Project Name: Click or tap here to enter text.

Climate Change Risk and Adaptation Assessment

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# Glossary

|  |  |
| --- | --- |
| Terms, abbreviations and acronyms | Meaning |
| BoM | Bureau of Meteorology |
| CCRAA | Climate Change Risk and Adaptation Assessment |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| GCM | Global Climate Models |
| RCP | Representative Concentration Pathway |

# Introduction

## Background

This document provides the Climate Change Risk and Adaptation Assessment for Click or tap here to enter text. Project.

The Climate Change Risk and Adaptation Assessment has been undertaken in accordance with the engineering policy EP170 *Climate Change Risk Assessment Methodology* and *Climate Change Risk Assessment and Adaptation Assessment Framework*.

The background policy context and process is outlined in these technical documents.

### Climate risk workshop

Assessing climate change risks for a project or asset involves a rigorous and comprehensive approach, and consideration and inclusion of important factors such as design life and stakeholder involvement are essential in identifying accurate climate risks and potential mitigation measures. In alignment with this, a preliminary desktop risk assessment was undertaken based on a review of project documentation, local hazard mapping and in consideration of future climate projections. These climate change hazards and climate risks were presented, refined and agreed for the project through a multidisciplinary Climate Risk Workshop attended by a multi-disciplinary internal team representing Transport and Main Roads and the consultant’s team.

The workshop reviewed the [amend as required]:

* validation of preliminary climate change risks informed by a desktop assessment
* identification of new climate change risks
* allocation of preliminary risk ratings, and
* identification of current adaptation actions and development of potential approaches / actions.

The climate change risk workshop was attended by:

*List staff attendance*

# Climate change projections

## Projected climate future

In accordance with the EP170 *Climate Change Risk Assessment Methodology*, the projected changes in local climate hazards were identified and considered over a variety of timeframes.

Local Governments have also undertaken a variety of climate change risk assessments and produced hazard mapping for their respective jurisdictions. Local hazard mapping commonly relates to sea level inundation and riverine flooding. The Town Planning Scheme for Click or tap here to enter text. Council was referenced for this project.

### Climate hazards

In accordance with the EP170 *Climate Change Risk Assessment Methodology*, the hazards that should be considered are listed below in Table 2.1.1.

Table 2.1.1 – The minimum climate change hazards that should be considered as part of TMR’s risk assessment

|  |  |
| --- | --- |
| Direct Impacts | Indirect Impacts |
| * Sea level rise and coastal inundation * Precipitation and rainfall intensity * Cyclones and storms * Flooding * Wind and hail * Air Temperature and humidity * Solar radiation * Heatwaves and droughts * Bushfire weather * ***Project specific*** | * Water shortages * Disruptions to electricity supply * Inundation of coastal areas * ***Project specific*** |

## Climate modelling

The climate of Queensland, as with global climate trends, is naturally variable. Climate change however, will lead to shifts beyond this natural variability. Risk assessment based on climate change requires an understanding of the current climate using historical data for comparison with future climate scenarios. Future climate scenarios are generated and prepared using data from Global Climate Models (GCM). GCMs are tools used for understanding how the climate will respond to changes in greenhouse gas (GHG) emission levels.

### Representative Concentration Pathways

The representative concentration pathways (RCPs) that were selected for this project climate change risk assessment are Click or tap here to enter text.

### Timescales

Roadway infrastructure has a varied expected design life depending on the component or system (e.g. pavement versus electrical). Minimum design lives outlined in Table 7 of the *Climate Change Risk and Adaptation Assessment Framework* are indicative for the purposes of the climate change assessment and may be subject to change through project design development.

For the Click or tap here to enter text. Project, the projections for timescales Click or tap here to enter text. and Click or tap here to enter text. have been selected. This is based on Click or tap here to enter text.

## Climate change projections

The Queensland Climate Futures Dashboard provides an interactive tool that can be used to identify the varying changes to climate across geographical areas, timeframes and climate change projection. The Queensland Government Future Climate Scenarios are presented in the Long Paddock Website and are subdivided into 14 regions. Recognising that the majority of the design elements have a less than xx - year design life, 20xx and 20xx were selected for the detailed climate change projections. Table 2.3 below provides the detailed climate change projections for the applicable region for the project, Click or tap here to enter text.

Table 2.3 – Detailed climate change projections for the project region Click or tap here to enter text.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Short timescale | | Long timescale | |
| Climate Variable | 20xx1 | 20xx2 | 20xx3 | 20xx4 |
| Mean Temperature (oC)(Annual) |  |  |  |  |
| Maximum Temperature (oC)(Annual) |  |  |  |  |
| Minimum Temperature (oC)(Annual) |  |  |  |  |
| Days above 40oC |  |  |  |  |
| Hot Days (days above 35oC) |  |  |  |  |
| Bushfire (Days) |  |  |  |  |
| Precipitation (%) |  |  |  |  |
| Surface Wind (%) |  |  |  |  |
| Solar Radiation (%) |  |  |  |  |
| Duration of Drought (change in months) |  |  |  |  |
| Duration of floods (change in months) |  |  |  |  |
| Sea level rise (metres) |  |  |  |  |
| Thunderstorms (days per year) |  | | | |

1 & 3 - Future Climate Dashboard (*Click or tap here to enter text, Region*):  
<https://app.longpaddock.qld.gov.au/dashboard>

2& 4 - CSIRO & BOM Climate Futures Tool: *Click or tap here to enter text.*

# Potential climate change consequences

## Sea level rise and coastal inundation

The Queensland Government has adopted a projected sea-level rise of 0.8 m by the year 2100. This is based on the climate modelling for probable scenarios presented at the Intergovernmental Panel on Climate Change Fifth Assessment Report 2014.

