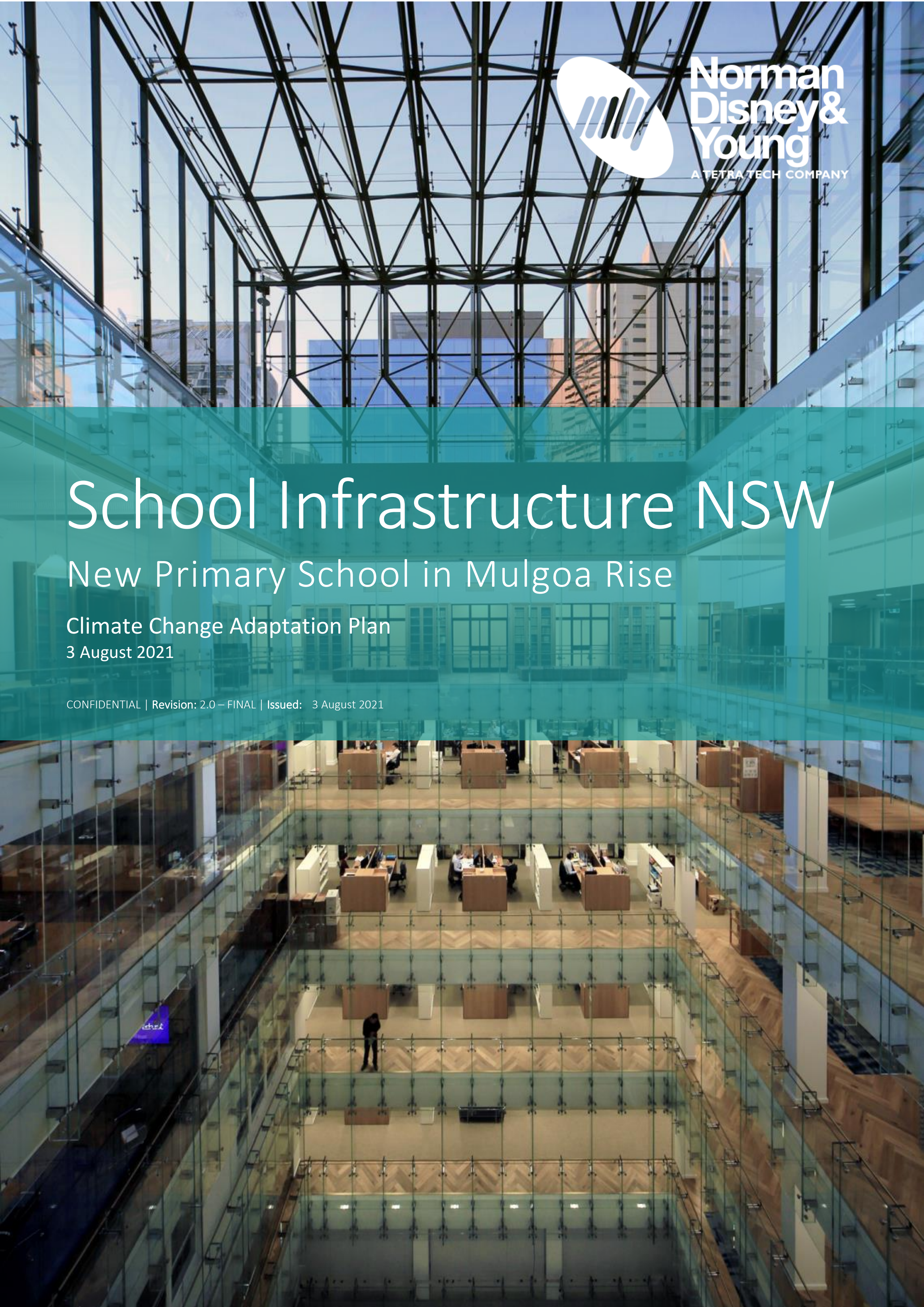

School Infrastructure NSW

New Primary School in Mulgoa Rise

Climate Change Adaptation Plan

3 August 2021

CONFIDENTIAL | **Revision:** 2.0 – FINAL | **Issued:** 3 August 2021

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EXECUTIVE SUMMARY

East Australia faces a combination of potential climate change scenarios. NDY assessed the impacts of predicted climate change models on the design and operation of the New Primary School in Mulgoa Rise development, NSW, over the expected 50-year life of the buildings. Projections in this report were based on outputs from global climate models (GCMs) with data provided by CSIRO's Climate Change in Australia's database relevant to the Sydney region. The results showed the following (CSIRO Climate Change Projections, East Coast Cluster Report 2015):

- Extreme temperatures are projected to increase with very high confidence, and substantial increases in temperatures reached on hot days, as well as the frequency of hot days
- Average temperatures will continue to increase in all seasons (very high confidence)
- Generally, less rainfall is expected in winter (medium confidence), but the intensity of extreme rainfall events is projected to increase (high confidence)
- There is high confidence that climate change will result in a harsher fire-weather climate in the future
- Time spent in drought projected to increase (medium confidence) over the course of the century.

A climate change risk assessment was undertaken as per AS 5334-2013 and Green Star Design & As Built v1.3 requirements using CSIRO projections for the East Coast (South) sub-cluster to identify expected impacts from climate change. A stakeholder workshop was undertaken to seek input from the design team members to identify the likely risks and how these would impact the project. Design mitigation strategies were developed to reduce these risks and design the building to be more resilient to future climate change. The climate change risk analysis identified no 'High' or 'Extreme' risks due to climate change impacts after design elements were considered for this project. Therefore, the credit criteria under Green Star Adaptation and Resilience (Credit 3) is deemed to be met.

1 INTRODUCTION

1.1 Development Description

1.1.1 Site

The New Primary School in Mulgoa Rise is situated in Glenmore Park, a suburb of Sydney, in the Greater Western Sydney region of New South Wales (NSW). The site coordinates are 33° 48′ 10.73″ S, 150° 40′ 53.87″ E. The development consists of the following major scope elements:

- New two-level buildings
  - Block A
  - Blocks B2 and B3
  - Block C
- The project is committed to achieving the following:
  - 4 star Green Star Design & As-Built v1.3
  - NCC Section J 2019 Compliance
  - SINSW's Sustainable School Infrastructure Strategy Priorities: Energy & Carbon, Water, Waste & Materials, Place & Resilience
  - SINSW EFSG

1.1.2 Location

The New Primary School in Mulgoa Rise falls within the East Coast (South) Sub-cluster, which categorises data within natural resource management (NRM) regions that are defined by catchments and bioregions by the CSIRO and Australian Bureau of Meteorology's "Climate Change in Australia" climate projections.

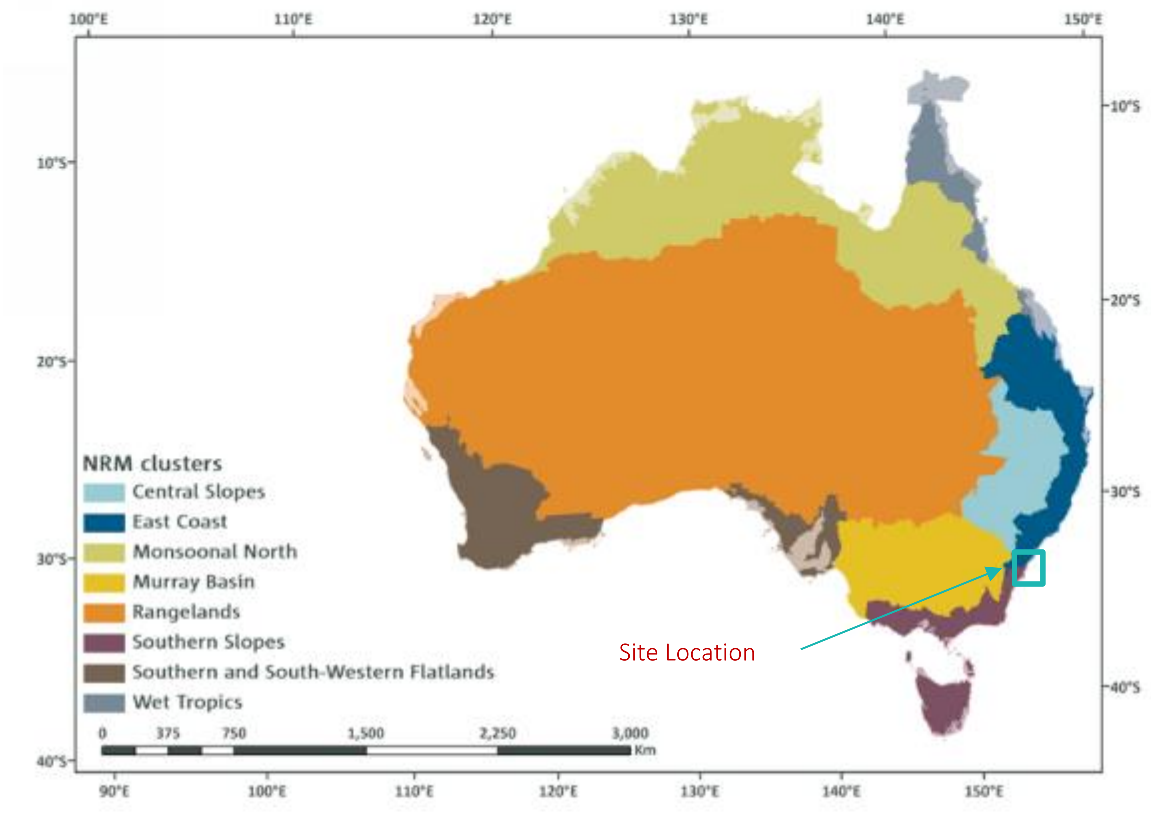


Figure 1 NRM Clusters – East Coast (South) Sub-cluster Location

1.1.3 Climatic Characteristics

The East Coast Cluster includes an area of ~395,000km^2 across NSW and Queensland, comprising 6 natural resource management regions with a Subtropical (East Coast North) or a Temperate (East Coast South) climate, and stretching across an extensive coastal zone **Invalid source specified.**.

