

NEXTDC

NEXTDC S5 Data Centre and Innovation Hub

Climate Change Adaptation Plan

Reference: S5-ESD-00-000-REP-D-DVA-APP-CCAP

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Contents

Executive Summary	1
1. Introduction	2
1.1 Proposal and site context	2
2. Policy and planning context	6
2.1 Resilience objectives	6
3. Methodology	8
3.1 Establishing context	8
3.2 Qualitative risk assessment	8
3.3 Risk treatment	10
3.4 Assumptions and limitations	10
4. Context	12
4.1 Site attributes	12
4.2 Historical and existing climate characteristics	12
5. Understanding future climate	17
5.1 Climate change scenarios	17
5.2 Time horizons	17
5.3 Climate change projections	19
6. Climate risk assessment	20
6.1 Climate risks identified	20
6.2 Inherent risk rating results	20
7. Adaptation	25
7.1 Priority risks	25
7.2 Implementation and monitoring	28
8. Next steps	29
9. References	A-30

Tables

Table 1: Proposal details	4
Table 2: Relevant legislation, regulations, policies, guidelines, and standards	6
Table 3: Baseline climate data and SSP3-7.5 climate projections for 2030, 2050 and 2070, for Macquarie Park. 2050 and 2070 have been selected as time horizons for this CCAP.	19
Table 4: Excerpt from CCRR of climate risks assessed as Medium or High inherent risk	21
Table 5: Priority climate risks	23
Table 6: Expected design life for select assets and components that will comprise the Proposal	A-31

Figures

Figure 1: Aerial photograph of site (source: Urbis GIS 2023)	2
Figure 2: AS 5334:2013 risk management process, adapted from AS/NZS ISO 31000	8
Figure 3: Climate hazard categories considered	9

Figure 4: Risk statement failure modes	9
Figure 5: Approximate location of Proposal site, highlighted in red (source: Bing Maps)	12
Figure 6: Extract from Flood Risk Precinct mapping, with Proposal site boundary in red (source: WMA Water, 2023)	16
Figure 7: Distribution of climate risks identified by their climate hazard category	20
Figure 8: Distribution of inherent risk ratings by time horizon, noting risk ratings have been assessed only for time horizons applicable to them.	20
Figure 9: Factors to consider in investigation and implementation from AS5334:2013	25

Appendices

Appendix A	A-31
Typical design life of assets and components	A-31
Appendix B	B-1
Climate change risk register	B-1

Executive Summary

This NEXTDC S5 Data Centre and Innovation Hub Architectural Design Report has been prepared by Arup on behalf of NEXTDC Limited to accompany a detailed State Significant Development Application (SSDA) for the data centre development at 269 Lane Cove Road. The legal description of the site is Lot 3 in Deposited Plan (DP) 1129811.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-63168959).

1. Introduction

This report has been prepared to accompany a detailed SSDA for the proposed data centre development at 269 Lane Cove Road, Macquarie Park (SSD-63168959).

The application seeks consent for construction and operation of a data centre development and includes site preparation works, bulk earthworks and infrastructure, and construction of the buildings, ancillary facilities, and associated site works. The application also includes the delivery of one internal road and an urban plaza adjacent to the Macquarie Park Metro Station entrance.

This CCAP provides an assessment of physical climate change hazards that may impact the environmental performance of the Proposal over its lifespan and assesses measures to reduce climate risk. This includes assessment on the immediate and ongoing effectiveness of these adaptation measures, and how they should be monitored and evaluated over time. Where necessary, the CCAP outlines contingency planning to manage ongoing residual risk. The CCAP also outlines how and when it should be reviewed and updated, to ensure that it remains a useful tool in managing climate change risk across the Proposal's lifespan.

1.1 Proposal and site context

1.1.1 Existing site

The Proposal site is located at 269 Lane Cove Road, Macquarie Park and is legally described as Lot 3 in Deposited Plan (DP) 1129811. It is located on the corner of Lane Cove Road and Waterloo Road, comprising a single rectangular lot, approximately 22,381m² in size. An aerial photograph of the site is provided in Figure 1:



Figure 1: Aerial photograph of site (source: Urbis GIS 2023)

The Proposal site is in the City of Ryde Local Government Area (LGA) in Macquarie Park, an established employment precinct with a focus on innovation. Macquarie Park is a nationally significant research and employment centre and includes the head offices for some of Australia's leading companies including

Foxtel, Optus and Siemens. The site is approximately 2km southeast of Macquarie University, and 1.5km southeast of Macquarie Shopping Centre.

Existing development includes a two-storey office furniture store (Work Arena) at the northern end of the site and offices and studios associated with Foxtel in the southern portion of the site. Scattered trees exist along the site boundaries, particularly within the western setback to Lane Cove Road, along the southern boundary and the eastern boundary.

Vehicle access to the site is currently provided from Waterloo Road with an internal driveway providing access to several at-grade parking areas. A further vehicle crossover has been constructed along the Lane Cove Road frontage; however, it is not currently in use and barriers have been installed prohibiting access.

The site is well serviced by public transport with several bus routes operating along Lane Cove Road and Waterloo Road. The entrance to Macquarie Park Metro Station is immediately to the north of the site. The site includes a lengthy frontage to Lane Cove Road which provides access to the M2 Hills Motorway and Epping Road.

1.1.2 Proposal

The Project comprises the redevelopment of the site as summarised below:

- Site preparation works including demolition and removal of existing structures, tree removal and bulk earthworks.
- Staged construction and operation of two connected data centre buildings (Building A and Building B) with a maximum height of 65 metres and a combined total gross floor area (GFA) of 47,285m² comprising 33,142m² of technical data hall floor space and 14,143m² of office, retail and innovation hub floor space.
 - Building A will be delivered in Stage 1 and will comprise the following:
 - Basement parking for 51 car spaces including two accessible spaces and 10 EV spaces
 - Seven storeys of technical data floor space accommodating seven data houses: 16,571m²
 - Utilities including diesel generators (3MWe), above-ground water tanks for industrial water (600kL each), above-ground diesel storage tanks (100kL each) and an aboveground water tank for fire water (400kL each).
 - Business identification signage facing Waterloo Road and Lane Cove Road.
 - Integrated ‘Building O’ component within Building A, comprising:
 - Two retail tenancies at ground level: 326m²
 - Lobby and innovation hub including auditorium and training rooms: 3,186m²
 - NEXTDC and ancillary office floor space on upper levels: 10,631m²
 - Building B will be delivered in Stage 2 and will comprise the following:
 - Seven storeys of technical data floor space accommodating seven data halls: 16,571m²
 - Utilities including diesel generators (3MWe), above-ground water tanks for industrial water (600kL each), above-ground diesel storage tanks (100kL each) and an aboveground water tank for fire water (400kL each).
 - Business identification signage on the western and southern building facades.
- Landscaping across the site in accordance with the project staging, delivering a mix of native and endemic plant species, shrubs and grasses, including 139 additional trees within a total area of 4,959m² deep soil and a resultant tree canopy cover of 5,707m²
- Staged delivery of public domain works including:

- Stage 1: construction of Road 13 within the subject site and urban plaza.
- Stage 2: construction of Road 6 (half-width) within the subject site, including provision for a future pedestrian/cycle overbridge (to be delivered by others), and works along Lane Cove Road.
- Delivery of 90 megawatts of power with a 33kV switching station to be accommodated on site, as well as other site services, including stormwater infrastructure.

Table 1: Proposal details

Descriptor	Project Details
Project Area	The site has a total area of approximately 22,381m ² . The entire site area will be disturbed as a result of the Project. The site does not contain any environmental constraints.
Proposed Use	Data centre with ancillary office and innovation space. Two retail premises at ground level.
Project Description	Demolition of existing buildings and structures. Site preparation works including tree removal, bulk earthworks, excavation and construction of retaining walls. Staged construction of the data centre buildings including technical data hall floor space, ancillary office and innovation space and two ground floor retail premises. Vehicle access via Waterloo Road with on-site car parking and loading within the building footprint. Associated landscaping including extensive trees, shrubs and grasses. Business identification signage. Staged delivery of public domain works via a Planning Agreement, including construction of Road 13, Road 6 and an urban plaza between Building A and Waterloo Road. Provision of required utilities, including an on-site switching station.
Gross Floor Area	Total GFA of 47,285m ² , broken down as follows: <ul style="list-style-type: none"> • Data halls/technical: 33,142m² • Lobby and innovation hub: 3,186m² • Office Building: 10,631m² • Retail including BOH: 326m² Total number of data houses: 14 data houses
Building Height	Building A: office and innovation hub – 49 metres over 10-storeys. Building A: data centre – 65 metres over nine-storeys. Building B: data centre – 60 metres over nine-storeys.
Proposed Floor Space Ratio	2.11:1
Deep Soil Area	4,959m ² of deep soil area (22.16% of site area or 35.6% of developable site area).
Car Parking	51 parking spaces, including 10 EV's and 2 accessible spaces
Motorbike Spaces	17 spaces.

