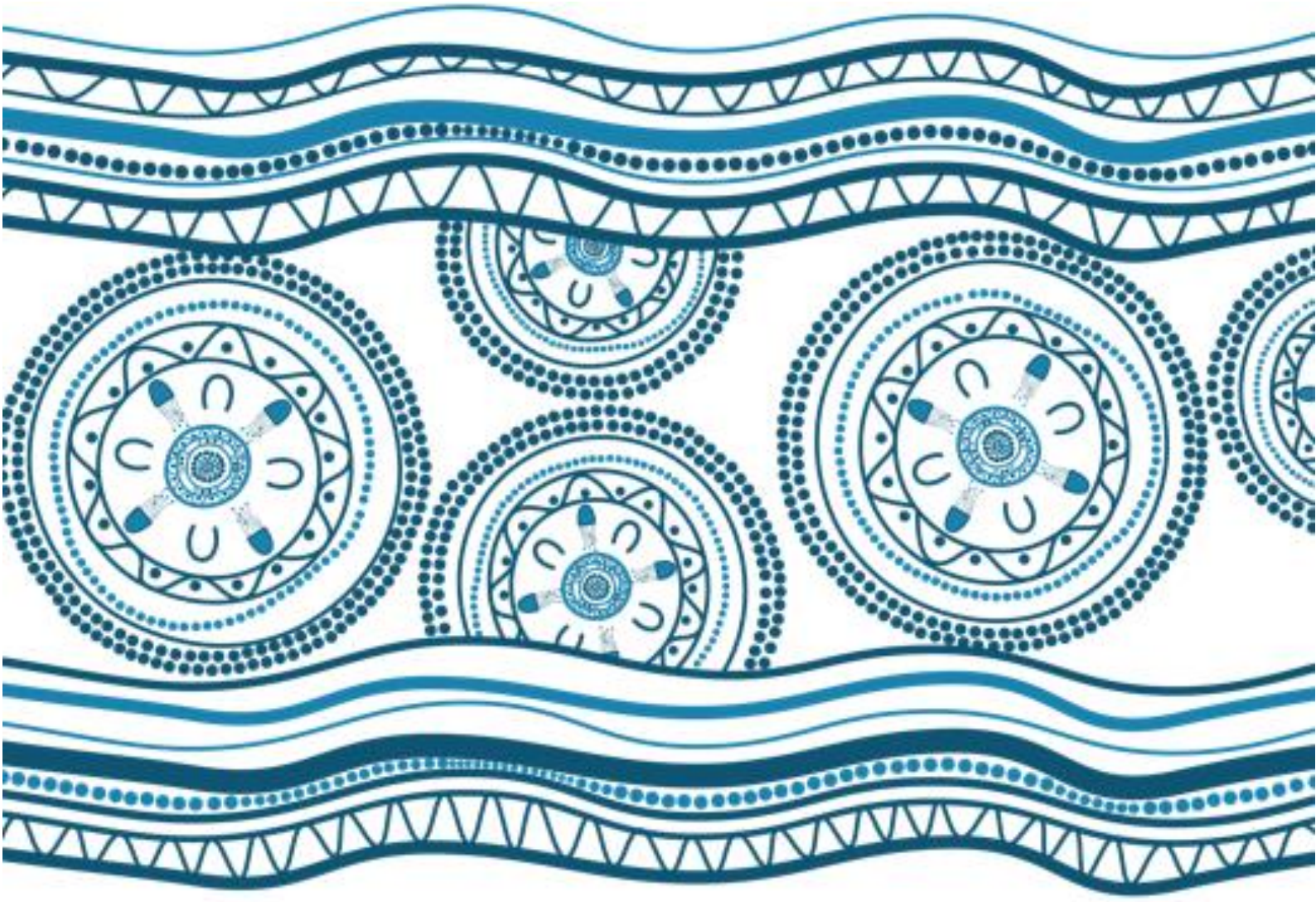
Chapter 19

Climate change



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19 Climate change

This chapter presents an assessment of how the project would affect climate change and how the project would be potentially affected by climate change in the future, and identifies mitigation and management measures to minimise and reduce these impacts. The assessment presented in this chapter draws on information from Appendix U (Climate Change Assessment).