As it spans a large range of latitudes and altitudes, the East Coast Cluster experiences a range of climate influences and drivers, both within and between regions, which result in a vast array of diverse bioclimatic zones. The cluster comprises the central part of the eastern seaboard of Australia and includes the drainage basins of several major rivers. The cluster contains both temperate broadleaf and mixed forests as well as tropical and subtropical grasslands, savannahs and shrublands.

The daily mean temperatures in the East Coast (South) sub-cluster ranges from 10°C (winter) to 22°C (summer), with a minimum of 4°C in July and maximum of 28°C in January (CSIRO Climate Change Projections, East Coast Cluster Report 2015). The rainfall characteristics of the region are a result of the interactions between several rain-bearing weather systems with monthly mean rainfall ranging from around 45 to 135mm (CSIRO Climate Change Projections, East Coast Cluster Report 2015). As a result of the varying rainfall and diverse landforms, the vegetation types, hydrology regimes, and land-uses vary greatly across this sub-cluster (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

1.2 Climate Change Risk Assessment Overview

Norman Disney & Young (NDY) were commissioned to undertake a climate change risk assessment for the New Primary School in Mulgoa Rise Buildings Blocks A, B2, B3 and C in line with current predictions to determine the hazards and risks associated with future climatic conditions, and how these are likely to affect this building into the future.

This report details the methodologies and outcomes of the climate change risk assessment, which was performed during the design phase and used to inform detailed design for the project. The climate change risk assessment used scientific projections to inform the identification of hazards and respective risks specific to the site. The assessment was developed in accordance with AS 5334-2013 Climate Change Adaptation for Settlements and Infrastructure, with reference made to the Australian Government guideline document Climate Change Impacts & Risk Management: A Guide for Business and Government (2006).

The risk assessment is detailed in Section 4 of this report and is broken into a description of the predicted climate scenarios and effects (temperature, sea level rises, increases in rainfall, evaporation, and flooding likelihoods in storm surge events, etc.), and risk assessments of how these climate change conditions are likely to impact the building and its users into the future.

2 CONTEXT ESTABLISHMENT

2.1 Scope & Purpose

NDY was engaged to prepare a Climate Adaptation Plan in accordance with a recognised standard for the New Primary School in Mulgoa Rise Buildings Blocks A, B2, B3 and C in order to be awarded 2 points under Credit 3: Adaption and Resilience within the Green Star Design & As Built v1.3 rating tool. This assessment was undertaken during the design stage of the project to assess the effectiveness of adaptation measures that had already been incorporated. It set out to identify any additional risks and consequently identify any additional adaptation measures that may be required for implementation in order to mitigate any risks identified as "High" or "Extreme".

NDY set out to assess the site's climate conditions and select and consider climate change scenarios for two time scales relevant to the project's lifespan, which in this case included 2030 (~Practical Completion + 10 years) and 2070 (+ 50 years), and identify associated potential direct and indirect climate change impacts.

The preparation of a climate change risk assessment was undertaken based on AS5334 which identified the likelihoods and consequences of potential risks of expected climate change projections sought from the CSIRO's Climate Change in Australia Projections **Invalid source specified.**, with reference made to the NSW Government's NSW and ACT Regional Climate Modelling (NARCliM) projections.

NDY then facilitated a workshop with key project stakeholders and the design team to identify key issues and discuss climate change projections identified for the site and relevant to the project. This included collaborating with the design team to map climate variables and direct/indirect effects to different aspects of the design and then evaluate the potential adaptation actions and responsibilities to manage unacceptable risks to the project, owner and end-users.

2.2 Suitably Qualified Professional Undertaking Assessment

This Climate Adaptation Plan has been developed by Claudia Burbidge (Sustainability Consultant).

Claudia has a formal tertiary qualification in Civil and & Environmental Engineering from the University of New South Wales, Sydney (Bachelor of Engineering), graduating with Honours. Claudia is also a qualified Green Star Accredited Professional (GSAP), and WELL Accredited Professional (WELL AP), and has undertaken CC&R assessments on numerous project typologies including offices, residential and education facilities (primary, secondary and tertiary).

2.3 Objectives

Success criteria for future-proofing the New Primary School in Mulgoa Rise against climate change impacts included the following, as per the Department of the Environment and Heritage Australian Greenhouse Office Climate Change Impacts and Risk Management: A Guide for Business and Government (2006):

- Public Safety - Maintaining public safety
- Local Economy and Growth - Protecting and enhancing local business
- Community and Lifestyle - Protecting the existing lifestyle enjoyed by the local community and visitors
- Environment and Sustainability – Protecting environmental amenity
- Administration - Ensuring sound public administration and governance

2.4 Climate Change Context/Scenarios

2.4.1 Greenhouse Gas Emissions Scenarios

Although future emissions growth is complex and uncertain, the Intergovernmental Panel on Climate Change (IPCC) developed a range of potential future greenhouse gas emissions scenarios to address this uncertainty and represent a plausible set of future economic and social conditions on which emission levels were generated (Australian Government Department of Climate Change, 2009).

The following IPCC climate change scenarios from the CSIRO's Climate Change in Australia Projections (as at 2015) were referenced in this impact assessment. These reflect the global climate model (GCM) simulations, as defined by the Representative Concentration Pathways (RCPs) used by the IPCC, with a particular focus on RCP4.5 and RCP8.5.

Representative Concentration Pathway 4.5 (RCP4.5)

This scenario represents a pathway consistent with low-level emissions, which stabilise the carbon dioxide concentration at about 540 ppm by the end of the 21st century and assumes that global annual GHG emissions (CO2-e) peak around 2040 before declining**Invalid source specified.**.

Representative Concentration Pathway 8.5 (RCP8.5)

This scenario is representative of a high-emission scenario, for which the carbon dioxide concentration reaches about 940 ppm by the end of the 21st century and assumes that global annual GHG emissions (CO2-e) continue to rise through to 2100**Invalid source specified.**.

2.4.1.1 JUSTIFICATION FOR SELECTING THESE RCP SCENARIOS

As per guidance in the AGO's Guide, "Climate Change Risks and Impacts: A Guide for Government and Business", Section B4.1, a limited number of scenarios covering the most plausible future climate changes was used for this analysis. This was deemed necessary to gain a holistic picture of predicted climate change impacts for this site.

These include the high emissions scenario (RCP8.5) which represents 'business as usual' and combines assumptions regarding the absence of climate change policies with higher world populations and modest rates of technological change or energy intensity improvements which culminate in higher energy demands and therefore Greenhouse Gas emissions increasing year on year. The final impact assessment used RCP8.5 as the basis for all projections.

The other, more optimistic emissions scenario referenced in this assessment includes emissions peaking at around 2040 and then declining due to rapid stabilization of Greenhouse Gas emissions in the global economy as a result of implementation of effective climate change policies (such as a price on emissions) and swift introduction of new, more resource efficient technologies that balance renewable energy sources with fossil-fuel sources and keep global mean warming within a 2 °C increase from pre-industrial levels.

2.4.2 Future Time Slices

In accordance with the requirements of Green Star, two time slices were chosen for the site.

On the basis that the project will reach practical completion in approximately 2022 and will have a life of approximately 50 or 60 years before major refurbishment, 2030 and 2070 were selected as the most appropriate time slices.

2.4.3 Climate Variables

Based on the site's location, vulnerabilities, and the explicit requirements of Green Star, the following climate variables have been considered:

Primary Effects

Average Temperature Extreme Temperature Solar Radiation	Average Rainfall Extreme Rainfall/Flood Average Humidity
Sea Level Rise	

Secondary Effects

Extreme Wind Hail / Snow / Lightning	Dust Storms Droughts
	Bushfire

2.4.4 Standards

The recognised standard used to carry out this assessment was AS5334. Section B, Sub-sections 4 to 6 of the AGO Guide, "Climate Change Risks and Impacts: A Guide for Government and Business" were also used to establish the context for this assessment prior to the stakeholder workshop and to ensure that all risks were identified, analysed, evaluated and mitigated accordingly.

2.4.5 Climate Data

In summary, the following are key projections for the East Coast (South) Sub-cluster (CSIRO Climate Change Projections, East Coast Cluster Report 2015):

- Mean, maximum and minimum temperatures will continue to increase in all seasons (very high confidence)
- More hot days and warm spells are projected with very high confidence. Fewer frosts are projected with high confidence
- Natural climate variability will remain the major driver of rainfall changes (high confidence). Generally, less rainfall in the winter is projected with medium confidence. Increases and decreases to summer, spring, and autumn rainfall are possible but less clear
- Increased intensity of extreme rainfall events is projected, with high confidence
- Greater time spent in meteorological drought is projected, with medium confidence. An increase in frequency and duration of extreme drought is projected, with low confidence
- Small changes in mean surface wind speed are projected with high confidence. Winter decreases are projected with medium confidence whilst spring increases are projected with low confidence
- Little change is predicted for solar radiation (high confidence) for the near future (2030)
- Little change in relative humidity (high confidence) for the near future (2030)
- Mean sea level will continue to rise (very high confidence)
- A harsher fire-weather climate is projected in the future (high confidence).