Descriptor	Project Details
Bicycle Spaces	20 spaces.
Utilities	Provision of required utilities, combined for both buildings, including: 48 x diesel generators (3MWe). 16 x above-ground diesel storage tanks (100kL each). Eight above-ground water tanks for industrial water (600kL each). One 400kL above-ground water tank for fire water. 33kV switching station.
Power Consumption	90 megawatts.
Operations and Management	The facility will be constructed and operated by NEXTDC. The site will be operated on a 24-hour, 7 day a week basis.
Existing Services and Infrastructure	The site is fully serviced; however, existing services and infrastructure will be extended, adapted and augmented to meet the demands of the Project. A new 33kV switching station will be required to provide power to the site in the event of an emergency blackout to facilitate power to the generators.
Staging/Phasing	The Project will be constructed in two stages: Stage 1 will include the early works for the entire site, construction of Building A, the urban plaza and Road 13 within the subject site. Stage 2 will include construction of Building B and Road 6 (half-width) within the subject site, including provision for a future pedestrian/cycle overbridge (to be delivered by others), and works along Lane Cove Road.

2. Policy and planning context

Table 2 presents relevant legislation, regulations, policies and guidelines that have been referenced during the preparation of this CCAP.

Table 2: Relevant legislation, regulations, policies, guidelines, and standards

Document	Description	Relevance to CCAP
NSW EPA's Climate Change Assessment Requirements and Guide	A draft set of requirements and a guide that shall be applicable to all new or significant developments anticipated to generate a large quantity of greenhouse gas emissions. The requirements will improve transparency around a development's emissions.	A driver for this CCAP, supporting the accompanying GHG assessment by addressing exposure to and adaptation against climate risk.
AS5334:2013 Climate change adaptation for settlements and infrastructure	A risk-based framework for adaptation to climate change impacts, including guidelines for integrating climate risk management into planning, design, and operation. Foregrounds vulnerability assessment, adaptation identification, and strategy implementation, while ensuring long-term sustainability and functionality.	Method adopted for this CCAP aligns with that outlined in AS5334:2013.
City of Ryde's Resilience Plan 2030	Outlines strategies to reduce climate risks like heatwaves, storms, and flooding, emphasising sustainable urban planning and disaster preparedness. Fosters community resilience through education, partnerships, and local engagement, empowering residents to actively participate in climate adaptation efforts.	Shows alignment between resilience objectives pursued by Proposal and City of Ryde's strategic direction for supporting resilience in its urban landscapes and communities.
NSW Climate Change (Net Zero Future) Act 2023	Legal framework for NSW to achieve net zero emissions by 2050, with interim reduction targets. Establishes the Net Zero Commission to oversee progress, advise government, and ensure accountability for emissions reduction and climate adaptation. Emphasises resilience by integrating an adaptation objective to prepare communities, infrastructure and ecosystems for climate impact.	Shows alignment between resilience objectives pursued by Proposal and wider state government legislated adaptation objectives.
NSW Climate Change Adaptation Action Plan 2025-2029	Outlines strategies to build resilience by integrating climate risk management into government policies and infrastructure planning. 46 actions across 7 themes of building capacity, expanding knowledge, communication, exploring new opportunities, and enhancing existing initiatives.	
Climate Risk Ready NSW Guide	A 4-step process to help NSW state agencies manage climate risks and opportunities. Aims to enhance capacity of agencies to identify and address climate risks to public assets, services, and objectives, contributing to improved climate resilience and adaptive capacity in government operations.	Shows alignment between state government method for climate risk assessment and adaptation planning and the method adopted for this CCAP.

2.1 Resilience objectives

The Uptime Institute (UI) Tier Certification system is a globally recognised framework for classifying data centres based on their reliability, performance, and operational sustainability [1] [2]. The certification process evaluates the design, construction, and operational sustainability of data centres. Design certification ensures infrastructure plans meet the targeted Tier level, while constructed facility certification validates the actual implementation. Operational sustainability certification assesses maintenance strategies and practices required for long-term reliability. These certifications not only signify reliability but also align infrastructure with business objectives, minimise downtime risks, and optimise return on investment [2].

The system comprises four tiers (I to IV), each defining specific standards of infrastructure redundancy, fault tolerance, and uptime reliability [1]. These tiers reflect increasing levels of performance and resilience:

- Tier I: Basic infrastructure with limited redundancy, offering 99.671% uptime.
- Tier II: Adds partial redundancy for components like power and cooling, with 99.741% uptime.
- Tier III: Provides full redundancy and maintenance without shutting down operations, ensuring 99.982% uptime.
- Tier IV: Designed for fault tolerance, enabling continuous operation during failures, with 99.995% uptime.

The Proposal will comprise both Tier IV and Tier III levels of redundancy. The lowest two floors, designated for enterprise retail, are to meet Tier IV, offering maximum fault tolerance and 99.995% uptime. The top five floors, designed for hyperscale operations, are certified to Tier III standards, providing full redundancy and 99.982% uptime while balancing performance and scalability.

3. Methodology

The method adopted for this CCAP consisted of the following steps, aligning with the method outlined in *AS 5334:2013 Climate change adaptation for settlements and infrastructure*, and with the *Climate Risk Ready NSW Guide*:

1. Establish context: Including identifying aspects of the Proposal that may influence vulnerability or exposure to climate change hazards, and aspects of the Proposal region that may inform climate change hazard exposure.
2. Identify, analyse, and evaluate the risks: Utilising risk criteria outlined in the *Climate Risk Ready NSW Guide*, and by liaising with design discipline representatives.
3. Identify and plan risk treatments: By liaising with design discipline representatives.
4. Monitor and review: By setting out steps for the monitoring and evaluation of climate change risk and risk treatments throughout the Proposal's lifespan.

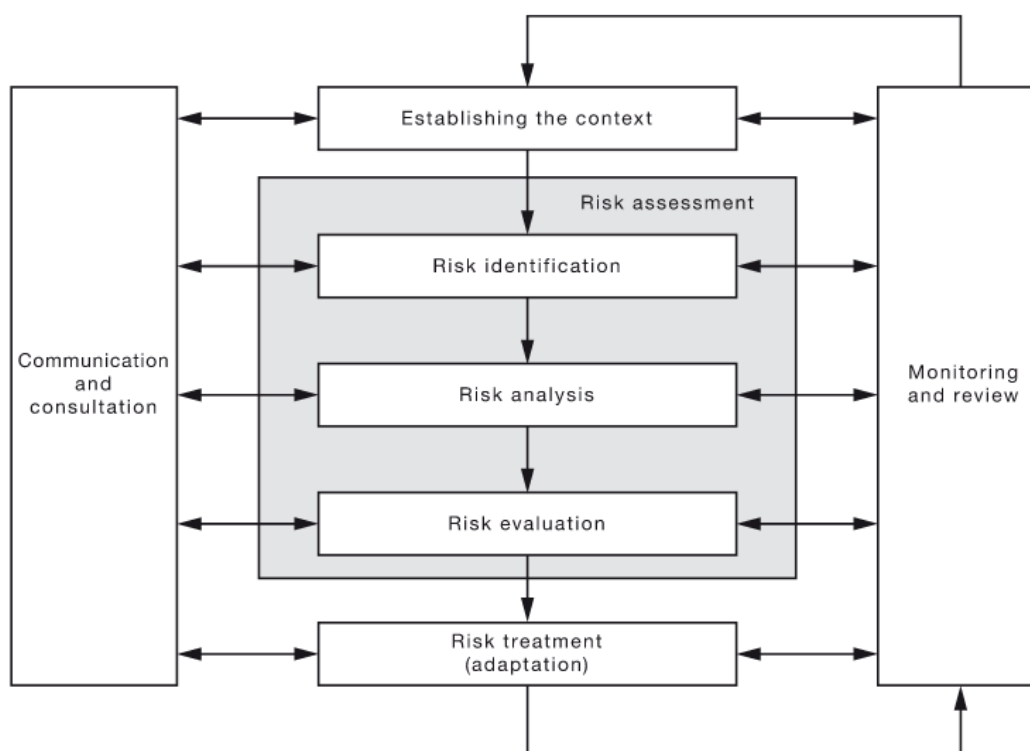


Figure 2: AS 5334:2013 risk management process, adapted from AS/NZS ISO 31000

3.1 Establishing context

Prior to risk identification, it is important to understand the context of the project, its existing exposure to climate hazards, and the range of climate projections applicable to its location. This was achieved by reviewing existing reports for the Proposal as well as publicly available information about historical climate data and climate hazards that have impacted the region. See section 4 Context, for detail.