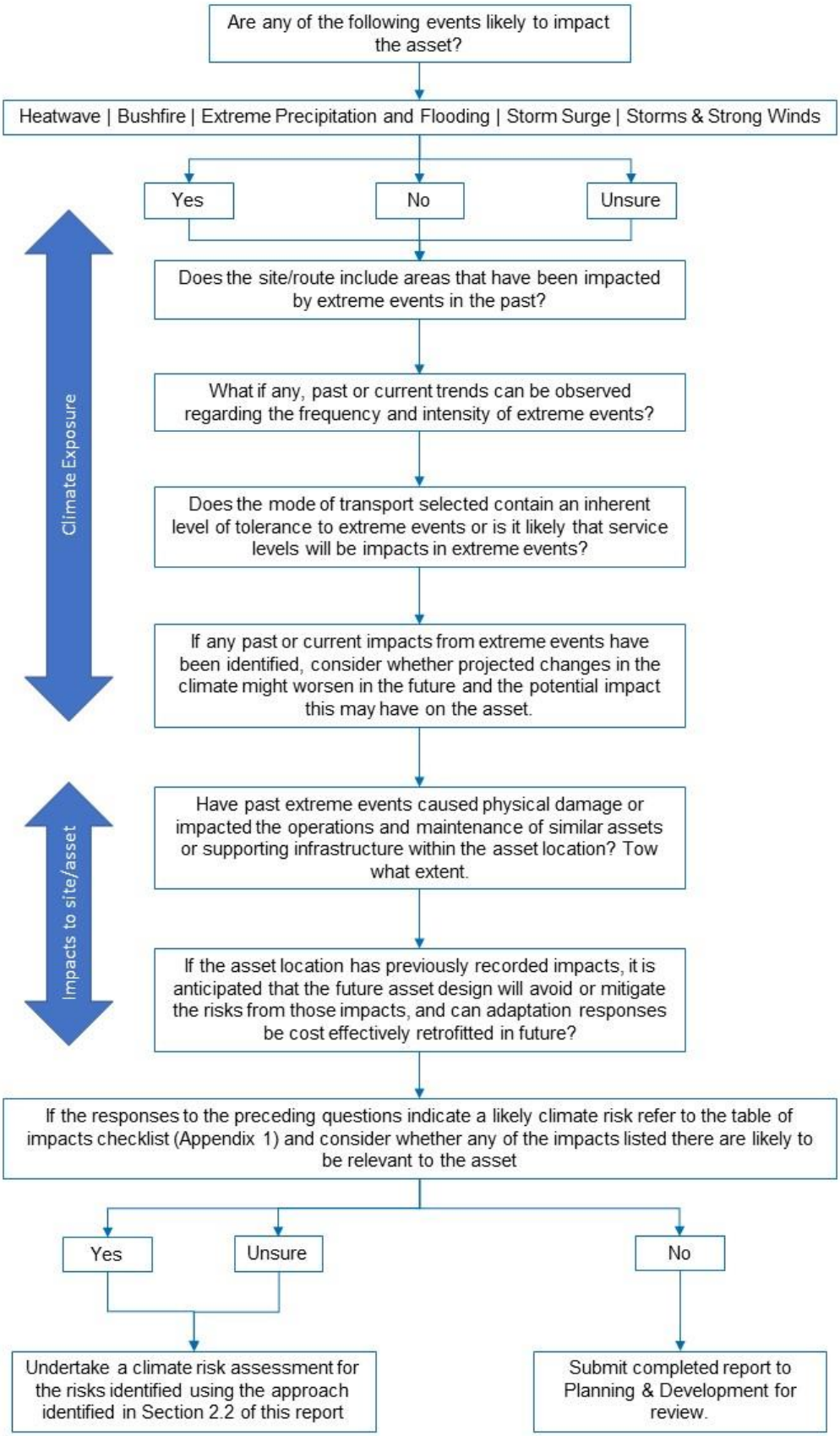
19.1 Assessment methodology

The Transport for NSW Climate Risk Assessment Guidelines (2019) were used to inform the risk assessment process. Initially, the Climate Risk Pre-Screening tool was used to confirm the need for a climate change risk assessment (CRA), see Figure 19-1.