2.4.6 Past Meteorological Records

Data from the Penrith weather station was used due to the proximity to the site and its extensive records. The 1981 – 2010 time period was chosen as it aligned most closely with the base case climate data used in the Climate Change in Australia projections (1986 – 2005).

2016 Intensity-Frequency-Duration (IFD) data regarding individual rainfall events was obtained for the site from the Bureau of Meteorology website.

2.5 Stakeholders

The following key stakeholders were identified for the project:

- Colliers International Project Leaders
- NBRS Architecture
- Woolacotts
- Richard Crookes
- Schools Infrastructure NSW
- Norman Disney & Young

2.6 Risk Criteria

2.6.1 Risk Assessment Likelihood Scale

The following likelihood scale, taken from AS 5334-2013, was used in the risk assessment for the project for recurrent and single events.

Table 1 Risk Assessment Likelihood Scale

Rating	Descriptor	Recurrent or Event Risks	Long Term Risks
Almost Certain	Could occur several times per year	Has happened several times in the past year and in each of the previous 5 years or Could occur several times per year	Has a greater than 90% chance of occurring in the identified time period if the risk is not mitigated
Likely	May arise about once per year	Has happened at least once in the past year and in each of the previous 5 years or May arise about once per year	Has a 60-90% chance of occurring in the identified time period if the risk is not mitigated
Possible	May arise a couple of times in a generation	Has happened during the past 5 years but not in every year or May arise once in 25 years	Has a 40-60% chance of occurring in the identified time period if the risk is not mitigated
Unlikely	May arise once in a generation	May have occurred once in the last 5 years or May arise once in 25 to 50 years	Has a 10-30% chance of occurring in the future if the risk is not mitigated
Rare	May arise once in a lifetime	Has not occurred in the past 5 years or Unlikely during the next 50 years	May occur in exceptional circumstances, i.e. less than 10% chance of occurring in the identified time period if the risk is not mitigated

2.6.2 Risk Assessment Consequence Scale

The following consequence scale, adapted from Climate Change Impacts & Risk Management, was adopted for the risk assessment.

Table 2 Risk Assessment Consequence Scale

Descriptor	Service Quality	Compliance	Infrastructure	Financial
Insignificant	Minor deficiencies in principle that would pass without comment	Concerns about compliance would be resolved without special attention	No infrastructure damage, little change to infrastructure service	Little financial loss or increase in operating expenses
Minor	Services would be regarded as satisfactory but personnel would be aware of deficiencies	Minor perceived or actual breaches of compliance would be resolved	Localised infrastructure service disruption, no permanent damage. Some minor restoration work required. Early renewal of infrastructure by 10-20%. Need for new/modified equipment	Additional operational costs. Financial loss is small <10%.
Moderate	Services would be regarded as barely satisfactory by the general public and the organisation's personnel	Formal action would be required to answer perceived breaches or charges of compliance failure	Limited infrastructure damage and loss of service. Damage recoverable by maintenance and minor repair. Early renewal of infrastructure by 20-50%	Moderate financial loss 10-50%
Major	The general public would regard the organisation's services as unsatisfactory	Significant amounts of management and advisers' effort would be required to answer charges of compliance failures	Extensive infrastructure damage requiring major repair. Major loss of infrastructure service. Early renewal of infrastructure by 50-90%	Major financial loss 50-90%
Catastrophic	Services would fall well below acceptable standards and this would be clear to all	Obvious and proven breaches of legal and regulatory requirements with the prospect of corporate or individual penalties	Significant permanent damage and/or complete loss of the infrastructure and infrastructure service. Loss of infrastructure support and translocation of service to other sites. Early renewal of infrastructure by >90%	Extreme financial loss >90%

2.6.3 Risk Rating Matrix

The following risk rating matrix, taken from AS 5334-2013, was used to determine risk levels.

Table 3 Priority Matrix

		Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Catastrophic	Low	Medium	High	Extreme	Extreme
	Major	Low	Medium	Medium	High	Extreme
	Moderate	Low	Low	Medium	High	Extreme
	Minor	Low	Low	Medium	Medium	High
	Insignificant	Low	Low	Low	Medium	Medium

3 CLIMATE CHANGE PROJECTIONS FOR EAST COAST (SOUTH)

The following climate change projections have been assigned a confidence rating which follows IPCC likelihood terminology. The IPCC uses the following terminology for certainty/likelihood of outcomes.

The confidence rating does not equate to a probabilistic confidence, rather it covers the type, amount, quality, and consistency of evidence, and the extent of agreement (CSIRO Climate Change Projections, East Coast Cluster Report 2015). The following terminology for certainty/likelihood of outcomes are used in this report:

- Low confidence
- Medium confidence
- High confidence
- Very high confidence

It is important to understand that climate change is not expected to be linear or smooth. It is anticipated that climate change will be characterised by extreme events that are hard to predict and even harder to manage and as a result many ecosystems, both natural and man-made, will find it difficult to adapt (IPCC, IPCC WGI AR5 Climate Change 2013: The Physical Science Basis, 2013).

3.1 Temperature

3.1.1 Higher Temperatures

Continued increases in mean, daily maximum and daily minimum temperatures are projected for the East Coast cluster with very high confidence with the near future (2030) projected increase of mean annual temperature around 0.4 to 1.3 °C above the climate of 1986–2005, with only minor differences between RCPs (CSIRO Climate Change Projections, East Coast Cluster Report 2015). Late in the century (2090), there is a large difference between scenarios, with projected warming of 1.3 to 2.5 °C for RCP4.5 and 2.7 to 4.7 °C for RCP8.5 (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

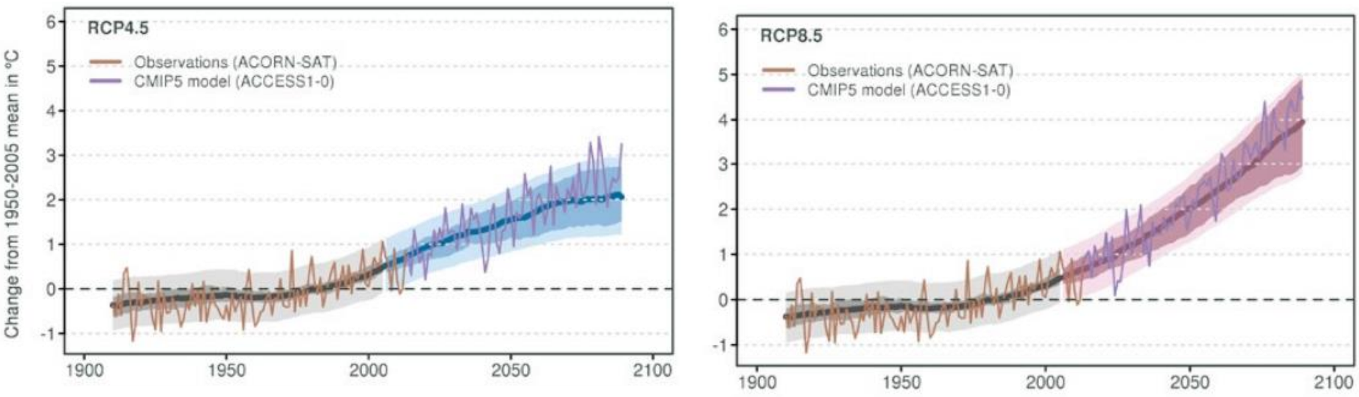


Figure 2 East Coast Annual Average Surface Air Temperature (°C) for 1910–2090 (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Table 4 Penrith Average Maximum Seasonal Temperature (Bureau of Meteorology) and Future Projections (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Season	Baseline (1981-2010)	2030 @ RCP8.5	2070 @ RCP8.5
Summer	28.1° C	29.1° C (+1° C)	30.4° C (+2.25° C)
Autumn	23.1° C	24.1° C (+1° C)	25.4° C (+2.25° C)
Winter	17.4° C	18.4° C (+1° C)	19.7° C (+2.25° C)
Spring	23.6° C	24.6° C (+1° C)	25.9° C (+2.25° C)

3.1.2 Hotter and More Frequent Hot Days, Fewer Frosts

A substantial increase in the temperature reached on the hottest days, the frequency of hot days and the duration of warm spells are projected with very high confidence and as a result, an expected decrease in the frequency of frost-risk days is projected with high confidence (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