3.2 Qualitative risk assessment

3.2.1 Risk identification

Risk statements were longlisted by screening for potential adverse impacts that may arise from the following climate hazard categories:

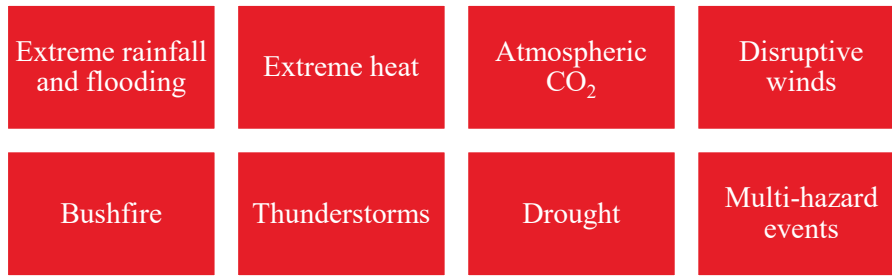


Figure 3: Climate hazard categories considered

Atmospheric CO₂ represents hazard associated with change in atmospheric CO₂ concentrations, primarily associated with the durability of exposed structural elements. Multi-hazard events represent hazard associated with coincident and / or compounding events, for example, extreme heat conditions that coincide with high winds.

The longlist of climate risks has been refined through consultation with design team members, testing for risk statement relevance and accuracy. Risk statements were authored to articulate how a given climate hazard event may interact with the project and result in adverse impacts, focusing on potential for given failure modes:

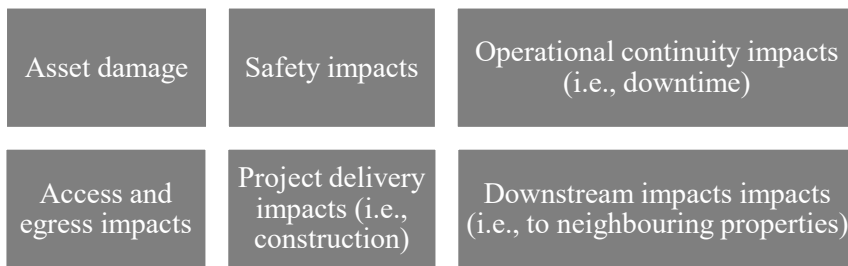


Figure 4: Risk statement failure modes

3.2.2 Risk analysis - qualitative

Risk analysis involves interrogating, for each climate risk, the probability of it occurring (i.e., its likelihood) and the severity of adverse impacts generated should it occur (i.e., its consequence). This is done for each risk statement, for all time horizons considered (including the baseline condition). The risk analysis for this CCAP is qualitative only, with likelihood and consequence assigned against criteria provided in *Appendix C Climate Risk Assessment Tool* of the *Climate Risk Ready NSW Guide*. A risk matrix is then used to derive inherent risk ratings – that is, the risk level prior to implementation of any adaptation measures. Refer to Appendix B for detail.

Likelihood and consequence ratings have been defined for each risk statement in consultation with relevant design team stakeholders, deriving as output inherent risk ratings. This has been done through individual discipline meetings and email correspondence, incorporating subject matter expert advice.

Likelihood and consequence ratings also consider relevant controls – that is, design elements or operational processes that are considered business-as-usual or typical practice, and that are relevant to the risk statement. Controls assist in defining the extent to which each risk has potential to result in adverse impacts for the project.

NB: It is anticipated that likelihood and consequence definition will continue to be refined as discipline designs progress.

3.2.3 Risk evaluation

Risk evaluation involves reviewing the outcome of the qualitative risk analysis. For this CCAP, this included:

- Risk comparison: For risks with equivalent inherent risk ratings, to sense check for equivalence.
- Risk interdependence: Review of how occurrence of one risk may trigger or interact with another risk.
- Existing adaptive capacity: Where adaptations, whether design-led or operational, have already been identified and progressed by a design discipline or the operator, these have been captured in the Climate Change Risk Register (CCRR) to inform residual risk ratings.
- Risk uncertainty: Noting in the CCRR uncertainties inherent within climate risks, including a risk's sensitivity to preconditions or assumptions. This has been captured in the CCRR under Risk Analysis.
- Risk prioritisation: Review of risks to be prioritised for specific adaptations.
- Initial adaptation strategies: Longlisting of adaptation options, for design discipline and operator consideration.

Finally, risk results will be disseminated to design disciplines to validate outcomes from the risk analysis and evaluation stages. This will inform further discussion on risk treatment identification and implementation, and risk monitoring and management.

NB: For this issue of the CCAP, risk evaluation is ongoing, with risk ratings to be finalised based on input from NEXTDC.

3.3 Risk treatment

Risk treatments, or adaptations, demonstrate response to the actual or expected effects of climate change. Adaptations may be design-led (e.g., physical changes to system design) or operational (e.g., management of risk through operational procedures). Adaptations have potential to mitigate the likelihood and / or consequence of a risk's occurrence. A risk's residual rating is assigned by taking the inherent risk rating and then assessing the mitigating effects of the risk's adaptations.

NB: Controls and adaptations are collated from conversations with the design team. For this issue of the CCAP, risk treatment identification is ongoing, with controls and adaptations still being identified and collated. It is the intent of this issue of the CCAP to trigger additional discussion on adaptation opportunities, based on draft findings from the qualitative risk assessment.

3.4 Assumptions and limitations

Please note the following assumptions and limitations applicable to this CCAP:

- Risk assessment and development of controls and adaptations is qualitative only.
- When interpreting the output of this CCAP, it is important to note that uncertainty is an inherent component of climate change risk identification, assessment, and adaptation. In preparing this CCAP we have used climate model outputs obtained from external sources including NARClIM, as outlined in section 5.3 Climate change projections.
- Such models can help consider possible future climate scenarios or outcomes, but no model that attempts to project the future can do so with certainty. Actual events may not occur as projected, and the differences may be material. As such, Arup cannot and does not make any representation or warranty, express or implied, regarding the accuracy or completeness of any such forward-looking advice, or any models, projections, forecasts, opinions or estimates, and Arup accepts no responsibility for the realisation or non-realisation of the same.

- Climate projections utilised are based on publicly available data. These inherently involve a degree of uncertainty and will be progressively updated in the coming years as global climate models iteratively improve. Any advice, including forward-looking advice, is time-sensitive at time of writing. Climate models are constantly updated and there may be material differences between climate models used at the time of writing and climate models generated later. Arup will not be under any obligation to update our work to address changes in facts or circumstances or modelling techniques that occur at a later date.
- The CCAP includes statements that are, or may be deemed to be, forward-looking statements or projections. These can be identified by use of forward-looking terminology, forecasts, or estimates including the terms “believes”, “estimates”, “plans”, “anticipates”, “targets”, “aims”, “continues”, “projects”, “assumes”, “expects”, “intends”, “may”, “will”, “would” or “should”, or, in each case, their negative or other variations or comparable terminology. These forward-looking statements or projections include all matters that are not historical and are based upon interpretations or assessments of available information at time of writing. By their nature, forward-looking statements or projections involve risk and uncertainty because they relate to future events and circumstances. Realisation of any forward-looking statement or projection is dependent upon the continued validity of the assumptions on which it is based. A number of factors could cause actual results and developments to differ materially from those expressed or implied by the forward-looking statements or projections. Actual events frequently do not occur as expected, and differences may be material. For this reason, we accept no responsibility for the realisation of any projection, forecast, opinion or estimate.

4. Context

4.1 Site attributes

The Proposal site is located on the corner of Lane Cove Road and Waterloo Road in Macquarie Park, an established employment precinct with a focus on innovation. The site is directly adjacent to the Macquarie Park metro station. Approximately 700m to the North-East of the site is Lane Cove National Park, a heavily vegetated area of high ecological and cultural value. The site slopes down to the North-East, from an elevation of approximately 70m AHD to 56m AHD.

The Proposal is one of several data centres either existing or under development in the Macquarie Park area.



Figure 5: Approximate location of Proposal site, highlighted in red (source: Bing Maps)

4.2 Historical and existing climate characteristics

4.2.1 Bushfires

Historically, the Proposal locality experiences 1.3 severe fire danger days per year (days where the Forest Fire Danger Index exceeds 50). Lane Cove National Park is Category 1 bushfire prone land; the Park experienced burning as recently as 2017 [3]. More significant bushfire events within the Macquarie Park catchment includes the Boxing Day fires in 1994. There have been no significant bushfire events recorded within the site boundary.

