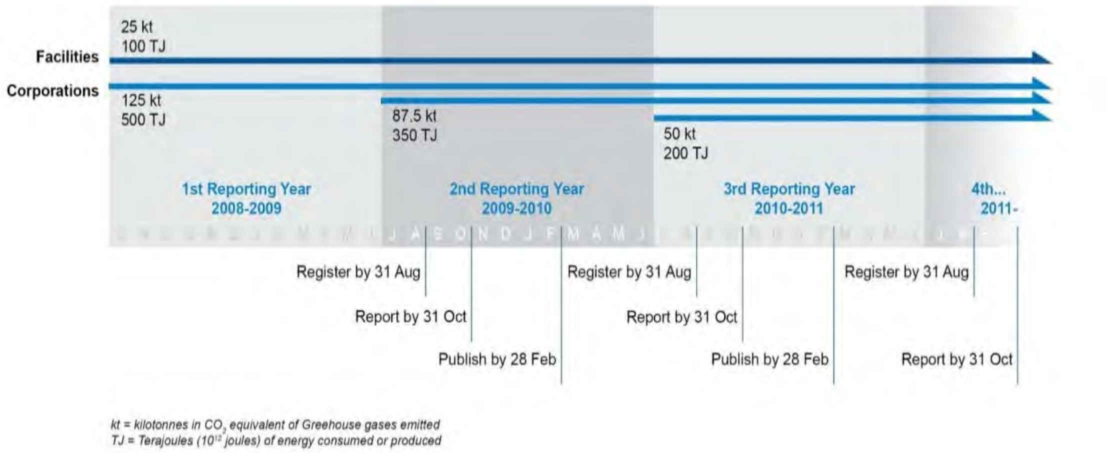

Figure 19.1 NGER Act's reporting timeline

Methods for measurement of greenhouse gas emissions and the production and consumption of energy are set by the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Cth).

Emissions Reduction Fund

The Emissions Reduction Fund is central to the Government's Direct Action Plan to cut emissions to 5% below 2000 levels by 2020 and to 26% to 28% below 2005 levels by 2030. It comprises an element to credit emissions reductions, a fund to purchase emissions reductions, and a safeguard mechanism (starting on 1 July 2016).

The Clean Energy Regulator will issue Australian Carbon Credit Units for emissions reductions from registered projects. Once credits have been issued they can be purchased by the Government through the Emissions Reduction Fund or sold to organisations that wish to offset their emissions.

United Nations Framework Convention on Climate Change

The UNFCCC is the foundation for global action to prevent interference with the climate system.

Kyoto Protocol

The Kyoto Protocol, ratified by Australia on 3 December 2007, committed Australia to limit its greenhouse gas emissions to 108% of 1990 emissions during the period 2008 to 2012; this was called the first commitment period.

At the United Nations climate change negotiations in 2011, parties to the Kyoto Protocol decided to establish a second commitment period from 2013 to 2020, with further negotiations to finalise the emission reduction targets to be taken by countries who participate in the second commitment period.

The Australian Government set a national target to reduce emissions by between 5% and 25% of 2000 emissions by 2020 (depending on action of other countries) and a long term goal to reduce greenhouse gas emissions by 60% on 2000 levels by 2050.

Paris Agreement and Intended Nationally Determined Contributions

Countries across the globe committed to a new international climate agreement at the conclusion of the UNFCCC conference in Paris in December 2015. In preparation for the Paris Agreement, countries agreed to publicly outline what post-2020 climate actions they intend to take under the new agreement, known as their Intended Nationally Determined Contributions (INDC). Australia's INDC is as follows:

> *The Australian Government will reduce greenhouse gas emissions to 26-28 per cent below 2005 levels by 2030. Our target is a step up from Australia's current target to reduce emission to five percent below 2000 levels by 2020.*

The Paris Agreement provides for five yearly reviews of national targets, underpinned by a rules based system that will assess whether countries are meeting their commitments.

Renewable Energy Target

In order to meet the 2020 target for emissions reduction, the Australian Government made a commitment that 20 percent of Australia's electricity supply will come from renewable sources by 2020. This target will be delivered through the Renewable Energy Target (RET) scheme, which aims to stimulate approximately $12 billion of investment in renewable energy across Australia by 2020.

The Clean Energy Regulator oversees the RET scheme, which is separated into two parts – the small-scale renewable energy scheme and the large-scale renewable energy target (LRET). The LRET will cover wind farm developments such as the Project. For each megawatt hour the Project produces, one large-scale generation certificate (LGC) is created. The LGCs are then sold to liable entities, which have a legal obligation to buy LGCs and surrender them to the Clean Energy Regulator on an annual basis. Liable entities will need to meet obligations under the LRET by acquiring and surrendering available LGCs. Each megawatt hour produced will contribute to the legislated annual target(s).

The LRET includes legislated annual targets which will require significant investment in new renewable energy generation capacity in coming years. The LRET was reviewed by the Government and reduced in June 2015 from the previously legislated 41,000 GWh to 33,000 GWh.

The new target for large-scale generation of 33,000 GWh in 2020 will double the amount of large-scale renewable energy being delivered by the scheme compared to current levels and means that about 23.5% of Australia's electricity generation in 2020 will be from renewable sources (DOTEE, 2016).

19.2.3 Existing environment

There are no significant existing sources of greenhouse gas emissions as the site is yet to be developed.

19.2.4 Potential impacts and mitigation measures

The greenhouse gas emissions produced from the Project are expected to be from the construction and maintenance phases. The greenhouse gas emissions from the construction phase will be emitted from fuel consumption, electricity consumption, stationary energy use and embodied energy from construction materials.

Greenhouse gas emissions from fuel consumption can be attributed to the following activities:

- Establishment of temporary site offices and lay down areas
- Clearing of the site where required
- Transportation of equipment, materials and staff
- Earthworks for roads and underground cables
- Foundation works
- Erection of wind tower and turbine structures
- Construction of the substation and control room
- Installation of electrical and communications cabling and equipment
- Site restoration.

Greenhouse gas emissions from electricity consumption during construction and operation will most likely be from the temporary site offices and any lighting for the site. Emissions from stationary energy will most likely be from any emergency diesel generators used on-site.

Greenhouse gas emissions associated with the embodied energy of construction materials may be associated with the use of materials such as concrete (used in constructing the foundation), pre-stressed concrete, aggregate, sand, steel, aluminium, copper, glass reinforced plastic, wood-epoxy and injection moulded plastic with carbon fibres (as applicable).