19.1.1 Policy framework

The following policies are relevant to climate change and have been considered for this assessment:

- National Climate Resilience and Adaption Strategy 2015 (Australian Government, Department of Agriculture, Water and the Environment, 2015)
- Smart Cities Plan 2016 (Australian Government, Department of Infrastructure, Transport, Regional Development and Communications, 2016)
- NSW Climate Change Policy Framework 2016 (NSW Office of Environment and Heritage, 2016)
- NSW State Infrastructure Strategy 2018-2038 (Infrastructure NSW, 2018)
- Greater Sydney Regional Plan – A Metropolis of Three Cities 2018 (Greater Sydney Commission, 2018)
- Sustainable Sydney 2030: Resilient Sydney (Resilient Sydney Office, 2019)
- Transport for NSW Climate Risk Assessment Guidelines (Transport for NSW, 2019c).



Source: Transport for NSW, 2019c

Figure 19-1: Transport for NSW Climate Risk Assessment Guidelines, Climate Risk Screening Decision Tree.

In line with the Transport for NSW Climate Risk Assessment Guidelines, a CRA workshop was held on 6 August 2020. Invitees to the workshop were both Arup and Transport for NSW professionals including designers, sustainability experts, planning approvals professionals, urban design representatives, the project design manager and engineers.

The workshop and subsequent work covered:

1. Assessing risk exposure
2. Developing risk statements
3. Undertaking risk assessments (see Table 19-1 for risk ratings)
4. Identifying adaptation measures
5. Reassessing risks.

A preliminary risk assessment was carried out within these steps using NSW and ACT Regional Climate Modelling Project (NARCliM) climate modelling, supplemented by the Representative Concentration Pathway (RCP 8.5) sea level rise and sea allowance data. RCP 8.5 refers to the concentration of carbon that results in global warming at an average of 8.5 watts per square metre across the planet.

These risks were used as a starting point and were updated, eliminated or validated during the workshop based on the knowledge of experts in the workshop. New risks, evaluations and adaptation methods were then identified.

The operation and maintenance of the project was considered given these are the phases that would occur when climate change impacts are projected to become more significant.

Table 19-1: Climate Risk Assessment Guidelines Risk Matrix Evaluation Table (Transport for NSW, 2019c)

Risk ratings **A – Very high** **B – High** **C – Medium** **D – Low**			**Consequence**					
			Insignificant	Minor	Moderate	Major	Severe	Catastrophic
			C6	C5	C4	C3	C2	C1
Likelihood	Almost certain	L1	C	B	B	A	A	A
	Very likely	L2	C	C	B	B	A	A
	Likely	L3	D	C	C	B	B	A
	Unlikely	L4	D	D	C	C	B	B
	Very unlikely	L5	D	D	D	C	C	B
	Almost unprecedented	L6	D	D	D	D	C	C

19.1.2 Selection of timescales

Projections within NARCliM are used for the near future (2020 to 2039) termed ‘2030’ and the far future (2060 to 2079) termed ‘2070’, compared to the baseline climate (1990 to 2009). The design life of the project is 50 years; therefore, both the near and far future timescales were used. For climate variables from outside of the NARCliM projections, different time scales were used in line with the timescales available (see Table 19-2).

RCP8.5 projections 2030 and 2090 were selected as timescales for this assessment as the project is expected to be commissioned in 2025, with a 50 year design life.

19.1.3 Selection of potential climate variables

The climate variables for the assessment were selected based on existing climate trends, such as increased temperature and change in rainfall, and specific risks to the project itself, such as sea level rise.

19.2 Existing environment

There is a wide body of scientific evidence indicating that warming of the climate system is occurring at a steady rate. Studies, reports and evidence demonstrate climate warming trends over the past century, and in particular, the last 50 years, has led to an increase in extremes in weather conditions and associated hazards impacting infrastructure.