*Add:* ***Project region specific comment for sea level risk and coastal inundation***

There are some concerns that this may be a low estimate. With a high emissions projection (RCP 8.5), modelling potential seal level rise is 2 m by 2100 as shown by the National Oceanic and Atmospheric Administration (NOAA) of the United States of America in Figure 3.1.

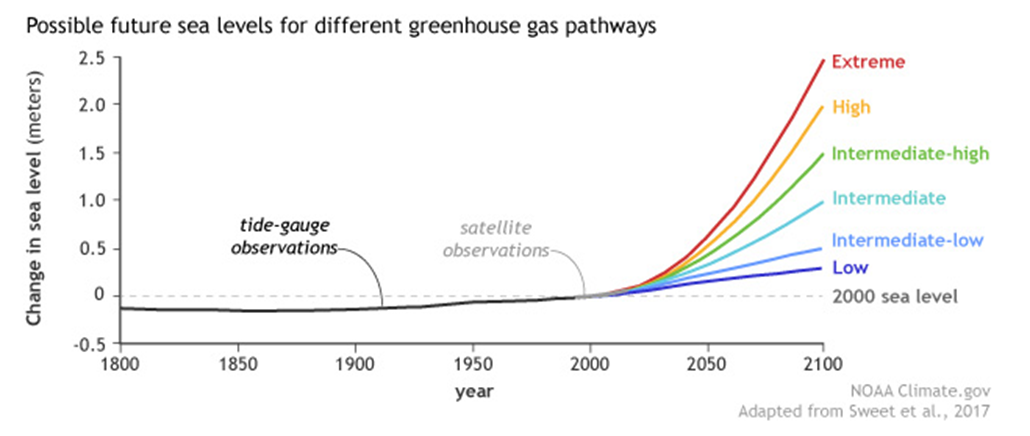


Figure 3.1 – Projected sea level rise

## Mean temperature

There is strong agreement on the direction and magnitude of temperature changes among GCMs and downscaling results and as a result, there is very high confidence in substantial warming for the annual and seasonal projections for daily mean, maximum and minimum surface air temperature for a range of emissions scenarios.

*Add:* ***Project region specific projection for mean temperature***

Changes in mean temperature that can affect road infrastructure occur at the extremes, for instance increasing the duration of bushfire seasons and impacting heatwaves and days over 35ºC. While mean temperature can influence most elements of the roadway, it is the extremes that could result in the greatest impact to the project, both from a construction and operational perspective, including prolonged bushfire seasons impacting roadside infrastructure, motorists, cyclists, pedestrians and operations personnel. Prolonged heat exposure can also impact on the materials and infrastructure as well as personnel working along the corridor.

## Extreme temperature and heatwaves

Heat related extremes are projected to increase at the same rate as projected mean temperature with a substantial increase in the number of warm spell days.

*Add:* ***Project region specific projection for extreme temperatures and heatwaves***

As noted above, extreme temperatures and heatwaves have the potential to reduce the efficiency of electrical infrastructure and impact on operations and maintenance activities (both personnel and rate of infrastructure renewal).

## Mean rainfall and drought

Projected changes in rainfall tend to be location specific. Projected changes to meteorological drought share much of the uncertainty of mean rainfall change, and there is no clear indication on changes to drought conditions.

*Add:* ***Project region specific projection for mean rainfall and drought***

Changes in precipitation and increased duration of drought can impact on the longer-life elements of the proposed works including drainage infrastructure, road base and bridges. Soil cracking and subsidence based on these changes in patterns can lead to instability and more frequent maintenance over the life of the project.

## Extreme rainfall and flooding

In a warming climate, heavy rainfall events are expected to increase in magnitude mainly due to a warmer atmosphere being able to hold more moisture (Sherwood et al., 2010).

*Add:* ***Project region specific projection for bushfire weather***

Extreme rainfall can result in severe flooding which can directly impact the road, including inundation of drainage infrastructure, damage/malfunctioning of electrical infrastructure and sheet flows resulting in aquaplaning. In addition, flooding can impact the surrounding local road network, potentially restricting emergency access and/or driving additional users onto the road.

## Bushfire weather

Studies suggest that climate change will have a significant impact on future fire weather (e.g. Williams et al., 2009; Clarke et al., 2011; Grose et al., 2014). Suitable weather conditions (hot, dry and windy) must generally exist for fires to spread. Given the combination of factors required for increased bushfire conditions, the potential increase in the future will rely heavily on projected changes in the weather.