The greenhouse gas emissions from the maintenance phase of the Project will most likely be from fuel consumption from the vehicle required for scheduled maintenance of the turbines. However, it is anticipated that the substation/switchyard facility, maintenance and operations facility, overhead and underground cabling and access roads will require minimal maintenance over time. The only time heavy equipment is likely to be required on site will be for unexpected and rare events, such as the repair or replacement of major components of the turbine or substation.

Greenhouse gas emissions will be reduced from the construction phase of the Project by considering the actions in Table 19.1. It is likely that the greenhouse gas emissions produced in the maintenance phase of the Project will be minimal compared to the construction phase of the Project, and as a result, no mitigation actions are presented for the maintenance phase.

Table 19.1 Greenhouse gas mitigation actions for the Project

Measure	Potential action
Awareness	- Provision of a greenhouse gas reduction management plan for the construction phase - Greenhouse gas awareness training as part of site inductions - Periodic energy audits to progressively improve energy efficiency on site.
Targets and goals	- Develop a set of key performance indicators for emissions to track performance over time - Set an overall target and individual goals to provide clear direction to construction staff - Monitor key performance indicators on a monthly basis.
Energy efficiency	- Provision of passive solar design features in the site offices where possible - Install lights with daylight sensors or timers on the construction path so they do not operate unnecessarily - Install energy saving equipment and energy efficient lighting - Implement a switch off campaign to increase staff awareness of the unnecessary energy consumption of office equipment and construction camp facilities - Purchase of Green Power for the site offices and construction camp.
Fuel efficiency	- Lay down areas located to minimise the distance needed to travel - implementation of a travel behaviour program for construction staff that travel to and from site - Gather and record fuel data, including fuel type, fuel consumed, vehicle type, date of fuel purchased and distance travelled - Purchase/lease of more fuel efficient vehicles and/or machines - Analyse the potential to regularly purchase less carbon intensive fuels such as E10 or biodiesel
Material use	- Purchasing materials with lower embodied energy emissions or increased recycled content where possible - Ensure the site office has recycling bins in addition to general waste bins.

19.2.5 Conclusion

The generation of energy from wind produces no greenhouse gas emissions. The annual greenhouse gas emissions displaced by the Project is estimated to be approximately 1,490,952 t CO_2-e (assuming a generation capacity of 460 megawatt and a capacity factor of 37%)[1]. This estimate does not include any indirect greenhouse gas emissions saved from avoiding the extraction, production and transportation of coal or the electricity lost in delivery in the transmission and distribution network.

The Project could supply power to service approximately 236,000 households (assuming an average household uses 6.3 megawatt hours) or would be the equivalent to taking approximately 438,515 petrol cars off the road each year (assuming an average petrol car produces approximately 4.33 tonnes of CO_2-e emissions annually).

[1] Greenhouse gas emissions displaced (t CO_2-e) = (generation capacity (kilowatts) x 8760 hours x capacity factor) x scope 2 emission factor for electricity generation in Queensland. The latest scope 2 emission factor for electricity in Queensland is 0.82 kg CO_2-e/kWh.

19.3 Climate change

19.3.1 Introduction and approach

Climate change is a change in the average pattern of weather over a long period of time. Climate varies naturally on many timescales; however recent observed changes in climate are unusual when compared to climatic records going back up to 20 centuries. Climate change science has shown that the warming in the past 50 years is very likely attributable to the observed increase in greenhouse gas concentrations in the atmosphere from human activities. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2014) stated that:

> *'Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen and the concentrations of greenhouse gases have increased.'*

Globally, increases in greenhouse gas concentrations in the atmosphere have contributed to the following observed changes:

- Increased ocean acidification, reducing the capacity of oceans to store carbon
- Increased melting of permafrost releasing methane into the atmosphere
- Increased number of natural hazards, including more extreme rainfall events resulting in flooding and more severe tropical cyclones
- More severe drought and bushfires
- Increased frequency of hot days, hot nights and heatwaves
- 2015 was Australia's fifth warmest year on record; all of the world's 10 warmest years have occurred since 1998.

Infrastructure with long life spans, such as wind farms, will be impacted by climatic conditions including natural disasters and the effects of climate change. Design, construction, operation and maintenance of the Project will need to take into account these changes to avoid any significant adverse impacts and to ensure the Project is able to continue to operate effectively and efficiently in a changing climate.

19.3.2 Existing environment

Observations of Australia's climate show that it has been changing, becoming hotter and drier. Figure 19.2 shows annual temperature departures from the mean for Australia from 1910 to present (based on 1961-90 climate record). The most significant changes have occurred since 1970, with the majority of years experiencing temperatures above the mean and this becomes more frequent as time progresses (BOM, 2015).

Average temperature in Australia has increased by 0.90°C since 1910, with significant regional variation. Since 1950 a warming trend of 0.16°C per decade has occurred, which is almost double the trend over the century as a whole. The frequency of hot nights has increased and the frequency of cold nights has declined. Warmer than average years have been experienced for 16 of the past 18 years (CSIRO and BoM, 2007).