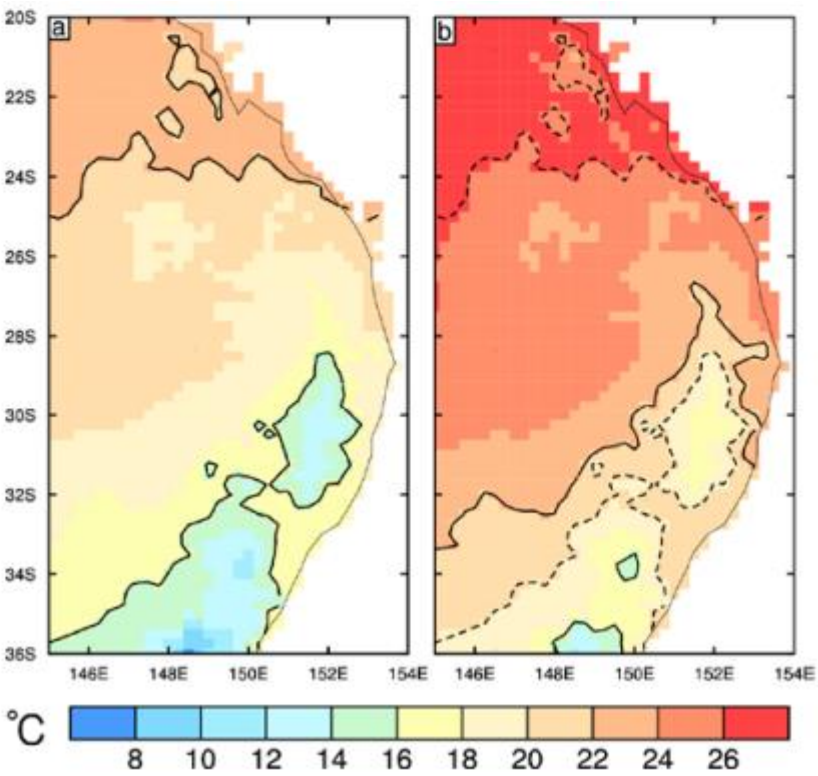


Figure 3 Annual Mean Surface Air Temperature (°C), for the Present Climate (a), and Median Warming under RCP8 5 for 2090 (b) (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Table 5 East Coast South – Average Annual Number of Days above 35°C and below 2 °C {Frosts} (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Threshold	East Coast (South) Sub-cluster			
	Current	**2030 RCP4.5**	**2090 RCP4.5**	**2090 RCP8.5**
Over 35 °C	3.1	4.3 (4.0 to 5.0)	6.0 (4.9 to 8.2)	11 (8.2 to 15)
Over 40 °C	0.3	0.5 (0.5 to 0.8)	0.9 (0.8 to 1.3)	2.0(1.3 to 3.3)
Below 2 °C	0	0	0	0

The risk of line outages, blackouts, and asset failures is likely to increase **Invalid source specified.**. This is due to increases in peak demand from increased air-conditioning use exceeding baseload increases. Although the main drivers for energy consumption are demographic and socio-economic factors, climatic conditions are also linked to average and peak energy demands. **Invalid source specified.**.

Higher rates of infectious and water-borne disease, as well as increased rates of heat-related stress and mortality, particularly among the aged and vulnerable populations, are likely outcomes (Grose et. al, 2015).

The frequency of hot days and the frequency of high fire risk weather is likely to increase. The East Coast (South) currently experiences temperatures above 35°C, on average, 3.1 days per year. Studies have highlighted that by 2030 this is predicted to increase to 4.3 days per year and by 2090 to between 6 and 11 days per year (CSIRO Climate Change Projections, East Coast Cluster Report 2015). This has important ramifications for air pollution and health, with ozone pollution events linked to the frequency of hot, sunny days and with the highest particle pollution concentrations linked to the presence of bushfire smoke (Grose et. al, 2015).

3.2 Precipitation

3.2.1 Extended Drought Periods

There is medium confidence that the time spent in drought will increase over the course of the 21st century in line with changes to mean rainfall, but low confidence in projecting the frequency and duration of extreme droughts (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

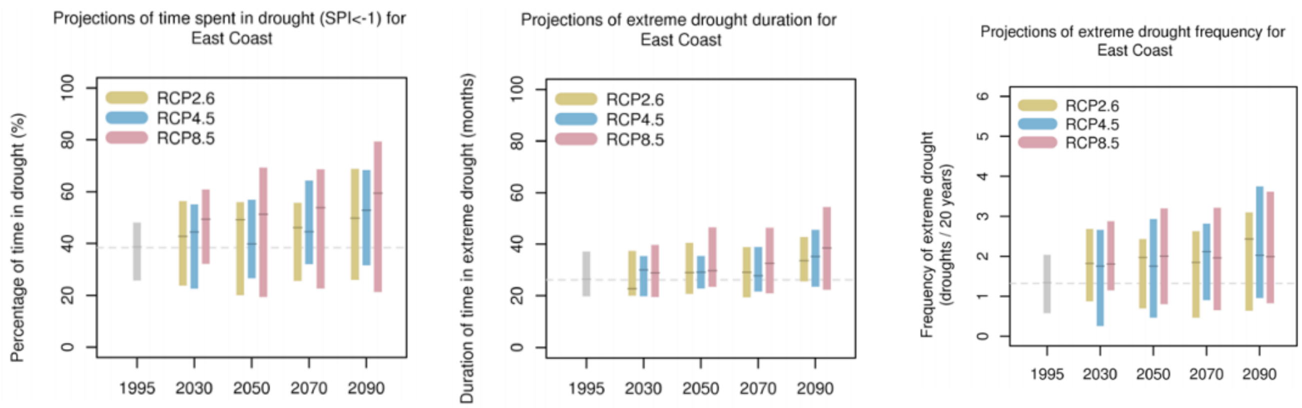


Figure 4 Time in Drought (Left), Duration of Extreme Drought (Middle), and Frequency of Extreme Drought (Right) (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

3.2.2 Extreme Rainfall Events

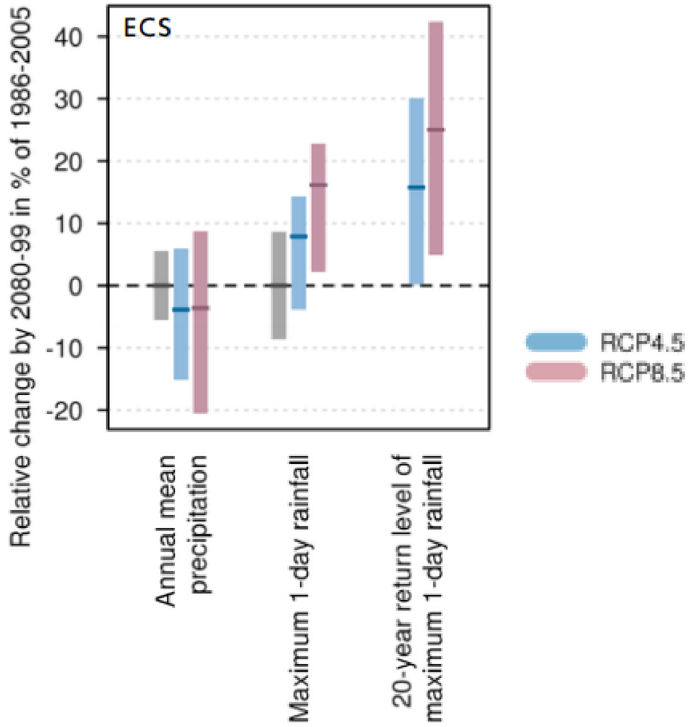
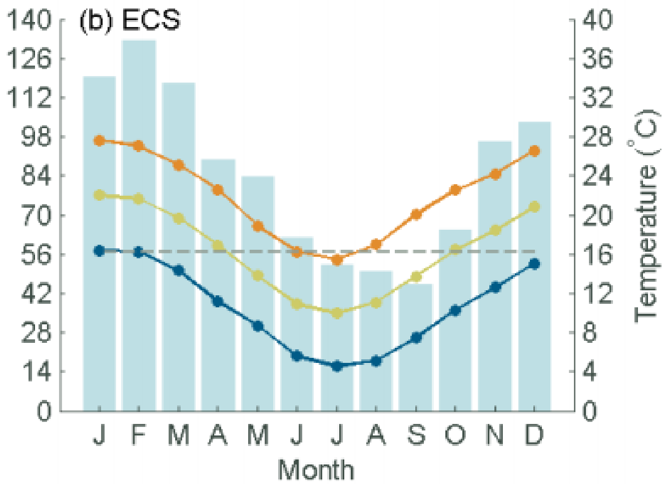


Figure 5 Projected Changes in Mean Rainfall, Magnitude of Annual Maximum 1-Day Rainfall, and Magnitude of 1 in 20-Year Rainfall Events for 2090 (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

There is high confidence that whilst the intensity of heavy rainfall extremes will increase, the magnitude of change cannot be reliably projected (CSIRO Climate Change Projections, East Coast Cluster Report 2015). The trend of annual mean rainfall is unclear and tending toward decrease whilst increased magnitudes of extreme rainfall events are projected. The magnitude of the anticipated extremes of rainfall are highly dependent on the emission scenario and the future time period.

3.2.3 Average Rainfall



Rainfall has not shown any long-term trends, rather the East Coast cluster has experienced intermittent wetter and drier periods. The observed trends in rainfall throughout the East Coast cluster are not very significant, with low confidence in both the magnitude and sign of observed trends. (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Rainfall is projected to decrease in winter, consistent with a reduction in the number of storms (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

Table 6 Penrith Average Seasonal Rainfall (Bureau of Meteorology) and Future Projections (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Season	Baseline (1981-2010)	2030 @ RCP8.5	2070 @ RCP8.5
Summer	92.7 mm	83.4 mm (-10%)	78.8 mm (-15%)
Autumn	53.9 mm	Little change	45.8 mm (-15%)
Winter	36.4 mm	30.9 mm (-15%)	30.9 mm (-15%)
Spring	56.1 mm	50.5 mm (-10%)	47.7 mm (-15%)

3.3 Sea Level Rise

Relative sea level has risen around Australia at an average rate of 1.4 mm per year between 1966 and 2009, and 1.6 mm per year after the influence of the El Niño Southern Oscillation (ENSO) on sea level is removed (CSIRO Climate Change Projections, East Coast Cluster Report 2015). Increasing global temperatures have a direct impact on sea level as the water expands with temperature and increases can also be expected from melting glaciers and ice caps. As temperatures are virtually certain to rise, sea levels are similarly virtually certain to rise, in line with IPCC predictions **Invalid source specified.**. There is very high confidence that sea level will continue to rise during the 21st century. In the near future (2030), the projected range of sea-level rise for the cluster coastline is 0.08 to 0.18 m above the 1986–2005 level, with only minor differences between RCPs (CSIRO Climate Change Projections, East Coast Cluster Report 2015). As the century progresses, projections are sensitive to emissions pathways. By 2090, RCP4.5 gives a rise of 0.30 to 0.65 m, and RCP8.5 gives a rise of 0.44 to 0.88 m (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

