Transport
for NSW

Sydney Terminal Building Revitalisation

Climate Change Adaptation Plan

February 2023

NSW GOVERNMENT

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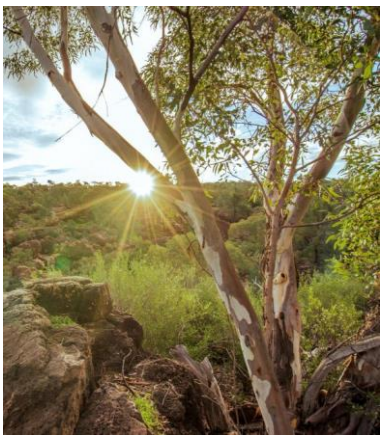
Acknowledgement of Country



We respectfully acknowledge the Traditional Custodians of the land of Central Precinct and the Sydney Terminal Building, the Gadigal. From time immemorial, this Country has been a place where people come to connect and reconnect. We pay our respects to all Aboriginal people who have journeyed and will journey through this place and acknowledge their ongoing connection to Country and culture. We pay our respects to members of the Stolen Generations and their descendants for whom the Sydney Terminal Building will always hold significance. We acknowledge that Platform One played a key role in Aboriginal children being removed from their families and communities.

Executive Summary

The purpose of this Climate Change Adaptation Plan (CCAP) is to highlight the climate change projections and identify potential risk drivers that could impact the Sydney Terminal Building proposed developments. The Sydney Terminal Building Revitalisation Project, located in the southern end of the Sydney Central Business District (CBD), consists of the restoration and revitalisation of the Sydney Terminal Building and its public domain interfaces, Eddy Avenue Colonnade, Eddy Avenue Plaza, and Western forecourt at Central Station. This report considers the CCAP for the upgraded Station and its interfaces

Climate risks to the Terminal Building have been identified through analysing climate forecasts specific to the Central Sydney region (Figure 0-1). Climate change projections for the region were assessed using the NSW Government's Climate Change in Australia RCP data at two-time scales relevant to the projects design life; 2050 and 2090.

A preliminary risk register was created where a total of 18 climate risks were identified for the project. By 2090, there were three 'low' risks, 10 'medium' risks, five 'high' risks and no 'extreme' risks identified. Following project specific climate risk identification and assessment, the design team and stakeholders determined the most cost-effective actions to treat and minimise the risks.

The five 'high' risks have been treated with risk treatment adaptation design responses to mitigate the impacts of climate change on the project. These 'high' risks, including their details and confirmed adaptation strategies as per the risk register, are presented in Appendix B.

This document should be considered a live document. The adaptation strategies include both design initiatives and adjustments to suggested operational management, currently being investigated to mitigate climate risks. Therefore, continual monitoring and review is necessary to understand climate risks and adaptation strategies throughout the project and during the operational life of the asset. This is commonly the responsibility of the operational management team. With each stage of the project, the following should be reviewed and updated: climate data and observed trends for extreme weather events, climate risks, and risk treatment adaptation strategies, complete with follow-up actions.

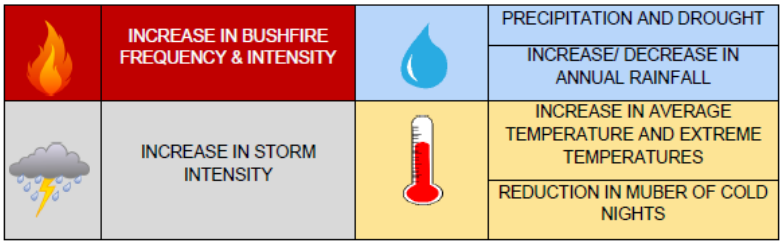


Figure 0- 1 Key Climate Projections for Central

Some of the key risk treatment adaptation strategies currently proposed for the Sydney Terminal Building site include:

- Reducing energy and water requirements during operation
- Sizing of HVAC system to incorporate climate change induced temperature increases
- Passive design principles to be incorporated into the design to promote shaded areas and reduce the urban heat island effect
- Designing more spaces for rest, increased planting, and shading areas

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1 Introduction

1.1 Purpose

The purpose of this Climate Change Adaptation Plan (CCAP) is to highlight climate change projections and identify potential risk drivers that could impact the Sydney Terminal Building Revitalisation (STBR) project. These drivers can then be used to identify specific climate risks over the useful life of the assets. Once the specific climate risks are identified and assessed, adaptation risk treatment strategies are appraised, refined, and integrated into the design. The development of this CCAP allows project teams and clients to assess the Sydney Terminal Building and the redevelopment works involved, taking climate change into account throughout the design process so that the building performs resiliently in the face of exacerbated climate conditions.

The assessment was completed to support the Environmental Impact Statement (EIS) and address the relevant Secretary's Environmental Assessment Requirements (SEARs) as they relate to climate resilience. As the design is still in the early stages, the primary purpose of this document is to discuss the climate risks facing the project and the mitigation strategies currently under investigation that could be implemented to lessen the impacts of climate change.

This CCAP should be considered as a live document and should be continually reviewed and updated as the project progresses through each phase. This iteration of the CCAP is used to inform the early-stage designs of the climate risks faced by the project. As the design is developed, the climate risk mitigation strategies will be updated and supported by detailed design documentation.

1.2 Project Introduction

The STBR project is one of the projects under the Central Precinct Renewal Program includes the restoration and revitalisation of the and its public domain interfaces, Eddy Avenue Colonnade, Eddy Avenue Plaza, and Western forecourt at Central Station.

For the Sydney Terminal Building, the project will provide:

- New access and egress points, including escalators and lifts between the Grand Concourse and ground level at Eddy Avenue and Eddy Avenue Plaza
- New lifts and stairs between the Grand Concourse and upper levels of the Sydney Terminal Building
- Adaptive re-use, additions, and alterations of retail space at the Grand Concourse and ground level of the Sydney Terminal Building
- New amenities and relocation of existing amenities at the Grand Concourse and ground level of the Sydney Terminal Building
- Reinstatement of the original Booking Hall's double height ceiling space
- New multipurpose space in the existing ground level of the Sydney Terminal Building
- New finishes to the Grand Concourse roof & flooring
- Improved roofing for natural lighting to the Porte Cochere over the existing light rail stop
- New awning over the eastern balcony of the Sydney Terminal Building, adjacent to Eddy Avenue Plaza
- Widening of Eddy Avenue footpath between Pitt Street and Eddy Avenue Plaza
- Market-style retail activation within the western loading dock
- Reconfiguration of the northwest corner of the Sydney Terminal Building and colonnade adjacent to Pitt Street, including creation of a new public access to the western loading dock from Pitt Street and Eddy Avenue
- Public domain improvements

1.3 Secretary's Environmental Assessment Requirements (SEARs)

The SEARs requirements issued on 17th October 2022 state that a climate resilience assessment must be undertaken for the Sydney Terminal Building Revitalisation to analyse the risks faced by the project through construction and operation phases caused by declining environmental conditions induced by climate change.

Table 1-1 outlines the SEARs for the climate resilience and where they have been addressed in this report.

Table 1-1 SEARs relevant to climate resilience

SEARs relevant to this technical report	Where addressed
1. An assessment of the following issues must be undertaken in accordance with the commitments in Section 7 of *Sydney Terminal Building Revitalisation Project – Scoping Report* (Transport for NSW, June 2022): (i) climate resilience	See Table 1-2