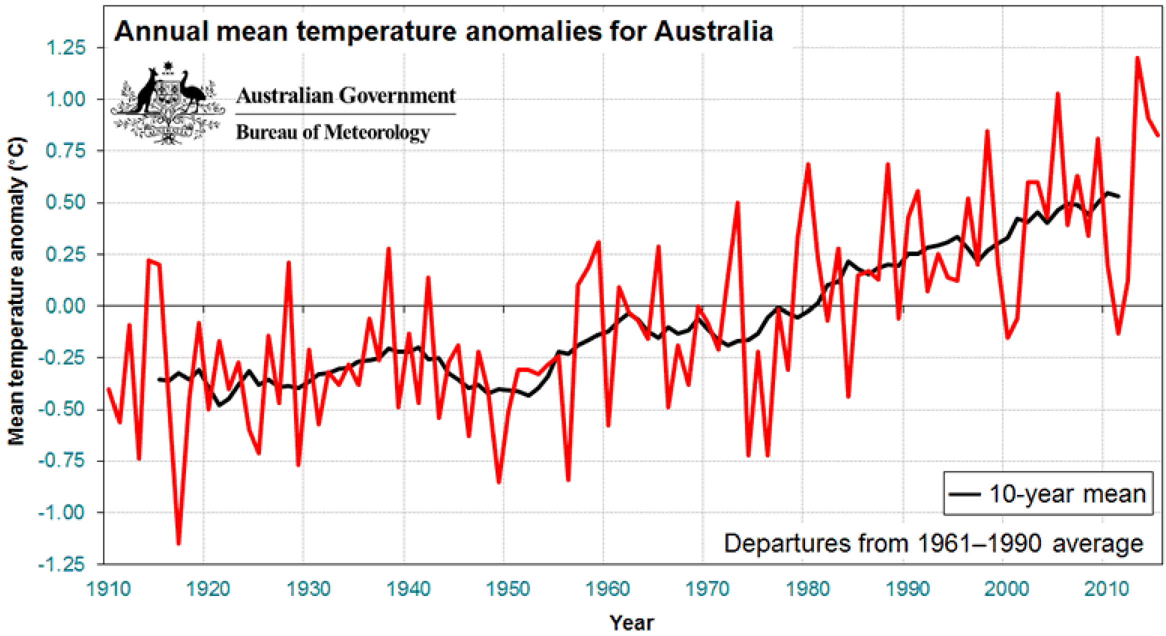

Figure 19.2 Annual mean temperature changes in Australia since 1910 (Source: BoM, 2015)

Figure 19.3 shows the trend in mean annual temperature in Queensland since 1950. The highest temperature increases are observed in areas of central Queensland, with the majority of the state experiencing an increase of 0.20°C per decade. Temperatures in the Study Area have increased at a rate of 0.15°C to 0.20°C per decade.

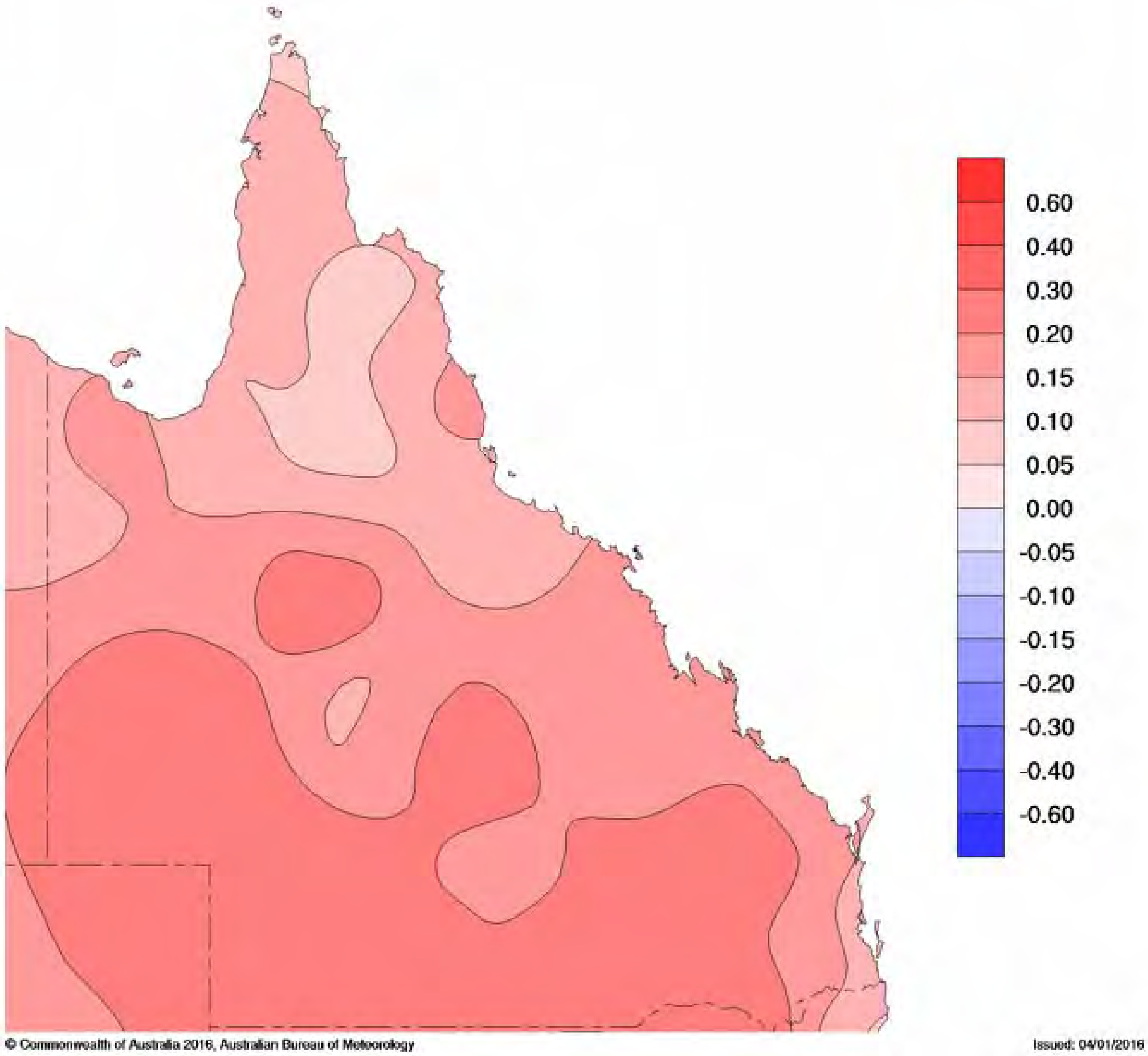

Figure 19.3 Trend in annual mean temperature, 1950 – 2015 (°C/10 years) (BoM, 2015b)

Figure 19.4 shows the trend in maximum temperature in Queensland since 1950. Maximum temperatures for the majority of the state have increased by 0.05°C to 0.15°C. Maximum temperatures in the Study Area have increased at a rate of 0.15°C to 0.20°C per decade.