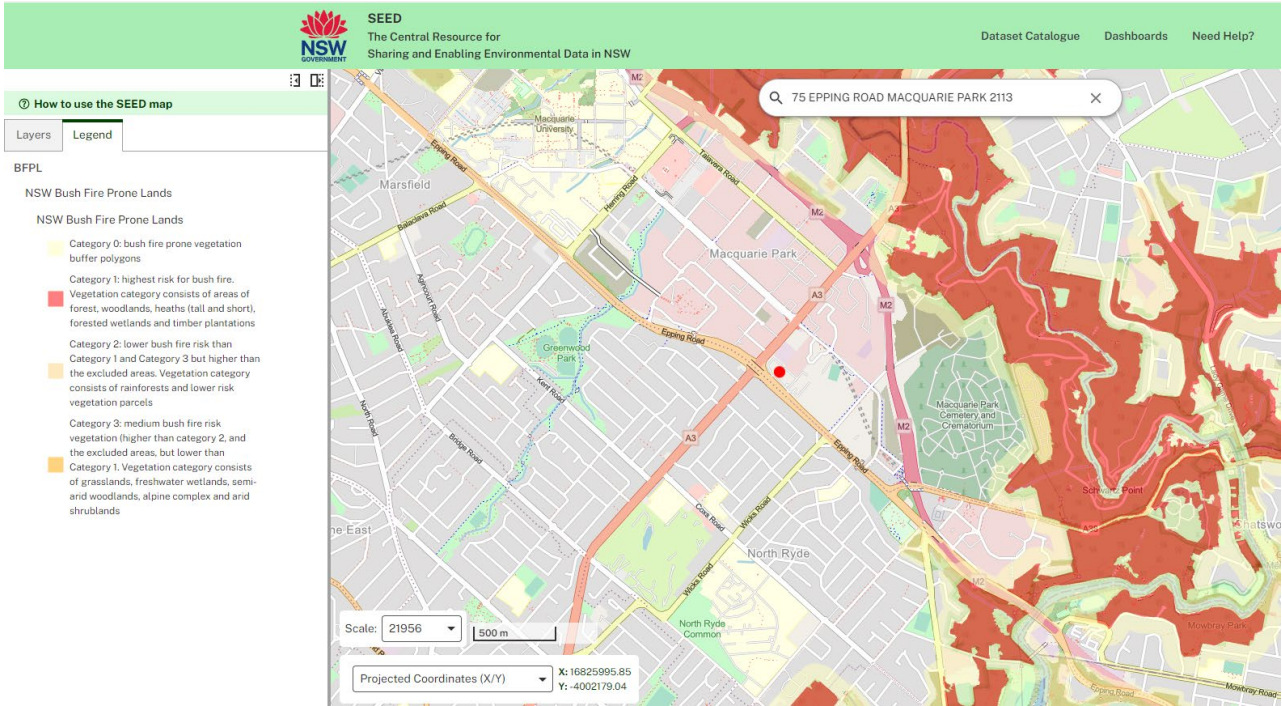


Figure 6: NSW Bush Fire Prone Lands map sourced from the NSW government SEED initiative.

4.2.2 Extreme heat

The Proposal locality has experienced significant extreme heat events historically. During a heatwave in January 2018, temperatures in Penrith reached 47.3°C. The average number of days exceeding 35°C, for the closest BoM station at Macquarie Park -Willandra Village, is 5.8 days per year. Inland Sydney is also notable for experiencing intense heat events due to urban heat island and limited sea breeze cooling. Extreme heat events have also triggered power supply warnings in the past; in November 2024, Australian Energy Market Operator (AEMO) warning of potential blackouts from heatwave conditions [4].

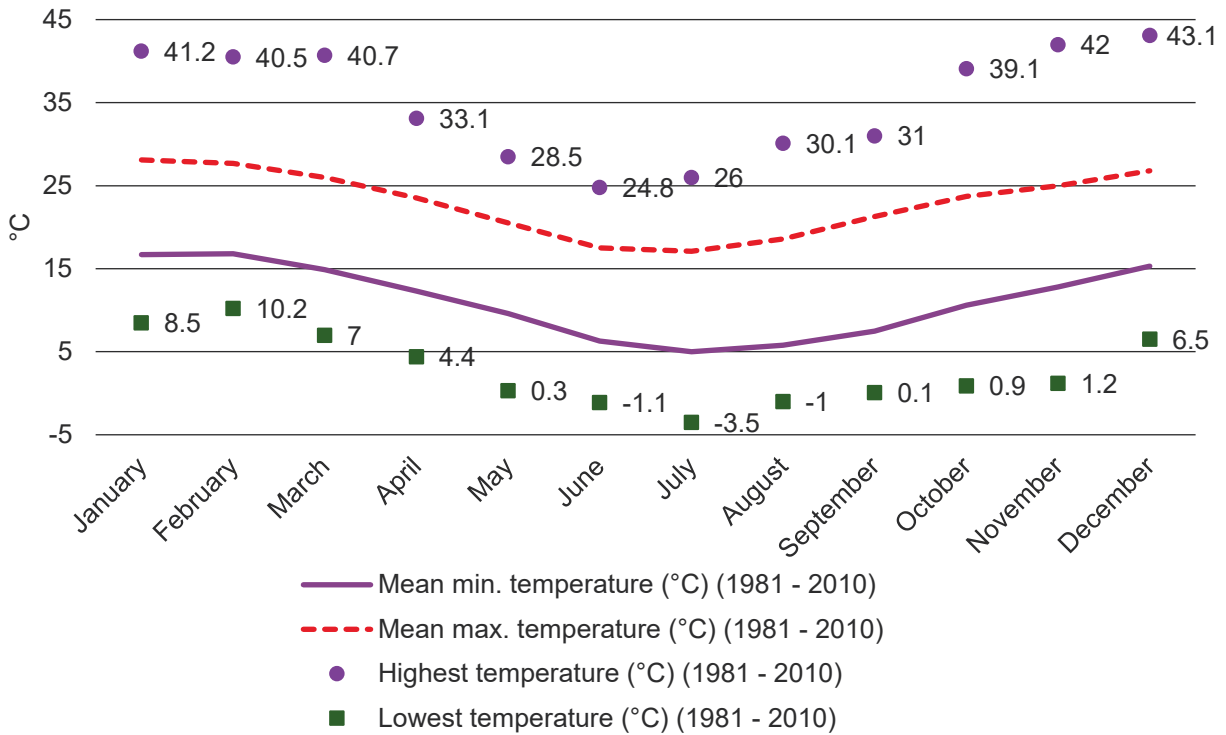


Figure 7: Monthly mean and highest temperature conditions, illustrating historical state for BoM station Macquarie Park - Willandra Village.

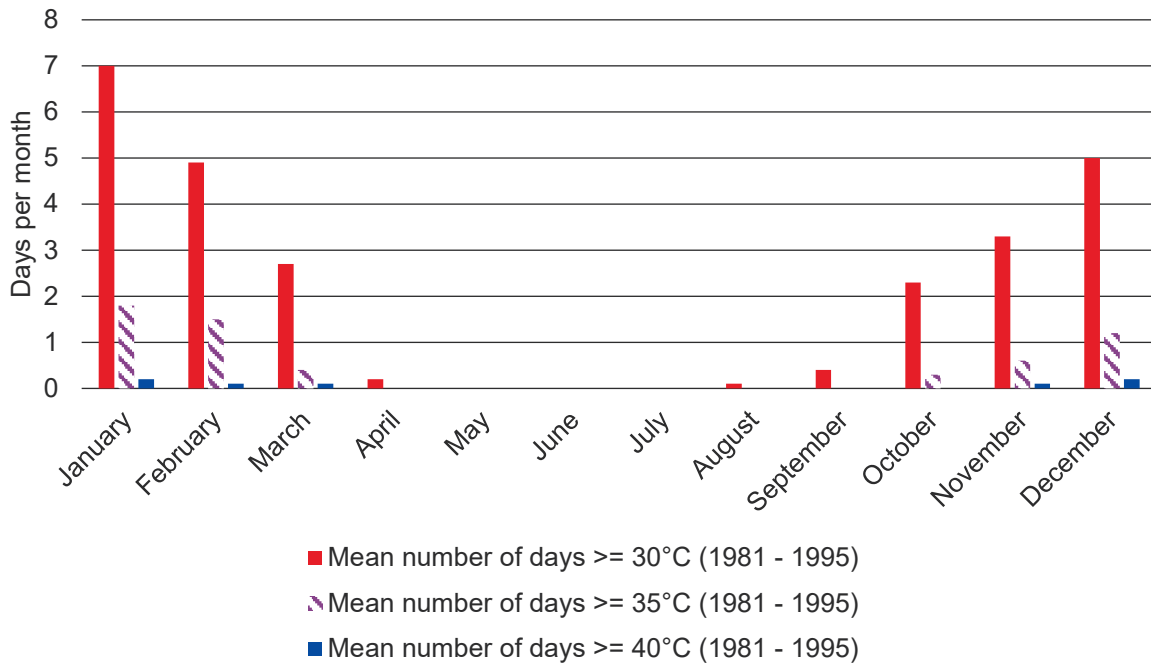


Figure 8: Monthly mean number of extreme heat days, illustrating historical state for BoM station Macquarie Park - Willandra Village.

4.2.3 High wind events

The Proposal locality has experienced several notable high wind events, typically linked to low-pressure fronts. On September 25, 2020, gusts of 105.5 km/h were recorded at the nearby BoM Fort Denison weather station. Historically, this area has experienced strong winds, ranging between 2 – 6m/s with max wind speeds during dry bulb temperature (DBT) events (BoM, Sydney Olympic Park AWS, 2011-2024).