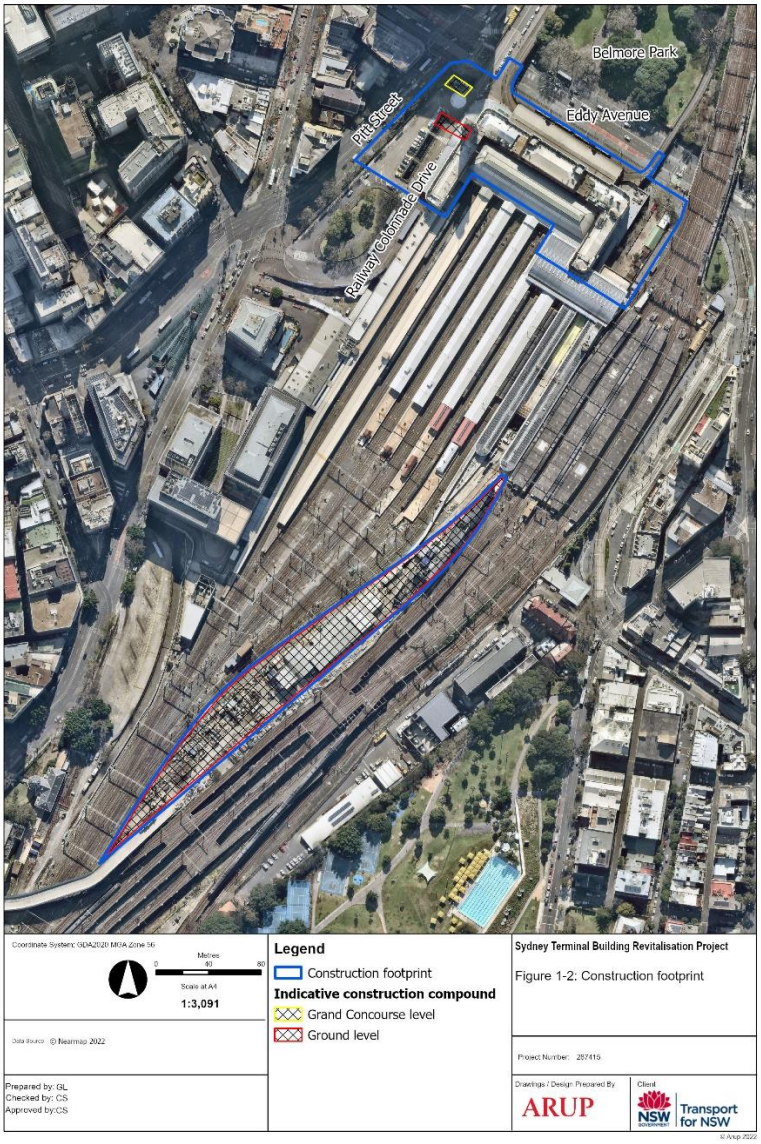
Table 1-2 Proposed investigations and assessment as identified in the Sydney Terminal Building Revitalisation Project – Scoping Report

Credit Achievement Compliance	Reference
• Assess the project against the current guidelines including targets and strategies that address sustainability themes (e.g., water, energy, and transport) – Green Star Buildings v1.0 (Green Building Council of Australia, 2020) – Carbon Estimate and Reporting Tool (Transport for NSW, 2017a) – Climate Risk Assessment Guidelines Version 4.0 (Transport for NSW, 2021c)	The project was assessed with the guidelines listed. Refer to Section 3, Section 4 and Appendix B. AS for the Carbon Estimate
• Assess potential impacts of climate change on the project, taking into account the climate change scenarios already considered within the design.	The climate change workshop was undertaken on 30th September 2022 taking two-time frames including 2050 and 2090. Refer to Section 4, Section 5, Appendix A and B.
• Provide sustainability risks and opportunities for improved sustainability outcomes during construction and operation	The climate risk adaptation measures include opportunities for improved sustainability outcomes as these strategies can work hand in hand. Refer to Section 4 and Appendix B.
• Consider how the project would demonstrate a best practice level of performance using sustainability ratings tools during design, construction, and operation	One of the ways the project would demonstrate a best level of practice is through the formulation and implementation of the CCAP along with ongoing update of the climate risk register during the entire project duration. Refer to Section 5, Section 6 and Appendix B.

1.4 Project site and location

The Sydney Terminal Building is located on Eddy Avenue, Sydney, New South Wales. A mark-up of the construction footprint is shown in Figure 1-1.

Figure 1-1 Location of Sydney Termina; Building Site, Source: ARUP



1.5 Context

The key features of the project aim to improve access, connectivity, activation and amenity of the ground level of the Sydney Terminal Building, whilst celebrating its heritage character and significance.

This CCAP defines the predicted climate risks and associated adaptations required for the Terminal Building to be resilient to the impacts of a changing climate and natural disasters.

1.6 Current climate characteristics

The Terminal Building is located within:

- Climate zone 5: based on average temperature data and used to determine the required thermal performance or minimum R-value requirements

- Flooding zone: the Sydney Terminal Building is not located directly in a flooding zone
- Bushfire zone: while there is minimal risk of direct impact from bushfires due to its urban setting, the greater climate risk is concerned with smoke exposure from regional bushfires having indirect impacts.
- Storm surge: as the Terminal Building is not near major waterbodies; the storm surge intensity will be minimal.

The Australian Building Codes Board has classified the Sydney Terminal Building within climate zone 5. This climate is characterised as warm temperate, meaning the region has a low daily temperature range and four distinct seasons. Summer and winter can exceed human comfort range and spring and autumn are ideal for human comfort. Mild winters with low humidity as well as hot to very hot summers with moderate humidity can be experienced. Summer temperatures typically fluctuate between 18°C to 27°C. Winter temperatures typically fluctuate between 10°C to 18°C.

Average annual rainfall is highly variable across the NSW region, with Sydney being higher than average at just over 1,150 millimetres annually due to its coastal location, shown in Figure 1-3.

Specific data for Sydney's current climate is shown in Table 1-1 Current Climate Data for Sydney (BOM, 2020) Table 1-1.

This information helps paint a picture of the current climate in Sydney, and therefore the starting point for climate change projections. While climate change is expected to have minimal impact during the construction period, the impact on the operations is to be more notable.

Table 1-3 Current Climate Data for Sydney
Source: BOM (2020)

Climate variable	Current Climate
Temperature	
Mean Maximum Temperature	22.8 ˚C
Mean Minimum Temperature	14.7 ˚C
Number of Hot Days (>30˚C)	19 hot days
Number of Cold Nights (<2˚C)	0 cold nights
Rainfall	
Mean Rainfall	1,150mm annually
Mean Number of Days with Rainfall	134 rainy days
Mean Number of Days with Extreme Rainfall (>25mm)	12 extreme rainy days
Other Variables	
Solar Radiation	16.4 MJ/m2/day
Relative Daytime Humidity	56-70% Relative humidity

2 Policy and planning context

2.1 Policies, Guidelines and Pans

The following policies, guidelines and plans have been considered when undertaking the climate change risk assessment:

- Section J Energy Efficiency (National Construction Code, 2019)
- AS ISO 31000-2018 Risk Management – Guidelines (Standards Australia, 2018)
- Green Star Buildings Version 1.0 (Green Building Council of Australia, 2020)
- Carbon Estimate and Reporting Tool (Transport for NSW, 2017a)
- Climate Risk Assessment Guidelines Version 4.0 (Transport for NSW, 2021d).
- AS 5334:2013 – Climate change adaptation for settlements and infrastructure – a risk-based approach (Standards Australia, 2018)
- Central Precinct Renewal Project Priority Works – Sustainability Strategic Management Plan (TfNSW, 2022)
- Sydney Terminal Building Revitalisation Project – Scoping Report (TfNSW, Arup, 2022)
- Central Precinct Renewal Program – Environmental Sustainability, Climate Change, and Waste Management (TfNSW, 2022)
- Central Precinct Renewal Program – Green Infrastructure Strategy (TfNSW, 2022)

It is noted that these standards align with the requirements outlined in Green Star. Likewise, for the Carbon Estimate and Reporting Tool (CERT) tool, as one of its main objectives is to estimate a project's Greenhouse Gas (GHG) emissions profile from detailed (SDR) design stage through to construction completion and operation (Transport for NSW, 2017a), the tool will be utilised around the later stages of the project.

3 Methodology

3.1 Assessment methodology

The method shown in Figure 3-1 was used to assess the climate risks. This is consistent with the guidelines listed in Section 2-1, the AS5334:2013 Climate Change Adaptation for Settlements and Infrastructure and TfNSW's CRA Guidelines as outlined in Section 6.13.3 of the STBR Scoping Report. Similarly, the State Study Precinct (SSP) study which was prepared to address different requirements of the Central Precinct SSP application, out of which climate change and resilience was one of the key areas of consideration, was also used to inform the risk assessment for the Terminal Building. The SSP study helped establish and identify the existing situation and opportunities as well as the design considerations for the master plan and the sustainability outcomes targeted which helped establish some key areas and risks to consider during the risk assessment.