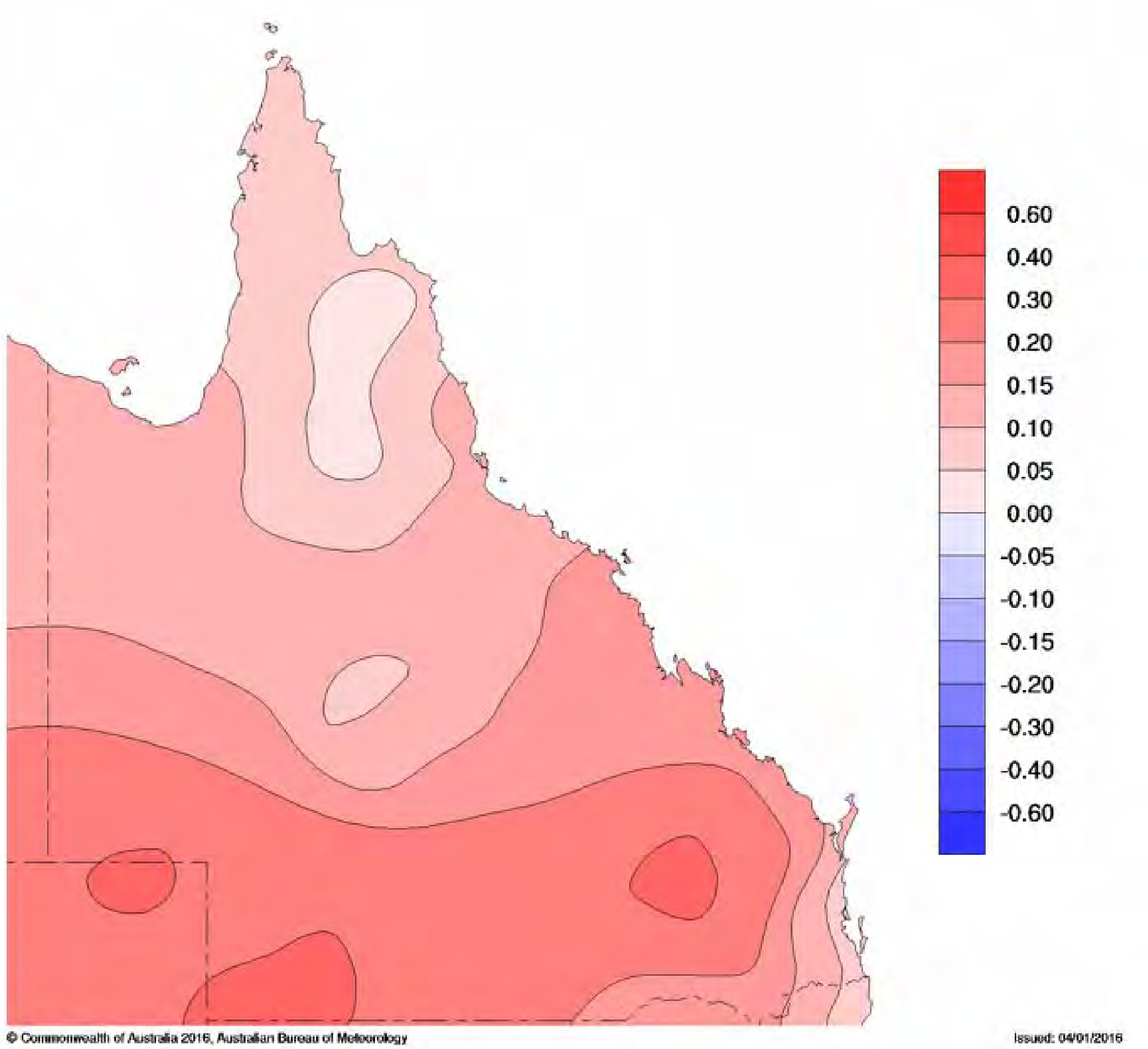

Figure 19.4 Trend in maximum temperature, 1950 – 2015 (°C/10 years) (BoM, 2015c)

Figure 19.5 shows the trend in minimum temperature in Queensland since 1950. Minimum temperatures for the majority of the state have increased by 0.20°C to 0.30°C. Minimum temperatures in the Study Area have increased at a rate of 0.15°C to 0.20°C per decade

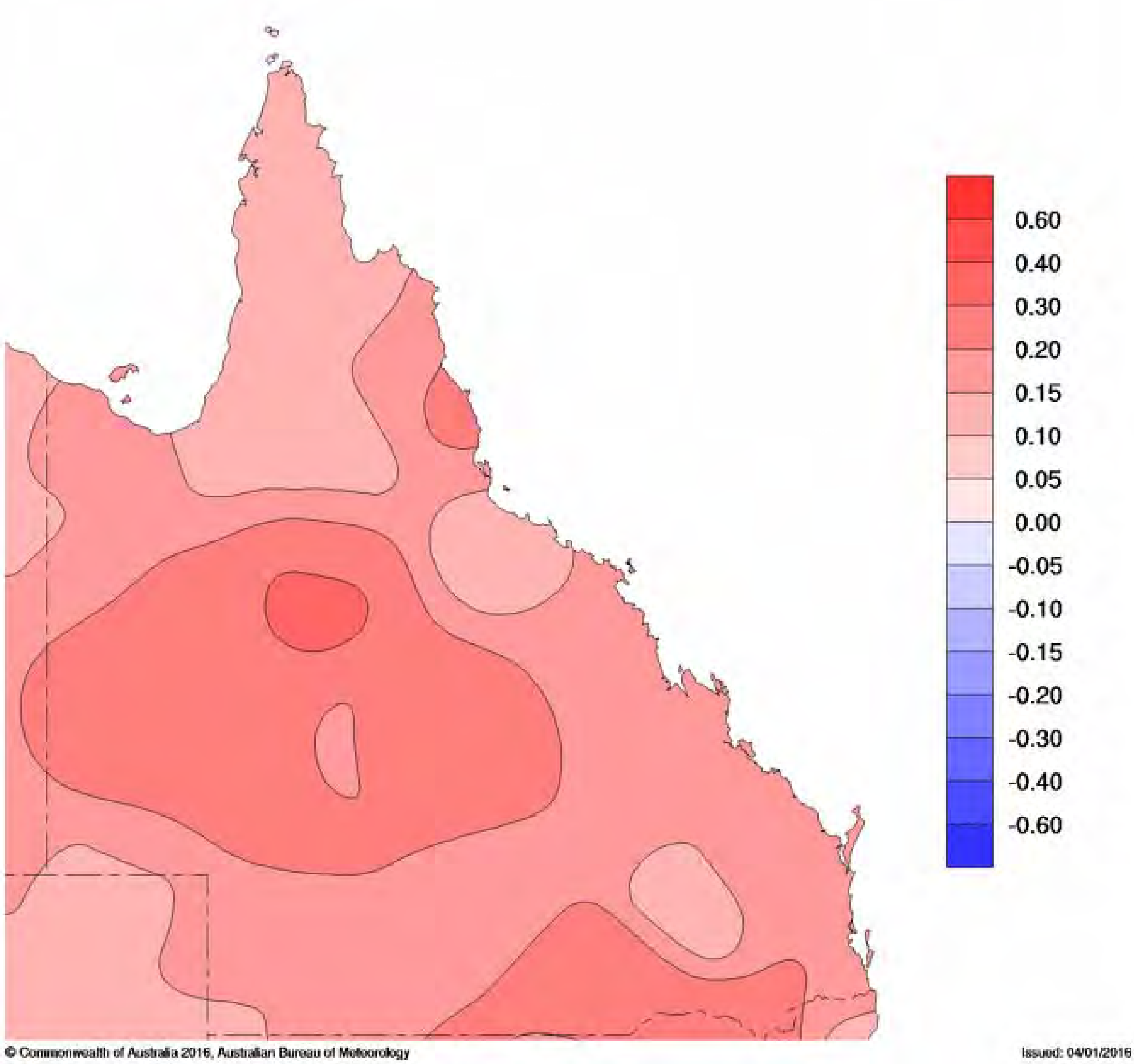

Figure 19.5 Trend in minimum temperature, 1950 – 2015 (BoM, 2015d)