There is high confidence that climate change will result in harsher fire weather in the future. This is seen in the mean changes and when examining individual models and scenarios. However, there is low confidence in the magnitude of the change, as this is strongly dependent on the rainfall projection. It is also recognised that the actual variability of fire weather across Queensland may be underestimated as the baseline fire climate is poorly sampled due to the small number of stations.

*Add:* ***Project region specific projection for bushfire weather***

Increased incidence of bushfire weather and the number of severe fire weather days could result in damage to electrical equipment and other roadside infrastructure (e.g. noise walls) as well as increased smoke impacting on the visibility for motorists and health of cyclists and pedestrians using the active transport network.

## Extreme storms (including wind, lightening and hail)

Projections indicate a decrease in the formation of tropical cyclones, however it is anticipated that the proportion of the most intense cyclones will increase over the century while the intensity of associated rainfall may increase further.

Thunderstorms can also be hazardous, bringing accompanying winds hail, tornados, flash flooding and lightening. While uncertainty exists with the projected changes in terms of number of additional thunderstorms, global models agree that the intensity of storms is predicted to increase.

*Add:* ***Project region specific projection for extreme storms***

As the intensity of cyclones and thunderstorms increase, potential impacts to transport infrastructure include damage to electrical infrastructure from high winds and hail as well as from debris blowing onto the corridor and adversely impacting vehicle safety.

## Solar radiation

For both 2030 and 2070, models simulate little change in radiation (about -1 to +3%) for both RCP4.5 and RCP8.5 with the higher changes projected for winter given decreases in cloudiness associated with reduced rainfall. Globally however, several models appear to underestimate the observed trends in some regions due to underestimation of influence caused by aerosol emissions (Allen et al., 2013). Taking this into account, we have high confidence in little change for 2030. For 2070, there is medium confidence in increased winter radiation, and low confidence for the small changes projected for the other seasons.

*Add:* ***Project region specific projection for solar radiation***

Increased solar exposure could potentially result in the accelerated degradation of materials, particularly the less hardened materials (e.g. signalling and cabling). Given the low relative change in the future, solar radiation isn’t considered likely to impact on the project.

## Water shortages

Related to mean rainfall and drought trends, water shortages may be a more common indirect consequence to QTRIP in future. This could present particular challenges for network operations and maintenance, particularly on gravel roads.

*Add:* ***Project region specific information on water shortages. Are existing shortages occurring? What******impact could this have on the project construction phase and asset during operation?***

## Electricity Supply Disruptions

Increase in the frequency and intensity of extreme weather events may also have an indirect impact to the road network through disruption to electricity supply. Again, this primarily has potential consequences for future network operations and impacts the level of service for the network.

*Add:* ***Project specific comment on the impacts from electricity supply disruptions***

# Potential Likelihood

The likelihood of particular climate hazards impacting on an asset are largely dependent on:

* Location of the asset
* Local climate projections.

# Climate Change Risks

The Climate Change risks identified and assessed for the Click or tap here to enter text. Project are listed in Table 5 below.

Table 5 - Click or tap here to enter text. Project Climate Change Risk Assessment

[**Action** – Complete *Project Climate Change Risk Assessment Template* and copy and paste into document]

# Network considerations

*Add*: ***Any considerations of the intra-dependency of the transport network***.

*For example: Consider whether there are broader network considerations in relation to climate change risk such as whether the project asset is dependent on other sections of the network being climate resilient and as such benefits of adaptation may not be realised. Whether the asset is the weakest link for a network and therefore benefits of adaptation are magnified. Whether the asset provides the sole access point for communities or critical infrastructure*.

# Adaptation options

The *Climate Change Risk Assessment and Adaptation Framework* outlines the adaptation options identified as common risk treatments that could be applied. Both current (i.e. planned) and future (i.e. potential) controls and actions are identified, including designation of which variable the control applies to and the responsibility for implementation.

# Project Adaptation and Residual Risk Assessment

The final step in completing the baseline assessment is understanding the level of residual climate risk relative to the project once the adaptation actions identified have been applied.

In support of this, the proposed and identified adaptation measures, have been developed. Certain generic adaptation actions (e.g. update emergency response plans) can be modified within the residual risk assessment to better clarify the intent and provide examples specific to the climate variable.

The following table (Table 8) outlines the identified adaptation treatment and residual risk assessment to understand the ability for the relevant adaptation options to treat and respond to specific risks. Some adaptation measures treat and reduce multiple risks while others are specific to a single risk.

In line with achieving both the Cli-1 and Cli-2 requirements, *has treated all very high and high risks as a minimum [****provide project strategy****].*

Risk statements that have been rated as low are not required to have treatment options identified and have not been considered further in the residual risk assessment.

Table 8 - Click or tap here to enter text. Project Climate Risks, Adaption Treatments for Capturing Residual Risk Ratings

[**Action** – Complete the *Adaptation Register* in the *Climate Change Risk Assessment Template* and copy and paste into this document.

# Conclusions

*Add:* ***Project-specific conclusions and actions to be taken forward to subsequent project phases. Where climate change risk assessments are completed as part of options analysis, discuss points of different between climate change risk assessments for each******option.***