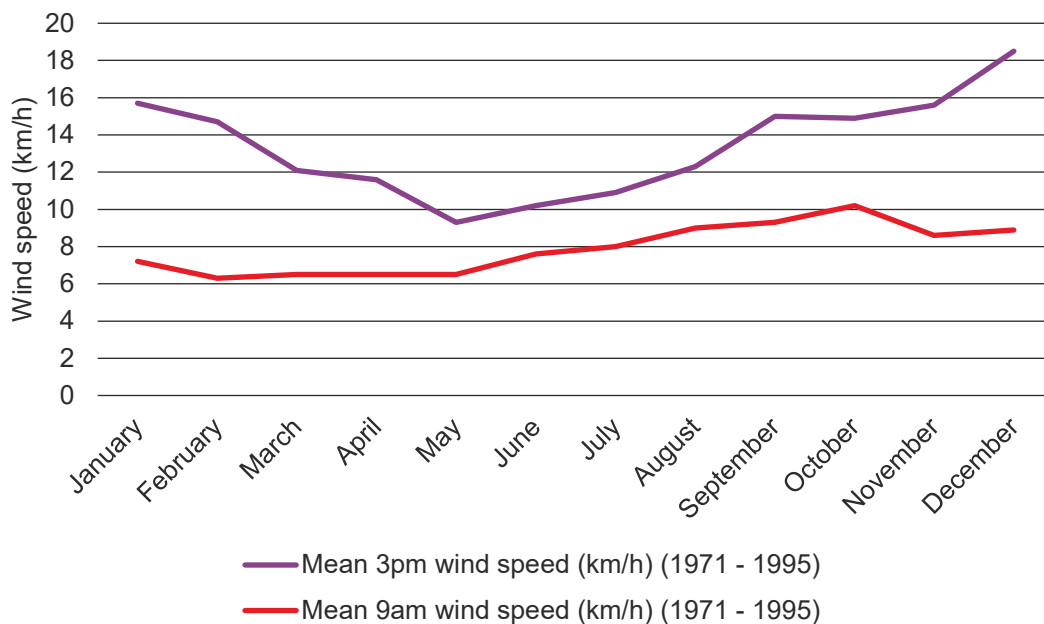


Figure 9: Monthly mean wind speed, illustrating historical state for BoM station Macquarie Park - Willandra Village.

4.2.4 Heavy rainfall and flooding

The Proposal is situated within the Lane Cove River floodplain, which has experienced severe flooding historically. In November 1984, 200mm of rain fell over 24 hours, leading to extensive overland flows and inundation of low-lying areas [5]. In February 1990, daily rainfall exceeded 150mm, causing significant disruption [6]. In 2022 Sydney recorded its wettest year on record, with rainfall totalling 2,530 mm, over

double the annual average [7]. Historically, the area experiences annual precipitation of 1129.2mm¹. During a 2% AEP event of 6-hour duration, the area exhibits a rainfall intensity factor of 127mm².

The site, in its pre-development state, is inundation free during PMF events. As such, the site is not expected to be highly exposed to flood risk. However, both Lane Cove Road (site North-West boundary) and Waterloo Road (site North-East boundary) would be partially inundated in a PMF event to depths of 0.3 and 0.5m, respectively. Shallow nuisance flooding may still occur for short durations during high rainfall events³.

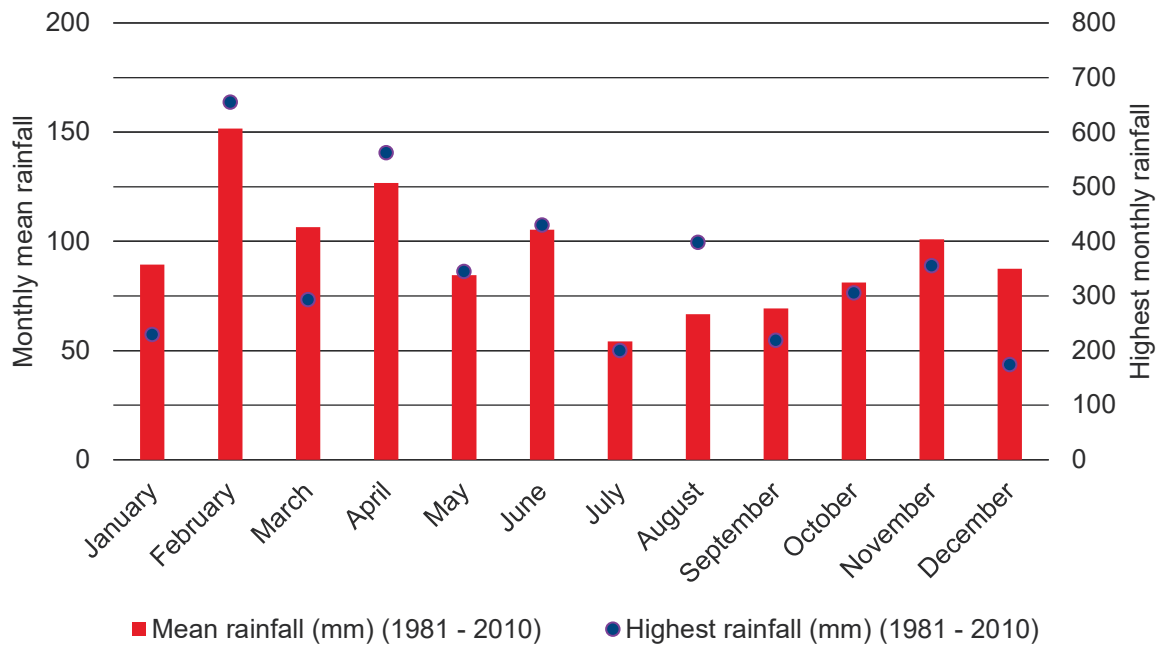


Figure 10: Monthly average (red bars) and monthly highest rainfall (blue points), illustrating historical state for BoM station Macquarie Park - Willandra Village.

¹ BoM station: Macquarie Park -Willandra Village, 1981-2010.

² BoM IFD design rainfall depths for the site location.

³ WMA analysis, 2023. See Flood Risk Assessment by TTW, 17/04/2024.



Figure 11: Extract from Flood Risk Precinct mapping, with Proposal site boundary in red⁴

4.2.5 Thunderstorms

The Proposal locality and surrounds have experienced some significant thunderstorms and associated hail and lightning, historically. A hailstorm on 14 April 1999 produced hailstones the size of cricket balls and caused approximately \$4.3 billion in damage (adjusted to 2011 values) [8]. Impacts from this storm included widespread power outages and infrastructure damage.

Lightning strikes during severe thunderstorms in the region have also posed significant risks, with incidents leading to power disruptions, structural damage, and tree collapses.

⁴ WMA Water, 2023

5. Understanding future climate

5.1 Climate change scenarios

Climate change scenarios provide coherent, plausible, and simplified descriptions of potential future climate conditions, serving as the foundation for climate projections. The IPCC, in its Sixth Assessment Report (AR6), introduced a new set of pathways known as Shared Socio-economic Pathways (SSPs). These explore how changes in social, technological, and economic factors may influence greenhouse gas emissions over time, ranging from SSP1-2.6 through to SSP5-8.5. Climate change projections for SSPs draw on the latest round of coordinated global climate models known as CMIP6, among many other lines of evidence [9].

CO2 emissions in CMIP6 scenarios

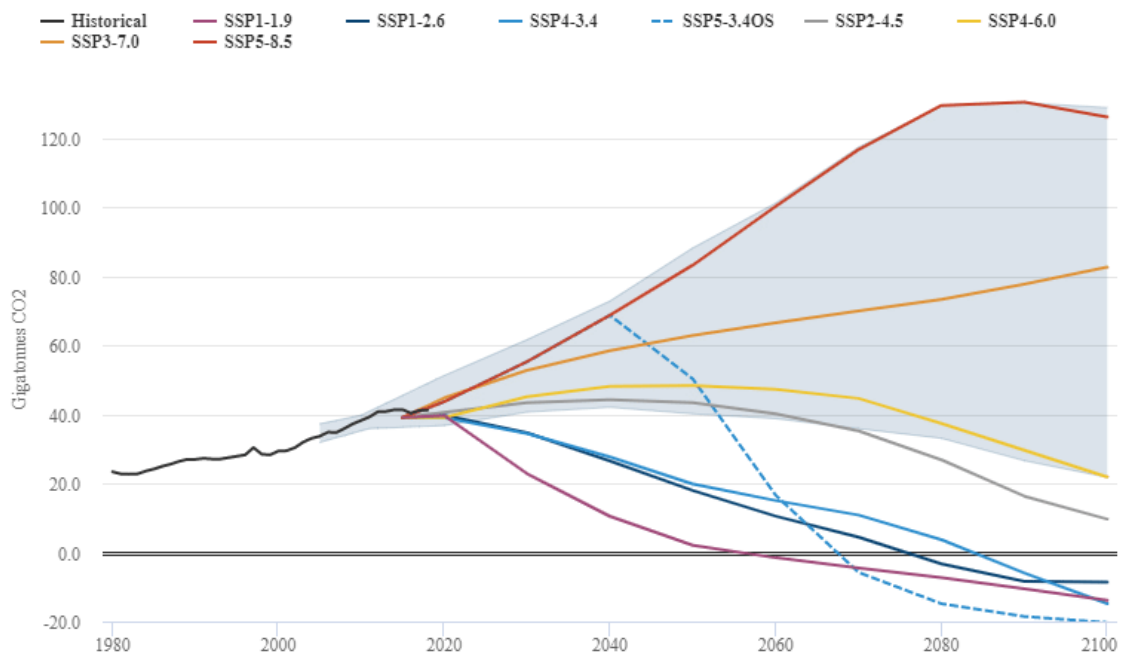


Figure 12: Historic emissions and future SSP scenarios in CMIP5 and CMIP6 models [9].