Climate change, including weather and severe climate extremes, can lead to costly impacts in terms of maintenance, repairs and loss of patronage for transport infrastructure. Building resilient infrastructure for current and changing climate conditions would help in reducing vulnerability and ensuring resilience, functionality and longevity of the project.

19.2.1 Historical climate trends

The Sydney Metropolitan Area experiences distinct seasons, with warm summers and cooler winters. These averages can be seen in Table 19-2 below.

In addition to these averages, more recent data suggests that impacts of climate change are already being seen in Sydney and should inform how climate change is considered in designing infrastructure. In 2019, Sydney was drier and warmer than average. Sydney also experienced its highest annual mean maximum temperature on record. Annual total rainfall was in the driest 15 per cent of years on record, although the year included several wet months. Warm and windy conditions led to severe bushfires across the State that burned over several months affecting Sydney's air quality and people's health.

19.2.2 Climate projections for Metropolitan Sydney

While NARCliM looks at a range of climate variables, limited projection information is available for certain variables, including rainfall intensity and sea level rise. These variables are shown in Table 19-2 and were used in the risk assessment.

NARCliM models use 1990 to 2009 as the baseline for comparison. Baseline data was extracted from the Metropolitan Sydney Climate Change Snapshot. This information was used for annualised daily temperatures, annualised hot and cold days and annualised rainfall.

Changes in rainfall intensity were calculated using information from the Australian Rainfall and Runoff (ARR) 2019 Guidelines. This accounted for climate change using the RCP 8.5.

Similarly, sea level rise and sea allowance variables were developed for the Sydney area using RCP 8.5 projections. Sea level rise is measured against a 1986 to 2005 baseline used by the NARCliM model.

Table 19-2: Climate change projections for Metropolitan Sydney Area

Variable	Baseline 1990-2009	Future baseline projections 2020-2039	2060-2079
Annualised daily temperature			
Mean ºC	13 to 15	+ 0.7	+ 2.0
	22 to 24	+ 1.0	+ 2.2
Maximum ºC	22 to 30	+ 0.7	+ 1.9
Minimum ºC	8 to 12	+ 0.6	+ 2.02
Annualised hot days each year			
Average days with avg. temp over 35 ºC	< 10	+ 4 to 5	+ 10 to 13
Annualised cold days each year			
Average nights under 2 ºC	< 10	- 4.5	- 10.9
Seasonal and annual average rainfall			
Annual (mm)	800 to 1,200	+ 1.7%	+ 8.9%
Severe Fire Conditions			

Variable	Baseline 1990-2009	Future baseline projections 2020-2039	2060-2079
Severe fire conditions average days per year (FFDI value 50-74)	1	+ 0	+ 0.6
Sea level rise relative to 1986-2005 average (m)	2030 RCP 4.5	2090 RCP 4.5	2090 RCP 8.5
Annual seal level rise (m) in Sydney	0.13	0.47	0.66
Sea allowance (m)	0.14	0.59	0.84

19.3 Assessment of potential impacts

This section assesses the potential effects of climate change from the project and on the project, including flooding, coastal processes and hazards with the meaning of the *Coastal Management Act 2016* (NSW), including sea level rise.

19.3.1 Impacts from the project

The impacts from the construction and operation of the project on climate change would be limited to greenhouse gas emissions and impacts on coastal processes. Greenhouse gas emissions from the project are assessed in Chapter 21 (Greenhouse gas). Impacts on coastal processes are assessed in Chapter 18 (Coastal processes). The potential effects of flooding, and hazards (within the meaning of the *Coastal Management Act 2016*), including sea level rise arising from the project have been considered, but the project does not affect these matters.

The project will generate greenhouse gases during construction and operation, which could contribute to climate change. Identifying the source of the emission and their relative intensities and recognising the ability to control and influence these emissions, can minimise greenhouse gas emissions both now and into the future. An assessment of the project's greenhouse gas emissions and the environmental management measures that can be used to help reduce these emissions are outlined in detail in Chapter 21 (Greenhouse gas).