Figure 19.6 shows the trend in annual rainfall in Queensland from 1950 to 2011. The brown areas indicate declining rainfall while green areas indicate an increase. Rainfall for most parts of the state has declined between 1950 and 2011, with the highest decrease recorded on the central coast. Rainfall in the Study Area has decreased by 10 to 15 mm per decade (BoM, 2013e).

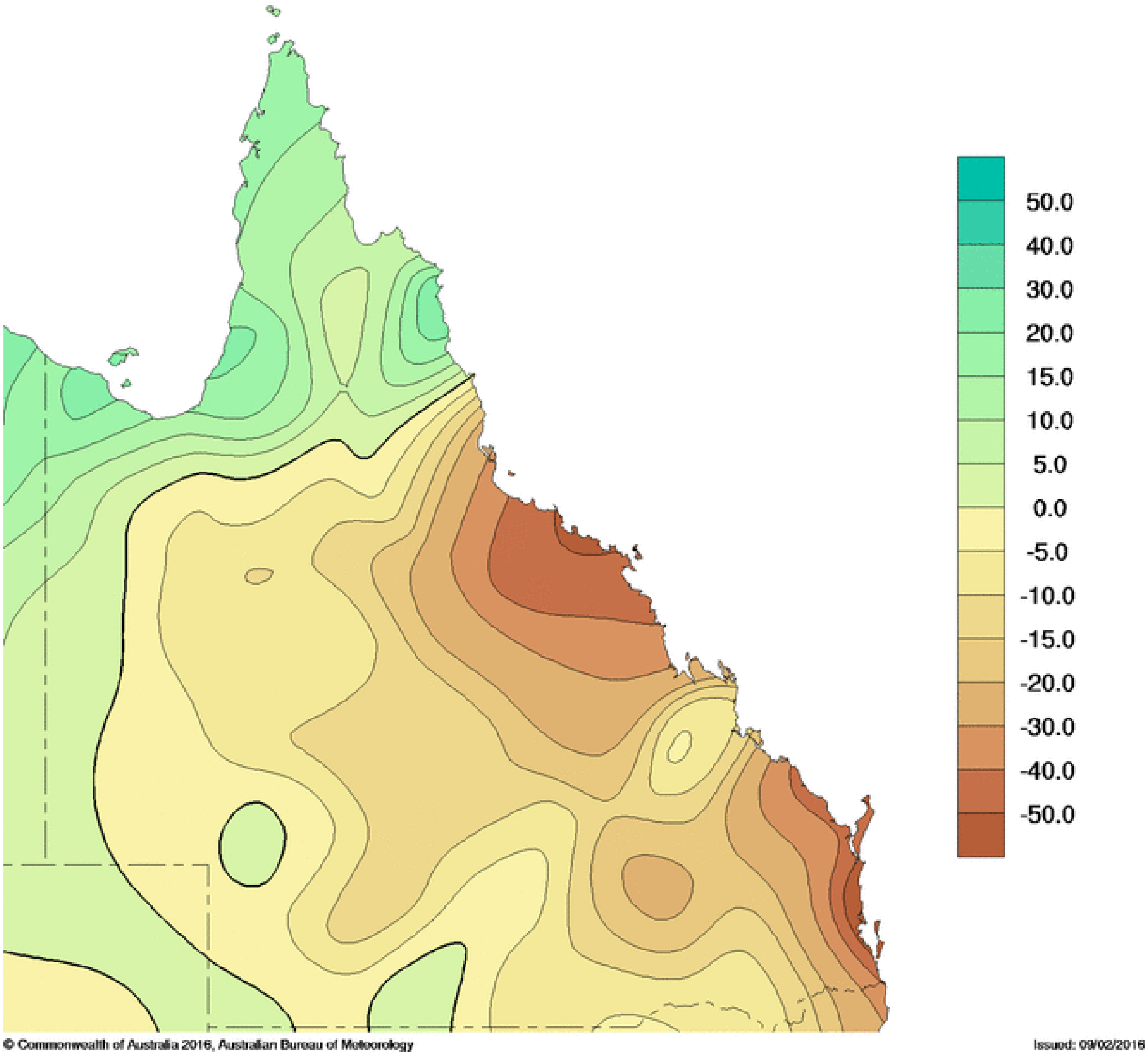

Figure 19.6 Trend in annual total rainfall, 1950 – 2015 (BoM, 2015e)

Climate change projections

Climate change projections are produced by simulating the effects of 'emissions scenarios' using climate models. The IPCC has developed a number of different emission scenarios for the 21st century. Each scenario is based on assumptions about future changes to demographic, economic and technological factors, which impact upon the concentrations of greenhouse gas concentrations in the atmosphere and therefore the degree of projected climate change (Office of Climate Change (OCC), 2010).

Climate models are mathematical representations of the Earth's climate system based on well-established laws of physics (OCC, 2010). The effects of each emissions scenario on the climate can be simulated using climate models. Climate models are currently considered to be the best tools for projecting changes to climate.

For each emissions scenario, as developed for the *IPCC Fourth Assessment Report: Climate Change 2007* (IPCC 4AR), there are projections available from up to 23 global climate models. These emissions scenarios have been updated in the recently released Fifth Assessment Report however, further analysis has not yet been undertaken by research bodies to develop projections specific to Queensland.

The climate change projections in this section are based on those provided by the *Climate Change in Australia: Technical Report* developed by CSIRO and the BoM in 2007, being the most relevant information for Queensland. This report incorporates material from the IPCC 4AR, along with information of specific relevance to Australia. The projections presented in the report are relative to the base period of 1980-1999 (except for days over 35°C).

The former DERM produced more specific climate change projections for a range of climate variables across a number of regions in Queensland using the climate change projections from the CSIRO and BoM report. The Project is located in the Wide Bay Burnett region. The 2009 DERM projections for Wide Bay Burnett are currently the best available information for the region.