The NSW Government has identified SSP3-7.0 as a conservative, high-emission scenario for planning purposes. Under SSP3-7.5, carbon dioxide emissions are expected to double by 2100 if no additional climate policies are implemented globally, potentially leading to an increase of approximately 4°C in global temperatures.

For this CCAP, SSP3-7.5 has been adopted, with climate projections sourced from NARcliM v2.0, which offers high-resolution data at a 4 km grid cell scale. NARcliM v2.0 data are supplemented with downscaled projections from the previous round of global climate models, CMIP5, published in the Fifth Assessment Report (AR5) and consolidated from the Climate Change in Australia (CCIA) Climate Futures datasets.

5.2 Time horizons

Prior to reviewing climate change projections, it is important to select future time horizons, or time slices, that will be useful in understanding what climate conditions the Proposal may be exposed to across its anticipated operational life. Climate projections for SSP3-7.5, for the Proposal site, currently extend from the near-term 2030 (capturing the 20-year period 2020 to 2039) through to the very far-term 2090 (capturing the 20-year period 2080-99).

2050 and 2070 (encompassing the periods 2040-59 and 2060-79) are nominated as informative time horizons through which to assess climate risk, noting that many electrical and mechanical assets are likely to be nearing or at their end-of-life around 2050. 2070, meanwhile, is informative for systems and components

with longer design lives, such as civil drainage and structural systems. Refer to Appendix A for estimated design lives of select systems and assets.

In addition to 2050 and 2070, climate projection data for 2030 is also presented in this CCAP, noting that, for the construction phase, climate conditions at year 2030 are likely to be more informative than conditions recorded in the historical baseline case.

5.3 Climate change projections

Table 3: Baseline climate data and SSP3-7.0 climate projections for 2030, 2050 and 2070, for Macquarie Park. 2050 and 2070 have been selected as time horizons for this CCAP.

Hazard	Climate variable	Baseline	Projections SSP3-7.0				
			Units	2030	2050	2070	Ref.
Heat	Annual mean surface temperature (°C)	18.5	Change (°C)	+0.72	+1.68	+2.40	CMIP6: NARCLiM2.0
	Annual mean max. temperature (°C)	23.0		+0.72	+1.69	+2.37	
	Summer mean max. temperature (°C)	27.5		+1.1	+1.59	+2.26	
Extreme heat	Average days above 35°C (days per annum)	5.8	Change (days per annum)	+2.34	+6.1	+9.75	CMIP6: NARCLiM2.0
	Hottest day (°C)	43.1	Change (°C)	+1.4	+2.2	+3.3	CMIP5: Climate Change in Australia, Extremes Data Explorer
Intense rainfall	Rainfall intensity for <1hr duration (mm)	63.6	Climate change factor	1.20	1.34	1.52	Australian Rainfall & Runoff Data Hub. Updated climate change factors for IFD Initial loss and continuing loss based on IPCC AR6 temperature increases from the updated Climate Change Considerations (Book 1: Chapter 6) in ARR (Version 4.2).
	Rainfall intensity for 6hr duration (mm)	127		1.13	1.23	1.34	
	Rainfall intensity for >24hr duration (mm)	260		1.11	1.18	1.26	
Drought	Mean annual rainfall (mm)	1129.2	Change (%)	-5.86	-15.12	-7.85	CMIP6: NARCLiM2.0
	Mean Autumn rainfall (mm)	105.9		8.89	-8.56	0.26	
	Mean Winter rainfall (mm)	75.4		-27.04	-28.39	-23.24	
	Annual pan evaporation (mm)	1600		+4.20		+10.50	CMIP5: Climate Change in Australia, Summary Data Explorer
Humidity	Mean relative humidity (9am) (%)	73				BoM, Parramatta North (Masons Drive), 1981-2010	
	Mean relative humidity (3pm) (%)	55					
	Summer near-surface relative humidity (%)		Change (%)	-0.31	-0.61	-0.92	CMIP5: Climate Change in Australia, Summary Data Explorer
Solar radiation	Annual surface downwelling shortwave radiation (Wm ⁻²)	16.3	Change (%)	+0.84	+0.89	+1.1	CMIP5: Climate Change in Australia, Summary Data Explorer
Bushfire	Severe fire danger days (FFDI > 50) (days per annum)	1.3	Change (days per annum)	+0.68	+1.32	+1.87	CMIP6: NARCLiM2.0
Disruptive winds	Max. wind speeds during extreme DBT events (m/s)	2 to 6	Climate Change Multiplier	1.0	1.0	1.0	CMIP5: Climate Change in Australia, Summary Data Explorer
CO₂	Atmospheric CO ₂	397	Absolute value (ppm)	448	558	737	University of Melbourne

6. Climate risk assessment

6.1 Climate risks identified

Thirty (30) individual climate risks have been identified for the Proposal. The figure below illustrates the distribution of risks by climate hazard category; ten (10) risks have been identified for extreme heat hazard, followed by multi-hazard with six (6) and bushfire with five (5).

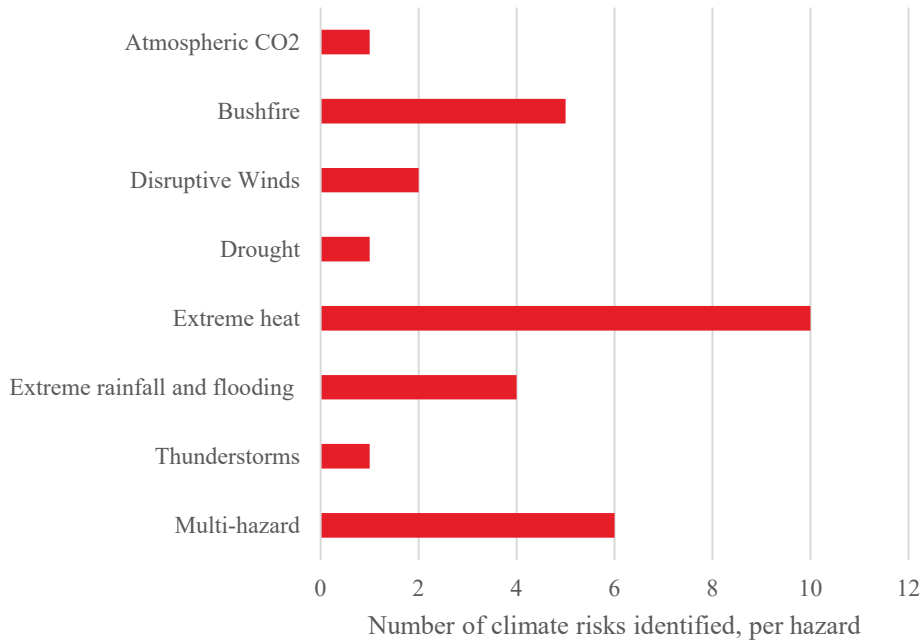


Figure 13: Distribution of climate risks identified by their climate hazard category

6.2 Inherent risk rating results

The figure below illustrates the distribution of inherent risk ratings across the time horizons considered. Only two (2) risks are rated as high inherent risk, and only for time horizon 2050.

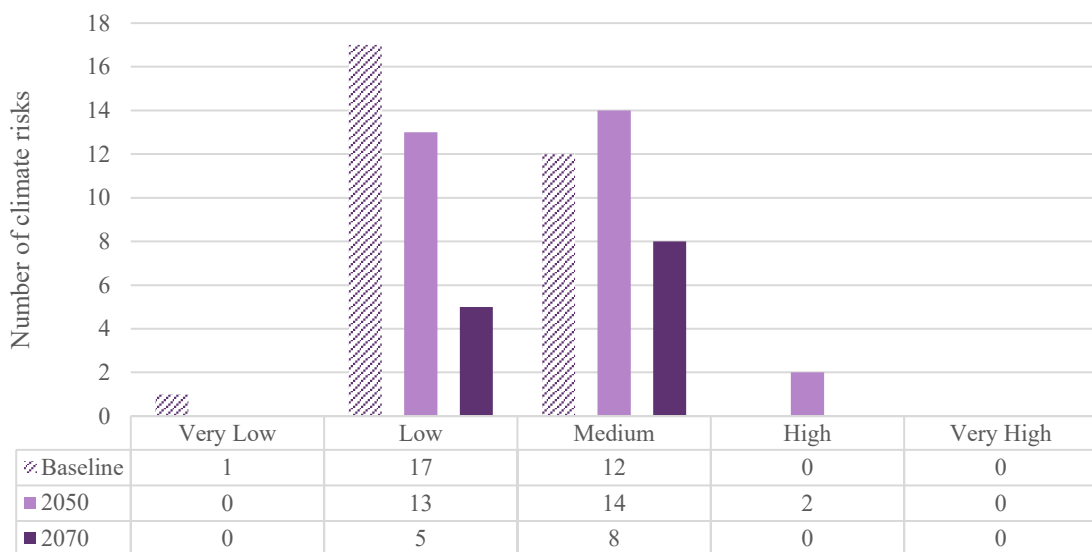


Figure 14: Distribution of inherent risk ratings by time horizon, noting risk ratings have been assessed only for time horizons applicable to them.