19.3.2 Impacts on the project

Climate change projections do not allow for the quantification of immediate climate change risks on the project and the processes of construction, as generally the immediate impacts are not considered in a climate change risk assessment. However, climate change can exacerbate the severity of natural hazards such as heavy rainfall, flooding, drought, extreme heat, and strong winds. These events could impact the constructability of the project and increase risk for construction staff. Measures to avoid and mitigate against any extreme climate events would be part of the Construction Environmental Management Plan.

The following section assesses impacts from climate change during the operation of the project.

The risk assessment identified 111 risks as detailed in Appendix U (Climate Change Assessment). Of these, five were rated 'very high' and eight were rated 'high'. These are listed in Table 19-3.

All of these operational impacts are related to risks around future climate variables, namely:

- Increased extreme rainfall events and flooding
- Increased extreme temperature events (number of days with average temp over 35℃)
- Storms and strong winds
- Sea level rise
- Increased atmospheric carbon dioxide (CO_2).

Table 19-3: Risks rated as ‘very high’ and ‘high’

Impact	Initial risk rating
Increased risk of slips and falls for passengers along concrete jetty and entranceways from increased extreme rainfall events and flooding	● A: Very high
Impact on users and staff comfort in extreme temperature events at ferry wharves during operations from increased extreme temperature events	● A: Very high
An increase in erosion of shorelines and damage to nearshore assets from storms and strong winds	● A: Very high
Passenger comfort and safety in storms and strong winds	● B: High
Damage to infrastructure (flooring, substructure, roofing) due to storms and strong winds	● B: High
Damage to secondary infrastructure (balustrades, signage/ information boards) due to storms and strong winds	● B: High
Damage to infrastructure (flooring, substructure) due to increased water level and wave heights from sea level rise	● A: Very high
Increased swell and wave action at wharves with increased water depths exacerbating erosion and other impacts from sea level rise	● A: Very high
Increased risk of carbonation (concrete cracking) due to increased atmospheric CO_2	● B: High
Safety and wellbeing of employees and maintenance workers on ferry services from increased extreme temperatures	● B: High
Impact on the ability to berth vessels and utilise wharves due to storms and strong winds	● B: High
Altered sediment transport and sedimentation/accumulation at waterside approach and surrounds as a result of storms and high winds	● B: High

Through the workshop process, the project team identified mitigation measures to minimise and reduce these risks in line with the Transport for NSW Climate Risk Assessment Guidelines.

Examples included:

- Carrying out specialist assessments to determine and influence the design
- Design orientation and specification:
  - Sea level rise (RCP 8.5) and increased wave heights are accounted for in the wharf design
  - The berths have been orientated to face the predominant wave direction
  - Fenders and mooring points will be positioned along the berths to account for various conditions and sea level rise.
- Material selection:
  - Secondary elements are designed for easy replacement
  - Slip resistant flooring and finishes
  - Mesh allowing water to flow through
  - Stainless steel for balustrades, steelwork connections and facings of fenders
  - Fibreglass reinforced plastic mesh decking
  - Marine grade coated steel for the substructure
  - A durability assessment to determine the appropriate concrete selection.
- Weather protection – waiting areas are provided with roofing and wind protected seating, and the existing shelter at Kurnell will be retained
- Maintenance schedules during operation.

The risks were reassessed with the mitigation measures employed (Residual risk column of Appendix U (Climate Change Assessment)). All post-mitigation risks were rated ‘medium’ or less, meaning they are acceptable in accordance with the Transport for NSW Climate Risk Assessment Guidelines.

19.4 Environmental management measures

The following summarises the management measures to mitigate the predicted impacts described above.

Table 19-4: Environmental management measures identified as part of the risk assessment process

Impact	ID	Environmental management measure	Responsibility	Timing
Impacts on wharf and future users from climate change induced events	CC1	The wharves will be designed to account for impacts of climate change, such as sea level rise and severe weather events.	Transport for NSW	Detailed design
Passenger comfort and safety in storms and strong winds or increased extreme temperatures.	CC2	The wharves will be maintained in accordance with the Transport for NSW operational management system to ensure the weather protection measures remain effective over time.	Transport for NSW	Operation