Climate change projections for 2030 and 2070 are likely to be the most relevant to the Project. The medium (A1B) scenario has been chosen for 2030 as the global climate models show little difference under the low, medium and high emissions scenarios to 2030. A low (B1) and high (A1FI) emission scenario has been chosen for 2070 to demonstrate the range in the projections. However, the most recent scientific reports are showing that observed emissions of carbon dioxide (the most important greenhouse gas) are exceeding the IPCC's highest emissions scenario (Steffen, 2009).

Where possible, the 10th, 50th and 90th percentile projections are provided for 2030 and 2070. The 10th, 50th and 90th percentile components of the projections enable uncertainties in the climate change science to be considered (e.g. uncertainty around the precise increase in temperature, sea level rise or amount of evaporation that will occur by a particular time period). It achieves this by providing the 50th percentile (best estimate) and close to the worst case (10th and 90th) percentiles at both ends of the spectrum (e.g. the wettest or driest, lowest or highest changes anticipated).

Temperature

The 'best estimate' projection for annual mean temperature (the average of all daily temperatures within a given year) is an increase of 0.9 C to 21.4 C by 2030 (DERM, 2009). By 2070, the 'best estimate' projection is an increase of 2.9 C to 23.4° C under a high emissions scenario (DERM, 2009). There is little variation in projections across the seasons. Table 19.2 outlines the 10th, 50th and 90th percentile projections for mean temperature.

Table 19.2 Mean temperature projections

Season	Current Historical Mean	2030			2070					
		Medium (A1B)			Low (B1)			High (A1FI)		
		10p	50p	90p	10p	50p	90p	10p	50p	90p
Summer	25.2 °C	+0.6	+0.9	+1.3	+1.0	+1.5	+2.2	+2.0	+2.9	+4.2
Autumn	21.1 °C	+0.6	+0.9	+1.3	+1.0	+1.5	+2.1	+2.0	+2.8	+4.1
Winter	14.8 °C	+0.6	+0.9	+1.3	+1.0	+1.5	+2.2	+2.0	+2.9	+4.2
Spring	20.9 °C	+0.6	+0.9	+1.4	+1.0	+1.6	+2.3	+2.0	+3.0	+4.4
Annual	20.5 °C	+0.6	+0.9	+1.3	+1.0	+1.5	+2.1	+2.0	+2.9	+4.1

The frequency of heat waves will increase as the number of days over 35°C increases. The nearest inland locality to the Project that has projections for the number of days over 35°C is Gayndah. The 'best estimate' projection is an increase of 12 days to 35 days by 2030 (DERM, 2009). Under a high emission scenario by 2050, the number of days over 35° C in Gayndah is projected to increase by 58 days to 81 days (DERM, 2009). Table 19.3 outlines the 10^{th}, 50^{th} and 90^{th} percentile projections for number of days over 35°C.

Table 19.3 Number of days over 35 C projections (Gayndah)

Season	Current Historical Mean	2030			2070					
		Medium (A1B)			Low (B1)			High (A1FI)		
		10p	50p	90p	10p	50p	90p	10p	50p	90p
Annual	23 days	+9	+12	+21	+15	+25	+41	+35	+58	+98

Rainfall

The 'best estimate' projection for annual average rainfall is a 26 mm decrease to 836 mm by 2030 (DERM, 2009). The largest seasonal decrease is projected for spring with a 6% decrease (DERM, 2009). By 2070, the best estimate projection is an 86 mm decrease to 776 mm under a high emissions scenario (DERM, 2009). The largest seasonal decrease is projected for spring with an 18% decrease (DERM, 2009). Table 19.4 outlines the 10^{th}, 50^{th} and 90^{th} percentile projections for average rainfall.

There is a high degree of uncertainty associated with projected changes in average rainfall, with some global climate models showing significant increases while others show significant decreases. This uncertainty is due to the sensitivity of global climate models to sub-global scale climate processes, such as cloud formation, and that there is no direct relationship between greenhouse gas concentrations and rainfall (Risk Frontiers, 2011).

Table 19.4 Average rainfall projections

Season	Current Historical Mean	2030			2070					
		Medium (A1B)			Low (B1)			High (A1FI)		
		10p	50p	90p	10p	50p	90p	10p	50p	90p
Summer	330 mm	-36	-3	30	-59	-7	46	-102	-13	89
Autumn	208 mm	-31	-6	19	-48	-10	29	-83	-21	58
Winter	112 mm	-17	-6	6	-26	-9	9	-45	-17	17
Spring	194 mm	-37	-12	12	-56	-19	19	-95	-35	37
Annual	862 mm	-103	-26	43	-164	-43	69	-284	-86	138

Evaporation

Potential evaporation is a measure of the evaporative power of the atmosphere. The potential evaporation rate assumes that there is unlimited supply of water to evaporate and gives an indication of the change in the evaporative power of the atmosphere.

The 'best estimate' projection for annual potential evaporation is a 51 mm increase to 1,766 mm by 2030 (DERM, 2009). The largest seasonal increase is projected for autumn and winter with a 4% increase (DERM, 2009). By 2070, the best estimate projection is a 189 mm increase to 1,904 mm under a high emissions scenario (DERM, 2009). The largest seasonal increase is projected for autumn and winter with a 12% increase (DERM, 2009). Table 19.5 outlines the 10^{th}, 50^{th} and 90^{th} percentile projections for potential evaporation.

Table 19.5 Evaporation projections

Season	Current Historical Mean	2030			2050					
		Medium (A1B)			Low (B1)			High (A1FI)		
		10p	50p	90p	10p	50p	90p	10p	50p	90p
Summer	575 mm	12	17	29	17	29	52	17	63	98
Autumn	377 mm	8	15	23	15	23	38	26	45	72
Winter	262 mm	5	10	16	10	16	26	21	31	50
Spring	505 mm	10	15	25	15	25	35	25	45	71
Annual	1715 mm	34	51	86	69	103	137	120	189	274

<u>Drought</u>

In regards to temperature, projections for Queensland indicate a significant increase in the frequency and extent of exceptionally hot years to an average of once every 1.7 years affecting approximately 62% of the state by 2040. Rainfall projections for Queensland indicate minimal change to the frequency and extent of low rainfall years. Soil moisture projections for Queensland indicate a slight increase in the frequency and extent of exceptionally low soil moisture years to an average of once every 12.6 years affecting approximately 7% of Queensland by 2040 (Hennessy *et al.*,2008). Drought projections specific to the Project area are not available.