The table below outlines all risks rated as Medium or High inherent risk. Note that inherent risk ratings are assessed only for time horizons that intersect the anticipated design life of the primary asset/s impacted. For example, risks to mechanical systems are assessed to 2050, noting that mechanical assets and / or components will likely be at or beyond end-of life around 2050:

Table 4: Excerpt from CCRR of climate risks assessed as Medium or High inherent risk

Risk ID	Relevant design discipline/s	Climate hazard category	Risk statement	Inherent risk ratings		
				Baseline	2050	2070
CCR1	Hydraulic	Extreme rainfall and flooding	Increase in rainfall intensities overwhelming hydraulic drainage systems, causing uncontrolled overflows and internal flooding, and resulting in asset damage, safety impacts, and impacts to operational continuity.	Low	Medium	Medium
CCR2	Civil		Increase in rainfall intensities overwhelming civil drainage systems, causing uncontrolled overland flows and localised flooding, and resulting in asset damage from water ingress and impacts to operational continuity.	Low	Medium	Medium
CCR3	Civil		Increase in rainfall intensities overwhelming civil drainage systems, causing uncontrolled overland flows and localised flooding, and impacting access and egress, worker safety, and operational continuity.	Low	Medium	Medium
CCR4	Civil, Construction		Increase in rainfall intensities overwhelming construction-phase drainage on site, causing uncontrolled overland flows and localised flooding, failure of embankments, safety risk to workers, environment impacts, and delay to project delivery.	Medium	-	-
CCR5	Mechanical, Architectural	Extreme heat	Environment control system for data halls overwhelmed, resulting in the exceedance of thermal conditions and shutdown or damage of data hall assets, impacting operational continuity.	Medium	Medium	-
CCR10	Electrical		More frequent and severe peak temperature events resulting in increased peak energy demand, exceeding substation sizing and redundancy, causing system re-rating, power loss, and impacting operational continuity.	Medium	Medium	-
CCR12	Mechanical		Change in average and extreme humidity conditions exceeding humidity setpoints for data halls, causing shutdown or damage to data hall assets and impacting operational continuity.	Medium	Medium	-
CCR13	Architectural		Increase in extreme heat conditions and urban hardscaping worsening local urban heat island (UHI) effect, reducing outdoor thermal comfort and worsening local UHI.	Medium	Medium	Medium
CCR16	Electrical, Wind		Disruptive winds	High wind events causing debris to impact energy infrastructure on site, including substations and overground cabling, resulting in power outages and impacting operational continuity.	Medium	Medium

Risk ID	Relevant design discipline/s	Climate hazard category	Risk statement	Inherent risk ratings		
				Baseline	2050	2070
CCR18	Mechanical	Bushfire	Bushfire smoke ingress via outdoor air intakes causing data hall pollutant tolerances to be exceeded, resulting in shutdown or damage to data hall assets and impacting operational continuity.	Medium	Medium	-
CCR23	Hydraulic	Thunderstorms	More intense hailstorms blocking hydraulic drainage, resulting in system overflow, internal flooding, damage to internal assets, and impacts to operational continuity,	Low	Medium	Medium
CCR24	Mechanical, Hydraulic	Drought	More frequent and prolonged droughts resulting in regional water restrictions, restricting mains water supply to cooling towers and impacting operational continuity.	Medium	Medium	-
CCR25	Mechanical, Wind	Multi-hazard	More frequent and severe peak temperature events, coinciding with high winds and / or high humidity, causing recirculation of hot exhaust air from heat rejection equipment and air intake temperature thresholds to be surpassed. This may result in data hall thermal conditions not being met, impacting operational continuity.	Medium	High	-
CCR26	Electrical, Wind		Regional climate hazard events, such as bushfires, flooding, and high wind events, resulting in power outages to the project site, impacting operational continuity.	Medium	Medium	Medium
CCR28	Hydraulic, Mechanical		Regional climate hazard events, such as bushfires and flooding, resulting in water outages, restricting mains water supply to cooling towers and impacting operational continuity.	Medium	Medium	-
CCR29	Façade, Wind, Hydraulic		Increase in rainfall intensities worsening wind driven rain, causing ingress of rainwater through façade louvres, damage to assets and equipment, and impacting operational continuity.	Low	Medium	Medium
CCR30	Wind, Mechanical		More frequent or severe climate hazard events resulting in regional blackouts, triggering use of generators for power supply. When this coincides with peak temperatures, high winds, and / or high humidity, heat exhausted from generators may circulate into heat rejection equipment. This may cause air intake temperature thresholds to be surpassed, resulting in data hall thermal conditions not being met and impacting operational continuity.	Medium	High	-

6.2.1 Priority risks

CCR25 and CCR30 are assessed as showing High inherent risk, for time horizon 2050. Both risks relate to potential for coincident high temperature, high wind events impacting the Proposal’s heat rejection system from recirculation of hot air, exceeding the design condition of the system. These risks have been authored with input from the project wind modelling and mechanical teams. Table 5 provides additional detail on both risks, from the risk analysis stage.

Table 5: Priority climate risks

Risk ID	Risk Statement	Controls	Inherent Risk Ratings									Risk analysis
			Baseline			2050			2070			
			C	L	R	C	L	R	C	L	R	
CCR25	More frequent and severe peak temperature events, coinciding with high winds and / or high humidity, causing recirculation of hot exhaust air from heat rejection equipment and air intake temperature thresholds to be surpassed. This may result in data hall thermal conditions not being met, impacting operational continuity.	Mechanical system designed for the N=50 condition (worst weather condition over an historical 50-year period) An external CFD study to determine max. recirculation temperatures expected at cooling towers.	Major	Unlikely	Medium	Major	Possible	High	-	-	-	<p>Likelihood deemed Unlikely for the baseline condition. This accounts for</p> <ol style="list-style-type: none"> The NEXTDC S5 - Risk Register, which lists cooling tower recirculation risk as Medium likelihood (deemed equivalent to Possible on the AS5334 scale), excluding climate change effects and excluding role of generators as sources of external heat; and Controls adopted for mechanical system. These controls are deemed to mitigate the likelihood from Possible. They are not deemed an adaptation because they are triggered by the Proposal's stringent redundancy and downtime requirements. <p>Likelihood deemed Possible in the medium-term due to uplift in temperature conditions projected for 2050.</p> <p>Consequence deemed Major, aligning with NEXTDC S5 - Risk Register which lists recirculation risk as High severity (deemed equivalent to Major on the AS5334 scale), excluding climate change effects. Major consequence also deemed appropriate due to potential for major financial losses and impact to the wider economy.</p>

Risk ID	Risk Statement	Controls	Inherent Risk Ratings									Risk analysis
			Baseline			2050			2070			
			C	L	R	C	L	R	C	L	R	
CCR30	More frequent or severe climate hazard events resulting in regional blackouts, triggering use of generators for power supply. When this coincides with peak temperatures, high winds, and / or high humidity, heat exhausted from generators may circulate into heat rejection equipment. This may cause air intake temperature thresholds to be surpassed, resulting in data hall thermal conditions not being met and impacting operational continuity.	<p>Mechanical system designed for the N=50 condition (worst weather condition over an historical 50-year period)</p> <p>An external CFD study to determine max. recirculation temperatures expected at cooling towers.</p>	Major	Unlikely	Medium	Major	Possible	High	-	-	-	<p>Likelihood deemed Unlikely for the baseline condition. This accounts for:</p> <ol style="list-style-type: none"> (1) The NEXTDC S5 - Risk Register, which lists cooling tower recirculation risk as Medium likelihood (deemed equivalent to Possible on the AS5334 scale), excluding climate change effects and excluding role of generators as sources of external heat; and (2) Controls adopted for mechanical system. These controls are deemed to mitigate the likelihood from Possible. They are not deemed an adaptation because they are triggered by the Proposal's stringent redundancy and downtime requirements. <p>Likelihood deemed Possible in the medium-term due to uplift in temperature conditions projected for 2050.</p> <p>Consequence deemed Major, aligning with NEXTDC S5 - Risk Register which lists recirculation risk as High severity (deemed equivalent to Major on the AS5334 scale), excluding climate change effects and excluding role of generators as a source of external heat. Major consequence also deemed appropriate due to potential for major financial losses and impact to the wider economy.</p>

7. Adaptation

AS5334:2013 defines adaptation as “*changes made in response to the likely threats and opportunities arising from climate variability and climate change*”. Adaptations may be design-led measures or be operational and procedural. AS5334:2013 outlines adaptation as cyclical, encompassing development, selection, and implementation of various measures to mitigate risks posed by climate change. This involves:

- a) Selecting one or more adaptation options.
- b) Deciding whether, either alone or in combination with other adaptation actions or controls, residual risk levels would become tolerable.
- c) If not tolerable, planning a new adaptation action or set of actions.
- d) Assessing the effectiveness of the new adaptation actions when compared with the risk criteria previously set.