Table 7 East Coast (South) Sea Level Predictions for 2090

IPCC Year Emissions Scenario	Sea Level Rise
RCP 4.5	0.30-0.65m
RCP 8.5	0.44-0.88m

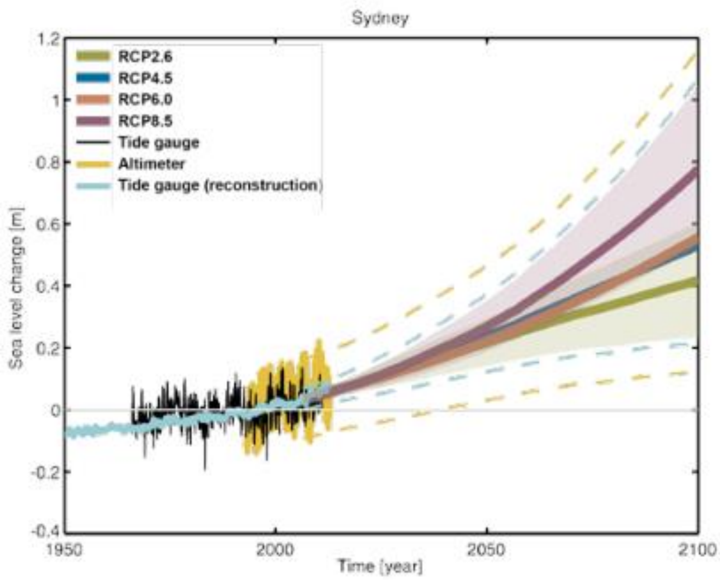


Figure 6 Observed and Projected Relative Sea Level Change (m) for Sydney (which has continuous records available (1966–2010) (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

The New Primary School in Mulgoa Rise project is located approximately 60m above sea level – well above even the most extreme CSIRO Climate Change Projections. Sea level rise is, therefore, not an impact that is relevant to the project.

3.4 Gustier Wind Conditions

There is high confidence in little change to mean wind speed under RCP4.5 and RCP 8.5 scenarios by 2030. For 2090 changes are projected to remain small with medium confidence under RCP4.5, and winter wind speed is projected to reduce with medium confidence under RCP8.5. These reduced winter wind speeds are assumed to be due to a projected southward movement of storm tracks and the subtropical ridge, thus weakening westerly winds. There is medium confidence that there will be a reduction in extreme wind speeds (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

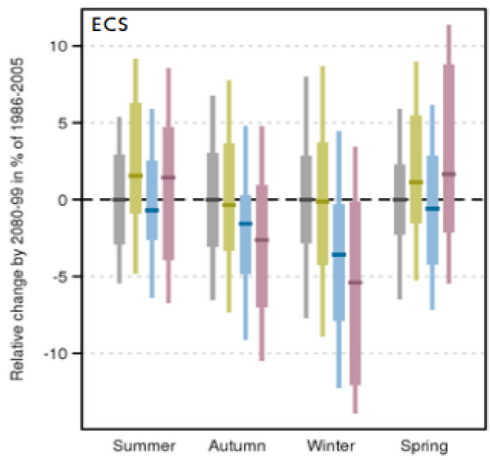


Figure 7 Projected Near-Surface Wind Speed Changes for 2090. Anomalies Are Given As A Percentage With Respect to the 1986-2005 Mean

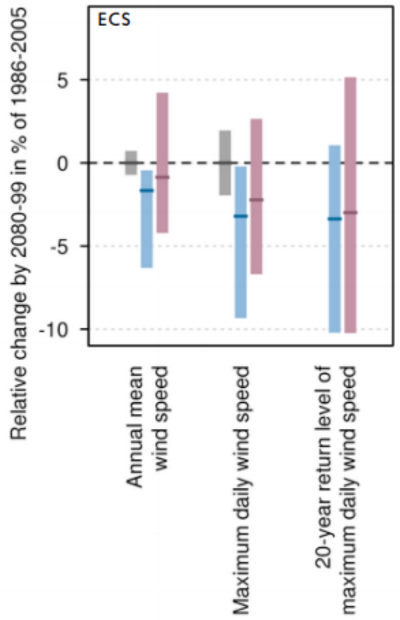


Figure 8 Projected Near-Surface Annual Mean Wind Speed, Annual Maximum Daily Wind Speed and the 20-year Return Value for the Annual Maximum Daily Wind Speed for 2090. Anomalies Are Given As A Percentage With Respect to the 1986-2005 Mean.

3.5 Solar Radiation & Relative Humidity

Solar radiation and relative humidity are projected to have little change for 2030 with high confidence. By 2090 there is medium confidence in a decrease in relative humidity and low confidence in increased winter and spring solar radiation with little change in other seasons (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

Table 8 Penrith Solar Radiation and Relative Humidity (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Climate Variable	Baseline	2030 @ RCP8.5	2070 @ RCP8.5
Yearly Average Daily Solar Radiation	16.0 MJ/m²	Little change	Little change
Yearly Average 3 pm Humidity	52% RH	Little change	Little change

3.6 Increased Evaporation Rates, Reduced Soil Moisture, and Runoff

There is high confidence that potential evapotranspiration will increase in the East Coast cluster in all seasons however, there is medium confidence about the magnitude of the increase. Changes to rainfall and evapotranspiration are projected to lead to a decrease in soil moisture, particularly in winter and spring, with medium confidence (CSIRO Climate Change Projections, East Coast Cluster Report 2015). There is low confidence that runoff will decrease by 2090 under RCP4.5 and RCP8.5 (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

3.7 Bush Fire

Bushfire occurrence depends on four 'switches': 1) ignition, either human-caused or from natural sources such as lightning; 2) fuel abundance or load; 3) fuel dryness, where lower moisture contents are required for fire, and 4) suitable weather conditions for fire spread, generally hot, dry and windy **Invalid source specified.**. There is high confidence that climate change will result in a harsher fire-weather climate in the future. However, there is low confidence in the magnitude of the change, as this depends on the rainfall projection (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

Table 9 Cluster Mean Annual Values of Maximum Temperature (°C), Rainfall (mm), Drought Factor, and Number of Severe Fire Danger days greater than 50 days per year (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Variable	1995 Baseline	2030 RCP4.5	2030 RCP8.5	2090 RCP4.5	2090 RCP8.5
T	24.9	26.0	26.3	27.2	28.8
R	1077	946	917	916	896
DF	6.3	6.4	6.5	6.6	6.9
SEV	0.9	1.1	1.3	1.3	2.1

4 RISK ASSESSMENT & ADAPTATION PLAN

4.1 Risk Management

Climate change adaptation is a risk management process just like any other risk considered by a successful modern business. The prioritisation of risk management actions comes from an informed understanding of the potential risks and the adaptation opportunities within the challenges ahead of us.

Modern business is ideally placed to tackle climate change, because businesses are inherently pragmatic and are used to change. However, the reason and time to act will be varied across the business community and must extend beyond legislated reporting of emissions and desire to curb energy use, to management of business risk for:

- Fiduciary liability
  - Fiduciary liability on Company Directors to consider and mitigate for climate change risk.
  - There is a real risk of 'litigation against a director who has failed to perceive, disclose or take steps in relation to a foreseeable climate-related risk that can be demonstrated to have caused harm to a company'. (Hutley SC, 2016)
- Risk disclosure
  - Publicly listed companies are increasingly being pressured to normalise their climate risk disclosure practices. Particularly as the world moves towards a carbon-constrained future.
- Financial risk
  - Long term financial planning. 'Climate change is a financial risk if you've got a long-term asset portfolio'. Paul Fisher who retired as deputy head of the Bank of England's Prudential Regulation Authority (climatealliance.org.au, 2016).
- Social license
  - Social license to operate. Failure to maintain your business social license with customers and the broader community at large has often resulted in real consequences for business operations because the market place is savage to businesses that ignore reality.

4.2 The Process

This Climate Adaptation Plan (CAP) for the New Primary School in Mulgoa Rise is the result of a collaborative and iterative risk management process engaging all relevant areas of the business as presented below:

- Step One: Climate projections with justification of modelling scenario
- Step Two: Risk management workshop records potential climate change impact and risk level
- Step Three: Risk management workshop records design and operational adaptation action and re-assessed risk level

4.3 Step One: Before the Workshop – Establishing the Context

Prior to the stakeholder workshop, NDY established the frameworks for identifying and analysing the risks identified for the project in relation to the climate projection data to ensure a common understanding amongst project stakeholders.

A Consultant Advice Note (reference number me210223s0007[1.0]) was issued by Justin Peberdy on 4th March 2021, prior to the workshop (Appendix B). This noted to stakeholders the difference between climate change mitigation versus adaption and summarised the following:

- The site specific climate change scenarios used to assume future changes
- The scope of the assessment including the boundaries, timescales and emissions scenarios utilized
- A 'Consequence Scale for Risk Assessment' and a 'Likelihood Scale for Risk Assessment' that would be required to be used in defining how the project risks would be defined and evaluated to measure the consequences, likelihoods and risk priorities for the project

- Set the priorities of the workshop as identifying and describing the risks posed by climate change for the development, rating these using the above scales, as well as identifying and evaluating potential adaptation actions to mitigate any risks identified as unacceptable.