In addition, drought projections based on simulated changes in rainfall and potential evaporation from two global climate models indicate up to 20% more drought months over most of Australia by 2030 and up to 40% more drought by 2070 in eastern Australia (Mpelasoka *et al* 2007 cited in CSIRO and BoM, 2007).

<u>Bushfire</u>

Fire weather conditions are expected to worsen due to climate change. For eastern and southern Australia, Lucas *et al* (2007) found that climate change can exacerbate the fire-weather risk of any given day (leading to increased frequency or intensity of extreme fire weather days) and result in a longer fire season that is more intense. This effect should be apparent by 2020 and most pronounced by 2050 (Lucas *et al,* 2007).

The number of high Forest Fire Danger Index (FFDI) days is likely to increase with a decrease in relative humidity, increase in average temperature, increase in the number of days over 35 C and decrease in annual rainfall (OCC, 2010). Research on projected changes is not available for the Project site. Rockhampton is the closest site studied to date, and results show an increase in the frequency of extreme fire danger days of between 5% and 140% by 2050 (Walsh *et al*., 2004).

<u>Wind speed</u>

With respect to average wind speed change, model to model uncertainty is high. The best estimate for the A1B scenario for 2030 is a 2% to 5% increase in average wind speed for the Project's location (CSIRO and BoM, 2007). The best estimate for the A1FI scenario for 2070 is a 5% to 10% increase in average wind speed (CSIRO and BoM, 2007).

19.3.3 Potential impacts and mitigation measures

The most likely climate change impacts for the Project will be from:

- Increase in frequency and intensity of extreme events
- Decreasing average rainfall
- Increase in days over 35°C
- Increasing average temperature
- Increase in wind speed.

The potential risks as a result of changes to climatic variables for the Project include the following:

- Damage to wind turbines from extreme events or extreme heat conditions leading to increased maintenance and reduced energy production

- Increased fire damage to environment and property resulting in increased maintenance and replacement costs
- Increased staff downtime due to hotter conditions resulting in reduced productivity
- Increase in health complaints to workers due to more frequent extreme heat conditions
- Increased vehicle and communication equipment maintenance and replacement costs due to heat related breakdowns
- Increased cooling demand resulting in higher electricity costs
- Increased water demand for dust suppression on access roads due to drier surface conditions
- Accelerated deterioration of infrastructure due to prolonged warmer periods resulting in reduced asset lives
- Faster deterioration of materials due to increased temperatures resulting in higher maintenance costs
- Reduction in energy output from the wind farm as a result of extreme weather events.

Table 19.6 outlines potential adaptation strategies to manage the potential risks for the Project.

Table 19.6 Adaptation strategies

Potential risk	Potential adaptation strategies
Damage to wind turbines from extreme events or extreme heat conditions leading to increased maintenance and reduced energy production	- Ensure all infrastructure is designed to cope with increases in rainfall intensity and increased number of days over 35°C - Develop contingency plans to respond to loss of critical equipment and for accessing additional staff (e.g. on-call agency/contractors) to respond to clean up requirements - Require suppliers of wind turbine equipment to demonstrate their product's capacity to cope in extreme heat conditions
Delays in construction of wind turbines and associated infrastructure	- Develop contingency plan to respond to construction delays
Increased fire damage to environment and property resulting in increased maintenance and replacement costs	- Review bush fire management planning to ensure it is suitable and appropriate under changed climatic conditions
Increased staff downtime due to hotter conditions resulting in reduced productivity	- Monitor incidences of staff heat stress and change work practices in response to any increases (e.g. change working hours, ensure appropriate PPE is provided, staff education etc.).
Increase in health complaints from workers due to more frequent extreme heat conditions	- Monitor incidences of staff heat stress and change work practices in response to any increases (e.g. change working hours, ensure appropriate PPE is provided, staff education etc.) - Establish procedures for accessing up-to-date weather data as an early warning about potential extreme events - Implement appropriate stop-work procedures for extreme events - Ensure appropriate emergency response and evacuation procedures have been developed for the site
Increased vehicle and communication equipment maintenance and replacement costs due to heat related breakdowns	- Require suppliers of vehicles and communications equipment to demonstrate their product's capacity to cope in extreme heat

Potential risk	Potential adaptation strategies
Increased cooling demand resulting in higher electricity costs	- Investigate potential for renewable technologies to be installed on buildings - Review air conditioning systems in buildings and facilities to ensure they can cope with any increased cooling requirements, along with being as energy efficient as possible
Increased water demand for dust suppression on access roads due to drier surface conditions	- Ensure low water intensity dust suppression methods are used, along with recycled water
Accelerated deterioration of infrastructure due to prolonged warmer periods resulting in reduced asset lives	- Identify and monitor infrastructure assets at risk due to climate change - Require suppliers of wind turbine equipment to demonstrate their product's capacity to cope in extreme heat conditions
Faster deterioration of materials due to increased temperatures resulting in higher maintenance costs	- Use materials which are less prone to heat related cracking/deterioration - Require suppliers to demonstrate product performance in changed climatic conditions
Reduction in energy output from wind farm as a result of extreme weather events	- Incorporate the likelihood of extreme weather events into economic planning

19.3.4 Conclusion

Effectively responding to climate change requires both mitigation and adaptation actions to address both the causes and the effects. Mitigating greenhouse gas emissions is needed to reduce the rate and overall magnitude of climate change, and adaptation is required to ensure we can live in a changing climate. One response directly influences the other (refer to Figure 19.7).

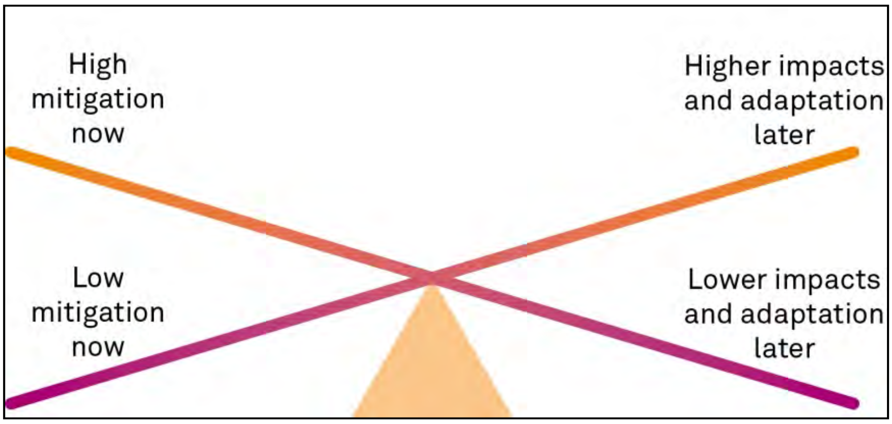

Figure 19.7 Relationship between climate change mitigation and adaptation

Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread, and irreversible impacts globally. There are multiple mitigation pathways that are likely to limit warming to below 2°C relative to pre-industrial levels. These pathways would require substantial emissions reductions over the next few decades and near zero emissions of carbon dioxide and other long-lived greenhouse gases by the end of the century. The Project will provide a significant contribution to reducing Queensland's greenhouse gas emissions, therefore assisting to avoid climate change.