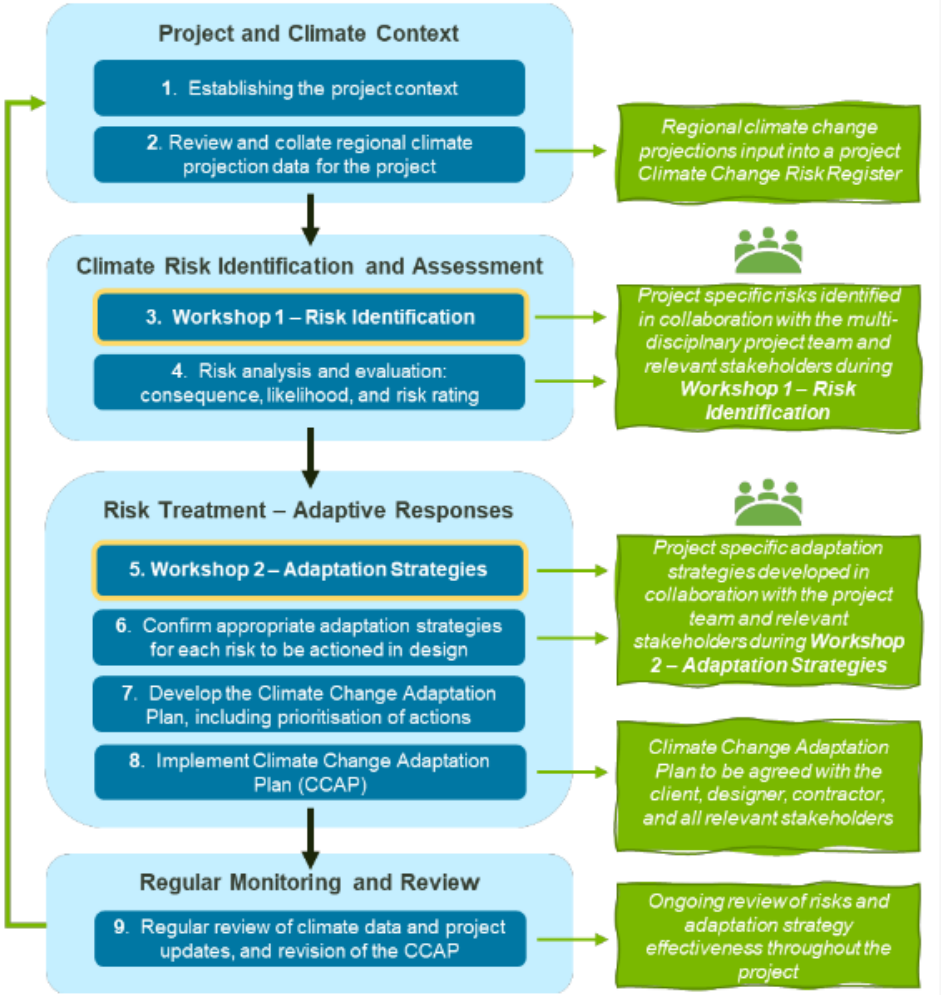


Figure 3-1 Climate Change Risk Assessment (CCRA) process (Adapted from AS 5334 and TfNSW's CRA guidelines)

Note* for this project the Risk Identification and Adaptation Strategies were combined and covered in a single workshop.

Aurecon Sustainability presented the climate change projections from which the design team identified climate risks for the project. Aurecon Sustainability then then collated them and with stakeholder input, each risk was assigned a likelihood and consequence, which corresponds to a rating as defined by the matrix in Appendix B.

Using the Risk Register, the design team then identified possible risk treatment adaptation strategies in the workshop. Further information and outcomes of this workshop are covered in Section 5. Currently, the project is at Step 7; Develop the Climate Change Adaptation Plan, with this CCAP draft for review. It is worth noting that some design responses are still under development and will be updated in the final version of this report. The implementation of the CCAP and the regular review of the CCAP will allow to justify and evaluate the overall impact of climate change on the project as per the EIS requirements.

3.2 Climate models

Climate models are mathematical representations of the earth that are used to inform the likely impacts that a changing climate would have across various regions at various timescales.

Climate models provide simplified versions of the real world that can be used to test our understanding of how the climate system will respond to changes in conditions.

Global climate models (GCMs) work by dividing the global climate system into grid cells, of different sizes. This division occurs both horizontally and vertically. Horizontal grid cells are typically 100 to 250 kilometres per side, whereas vertical grid cells correspond to known layering of the air or ocean. GCMs are

limited to minimum 100-to-250-kilometre grid sizes as the models are complex. The models include information such as atmospheric chemistry, land type, carbon cycle, ocean circulation and glacial makeup. The sophistication of the models leads to long computing times, restricting the precision of grid sizes feasible.

GCMs produce outputs for each grid cell, such as temperature, precipitation, pressure, humidity, and wind speed. GCMs have some important limitations in providing projections suitable for regional planning, however, they are limited in the locally specific information that they can provide, for example local geographical features that influence climate, such as coastlines and mountain ranges.

The modelled information has played a vital role in observing the climate change scenario projections which were then used to gauge the impact of climate change for different time frames of the project and create an adaptation plan ensuring the delivered project is climate resilient in terms of design and operation. The information was used during the climate change workshop to give a graphical representation of the future climate scenarios to all the attendees and use those projections for creating adaptation and mitigation responses.

3.3 Climate change scenarios

Defining how the climate will change in the future and throughout the design life of an asset is necessary to manage the risks of climate change. Climate change will have considerable impacts on the conditions that today's buildings will be subject to in the future. Resilience to the projected climate change scenarios will play a role in the design of the Terminal Building at each stage, and strategies have been developed to position the project to respond to future risks.

The projection time frames were selected with reference to the TfNSW Climate Risk Assessment Guidelines. Therefore, to evaluate the climate risks in both in the short and long term, the time frames of 2050 and 2090 were selected to suit the known occupancy period of the building.

3.4 Data source & climate change characteristics

Climate projection data for the STBR project used for this analysis was sourced from the NSW Government's Climate Change in Australia that used RCP projections for the 2040-2059 and 2080-2099 (e.g., the time periods in which the above scenario fall). A summary of the climate projections for the NSW region are shown in Table 3-1. Likewise, The NSW Urban Heat Island Mapping tool which is based on the 2015-2016 dataset which is the latest dataset available was used to measures the urbanisation effects on land surfaces across Sydney Metropolitan Area. While a more recent UHI effect tool is required, based on the rise in extreme temperature days, the UHI effect can be expected to increase.

Table 3-1 Severe and High Risks Identified

CLIMATE CHANGE VARIABLES AND RISKS FOR NSW **SOURCE: Climate Change in Australia**		
	Increase in average temperature	2050: +1°C 2090: +3.7°C
	Extreme temperatures (above 35°C)	2050: >11 days more 2090: >20 days more
	Extreme temperatures (below 2°C)	2050: Zero days 2090: Zero days

CLIMATE CHANGE VARIABLES AND RISKS FOR NSW SOURCE: Climate Change in Australia		
	Precipitation and drought	Time spent in drought is projected, with medium confidence, to increase over the course of the century.
	Increase/Decrease in Annual Rainfall	2050: -4.3% change in rainfall 2090: -12.7% change in rainfall
	Bushfire Source: AdaptNSW NARCliM	In 2030, high fire danger days is expected to decrease by 0.5 days while the regional areas are to increase by 0.5 days. Meanwhile, in 2070 the high fire danger days is projected to increase to a day and the regional areas around to 1.5 days which is critical due to the smoke that can still impact the site.

Note* the bushfire climate projections use the 2030 and 2070 time periods as 2050 and 2090 projections were not available. Climate Change in Australia projections simply state that "A harsher fire-weather climate in the future" is projected with high confidence.

4 Risk Assessment

4.1 Identification of Risks and Potential Impacts

The design team worked together to identify the project's climate risks and assessed the likelihood and consequence of each risk. The severity (risk rating) for each risk was then determined according to the evaluation matrix shown in Appendix B. After the Risk Register was completed by Aurecon, it was reviewed by the project team members through subsequent draft Risk Register reviews. Likewise, the risk assessment also helped with the identification of the potential impacts in terms of the construction and operation.

4.1.1 Risk identification

A register was created where a total of 18 climate risks were identified for the project. By 2090, there were three 'low' risks identified, ten 'medium' risks and five 'high' risks and no 'extreme' risks, refer to Table 4-1. All the high risks identified have be listed in Table 4-2. The full risk register can be found in Appendix B.

Table 4-1 Summary of identified climate risks

Risk Rating	2050	2090	Residual Risk Rating (Post-Adaptation Response)
Low	7	3	7
Medium	11	10	11
High	0	5	0

Table 4-2 2090 High Risks Identified

Risk Number	Climate risk identified	Explanation	Risk rating in 2090
2	Bushfire	Distant bushfire smoke blows into the station and causes poor air quality, poor visibility, dust/particulate matter, flying ash and debris- leading to poor health outcomes for staff and travellers.	High
8	Increase in average temperature	Increased reliance on air conditioning in conditioned spaces (including enclosed and retail spaces) due to higher average temperatures resulting in higher energy consumption and increased maintenance requirements.	High
10	Dry periods and regional drought	Drought causing decrease in water supply/imposition of water restrictions causing the rainwater tanks to be emptied. Increasing dependence on Sydney Water supply.	High
11	Higher frequency of extreme heat	Higher frequency of extreme heat causes decreased thermal comfort indoors for unconditioned spaces such as the grand concourse.	High
12	Higher frequency of extreme heat	Degradation of vegetation and biodiversity existing along Eddy Av. Colonnade, Eddy Av. Plaza and the Western Forecourt due to higher frequency of extreme heat. See the Biodiversity Development Assessment Report for further information on vegetation locations.	High

4.1.2 Potential impacts

Over the construction period, based on the projected climate change data, it is expected to have minimal impact. However, there is still the potential need to work in more extreme weather conditions.

As for operations, some of the potential impacts that it could face include the health and safety of the staff and customers especially during extreme temperature days and weather events. Likewise, frequent maintenance or damage to property due to extreme weather events is another impact on the operations.