4.4 Step Two: During the Workshop

The following stakeholders attended the workshop and/or included their views to contribute to the climate change assessment and analysis of risks for the project:

Attendees:

- Ryan Hahn – Norman Disney & Young (Services Lead)
- Justin Peberdy – Norman Disney & Young (Sustainability Lead)
- Sanjeev Ganda - Norman Disney & Young (Sustainability Consultant)
- Satheeshun Dashidaran – Norman Disney & Young (Hydraulic Engineer)
- Kristina Fernandez – Norman Disney & Young (Electrical Engineer)
- Paul Hover - SINSW (Client)
- Lizza Young – Colliers (Project Manager)
- Maddy Stenniken – Colliers (Project Manager)
- Anthony Maughan-Wright - Colliers (Project Manager)
- Stephanie Ferguson – NBRS Architecture (Architect)
- Elias Khamis – NBRS Architecture (Architect)
- Carmit Harnik Saar – NBRS Architecture (Architect)
- Simon Clemmett – Woolacotts (Civil / Structural)

Facilitators:

- Claudia Burbidge - Norman Disney & Young (Sustainability Engineer)

Additional Contributors to this Assessment:

The following people were contacted separately in addition to those listed above, as they were unable to attend the workshop. Their project knowledge was sought to gain insight into the building's design and adaptability to risks identified in the assessment during the workshop:

- Aslaug Blitzner – Norman Disney & Young (Mechanical Engineer)
- Tom Hemmett – Woolacotts (Civil / Structural)
- Kevin Christesen – Woolacotts (Civil / Structural)
- Johnsen Lim – NBRS Architecture (Architect)

All participants were provided with quantitative and descriptive information on the climate change scenarios and data produced by NDY's analysis.

The workshop generated a list of risks directly related to the site-specific data and project risks associated with climate change. These risks were then evaluated using knowledge of existing controls that are already designed to mitigate these risks, the consequences of the risks identified as well as the likelihood of their occurrence for this site. This, in turn, informed the priority rating for each risk identified in Table 11. The workshop included a brainstorming exercise to identify additional risk controls or future measures to reduce the risk of hazards at the site.

4.5 Step 3: After the Workshop

The risk register established for the project was circulated to all attendees and project stakeholders for comment on 12 March 2021. All outstanding items were collated by Claudia Burbidge at NDY and closed out and agreed by the project stakeholders by 19 March 2021.

As a result, the final table of risk items was identified and evaluated as the project-specific Climate Change Risk Register.

No 'High' or 'Extreme' risks were identified during the assessment.

All risk items identified had design elements and/or policies in place prior to this assessment to mitigate the risks identified.

4.6 Design Life of Asset

It is important to select a timeline relevant to the design life of the infrastructure components and one that is appropriate to cover the asset investment horizon, such as leasing tenure, as this will affect the climate projections used, the level of climate risk the asset may potentially be exposed to and the climate Adaptation response.

Where local data is available, it has been used in preference to larger-scale regional data. The time frame for the 'near future' is 2030, and for 'far future' are 2070 and 2090 depending on the available climate data.

4.6.1 5.2.2.1 Design Life

Design life is defined as the period within which an element of the works must continue to meet the performance and technical requirements for the project and remain within specified limits of reliability, availability and maintainability without major renewal beyond normal cyclic maintenance activities. It also benchmarks the requirements for durability.

The preliminary design life of asset elements are defined below.

Table 10 Design life of asset elements

Asset Type	Design Lifespan (Years)
Structure	50
Drainage (Civil and Hydraulic)	50
Building Pavement (Civil and Hydraulic)	50
Road pavement (Civil and Hydraulic)	15
Critical infrastructure systems – security & communications	25
HVAC	25
Façade	30
Materials and Finishes (Architectural elements)	20

4.7 Identifying Adaptation Actions and Reassessing Risk

Once climate risk ratings have been applied to potential climate change risks, adaptation actions are identified to reduce the risk rating of extreme, high, medium and low risk rated climate risks.

Generally, there are four possible approaches in responding to climate change:

- Avoid: Avoid locating assets in vulnerable areas or ignore and replace when required
- Adapt: Design systems and adaption measures to operate in predicted future climate conditions. There are two approaches: 1. Respond Now (future proof through current measures), OR Anticipate and Respond Later (enable future adaptive measures)
- Defend: Install defences at or around critical infrastructure

- Retreat: Develop and implement plans to relocate from the vulnerable area

The project has looked to incorporate the above 'Adapt' measures where risks to the project have been identified. These have either been through design considerations or through future-proofing the asset to allow for flexible responses that will allow for adaptive measures to be implemented in the future. To address potential climate change impacts and inform further design development and operational considerations, the mitigation measures are detailed in the Climate Change Risk Register spreadsheet (Table 11).

4.8 Green Star Requirements

A climate change risk assessment was undertaken as per AS 5334-2013 and Green Star Design & As Built v1.3 requirements using CSIRO projections for the East Coast (North) sub-cluster to identify expected impacts from climate change. A stakeholder workshop was undertaken to seek input from the design and construction team members to identify the likely risks associated with a changing climate and how these changes would impact on the project. Design mitigation strategies were developed to reduce the risks highlighted and design the building to be more resilient to future climate change. A climate change risk analysis was produced and identified no 'High' or 'Extreme' risks due to climate change impacts after design elements were considered for this project. Therefore, the credit criteria under Green Star' Adaptation and Resilience (Credit 3) is deemed as met.

4.8.1 Summary of initial and reassessed risks

Figure 9 Number of Risks Identified

Risk Rating	Low	Medium	High	Extreme	Total
Number of Initial Risks	6	12	0	0	18
Number of Reassessed Risks	5	4	0	0	9

4.8.2 Green Star Submission Requirements

Figure 10 Green Star Submission Requirements

Requirement	Design Review Submission	As Built Submission
Climate Adaptation Plan — Details of the two risk items that have been addressed by a specific design response — Details of any 'high' or 'extreme' risks	Not applicable	✓ This report
CV of professional that developed the Climate Adaptation Plan	Not applicable	✓ This report (Appendix A)
Drawings and specifications demonstrating design responses to the Climate Adaptation Plan	Not applicable	✓ To be provided at Practical Completion
Commissioning report or other technical document demonstrating design responses to the Climate Adaptation Plan	Not applicable	✓ To be provided at Practical Completion

4.9 Review

As a minimum the Climate Adaptation Plan should be reviewed whenever the base information utilised to develop site specific climate change scenarios has been updated or every five (5) years, as good practice.

Table 11 Climate Change Risk Register (Adaptation Measures and Residual Risks Omitted)

Description of Hazard (Cause & Effect)	Aspect	Discipline	Project Design Responses	Timeframe 2030 @ RCP8.5			Timeframe 2090 @ RCP8.5		
				Conseq.	Likel.	Risk	Conseq.	Likel.	Risk
Surrounding sewer / stormwater infrastructure impacted by storm surge.	Extreme Rainfall	Civil	It is a Council requirement for the floor level to be a minimum of 500 above the design 1-in-100 year flood levels which is reflected in the current design. Expectation is that Council required 500 freeboard includes an adequate allowance for an increase in extreme rainfall intensity unto 2070. As the site is approximately 60m above existing sea level the projected rise in sea level of 0.66 m will have no direct impact on the site or site drainage.	Insignificant	Unlikely	Low	Insignificant	Possible	Low
Structural stability of buildings and foundation systems affected by water table height increase causing changes to ground structure.	Extreme Rainfall Extreme Wind	Structural	As noted in item 1, the maximum potential flood would be equal to, or less than the 500 freeboard. All elements of the building structure that would be exposed to the potential flooding shall be designed for a 500mm flood depth. With respect wind loads, the design wind load for the school shall be based on an importance level 3 classification in accordance with the BCA. Importance level 3 requires the design wind to be based on a 1:1000 event compared to normal structures which are based on 1:500 event. The more stringent design event will mitigate the effects of increase extreme wind events.	Major	Rare	Low	Major	Rare	Low

Description of Hazard (Cause & Effect)	Aspect	Discipline	Project Design Responses	Timeframe 2030 @ RCP8.5			Timeframe 2090 @ RCP8.5		
				Conseq.	Likel.	Risk	Conseq.	Likel.	Risk
Extended blackouts due to transmission infrastructure failure or capacity being exceeded.	Bushfire Extreme Wind Extreme Rainfall Extreme Temperature	Electrical & Comms, Mechanical	Each site is provided with a dedicated site substation, sized per the EFSGs to provide 15% spare capacity. Mulgoa Rise has provision for generator connection in the main switchboard. In case of blackout, the school can hire and connect the hired generator into dedicated supply. Installation of a new PV system is currently allowed under design. Project cannot control the supply authorities infrastructure.	Major	Unlikely	Medium	Major	Unlikely	Medium
HVAC not maintaining internal conditions during heat waves.	Extreme Temperature	Mechanical	Specification for heat rejection equipment requires plant to operate up to 5oC above the current design external ambient. Balancing efficiency on the average day compared to meeting peak demands. Equipment has 15-20 year design life. Shading on the facade to reduce direct solar load. Design implements outdoor air modulation, that will reduce outdoor air load on the space.	Insignificant	Likely	Medium	Insignificant	Almost Certain	Medium
Accelerated material deterioration (colour fading or failure) due to solar radiation / higher temperatures.	Solar Radiation	Architectural	Roof sheeting selected is light in colour to mitigate the heat island effect. Large COLA areas between the buildings, covered walkways and sun shading screens shall provide protection from material deterioration. Selection of non-combustible materials and fire-related materials for future increased temperatures. Planting is incorporated across the site, with significant landscaping on the ground plane.	Moderate	Unlikely	Low	Moderate	Unlikely	Low