Infrastructure with long life spans, such as wind farms, will be impacted by climatic conditions including natural disasters and the effects of climate change. Design, construction, operation and maintenance of the Project will need to take these changes into account to avoid any significant adverse impacts and to ensure the Project is able to continue to operate effectively and efficiently in a changing climate.

19.4 Sustainability

19.4.1 Introduction and approach

Greenhouse and climate change issues are considered high profile and urgent sustainable development issues and have been covered separately in the sections above. This section considers the broader sustainable development benefits from the Project.

The definition for sustainable development is drawn from the *Sustainable Planning Act 2009*[2] (SP Act) which means to balance in an integrated way:

- Protection of ecological processes and natural systems at local, regional, State and wider levels;
- Economic development; and
- Maintenance of the cultural, economic, physical and social wellbeing of people and communities.

19.4.2 Legislative context

National Strategy on Ecological Sustainable Development

The NSESD was ratified by the Council of Australian Governments in 1992 in response to the signing of the Rio Declaration and Agenda 21 at the United Nations Commission on Economic Development. The NSESD has as its goal 'development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes on which life depends'. NSESD also outlines objectives and principles and provides a broad strategic framework for key industries that rely on natural resources as their productive base. In relation to energy, renewables are identified as a key strategy in limiting harmful emissions including greenhouse gases, improving energy production and distribution, and the efficiency and performance of the buildings, transportation and manufacturing sectors.

Sustainable development benefits of the Project are associated with activities and outcomes that simultaneously provide social, environmental and economic benefits. This means there is integration across the 'triple bottom line' with no intended net trade-off.

19.4.3 Potential impacts and mitigation measures

Table 19.7 provides a summary of key sustainable development opportunities that the Project will explore during the detailed design phase. This table does not include Project opportunities to reduce greenhouse gas emissions or climate change adaptation strategies as these are outlined in previous sections.

Table 19.7 Project sustainability opportunities

Category	Theme	Future Opportunities
Environment	Energy	- Ensure lighting is energy efficient while still delivering any safety requirements of the Project Site - Reduce access road gradients were possible to improve the fuel efficiency of construction vehicles/machinery - Design associated infrastructure to minimise lifecycle energy consumption
	Water	- Minimise the use of potable water on site during construction - Use construction wastewater rather than potable water for dust suppression - Develop an erosion and sediment control plan
	Materials	- Include sustainability scoring criteria to use when assessing potential suppliers in the procurement strategy - Use materials with recycled content or that are sustainably sourced where possible - Choose materials that have low maintenance and/or are high durability in the weather conditions of the site - Utilise second hand stock for temporary drainage and piping that can be on-sold - Reuse spoil on-site or off-site

[2] *Sustainable Planning Act 2009*, Part 3, Division 2 – note, the term used is ecological sustainability

Category	Theme	Future Opportunities
	Waste	- Ensure recycling bins are available at the site offices - Order materials in bulk where possible to minimise packaging waste - Avoid over-ordering where possible - Avoid waste generation (direct or indirect) of hazardous material(s) - Identify opportunities for waste avoidance, reuse and recycling by identifying the likely waste streams to be generated from the Project - Develop a waste management plan for the construction phase of the Project to implement the waste management hierarchy - Develop an incident management plan for potential spills and leaks during the construction phase
	Flora and fauna	- Avoid the clearing of sensitive vegetation where possible - Develop site clearing plans identifying ‘no go’ zones, buffers and additional management measures to protect sensitive areas during construction and maintenance - Develop weed and pest management plans as required - Any future rehabilitation works to contribute to habitat areas, connectivity and to be reflective of local vegetation communities
	Noise	- Develop a noise management plan to ensure noise levels are minimised for sensitive receivers
	Air	- Develop actions to manage dust during the construction phase
Social	Land use	- Determine whether the wind farm development can co-exist with other land-used opportunities such as agriculture
	Community safety and security	- Ensure adequate safety measures have been taken to prevent community members from accessing the wind turbines or other electricity distribution infrastructure - Ensure adequate safety measures have been taken to ensure the community is not impacted by noise
	Community engagement	- Develop a community engagement action plan - Ensure stakeholder satisfaction is regularly measured
	Social inclusion	- Minimise visual amenity impacts where possible
	Cultural heritage	- Assess and consider indigenous and non-indigenous heritage values and engage in an appropriate manner with indigenous communities where required
Economic	Local economy	- Ensure procurement favours local suppliers and service providers - Ensure employment of local residents is preferred
	Marketing	- Align the Project design, delivery and operation of the Project with the Australian Green Infrastructure Council sustainability principles (including the Quick Check tool) to demonstrate the sustainability credentials of the Project

19.4.4 Conclusion

Key sustainable development benefits of wind farm developments can be divided into environmental, social and economic benefits.

The environmental benefits include:

- Wind power is considered a renewable energy source because it involves converting wind energy into electricity by using wind turbines. Wind is an abundant source of energy that is not exhaustive (however it may be subject to climate change variations)
- When considered on a lifecycle basis, wind energy generates less air emissions, uses less fossil fuels and water, and generates less waste than its fossil-fuel based and nuclear alternatives
- Wind farms can be built with minimal loss of natural vegetation, minor impacts on surface and ground water and minor soil and geotechnical constraints.

The social benefits include:

- Wind farms can create additional tourism and educational opportunities, depending on location and proximity to communities (noting communities may have concerns about wind farm developments).

The economic benefits include:

- Wind powered electricity generation is a currently available and commercially viable technology
- Renewable energy provides improved security of electricity supply through diversification
- The Project may provide improved land-use options and increase the economic productivity of the land, with some agricultural activities effectively co-existing with wind farms
- The Powerlink 275 Kv transmission line is available to connect the Project to regional and major urban centres and customers.

19.5 References

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