4.2 Analysis and evaluations of risk

Analysis and evaluation of the identified risks was carried out using the risk matrix which has been derived from the risk matrix in AS5334-2014 requirements.

Noting that this climate change risk assessment process focuses on adapting to the impacts of a changing climate, not mitigating climate change to begin with (e.g., by reducing emissions). For more information on the project's environmental sustainability and climate change policies, see "Attachment 24: Environmental Sustainability Study" found on the Central Precinct NSW Planning Portal.

Table 4-3 AS 5334:2013 Risk Rating Matrix used to classify degree of risk

RISK RATING MATRIX					
	Rare	Unlikely	Possible	Likely	Almost Certain
Extreme	15 - Medium	19 - High	22 - Severe	24 - Severe	25 - Severe
Major	10 - Medium	14 - Medium	18 - High	21 - High	23 - Severe
Moderate	06 - Low	09 - Medium	13 - Medium	17 - Medium	20 - High
Minor	03 - Low	05 - Low	08 - Low	12 - Medium	16 - Medium
Insignificant	01 - Very Low	02 - Very Low	04 - Low	07 - Low	11 - Low

5 Risk treatment adaptation

5.1 Risk treatment targets

Following project specific climate risk identification and assessment, the design team and stakeholders determine the most feasible actions to treat and minimise the risks. The most feasible actions are determined through adopting the "Best Available Technology" approach where outcome is prioritised over cost. Furthermore, this CCAP addresses "Compulsory Requirement 3 – climate change risk" of the TfNSW SDG v4 which requires:

"Completed climate risk assessment in line with TfNSW's Climate Risk Assessment Guide which demonstrates that there are no extreme or high residual risks at a minimum."

This comprehensive assessment is aimed at managing climate change risk for the project, but also to promote assessment of the costs and benefits of climate change adaptation and that adaptations are still considered for lesser climate change risks (especially where benefits/co-benefits may exist with other sustainability outcomes).

The climate risk adaptation strategies were developed in alignment with the relevant transport sustainability focus areas. The relevant focus areas are discussed below:

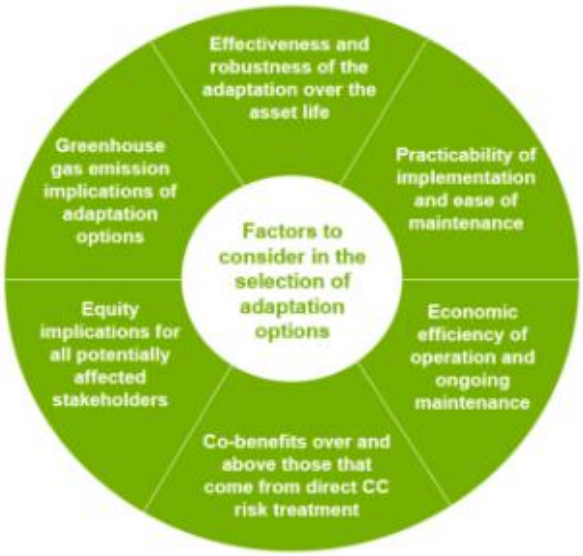
Table 5-1 Transport sustainability focus areas considered in the CCAP

Transport Sustainability Focus	CCAP consideration
Respond to climate change	• The core premise of the CCAP is to mitigate the impacts of climate change through the investigation into and finally implementation of climate change adaptation strategies
Protect and enhance biodiversity	• Include pro-biodiversity adaptation strategies where possible to encourage a net increase in biodiversity in detailed design
Improve environmental outcomes	• Investigate climate change adaptation strategies that are not material intensive and reduce the project's environmental impacts during construction and operation
Respect culture and heritage	• Incorporate limitations to design changes incurred by the project's heritage listing while still achieving improved environmental and social outcomes

5.2 Risk treatment adaptation workshop

On Friday, 30th September 2022, the sustainability team facilitated an online workshop to identify climate change risk review and climate risk treatment – adaptations. A multi-disciplinary team including representatives from all design disciplines including the architect, project manager, and client attended (see Appendix D & E). The workshop focused on Climate Risk Treatment and Adaptation Strategies. The sustainability team facilitated a discussion around how the project could adapt or mitigate to each of the identified risks through the design of the project. Factors that have been identified in AS 5334:2013 to be key in the selection of adaptations can be seen in Figure 5-1. In the workshop the attendees then provided design expertise and knowledge about the project, to identify either possible or existing mitigation approaches.

Figure 5-1 Factors to consider in the selection of adaptation options



5.3 Design responses

During the risk treatment adaptations workshop, the design team and stakeholders put forward several existing and/or possible design adaptation strategies to mitigate the likelihood or consequence of the risks identified. The risk register, including adaptation strategies, is a living document that should be updated and modified to take changing circumstances into account throughout the design.

As per AS 5334-2013, 'high[1]' and 'extreme[2]' risks identified be addressed by specific design responses and have actions and responsibilities assigned to them, as well as at least two risk items identified be addressed by specific design responses. Refer to Appendix B (Climate Risk Register & Adaptation Strategies) for the full list of adaptation strategies being investigated. The adaptation strategies will be confirmed/updated in the detailed design phase.

The STBR Scoping Report (6.13.1) identified 3 key actions to be considered in the next stage of design development. These actions are listed below with references to their consideration in the risk register detailed:

[1] High risks are defined as are issues that require detailed research and planning at a senior management level.

[2] Extreme risks are defined as those risks which require immediate action.

- Façade materials to be designed to withstand extreme temperatures and solar exposure (Risk No. 5)
- Guttering and drainage needs to be designed to accommodate future rainfall capacity (Risk No. 9)
- Electrical systems to have capacity to accommodate future cooling requirements (Risk No. 11)

These actions were consistent with potential mitigation strategies raised for investigation during the Workshop and continue to be considered during the design stage.

Table 5-2 demonstrates the specific design responses to the five 2090 'high' risks. Design responses that have been confirmed are labelled "***(Confirmed)***". Discussion and evidence supporting these are detailed below Table 5-2.

Table 5-2 Risk items and specific design responses

Risk Number	Climate risk identified	Explanation	Design responses to be investigated during detailed design
2	Bushfire	Distant bushfire smoke blows into the station and causes poor air quality, poor visibility, dust/particulate matter, flying ash and debris- leading to poor health outcomes for staff and travellers.	• Increased Heating, Ventilation and Air Conditioning (HVAC) monitoring schedule to ensure filters are replaced frequently to maintain fresh airflow in conditioned areas. • Proper management plans and public help points to be set in place for people requiring medical assistance. • Smoke sensors in the intake to shut down mechanical systems when smoke is sensed to prevent smoke entering conditioned areas or overheating the system.
8	Increase in average temperature	Increased reliance on air conditioning due to higher average temperatures resulting in higher energy consumption and increased maintenance requirements.	• Investigate optimal passive design (window selection, shading strategy etc) to promote passive cooling of the building and reduce reliance on HVAC. • Implement a night purge (releasing heat from the building to cool the internal temperature). • Size the HVAC equipment based on appropriate design temperature (in-line with increased temperatures incurred by climate change) so that systems operate efficiently in future higher temperatures.

Risk Number	Climate risk identified	Explanation	Design responses to be investigated during detailed design
10	Dry periods and regional drought	Drought causing decrease in water supply/imposition of water restrictions causing the rainwater tanks to be emptied. Increasing dependence on Sydney Water supply.	• Implement water sensitive urban design ***(Confirmed).*** • Future proofing for shared recycled water systems. • Implement appropriate metering, monitoring, and response. • Engage a recycled water purchase agreement. • Add information signage to encourage water saving practices. • Water efficiency measures to be implemented that is, Minimum Water Efficiency Labelling and Standards (WELS) ratings for taps, toilets, showers, and appliances, currently in communication with architect. • The site currently has rainwater tanks allowing rainwater storage. • Low water use species selected for landscaping. • Smart dripline irrigation system will be installed which will consist of Automatic Smart Controller with Rain Sensor and irrigation soil moisture sensor to sure water is used efficiently.
11	Higher frequency of extreme heat	Higher frequency of extreme heat causes decreased thermal comfort indoors.	• Passive design principles to be incorporated into the design. • Investigate tempered ventilation solutions • Providing amenities (drinking fountains, increased retail, food, and beverage locations). • Designing in more spaces for rest. Increased planting and shading areas to reduce Urban Heat Island (UHI) effect.
12	Higher frequency of extreme heat	Degradation of vegetation and biodiversity due to higher frequency of extreme heat.	• Landscaping design to implement shading strategies to reduce vegetation over-exposure to sunlight ***(Confirmed).*** • Balance vegetation species with both high and low transpiration to help control the cooling effect while also having some drought-resistance ***(Confirmed).*** • Refer to the recommendations set by the City of Sydney Urban Forest Strategy for maintaining the existing species diversity which in return is more resilient to climate change in general thus, lowering the impact from extreme heat ***(Confirmed).*** • Low water use species selected for landscaping • Smart dripline irrigation system will be installed which will consist of Automatic Smart Controller with Rain Sensor and irrigation soil moisture sensor for water usage efficiency