In the context of this CCAP, adaptations are distinct from controls; controls are standard or business-as-usual measures that define inherent risk, but do not respond to anticipated effects from climate change. In selecting adaptations for investigation and implementation, AS5334:2013 outlines the following factors:

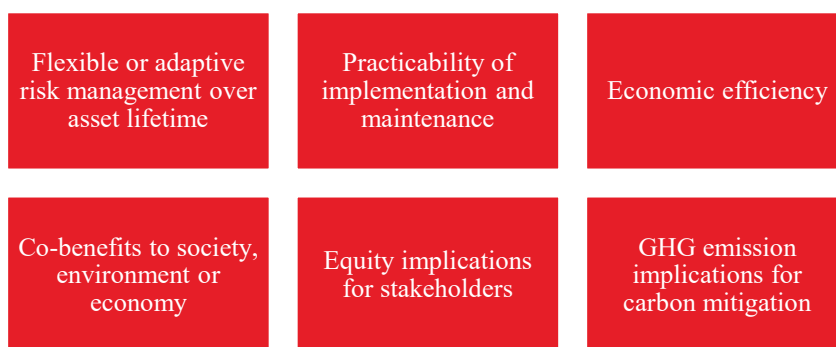


Figure 15: Factors to consider in investigation and implementation from AS5334:2013

Controls and potential adaptations have been identified through liaison with design disciplines. Refer to Appendix B for detail of adaptations tabled for each risk.

7.1 Priority risks

The table below detailed potential adaptations, identified at this stage, for risks rated as having a High inherent risk. Please refer to the CCRR appended for details on all controls and adaptations identified, for all climate risks, including key areas for review:




Table 6: Adaptations tabled for priority risks

Risk ID	Risk Statement	Controls	Inherent Risk Ratings		Adaptations	Residual Risk Rating	
			Baseline	2050		Baseline	2050
CCR 25	More frequent and severe peak temperature events, coinciding with high winds and / or high humidity, causing recirculation of hot exhaust air from heat rejection equipment and air intake temperature thresholds to be surpassed. This may result in data hall thermal conditions not being met, impacting operational continuity.	<p>Mechanical system designed for the N=50 condition (worst weather condition over an historical 50-year period)</p> <p>An external CFD study to determine max. recirculation temperatures expected at cooling towers.</p>	Medium	High	<p>Mechanical system design condition set at 47.8°C dry bulb and 28.3°C wet bulb temperature (per the ASHRAE 2025 climate dataset), an uplift on the ASHRAE 2021 dataset, affording a more conservative climate condition.</p> <p>Additional scenario testing to be conducted from CFD analysis, focusing on most problematic scenarios identified. See CFD analysis for detail.</p> <p>Risk and potential adaptation to be further investigated and refined, noting that:</p> <ul style="list-style-type: none"> • Additional scenario testing has the potential to better articulate this risk and improve the accuracy of the inherent risk rating. • Depending on the outcome of the external CFD modelling, additional testing may be deemed important by NEXTDC. • Because the inherent risk rating of High occurs at the 2050, it is pertinent to consider the uplift in risk expected to occur between baseline (i.e., day 1) and 2050 and how this may be managed. This may be through a log of extreme heat condition days and heat rejection system performance, to test system sensitivity, for example. 	<p>To be defined when adaptation is refined and evidenced.</p> <p>For conservatism, residual ratings are set at inherent levels in the CCRR.</p>	

Risk ID	Risk Statement	Controls	Inherent Risk Ratings		Adaptations	Residual Risk Rating	
			Baseline	2050		Baseline	2050
CCR 30	More frequent or severe climate hazard events resulting in regional blackouts, triggering use of generators for power supply. When this coincides with peak temperatures, high winds, and / or high humidity, heat exhausted from generators may circulate into heat rejection equipment. This may cause air intake temperature thresholds to be surpassed, resulting in data hall thermal conditions not being met and impacting operational continuity.	<p>Mechanical system designed for the N=50 condition (worst weather condition over an historical 50-year period)</p> <p>An external CFD study to determine max. recirculation temperatures expected at cooling towers.</p>	Medium	High	<p>Mechanical system design condition set at 47.8°C dry bulb and 28.3°C wet bulb temperature (per the ASHRAE 2025 climate dataset), an uplift on the ASHRAE 2021 dataset, affording a more conservative climate condition.</p> <p>Additional scenario testing to be conducted from CFD analysis, focusing on most problematic scenarios identified. See CFD analysis for detail.</p> <ul style="list-style-type: none"> Additional scenario testing has the potential to better articulate this risk and improve the accuracy of the inherent risk rating. Depending on the outcome of the external CFD modelling, additional testing may be deemed important by NEXTDC. Because the inherent risk rating of High occurs at the 2050, it is pertinent to consider the uplift in risk expected to occur between baseline (i.e., day 1) and 2050 and how this may be managed. This may be through a log of extreme heat condition days and heat rejection system performance, to test system sensitivity, for example. 	<p>To be defined when adaptation is refined and evidenced.</p> <p>For conservatism, residual ratings are set at inherent levels in the CCRR.</p>	

7.2 Implementation and monitoring

AS5334:2013 details that adaptation planning should clearly identify an implementation pathway to realise resilience outcomes, including nominating responsible parties, reporting and monitoring requirements, and timing and scheduling of adaptations. To assist in the implementation of adaptations tabled in the CCRR appended to this CCAP – as well as future adaptations identified and developed as the Proposal’s design progresses – the following actions are outlined:

<p>Review of risks prior to design milestones</p> 	<p>Risk statements and ratings should be reviewed prior to each design milestone throughout project delivery. Risk statements may be revised or added to, to improve accuracy, applicability, and completeness of the assessment, following input from design disciplines and Multiplex and NEXTDC.</p> <p>When: At each design milestone, or at least 2-yearly, whichever is more frequent.</p>
<p>Review of controls & adaptations prior to design milestones</p> 	<p>Controls and adaptations should also be reviewed prior to each design milestone throughout project delivery. This should include a review of control and adaptation documentation, with evidence tracked in the CCRR.</p> <p>The review should also capture new detail on each measure arising as designs develop.</p> <p>Lastly, the review should consider adaptation efficacy in risk mitigation; where a control or adaptation is modified, removed, or enhanced, its mitigating effect (or lack of mitigating effect) should be recorded in the CCRR and relevant inherent and / or residual risk ratings updated. This review should consider how far-reaching the adaptation is (i.e., what asset types, user groups and external stakeholders does it benefit?) and whether it aligns with the Proposal’s GHG emissions strategy (i.e., avoid adaptations that may result in a significant uptick in embodied carbon).</p> <p>When: At each design milestone, or at least 2-yearly, whichever is more frequent.</p>
<p>Construction and operational procedures</p> 	<p>Climate change risk, as outlined in this CCAP and CCRR, should be captured within construction and operational documentation to inform climate risk management across Proposal delivery and operation. This should include, at a minimum, construction management planning and documentation (for climate risks that intersect the construction phase) and building management procedures and operational management plans.</p> <p>These documents and procedures should reference live versions of the CCAP and CCRR, so that these may be updated as new risks are identified, and as controls and adaptations are tracked. This will ensure that climate risk management is proceduralised, with responsibility maintained across the infrastructure lifetime.</p> <p>When: At least 2-yearly, throughout the delivery and operational life.</p>

To assist in this, the CCRR details for each climate risk:

- **Risk analysis:** Including assumptions and constraints, to detail why risks are deemed relevant and how inherent risk ratings have been derived.
- **Risk mitigating effects:** To detail the efficacy of adaptations in mitigating risk levels.
- **Responsible party:** To ensure that stakeholders and disciplines are accountable for delivery of adaptations, where it is deemed relevant.
- **Timing and scheduling:** To detail when adaptations will be implemented, or when they should be considered for implementation.

8. Next steps

The intent of this issue of the CCAP is to disseminate initial results to NEXTDC and design disciplines, to validate findings and to inform ongoing design and adaptation development for disciplines with priority climate risks. The CCAP should be reviewed and updated at each design stage to capture:

- Inputs and commentary from disciplines on the CCAP's initial results
- Continued refinement of controls and adaptations
- Findings from other studies being conducted, including but not limited to ultimate limit state wind modelling.

9. References

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Appendix A

Typical design life of assets and components

Table 7: Expected design life for select assets and components that will comprise the Proposal

Asset class and component	Expected design life (yrs)
Mechanical	
Cooling towers	20
Chillers	20 to 23
Boilers	24 to 30
Boilers (electric)	15
Heat pumps	15 to 19
Valve actuators	10 to 20
Fans	15 to 25
Ductwork	30
Package air conditioners	15
Condensers	20
Pumps	10 to 20
Electrical	
BMCS	20
UPS, batteries	10
Vertical transport	
Lifts	25
Elevator system	25
Civil and hydraulic	
Hydraulic drainage	50
Civil drainage	70
OSD tank	70
Concrete elements	40 to 60
Architectural elements	50
Landscaping	20

Appendix B

Climate change risk register