Description of Hazard (Cause & Effect)	Aspect	Discipline	Project Design Responses	Timeframe 2030 @ RCP8.5			Timeframe 2090 @ RCP8.5		
				Conseq.	Likel.	Risk	Conseq.	Likel.	Risk
Water entering ground floor or building flooding as a result of overland flow / heavier rainfall events / localised flooding.	Extreme Rainfall	Electrical & Comms, Civil, Architectural	Mulgoa Rise flood analysis shows the site is not impacted by localised flooding.	Moderate	Possible	Medium	Moderate	Possible	Medium
Soft landscaping damage due to scouring or hail, or planting dieback due to extended periods of drought.	Extreme Rainfall Droughts	Landscape	Plant selection appropriate to site conditions/environment (more than 50% native vegetation). All garden beds are mulched to retain soil moisture, Irrigation provided as per EFSG standard.	Minor	Possible	Medium	Minor	Possible	Medium
Smoke / dust impacting upon air quality, or accidentally shutting down air handling units that have smoke detectors. Airborne dust soiling ventilation filters more quickly than maintenance regimes allow for cleaning.	Dust Storms Bushfire	Mechanical	High efficiency F4/F5 filters specified.	Major	Possible	Medium	Major	Possible	Medium
Lightning strike due to increased intensity of storm events.	Hail / Snow / Lightning	Electrical	Surge protection devices specified and good earthing design.	Catastrophic	Rare	Low	Catastrophic	Rare	Low

Description of Hazard (Cause & Effect)	Aspect	Discipline	Project Design Responses	Timeframe 2030 @ RCP8.5			Timeframe 2090 @ RCP8.5		
				Conseq.	Likel.	Risk	Conseq.	Likel.	Risk
Roofing / roof-mounted equipment damaged by hail / lightning	Hail / Snow / Lightning	Mechanical	Nil. No box gutters, overflow in case of hail blocking drainage.	Moderate	Unlikely	Low	Moderate	Unlikely	Low
Façade damage by hail / lightning	Hail / Snow / Lightning	Architectural, Façade	Any glazed façades are protected by covered walkways, large COLA's and sun shading screens therefore limiting and breakages due to hail and lighting. All other façade elements are prefinished CFC. Any sheet metal façade elements have been articulated to a recess in the facade and are protected by first floor overhangs and sun shading screens.	Minor	Possible	Medium	Minor	Possible	Medium
Fire protection system performance affected by reduced water supply pressure.	Bushfire	Fire Protection	Compliant hydrant booster coverage provided. Board authority advises on 95% percentile pressure/flow rates, and design based on this.	Major	Rare	Low	Major	Unlikely	Medium
External materials being stained by settling of airborne ash (ember attack).	Bushfire	Architectural	Site is not identified as being within a Bushfire prone land zone.	Moderate	Unlikely	Low	Moderate	Unlikely	Low

Description of Hazard (Cause & Effect)	Aspect	Discipline	Project Design Responses	Timeframe 2030 @ RCP8.5			Timeframe 2090 @ RCP8.5		
				Conseq.	Likel.	Risk	Conseq.	Likel.	Risk
Water needs of the site not met due to reduced rainfall and prolonged periods of drought.	Average Rainfall Droughts	Hydraulic, Landscaping, Architectural	Water efficient fixtures specified to reduce the water demand of the site. This however is partially outside of project boundary / council infrastructure. Water authority to mitigate this risk. Rainwater is captured and reused for toilet flushing and irrigation to reduce the potable cold water demand.	Moderate	Unlikely	Low	Moderate	Possible	Medium
Gutters, downpipes and inground stormwater network unable to handle the increase in 1-20 year rainfall event.	Extreme Rainfall	Hydraulic, Civil	Eaves, gutters and downpipes will be designed to the predicted 1-in-20 year rainfall event in 2070. Overflow provided and no box gutters. OSD is not required for this site.	Moderate	Possible	Medium	Moderate	Possible	Medium
Health impacts (e.g. heat stroke) due to warmer temperatures	Average Temperature	Landscaping, Civil, Architectural	High performance building façade supported by covered walkways, large COLA's, sun shading screens and cross ventilation where possible. Significant landscaping and low solar absorptance materials to support a reduction in the heat island effect experienced at the site.	Moderate	Possible	Medium	Moderate	Possible	Medium
Risk of any exposed or sub-soil hydraulic pipework cracking due to increased extreme weather conditions or soil changes	Extreme Temperature	Hydraulics, Civil	All inground pipework to be in PE with flexible joints to allow for any soil movement. With respect to stormwater pipework, soil reactivity / cracking poses no significant impact. Cracking in soil from prolonged drought to be infilled and maintained as part of regular stormwater maintenance.	Moderate	Unlikely	Low	Moderate	Possible	Medium

Description of Hazard (Cause & Effect)	Aspect	Discipline	Project Design Responses	Timeframe 2030 @ RCP8.5			Timeframe 2090 @ RCP8.5		
				Conseq.	Likel.	Risk	Conseq.	Likel.	Risk
Extreme winds and dry weather could cause some trees to fall onto buildings or people.	Extreme Temperature	Landscape, Architectural	Trees known to suffer heat stress and drop limbs have not been selected.	Major	Rare	Low	Major	Unlikely	Medium

5 ASSUMPTIONS AND LIMITATIONS

The key assumptions underpinning this risk assessment are as follows:

- The purpose of the risk assessment is to highlight the potential for climate change induced risks and inform the decision-making process, which in turn enables the design and operation of climate resilient infrastructure
- Risk assessment and mitigation is a dynamic and iterative process for the duration of the asset's life cycle. This report is the first step in the process as described in the Green Star Requirements section
- The assessment of risks and possible adaptation measures is qualitative and not quantitative
- The climate change projections adopted are those that have been reasonably predicted for future climatic conditions. It should be noted that some projections currently involve a considerable degree of uncertainty
- The climate projections are regional, not localised (climate change modelling would be required to provide more localised data, which was not considered necessary for the purposes of this risk assessment), so their accuracy is limited and subject to the uncertainties of scientific and technical research; but sufficient for the purposes of this assessment with recommendations representing professional judgement.

6 RECOMMENDATIONS

The climate change risk assessment process has assessed the above risks, including existing controls, as being either 'low' or 'medium.' This is a reflection on the fact that the designers of the project have already incorporated a number of adaptation measures into the design.

The credit requirements of Green Star require that all high and extreme risks are identified and addressed by specific design responses however, no high and extreme risks were identified. The following table outlines the residual risk assessment following implemented adaptation measures.

Table 12: Residual Risk Following Adaptation Measures

Description of Hazard (Cause & Effect)	Aspect	Adaptation Measures	Residual 2030			Residual 2070		
			Conseq.	**Likel.**	**Risk**	**Conseq.**	**Likel.**	**Risk**
Water entering ground floor or building flooding as a result of overland flow / heavier rainfall events / localised flooding.	Extreme Rainfall	Substation to be located above 1:100 flood level, rooms within buildings, such as comms and main switch room will be 500mm above 1:100 year flood level. Walkways to be graded away from the building entries, directing the overland flow around the building to connect into the existing drainage system.	Major	Rare	Low	Major	Rare	Low
Roofing / roof-mounted equipment damaged by hail / lightning.	Hail / Snow / Lightning	Specify hail protection on condenser coils.	Minor	Unlikely	Low	Minor	Unlikely	Low

The process has identified additional adaptation measures that may be adopted to reduce risk to ALARP (as low as reasonably practicable) levels. Key recommendations include those listed below:

- In the event that the building cannot be inhabited for an extended period – through extended blackout, bushfire, health pandemic - school management should ensure teaching by distance / schooling from home arrangements for students and staff
- During drought and after periods of heavy rainfall, increase maintenance of rainwater and stormwater drainage systems to avoid blockages and clean out siltation
- School management should ensure management of landscaping during operation includes strategies to replace soft landscaping in the event of dieback, and consideration of species most appropriate to site at the time of replacement (e.g. drought-tolerant planting, species from locations which reflect future climate predictions rather than current local climate)
- Building management should have an emergency management plan (with effective incident response actions) in place for major and catastrophic events. The plan should include a methodology for effective communication to building users and regular updates

- If dust storms or bushfires with heavy smoke do eventuate, urgently undertake cleaning of ventilation system filters, and prioritise cleaning of solar panels and the facade.

NDY recommends that this adaption plan should be reviewed on a regular basis (every five years). This should include:

- Review of previous climate data and comparison with potential new climate predictions at the site
- Review of previously identified risks against the new climate projections, and evaluation of any new potential adaptation actions to mitigate any risks identified as unacceptable.

7 APPENDIX A: CV

CLAUDIA BURBIDGE

ENGINEER | SUSTAINABILITY

YEARS EXPERIENCE

3+

SERVICES EXPERTISE

Green Star, Life Cycle Assessment, Sustainability Strategy, Masterplanning, Carbon Neutrality

OFFICE LOCATION

Sydney

Qualifications: Bachelor of Engineering (Civil and Environmental) – University of New South Wales (UNSW), WELL Accredited Professional, Green Star Accredited Professional

BIO

Claudia joined Norman Disney & Young (NDY) in 2016 as an Undergraduate Sustainability Engineer before transitioning to a Sustainability Consultant role in 2019. During this time, Claudia has developed technical and practical experience through involvement on various projects in the commercial, residential, retail, transport, and education sectors. Claudia currently has multi-disciplinary expertise in sustainability frameworks, Life Cycle Assessment, Climate Change Adaptation and Resilience, sustainability strategy, masterplanning and carbon neutrality.