The Central Precinct Renewal Program – Green Infrastructure Strategy (TfNSW, 2022) confirms several of the design adaptation strategies shown in Table 5-2. The report discusses the following climate change adaptation strategies:

- Water Sensitive Urban Design - Section 8. Water Strategy (Page 78):
    - Grading paved areas to drain run off towards planted areas to provide passive irrigation, slow run off and help improve water quality

- Grading paving to direct water run-off to areas of permeable paving beneath trees, to provide passive irrigation, slow water run-off and help improve water quality.
- Consider whether strategies like wicking beds or water storages under planted areas would be appropriate in the deck structure

- Implementation of Shading Strategies – 9. Planning Framework (Page 86)
  - Landscapes designed to provide shelter to local fauna during times of heat stress in the form of beehives, nesting boxes, structured earth forms and select vegetation.
- Balanced Vegetation with High and Low Evapotranspiration - 9. Planning Framework (Page 86)
  - Balance of high- and low-evapotranspirative plant species takes into account RCP 8.5 climate predictions
  - Smaller evapotranspiration gardens for urban cooling provide local areas of respite for visitors
- Climate Change Resilient Vegetation - 9. Planning Framework (Page 86)
  - Urban forest strategy with vegetation and canopy coverage targets in line with City of Sydney's Greening Sydney Strategy (Draft) will reduce regional UHI effects
  - Smaller evapotranspiration gardens for urban cooling provide local areas of respite for visitors.
  - WSUD strategies – swales, basins, wetlands, ponds, permeable pavement

Likewise, the mitigation measures as part of the EIS are listed in Table 5-3 below.

Table 5-3 EIS mitigation measure

Ref	Impact / Uncertainty	Environmental management measure
CC01	Impact | Climate change risks	Climate change risk treatments identified in Table 20-4 will be confirmed and incorporated into the detailed design.
CC02	Impact | Greenhouse gas emissions	An iterative process of greenhouse gas assessments and design refinements will be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance will be measured in terms of a percentage reduction in greenhouse gas emissions from a baseline inventory calculated at the detailed design stage. The Carbon Estimate and Report Tool will be used to estimate the project's emissions.
CC03	Impact | Sustainability	Sustainability initiatives (such as solar panels, LED lighting, water efficient fixtures) will be considered and incorporated where appropriate in the detailed design and construction of the project. A sustainability management plan will be prepared to guide the sustainability outcomes of the project. The project will seek a Green Star Rating through the GBCA Greenstar program
CC04	Impact | Climate change risks	Ongoing monitoring and updating of the Climate Change Adaptation Plan will be carried out to capture changes in climate projection data, climate risks and adaptation strategies in accordance with TfNSW's Climate Risk Assessment Guidelines and the requirements of Green Star Buildings version 1.0 (GBCA 2020).

6 Future Mitigation Strategies

6.1 Operational procedures & structure

The ongoing management of the Sydney Terminal Building throughout operation is a key aspect of mitigating the impacts of climate change. This document provides the 'high' and 'extreme' risks and subsequent mitigation strategies currently under investigation through the design process. As a mitigation strategy, operational management should utilise this CCAP to inform operational measures undertaken to reduce the impacts of climate change by ensuring the mitigation strategies are being undertaken.

6.2 Interface with other plans

Developing an organisational Climate Policy should be investigated by the client to support the ongoing risk management associated with climate change.

The operational management team should develop and hold a Climate Action Plan (CAP), for ongoing tracking of climate risks, adaptation strategies, and changes to climate risk predictions. The CAP is a practical tool to drive action and facilitate efficient tracking and review of progress.

The CAP nominates the responsible party for each action. The responsible party is the person with the technical expertise and authority to deliver the actions and requirements. For each action, the plan should define:

- Stakeholders and team members to be engaged
- Requirements
- Relevant reference document
- Indicative timeframes for each deliverable

Actions that will require an additional investment of time and resources beyond what was originally planned, should be analysed using multi-criteria and cost benefit analysis methodologies to confirm their sustainability benefits or disadvantages against alternative options.

6.3 Monitoring

Ongoing monitoring of the climate action plan, including climate projections data, climate risks, and adaptation strategies, helps identify any change in circumstances and new information as it comes to hand.

The Australian Greenhouse Office Climate Change Impacts & Risk Management Guide, referenced by Green Star, suggest that the following aspects of monitoring and review are important to consider:

Keeping the analysis and evaluation up to date, including updating climate change scenarios or incorporating new information about climate change impacts

Reviewing progress on actions flowing from the process, including implementing treatment actions to reduce risks or undertaking further and more detailed analyses

Ensuring that the process itself is implemented in a timely and cost-effective fashion with documents produced, meetings held, plans reviewed and so on. The focus of this Guide is firmly on the framework and process for an initial strategic assessment.

6.4 Next Steps

The data, risks, and proposed strategies in this report should be considered as evolving, and continual review is necessary to understand climate risks and adaptation, as such the following actions should be taken to best mitigate the impacts of climate change:

- Project team to investigate the impact of value engineering on CCAP, ensuring that requirements are being met
- Climate data reviewed at the end of construction – climate data is not static and is subject to change based on projections published by the IPCC. Mitigation strategies may need to be adjusted depending on new climate data
- Project climate risks reviewed and updated at each stage of the design by the design team – risk profiles can change and will be regularly reviewed for relevance and accuracy
- This document will be reviewed before, during, and at the end of construction to re-evaluate how installed initiatives respond to the risks
- This document, or the key content of this document should inform the operation and maintenance of the Terminal Building
- All future design teams undertake a CCAP and respond to project specific risks

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Appendix A

Climate Change Workshop Miro Board

	Increased temperatures and higher frequency of **extreme heat**	Decrease in **annual rainfall and increase in drought**	Increase **extreme rainfall** intensity **and flooding**	Increased **Storm** intensity	**Increased Wildfire** risk	Increased **Solar Radiation**	**Sea level rise** and increase in storm surge and tide
Project area	**Present Average** 22.8°C **2050** 1°C over all scenarios **2090** 1°C and 3.7°C (RCP2.6, RCP8.5) Increase in hot days (>35°C) (RCP8.5) **Present** 5 Days **2050** 11 Days **2090** 20 Days	**Increase/Decrease in Annual Rainfall** **2050** -6.3% and -4.3% (RCP2.6, RCP8.5) **2090** -5.7% and -12.7% (RCP2.6, RCP8.5) **Time spent in drought is projected, with medium confidence, to increase over the course of the century.**	***High confidence*** **future increase in the intensity of extreme rainfall events, although the magnitude of the increases cannot be confidently projected.**	**Based on global and regional studies, tropical cyclones are projected with *medium confidence* to become less frequent with increases in the proportion of the most intense storms.**	**There is *high confidence* that climate change will result in a harsher fire-weather climate in the future.**	**2050** +1.6 and +0.6% (RCP2.6, RCP8.5) **2090** +1.7 and +0.7% (RCP2.6, RCP8.5)	**Sea Level Rise (m)** **2050** +0.22 and +0.27m (RCP2.6, RCP8.5) **2090** +0.38 and +0.66m (RCP2.6, RCP8.5) **Mean sea level will continue to rise and height of extreme sea-level events will also increase (very high confidence).**
All	Undersized cooling plant Increased demand for HVAC system with increase in heat Dehydration - Would need areas for potable water drinking for commuters Risk of premature failure of asphalt surfacing due to increased surface temperature Health and well-being of commuters, workers, visitors and tourists Risk of HVAC plant unable to operate at all/ or degraded performance in extreme conditions especially where exposed to solar accelerated degradation of materials (asphalt etc.) Lost retail opportunity - train lines closed due to heat Power outages at substations due to increase electrical demand Environmental conditions within plant rooms exceeds operating temperature range of plant and equipment resulting in failures risk to the viability of future landscapes as delivered as part of the SSP - how will they cope with increased heat? risk of overcrowding in areas that are shaded/cool during extreme events Risk of naturally ventilated plantrooms being uninhabitable for maintenance staff Inadequate insulation of fabric and HVAC systems risk to conservation of significant landscapes and gardens i.e Belmore Park, Eddy Plaza, PA Park Increased energy costs for cooling More regular lack of Thermal comfort in passively ventilated spaces Reduced COP of HVAC systems and higher frequency of operation at peak load COP (which is poorest)	uncomfortable heat levels and drying out of landscape - expnsive to replace and a lack of vegetation would make it hotter More reliance on Sydney Water supply, as rainwater re-use tanks frequently empty Increased price of water in response to a shortage Potential need for humidification systems in sensitive environments risk to conservation of significant landscapes and gardens i.e Belmore Park, Eddy Plaza, PA Park Loss of vegetation inability to use water-based cleaning methods to maintain the site due to water restrictions Increased humidity resulting degradation of switchboard components, impacting the lifespan change in soil moisture levels leading to shifts in the foundation and pavement cracking or impacts to structures risk to water based fire suppression system --> increased cost/ harder to source Risk of damage from tree branch/limb falls as a result of vegetation suffering from drought	Drowning of customers or users - flash flood Periods of very high humidity and AC systems unable to adequately dehumidify Local flooding in Marketplace and/or Pitt St ---> impact operations (during and after hours) & impact to systems and materials Insufficient existing OSD tank capacity On site water detention sizing and potential overflow Station shut down and impact to the suburban and regional rail connections ingress of water into ground level electrical rooms exacerbating of damp, mould and humidity-type condition issues that historic buildings are already susceptible to Risk to operations and electrical systems/ signaling if substation goes down risk to cultural heritage items, built heritage fabric and significant moveable heritage items and collections by flooding and water ingress - flow on impacts for community and social resilience People are stuck at the Station and cant get home/ work Water damage to structural elements from loading induced by extreme floods. Exacerbated corrosion of structural elements due to increased humidity. Damage to Eddy Plaza retaining wall underlying suburban lines due to excessive rainfall and water build-up within retained fill. pressure on site to potentially fulfill new roles and provide immediate shelter and resistance	risk to cultural heritage item and built heritage fabric by storm damage Loss of life People are stuck at the Station and cant get home/ work Damage to property - expensive rebuild and insurance premiums/ claims Infrastructure shutdown Risk of damage to roof mounted or exposed equipment - lightning, wind or flying debris Structural damage from extreme wind speeds to clock tower, Grand Concourse roof, STB roof, Porte-Cochere roof, and awning structure. Wind pressures increase infiltration thru building fabric increased lightning strikes damaging plant, equipment and structure, and potentially persons. This could be directly via direct strike, or indirectly via surges. Changes in prevailing wind direction and strength may affect recirculation of exhausts into intakes, or prevent ventilation systems operating against wind pressures Station shut down and impact to the suburban and regional rail connections changes in role of station spaces in the event of disaster - needing to function as shelter, assistance hub etc - this is also relevant for storm, flood, fire and pandemic Blocking & Overflow of gutters/downpipes etc. pressure on site to potentially fulfill new roles and provide immediate shelter and resistance risk of damage to concourse glazing due to hail wind impacts on safety - pressure difference on exits/ doorways etc hazards to construction and maintenance workers due to flying objects - high winds	bushfire risk from ember attack - risk to lives and property Air quality in the open areas Terminal Building People not being able to commute to the city due to bushfires - to work, frequent the Terminal Building shops and restaurants, etc. construction delays due to high wind Filtration equipment inadequate for handling smoke risk to cultural heritage items, built heritage fabric and significant moveable heritage items and collections by fire flow on impacts for community and social resilience damage to transmission networks supplying station infrastructure Increased pollutants in stormwater Damage / cleaning required to HVAC plant exposed to ash / particulates Visibility concerns due to increased smog inundation of operations --> people potentially trying to flee from the fire Increased maintenance for HVAC due to smoke (increased filter replacement rate?) health impacts to workers/ commuters due to smoke/ dust	Increased solar gain will increase load on HVAC systems Increased solar gain on roof will increase roof surface temp - impact on roof equipment and maintenance staff Health and well-being of commuters, workers, visitors and tourists accelerated deterioration of materials including of the heritage fabric of the building excessive heat gain in materials affecting human comfort	Is this material to the project? Central Station is located 20m above sea level.
	Electrical Demand on heating/cooling systems accelerated deterioration of materials including of the heritage fabric of the building Increased radiant heat from existing heritage materials (eg. roofing/stone) key spaces do not become viable to dwell, meet and gather due to lack of thermal comfort and amenity. People stuck if trains line go down thermal shock Darker roof colours will increase temperature at roof surface Biodiversity impacts accelerated degradation of electrical and signaling equipment and cabling Damage from thermal expansion to longitudinal steel elements exposed to extreme heat (e.g. awning structure).						

Increased temperatures and higher frequency of extreme heat

Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations
1	Power outages at substations due to increase electrical demand				
2	accelerated deterioration of materials including of the heritage fabric of the building		material selection to consider durability monitoring of sensitive areas maintenance plan shading of sensitive areas		
3	accelerated degradation of materials (aspahlt etc.)				
4	key spaces do not become viable to dwell, meet and gather due to lack of thermal comfort and amenity.				
5	Dehydration - Would need areas for potable water drinking for commuters				
6	thermal shock		thermal comfort analysis (thermal transition zones etc.		
6	Health and well-being of commuters, workers, visitors and tourists		water sensitive urban design thermal comfort analysis (thermal transition zones etc. tempered ventilation solutions	Providing amenities (drinking fountains, shade, seating, toilets, increased retail and food and beverage)	Designing in many more spaces for rest Increased planting and shading areas to reduce UHI
8					
9					
10					
Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations

Decrease in average rainfall and increase in evaporation

Risk #	Risk Statement	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations
1	More reliance on Sydney Water supply, as rainwater re-use tanks frequently empty	consultation and strategic planning to align with city wide water saving initiatives etc.	water sensitive urban design future proofing for shared recycled water systems (other train lines) increase the capacity of the rainwater tank appropriate metering and monitoring and response (possibility) recycled water purchase agreement Grey or black water re-use efficient fixtures and avoidance of water education/ information signage etc. To inform on best practice water saving initiatives		
2	risk to water based fire suppression system --> increased cost/ harder to source				
3	change in soil moisture levels leading to shifts in the foundation and pavement cracking or impacts to structures				
3	inability to use water-based cleaning methods to maintain the site due to water restrictions				
4	Potential need for humidification systems in sensitive environments				
5	Risk of damage from tree branch/limb falls as a result of vegetation suffering from drought				
6	Loss of vegetation		water sensitive urban design Native drought tolerant species Utilising rain water capture for irrigation Back up irrigation for redundancy		
7					
8					
9					
10					
Risk #	Risk Statement	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations

Increased extreme rainfall intensity and flooding

Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations
1	Insufficient existing OSD tank capacity		Additional capacity with an additional tank elsewhere		
2	Local flooding in Marketplace and/or Pitt St —> impact operations (during and after hours) & impact to systems and materials				
3	exacerbating of damp, mould and humidity-type condition issues that historic buildings are already susceptible to		identifying original ventilation systems and reinstating ventilation analysis to see where we need to upgrade ventilation systems on-going monitoring susceptible areas re-assess control strategy of mechanical design		
4	ingress of water into ground level electrical rooms				
5	Drowning of customers or users - flash flood				
6	Risk to operations and electrical systems/ signaling if substation goes down				
7	Blocking & Overflow of gutters/downpipes etc.				
8					
9					
10					
Risk #	Risk Statement	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations

Increase storm intensity and potentially frequency

Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations
1	Higher wind speeds than the existing Heritage Building has been designed to withstand		records keeping collections management to inform repair and restoration if necessary disaster risk management plan/ strategy shading of sensitive areas design checks/ structural assessment on building (what capacity does the building have)		
2	risk to cultural heritage item and built heritage fabric by storm damage				
3	Risk of damage to roof mounted or exposed equipment - lightning, wind or flying debris				
4	Wind pressures increase infiltration thru building fabric				
5	increased lightning strikes damaging plant, equipment and structure, and potentially persons. This could be directly via direct strike, or indirectly via surges.		designing to standards but potentially exceeding benchmarks for climate risk critical equipment and infrastructure to be sheltered		
6	Changes in prevailing wind direction and strength may affect recirculation of exhausts into intakes, or prevent ventilation systems operating against wind pressures				
7	pressure on site to potentially fulfill new roles and provide immediate shelter and resistance				
8					
9					
10					
Risk #	**Climate Risk Variable**	**2050 2090**	**Possible Adaptations**	**Current Adaptations**	**Confirmed Adaptations**

Increased fire days (very high Forest Fire Danger Index)

Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations
1	bushfire risk from ember attack - risk to lives and property				
2	construction delays due to high wind				
3	damage to transmission networks supplying station infrastructure				
4	Visibility concerns due to increased smog				
5	Increased maintenance for HVAC due to smoke (increased filter replacement rate?)				
6	Increased pollutants in stormwater				
7	Air quality in the open areas Terminal Building				
8	Filtration equipment inadequate for handling smoke				
9	risk to cultural heritage items, built heritage fabric and significant moveable heritage items and collections by fire flow on impacts for community and social resilience				
10	inundation of operations --> people potentially trying to flee from the fire				
Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations

Increased Solar Radiation

Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations
1	Increased solar gain will increase load on HVAC systems				
2	accelerated deterioration of materials including of the heritage fabric of the building				
3	Increased solar gain on roof will increase roof surface temp - impact on roof equipment and maintenance staff				
4	Health and well-being of commuters, workers, visitors and tourists				
5					
6					
7					
8					
9					
10					
Risk #	Risk Description & Impact	2050 2090	Possible Adaptations	Current Adaptations	Confirmed Adaptations

Appendix B

Climate Risk Register & Adaptation Strategies

Project:	Central Precinct
Document Title:	**Risk Rating Evaluation Matrix**
Revision:	**For Information Only**
Date:	**18-Nov-22**

	Discrete events	Recurring events
Rare	May occur in exceptional circumstances within the asset's lifetime period if the risk is not mitigated	Has not occurred in the past 5 years OR Unlikely during the next 50 years
Unlikely	Has a 10–30% chance of occurring in the asset's lifetime if the risk is not mitigated	May have occurred once in the last 5 years OR May arise once in 25 to 50 years
Possible	Has a 40–60% chance of occurring in the asset's lifetime if the risk is not mitigated	Has happened during the past 5 years but not in every year OR May arise once in 25 years
Likely	Has a 60–90% chance of occurring within the asset's lifetime if the risk is not mitigated	Has happened at least once in the past year and in each of the previous 5 years OR May arise about once per year
Almost Certain	Has a greater than 90% chance of occurring within the asset's lifetime if the risk is not mitigated	Has happened several times in the past year and in each of the previous 5 years OR Could occur several times per year

RISK RATING MATRIX					
	Rare	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
Extreme	**15 - Medium**	**19 - High**	**22 - High**	**24 - Extreme**	**25 - Extreme**
Major	**10 - Low**	**14 - Medium**	**18 - Medium**	**21 - High**	**23 - Extreme**
Moderate	**06 - Low**	**09 - Low**	**13 - Medium**	**17 - Medium**	**20 - High**
Minor	**03 - Very Low**	**05 - Low**	**08 - Low**	**12 - Low**	**16 - Medium**
Insignificant	**01 - Very Low**	**02 - Very Low**	**04 - Low**	**07 - Low**	**11 - Low**

DESCRIPTORS	Adaptive capacity[1]	Infrastructure service	Social/cultural	Governance	Environmental	Economy	Financial	Asset Value[2]
Extreme	Capacity destroyed, redesign required when repairing or renewing asset	Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service. Loss of infrastructure support and translocation of service to other sites. Early renewal of infrastructure by >90%	Severe adverse human health effects, leading to multiple events of total disability or fatalities Total disruptions to employees, customers or neighbours Emergency response at a major level	Major policy shifts. Change to legislative requirements. Full change of management control	Very significant loss to the environment. May include localized loss of species, habitats or ecosystems Extensive remedial action essential to prevent further degradation. Restoration likely to be required	Major effect on the local, regional and state economies	Extreme financial loss >90%	Extreme loss in asset value (>40%)
Major	Major loss in adaptive capacity. Renewal or repair would need new design to improve adaptive capacity	Extensive infrastructure damage requiring major repair. Major loss of infrastructure service. Early renewal of Infrastructure by 50–90%	Permanent physical injuries and fatalities may occur Severe disruptions to employees, customers or neighbours	Notices issued by regulators for corrective actions. Changes required in management. Senior management responsibility questionable	Significant effect on the environment and local ecosystems. Remedial action likely to be required	Serious effect on the local economy spreading to the wider economy	Major financial loss 50-90%	Major loss in asset value (>5%)
Moderate	Some change in adaptive capacity. Renewal or repair may need new design to improve adaptive capacity	Limited infrastructure damage and loss of service. Damage recoverable by maintenance and minor repair. Early renewal of Infrastructure by 20–50%.	Frequent disruptions to employees, customers or neighbours. Adverse human health effects	Investigation by regulators. Changes to management actions required	Some damage to the environment, including local ecosystems. Some remedial action may be required	High impact on the local economy, with some effect on the wider economy	Moderate financial loss 10-50%	Moderate loss in asset value (2-5%)
Minor	Minor decrease to the adaptive capacity of the asset. Capacity easily restored	Localized infrastructure service disruption. No permanent damage. Some minor restoration work required. Early renewal of infrastructure by 10–20%. Need for new/modified ancillary equipment	Short-term disruption to employees, customers or neighbours Slight adverse human health effects or general amenity issues	General concern raised by regulators requiring response action	Minimal effects on the natural environment	Minor effect on the broader economy due to disruption of service provided by the asset	Additional operational costs Financial loss small, <10%	Small loss in asset value (<2%)
Insignificant	No change to the adaptive capacity	No infrastructure damage, little change to service	No adverse human health effects	No changes to management required	No adverse effects on natural environment	No effects on the broader economy	Little financial loss or increase in operating expenses	Negligible change in asset value

Project:	Central Precinct
Client:	Transport For New South Wales
Document Title:	Climate Change Risk Register
Revision:	1
Date:	18-Nov-22

Miroboard link: https://miro.com/app/board/uXjVPSwI4FU=/

			Present Day Statistics (2022) Average Temperature: 22.81°C No. of Days >35°C: 5												
			2050 Estimated Temp Increase: +1°C (RCP 8.5) Increase in hot days (>35°C) (RCP8.5) 2050: +11 Days			2090 Estimated Temp Increase: +3.7°C (RCP 8.5) Increase in hot days (>35°C) (RCP8.5) 2090: +20 Days					Residual rating (after mitigation and controls)				
Risk no.	Risk category	Impact statement	Likelihood	Consequence	Rating	Likelihood	Consequence	Rating	Adaptation response	Reference	Likelihood	Consequence	Rating	Comments	Residual Risk Analysis
1	Bushfire	**Distant bushfire** damages power infrastructure distant to the site. Results in **power outage** to area. Impacts power supply to the station. *Consequence - Infrastructure service, social/cultural*	Unlikely	Moderate	09 - Low	Possible	Moderate	13 - Medium	-On site energy storage to be considered as a minimum and possible battery operated power as a backup. - PV to be considered moving forward. Output likely to be insufficient and operate in a supplementary capacity	- CPRPTB001-AURC-HRSCEN-ME-DRG - CPRPTB001-AURC-HRSCEN-FE-DRG - CPRPTB001-AURC-HRSCEN-EL-DRG	Possible	Moderate	13 - Medium		
2	Bushfire	Distant **bushfire smoke** blows into the station and causes poor air quality, poor visibility, dust/particulate matter, flying ash and debris- leading to **poor health outcome**s for staff and travellers. *Consequence - Social/cultural, Environmental, Ifrastructure Service*	Likely	Moderate	17 - Medium	Almost Certain	Moderate	20 - High	- Increased HVAC monitoring schedule to ensure filters are replaced frequently to maintain fresh airflow in conditioned areas - Proper management plans and public help points to be set in place for people requiring medical assistance. - Smoke sensors in the intake to shut down mechanical systems when smoke is sensed to prevent smoke entering conditioned areas or overheating the system	- CPRPTB001-AURC-HRSCEN-ME-DRG - CPRPTB001-AURC-HRSCEN-FE-DRG	Likely	Moderate	17 - Medium	As the site is not directly located in a bushfire zone, the impacts associated from the smoke outside the zone is not as critical. But some measures do need to be in place for this indirect impact.	Another prolonged bushfire season such as the one seen in 2019-2020 is difficult to mitigate through building design due to the Sydney Terminal Building open-plan design
3	Dry periods and regional drought	Prolonged **dry periods** and regional drought causes increased demand of water requirements for vegetation and landscaping paired with **lower water availability** Results in: - Decreased vitality / death of vegetation and landscaping which impacts the biodiversity on site as well as the aesthetics associated and / or - Increased reliance on water for active irrigation of landscaping. *Consequence - Environmental , Social/cultural*	Possible	Moderate	13 - Medium	Likely	Moderate	17 - Medium	- Encourage water senstive urban design - Utilising rainwater capture for irrigation - Consider back up irrigation for redundancy - Implement water efficient sprinkler system for vegetation - Local indigenous plants have been selected that is capable of adapting to RCP 8.5 climate change	- CPRPTB001-AURC-HRSCEN-ME-DRG - CPRPTB001-AURC-HRSCEN-HY-DRG	Almost Certain	Minor	16 - Medium		Risk of prolonged drought may cause rainwater tanks to be emptied with continued consumption and force the station to adhere to Government water consumption minimisation standards
4	Higher frequency of extreme heat	**Extreme heat** causes an increase in electricity demand (on site and throughout the wider network), resulting in **possible brown or black outs.** *Consequence - Adaptive capacity, Infrastructure service, Social.*	Possible	Moderate	13 - Medium	Likely	Moderate	17 - Medium	- Install a HVAC system in conditioned spaces that when ambient conditions are above 35°C the VRF condenser (within the mechanical system) will run at derated capacity - No HVAC system installed for the Grand Concourse due to open concept, reducing electricity demand during peak periods - PV to be considered moving forward. Output likely to be insufficient and operate in a supplementary capacity	CPRPTB001-AURC-HRSCEN-ME-DRG CPRPTB001-AURC-HRSCEN-EL-DRG	Possible	Moderate	13 - Medium		No PV to be installed, meaning full electrical demand is dependent on the grid and vulnerable to blackouts and brownouts
5	Higher frequency of extreme heat	**Extreme heat** damages building services components and reduces material durability (including roofs, facades, asphalt pavements, etc.); resulting in damage, **compromised reliability and reduced durability/longevity** of building components and materials . *Consequence - Infrastructure services, Social/cultural, Financial*	Possible	Moderate	13 - Medium	Likely	Moderate	17 - Medium	- Facade materials to be designed to withstand extreme temperatures and solar exposure - High SRI Roofing materials in accordance with Green Star Urban heat island requirements (surf mist) - Building designed with passive shading to mitigate extreme heat impacts - Prefinished architectural materials - Monitoring sensitve areas, provide shading to sensitive areas - Produce maintenance plan		Likely	Minor	12 - Low		
6	Rain, flooding and storms	**Lightning** strikes network electrical equipment, causing infrastructure damage or failure, resulting in **loss of power** to the site (consider houses and traffic lights, etc.) *Consequence - Infrastructure services, Social, Financial*	Rare	Moderate	06 - Low	Unlikely	Moderate	09 - Low	- Designing to standards but potentially exceeding benchmarks for climate risk - Critical equipment and infrastructure to be sheltered - Design to incoprorate RCP 8.5 climate scenarios	- CPRPTB001-AURC-HRSCEN-ME-DRG - CPRPTB001-AURC-HRSCEN-EL-DRG	Unlikely	Minor	05 - Low		
7	Rain, flooding and storms	More **extreme rainfall** events cause overflow of the stormwater systems resulting in **flooding** to the site *Consequences - Environmental, Social, Financial*	Possible	Moderate	13 - Medium	Likely	Moderate	17 - Medium	- Existing guttering system to be checked for its capacity in relation to the increasing rainfall - Design to encourage infiltration in areas such as the plaza area (reducing/not increasing) impermeable area - Potential reduction of the current catchment area with proposed Over Station Development	Hydrology and flooding assessment_Rev A1	Likely	Moderate	17 - Medium		
8	Increase in average temperature	Increased reliance on air conditioning due to **higher average temperatures** resulting in higher energy consumption and **increased maintenance requirements** *Consequence - Infrastructure services, Financial*	Likely	Moderate	17 - Medium	Almost Certain	Moderate	20 - High	- Optimise passive design (window selection, shading strategy etc) to promote passive cooling of the building and reduce reliance on HVAC - Consider implementing a night purge (releasing heat from the building to cool the internal temperature) - Size the equipment based on appropriate design temperature (in-line with increased temperatures incurred by climate change)	- CPRPTB001-AURC-HRSCEN-ME-DRG - CPRPTB001-AURC-HRSCEN-EL-DRG	Almost Certain	Minor	16 - Medium		
9	Rain, flooding and storms	**Blocking and overflow of gutters/downpipes** during **extreme storms** caused by flying debris/branches etc. *Consequences - Environmental, Social, Financial*	Unlikely	Moderate	09 - Low	Possible	Moderate	13 - Medium	- Guttering and drainage needs to be designed to accommodate future rainfall capacity - New gutter/drain system to be designed in accordance with the Hydrology and Flooding Asessment and climate change projections.	- Hydrology and flooding assessment_Rev A1	Possible	Minor	08 - Low		