Relevant Project Experience

EDUCATION

- Monaro Schools - Bungendore and Jerrabomberra – Climate Adaptation – Bungendore/Queanbeyan NSW
- Mulgoa Rise – Climate Adaptation – Sydney NSW
- Hawkesbury Centre of Excellence – Climate Adaptation – Sydney NSW
- Richmond High School – Climate Adaptation – Sydney NSW
- Marsden Park Secondary School – Green Star – Sydney NSW
- Green Square Integrated Community Facility and Public School Development – Green Star – Sydney NSW

OFFICES NEW

- 1 Eden Park Drive – Section J, NABERS Energy, Green Star & WELL – Sydney NSW

RETAIL

- 17 Cordelia Street – Climate Adaptation – Brisbane NSW

8 APPENDIX B: PRE-WORKSHOP CONSULTANT ADVICE NOTE

MEMORANDUM

Project: SINSW - Greater Western Sydney – Schools Projects
Date: 4 March 2021

Name	
To:	All workshop attendees

SUSTAINABILITY- CLIMATE CHANGE ADAPTATION WORKSHOP: PRE-WORKSHOP NOTES

The purpose of this memorandum is to provide information to all stakeholders that will attend NDY's climate change adaptation workshop to facilitate the consultation process for establishing the Climate Adaptation Plan for the Greater Western Sydney (GWS) schools projects. Information in this memorandum has been prepared for the Richmond High School, Hawkesbury Centre of Excellence and Mulgoa Rise schools projects. Please familiarise yourself with this information before the workshop scheduled for Tuesday 9th March 2021.

Climate change adaptation is something quite distinct from climate change mitigation:

- Mitigation is about making climate change less severe - this is where our focus to date on this project has been (energy efficiency, renewable energy, low-carbon materials).
- Adaptation accepts that there will be some degree of climate change no matter how successful our combined mitigation efforts are - and looks to design buildings that are resilient to it. This will be the focus of our workshop.

This memorandum consists of the following parts:

- Climate Change Projections
- Consequence Scale for Risk Assessment
- Likelihood Scale for Risk Assessment

The two 'time slices' that will be referenced throughout the risk assessment and adaptation planning process are +/-2030 (~Practical Completion + 10 years) and 2070 (+ ~50 year building life). The United Nations Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways (RCP) correspond to different greenhouse gas (GHG) concentration trajectories with each level based on different assumptions. RCP8.5 is representative of a high-emissions scenario, assuming that emissions continue to rise throughout the 21st century.

Climate change projection data has been sourced from CCIA (a joint BoM and CSIRO initiative), and baseline data has been sourced from BoM for the Greater Western Sydney area. Full references will be included in the final report.

The priorities for the workshop will be two-fold:

- Identify and describe risks posed by climate change to the development and rate the consequence and likelihood of each.

Identify and evaluate potential adaptation actions and/or design strategies to mitigate those risks which are deemed unacceptable.

CLIMATE CHANGE PROJECTIONS – PENRITH, NSW (STATION NO. 067113) SYDNEY EAST COAST (NORTH) SUB CLUSTER

Climate Variable		Baseline	2030 @ RCP8.5	2070 @ RCP8.5	Commentary
Average Maximum Temperature	Summer	28.1° C	29.1° C *(+1° C)*	30.4° C *(+2.25° C)*	There is *very high confidence* in continued substantial increases in projected **mean, maximum and minimum temperatures**. By late in the century (2090), there is a large difference between scenarios. The projected range of warming is 1.3 to 2.5°C above the climate of 1986-2005 for RCP4.5 and 2.7 to 4.7°C for RCP8.5.
	Autumn	23.1° C	24.1° C *(+1° C)*	25.4° C *(+2.25° C)*	
	Winter	17.4° C	18.4° C *(+1° C)*	19.7° C *(+2.25° C)*	
	Spring	23.6° C	24.6° C *(+1° C)*	25.9° C *(+2.25° C)*	
Maximum Recorded Temperature		48.9° C *(4th Jan 2020)*	49.9° C *(+1° C)*	51.2° C *(+2.25° C)*	More hot days and warm spells are projected with *very high confidence*. Extreme temperatures are projected to increase at a similar rate to mean temperature, with a substantial increase **in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells** *(very high confidence)*.
Number of Hot Days (over 35°C)		3.1 days	4.3 days **2030 RCP4.5*	11 days **2090 RCP8.5*	
Number of Hot Days (over 40°C)		0.3 day	0.5 days **2030 RCP4.5*	2.0 days **2090 RCP8.5*	
Average Rainfall	Summer	92.7 mm	83.4 mm *(-10%)*	78.8 mm *(-15%)*	Annual rainfall shows no long-term trend, however there has been prolonged periods of extensive drying throughout the 20th Century to the present, particularly in winter and spring. **Decreasing winter rainfall** is projected with medium confidence based on good understanding of the contributing underlying physical mechanisms driving this change (relating to a southward shift of winter storm systems).
	Autumn	53.9 mm	little change	45.8 mm *(-15%)*	
	Winter	36.4 mm	30.9 mm *(-15%)*	30.9 mm *(-15%)*	
	Spring	56.1 mm	50.5 mm *(-10%)*	47.7m *(-15%)*	
1-in-20 Year Rainfall Event (24 Hour)		139.0 mm *(12th Feb 1997)*	152.9 mm *(+10%)*	166.8 mm *(+20%)*	Increased intensity of extreme rainfall events is projected, with high confidence. Even though annual mean rainfall is projected to decrease in the region, projections indicate increases in extreme rainfall.
Time in Drought (%)		40%	50%	55%	**Time spent in drought is projected to increase** (low confidence) over the course of the century.
Fire Weather (Severe Fire Danger Days FFDI >50)		1.1 days	1.53 days 40% increase	2.3 days 110% increase **2090 RCP8.5*	There is high confidence that climate change will result in a **harsher fire-weather climate** in the future. However, there is low confidence in the magnitude of the change, though predicted to be extreme, as this is strongly dependent on rainfall projections, which as we have seen are declining in almost all seasons.
Sea Level Rise *Change relative to 1986-2005*		-	14cm above baseline	66cm above baseline **2090 RCP8.5*	There is very high confidence in future sea-level rise. **Mean sea level will continue to rise and height of extreme sea-level events will also increase** (very high confidence).
Yearly Average Daily Solar Radiation		16.0 MJ/m²	16.2 MJ/m² *(+1.08%)*	16.2 MJ/m² *(+1.08%)*	**Little change is projected for solar radiation** (high confidence), except for winter and spring increases.
Yearly Average 3pm Humidity		52% RH	little change	little change	A tendency for a decline in relative humidity away from coasts although changes in the near term will be small (high confidence).
Yearly Average 3pm Wind Speed		15.2 km/h	little change	little change	There is high confidence in little change.

CONSEQUENCE SCALE FOR RISK ASSESSMENT

Descriptor	Service Quality	Compliance	Infrastructure	Financial
Insignificant	Minor deficiencies in principle that would pass without comment	Concerns about compliance would be resolved without special attention	No infrastructure damage, little change to infrastructure service	Little financial loss or increase in operating expenses
Minor	Services would be regarded as satisfactory but personnel would be aware of deficiencies	Minor perceived or actual breaches of compliance would be resolved	Localised infrastructure service disruption, no permanent damage. Some minor restoration work required. Early renewal of infrastructure by 10-20%. Need for new/modified equipment	Additional operational costs. Financial loss is small <10%.
Moderate	Services would be regarded as barely satisfactory by the general public and the organisation's personnel	Formal action would be required to answer perceived breaches or charges of compliance failure	Limited infrastructure damage and loss of service. Damage recoverable by maintenance and minor repair. Early renewal of infrastructure by 20-50%	Moderate financial loss 10-50%
Major	The general public would regard the organisation's services as unsatisfactory	Significant amounts of management and advisers' effort would be required to answer charges of compliance failures	Extensive infrastructure damage requiring major repair. Major loss of infrastructure service. Early renewal of infrastructure by 50-90%	Major financial loss 50-90%
Catastrophic	Services would fall well below acceptable standards and this would be clear to all	Obvious and proven breaches of legal and regulatory requirements with the prospect of corporate or individual penalties	Significant permanent damage and/or complete loss of the infrastructure and infrastructure service. Loss of infrastructure support and translocation of service to other sites. Early renewal of infrastructure by >90%	Extreme financial loss >90%

LIKELIHOOD SCALE FOR RISK ASSESSMENT

Rating	Descriptor	Recurrent or event risks	Long term risks
Almost Certain	Could occur several times per year	Has happened several times in the past year and in each of the previous 5 years *or* Could occur several times per year	Has a greater than 90% chance of occurring in the identified time period if the risk is not mitigated
Likely	May arise about once per year	Has happened at least once in the past year and in each of the previous 5 years *or* May arise about once per year	Has a 60-90% chance of occurring in the identified time period if the risk is not mitigated
Possible	Maybe a couple of times in a generation	Has happened during the past 5 years but not in every year *or* May arise once in 25 years	Has a 40-60% chance of occurring in the identified time period if the risk is not mitigated
Unlikely	Maybe once in a generation	May have occurred once in the last 5 years *or* May arise once in 25 to 50 years	Has a 10-30% chance of occurring in the future if the risk is not mitigated
Rare	Maybe once in a lifetime	Has not occurred in the past 5 years *or* Unlikely during the next 50 years	May occur in exceptional circumstances, i.e. less than 10% chance of occurring in the identified time period if the risk is not mitigated

Should you have any queries or would like further information prior to the workshop please do not hesitate to contact me.

Regards,

NORMAN DISNEY & YOUNG

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NDY QA SYSTEM

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