10	Dry periods and regional drought	**Drought** causing **decrease in water supply**/imposition of water restrictions causing the rainwater tanks to be emptied. Increasing dependence on Sydney Water supply. Also results in **risk to water-based fire suppression system** and inability to use water-based cleaning methods to maintain the site during water restrictions. (Would there be separate water storage for this/ certain amount that has to be maintained no matter the situation for emergencies? TBC and to add in adaptation) *Consequences - Environmental, Social, Financial, Governance, Infrastructure service*	Possible	Major	**18 - Medium**	Likely	Major	**21 - High**	- Encourage water sensitive urban design - Future proofing for shared recycled water systems - Implement appropriate metering, monitoring and response - Consider engaging in a recycled water purchase agreement - Add information signage to encourage water saving practices - Water efficiency measures to be implemented i.e. Minimum WELS ratings for taps, toilets, showers and appliances, currently in communication with architect - Site has existing rainwater tanks - Low water use species selected for landscaping - Smart dripline irrigation system will be installed which will consist of Automatic Smart Controller with Rain Sensor and	- CPRPTB001-AURC-HRSCEN-FE-DRG - CPRPTB001-AURC-HRSCEN-HY-DRG	Likely	Moderate	**17 - Medium**		
11	Higher frequency of extreme heat	Higher **frequency of extreme heat** causes **decreased thermal comfort indoors** *Consequence - Social/cultural*	Likely	Moderate	**17 - Medium**	Almost Certain	Moderate	**20 - High**	- Electrical systems to have capacity to accommodate future cooling requirements - Passive design principles to be incorporated into the design - Tempered ventilation solutions to be considered - Providing amenities (drinking fountains, increased retail, food and beverage locations) - Designing in more spaces for rest - Increased planting and shading areas to reduce UHI	- CPRPTB001-AURC-HRSCEN-ME-DRG - CPRPTB001-AURC-HRSCEN-EL-DRG	Almost Certain	Minor	**16 - Medium**		No HVAC system in open-plan section of Sydney Terminal Building. The station will still be forced to operate at high temperatures during extreme heat, leading to thermal discomfort for travellers
12	Higher frequency of extreme heat	**Degradation of vegetation and biodiversity** due to **higher frequency of extreme heat** will affect the **ecosystem** on site as well as the **external visual impact** for the general public.	Likely	Moderate	**17 - Medium**	Almost Certain	Moderate	**20 - High**	- Landscaping design to consider shading strategies to reduce vegetation over-exposure to sunlight - Balance vegetation species with both high and low transpiration to help control the cooling effect while also having some drought-resistance. Vegetations are yet to be finalised. -Refer to the recommendations set by the City of Sydney Urban Forest Strategy for maintaining the existing species diversity which in return is more resilient to climate change in general. - Low water use species selected for landscaping - Smart dripline irrigation system will be installed which will consist of Automatic Smart Controller with		Almost Certain	Minor	**16 - Medium**		
13	Higher frequency of extreme heat	**Thermal shock** for passengers caused by transition from conditioned to unconditioned spaces for travellers due to temperature gradient increase incurred by **increased frequency of extreme heat.** *Consequence - Social/cultural*	Likely	Minor	**12 - Low**	Almost Certain	Minor	**16 - Medium**	- Thermal comfort analysis to be considered for thermal transition zones (to be conducted in detailed design phase)		Almost Certain	Minor	**16 - Medium**		
14	Rain, flooding and storms	Extreme **storm events** resulting in **high winds** causes **damages to buildings and results in flying objects.** Likewise, this can also result in vegetation/branches dropping resulting in **injury or property damage.** *Consequences - Environmental, Social/cultural, Financial, Governance, Infrastructure service*	Unlikely	Major	**14 - Medium**	Possible	Major	**18 - Medium**	- Non structural elements (e.g. landscaping fixtures) to be designed for minimum wind speeds as per AS1170.2- 2021 - Records keeping, collections management to inform repair and restoration if necessary - Disaster risk management plan/strategy to be developed - Design check/structural assessment on building (what capacity does the building have) based on the updated AS1170.2-2021 - Tree species selected to be appropriate for the wind environements of the site.		Possible	Minor	**08 - Low**		
15	Rain, flooding and storms	**Flooding** causing **exacerbation of damp, mould** and humidity-type condition issues that historic buildings are already susceptible. *Consequences - Social/cultural*	Unlikely	Minor	**05 - Low**	Possible	Minor	**08 - Low**	- Identifying original ventilation systems and reinstating - Ventilation analysis to see where we need to upgrade ventilation systems - On-going monitoring susceptible areas - Re-assess control strategy of mechanical design	- Hydrology and flooding assessment_Rev A1	Possible	Insignificant	**04 - Low**		
16	Rain, flooding and storms	Changes in role of station spaces in the event of disaster - **needing to function as shelter, assistance hub** etc - this is also relevant for **storm, flood, fire and pandemic.** *Consequences - Social/cultural*	Unlikely	Minor	**05 - Low**	Possible	Minor	**08 - Low**	- Providing amenities (drinking fountains, increased retail, food and beverage locations) - Designing in more spaces for rest	- Hydrology and flooding assessment_Rev A1	Possible	Insignificant	**04 - Low**		

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