MOTT MACDONALD

Riverwood Estate State Significant Precinct

Climate Change Adaptation (CCA) Report

March 2022

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NSW Land and Housing Corporation

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Climate Change Risk

The effects of a changing climate present complex challenges to the built environment and transport infrastructure due to projected changes in intensity and frequency of severe weather events. Climate change can increase the exposure of transport and property infrastructure to risks, including:

- Structural asset damage;
- Service interruption;
- Productivity losses;
- Reduced customer satisfaction;
- Death, injury and ill health; and
- Interruption of access to critical services such as electricity, water and emergency services.

Recognising the importance of understanding projected climate impacts and effectively managing the risks associated with climate change, the Land and Housing Corporation (LAHC) engaged Mott MacDonald to perform a Climate Change Assessment (CCA) of the Riverwood State Significant Precinct to determine its exposure to projected climate change variables.

Our Approach

Mott MacDonald undertook analysis to understand how climate change impacts could affect the Riverwood Renewal project and explored potential adaptation measures to mitigate these risks through multi-disciplinary climate risk workshops. A climate risk register was developed collaboratively with key project team members exploring both risk exposure and opportunities for risk mitigation and adaptation in response to the relevant State Significant Precinct requirements issued by Department of Planning, Industry and Environment (DPIE) in December 2020.

1 Introduction

Mott MacDonald has been engaged by the NSW Land and Housing Corporation (LAHC) to provide a Climate Change Adaptation Report for the Riverwood Estate State Significant Precinct (the Study Area). The report supports the master plan and development controls to facilitate the renewal of existing social housing, to deliver an integrated community with a mix of social and private housing and improved social outcomes.

1.1 Scope of Works

LAHC is preparing a master plan to guide the revitalisation of Riverwood Estate. Mott MacDonald has been engaged to identify opportunities for the development to address the impacts of climate change to support the delivery of the master plan.

To assist in the preparation of the master plan, Mott MacDonald has undertaken the following tasks in accordance to the State Significant Precinct requirements:

- Described opportunities for the development to address climate change impacts, including the integration of vegetation (existing and future), permeable and reflective surfaces and Water Sensitive Urban Design features into the design of the development; and
- Considered climate science and observational data for the area including Urban Green Cover in NSW Technical Guidelines.

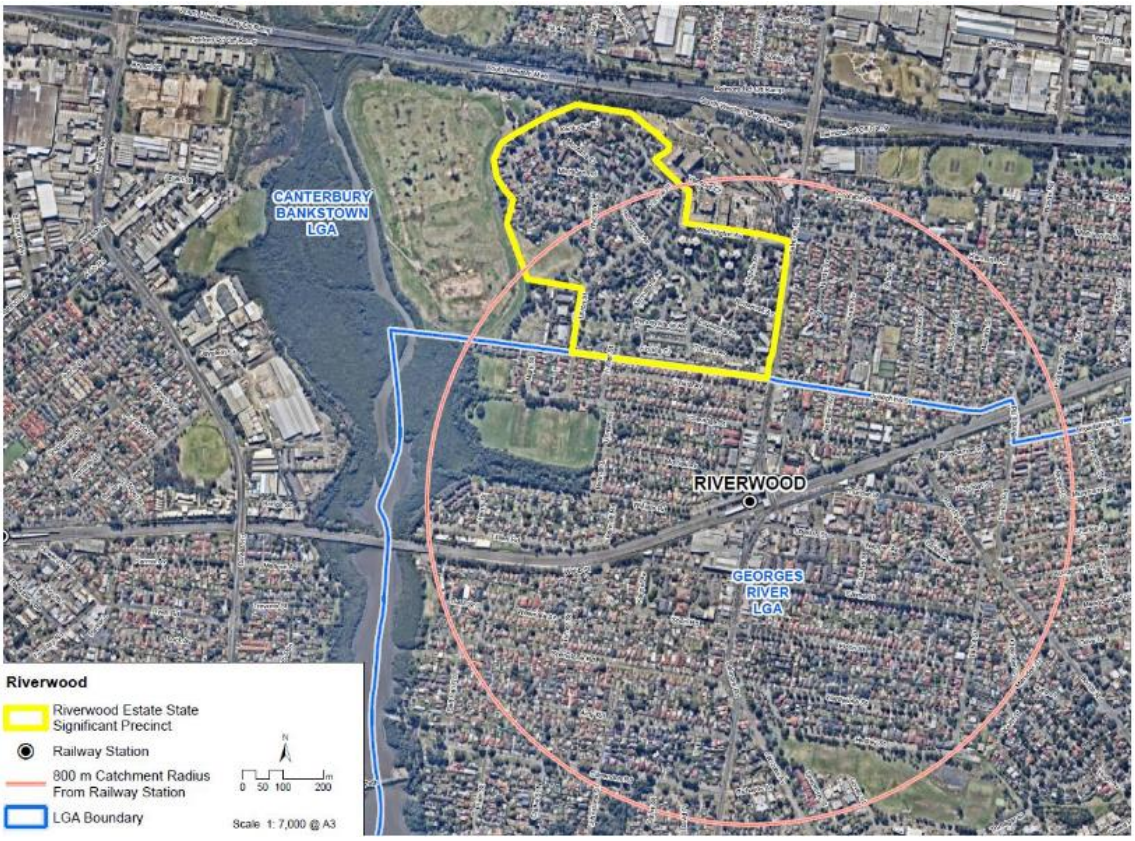
1.2 Project Overview

The area to which the Study Requirements apply to - i.e. The Study Area is a 30 ha site and comprises of social housing dwellings, privately owned properties and a number of parcels of land owned by Canterbury Bankstown Council and is located in close proximity of the Riverwood town centre.

The project team have worked with NSW Land and Housing Corporation to prepare a master plan for the redevelopment of the site that will replace the existing dwellings, provide for additional private dwellings, new streets, parks and community uses.

The proposed master plan provides for approximately 3,900 new dwellings, buildings ranging between three and 12 storeys and two local open spaces – Roosevelt Park and Play Street. It will be a high-density community, with the amenity and community of a traditional Sydney suburb. The development program for the proposed Riverwood Estate State Significant Precinct is in the order of 20 years.

Figure 1: Riverwood SSP Study Area



2 Report Aims

The aim of this report is to articulate the likely future climate change impacts to the Study Area, and to convey a suite of proposed suitable responses based on regulation, policy, and best practice. This report has been prepared in direct response to the Study Requirements for the Riverwood Estate State Significant Precinct issues by the Department of Industry, Planning and Environment (DPIE) issues in December 2020.

This report and associated deliverables include:

- Description of the Project methodology and CCA process;
- A summary of current climate and natural hazards for the Project's location;
- A summary of best available climate change projections, sourced from the Intergovernmental Panel on Climate Change (IPCC) endorsed Global Circulation Models (GCMs) for the Project's location; and
- A risk assessment output of climate change exposure and vulnerability based on projections and key stakeholder input.

3 Methodology

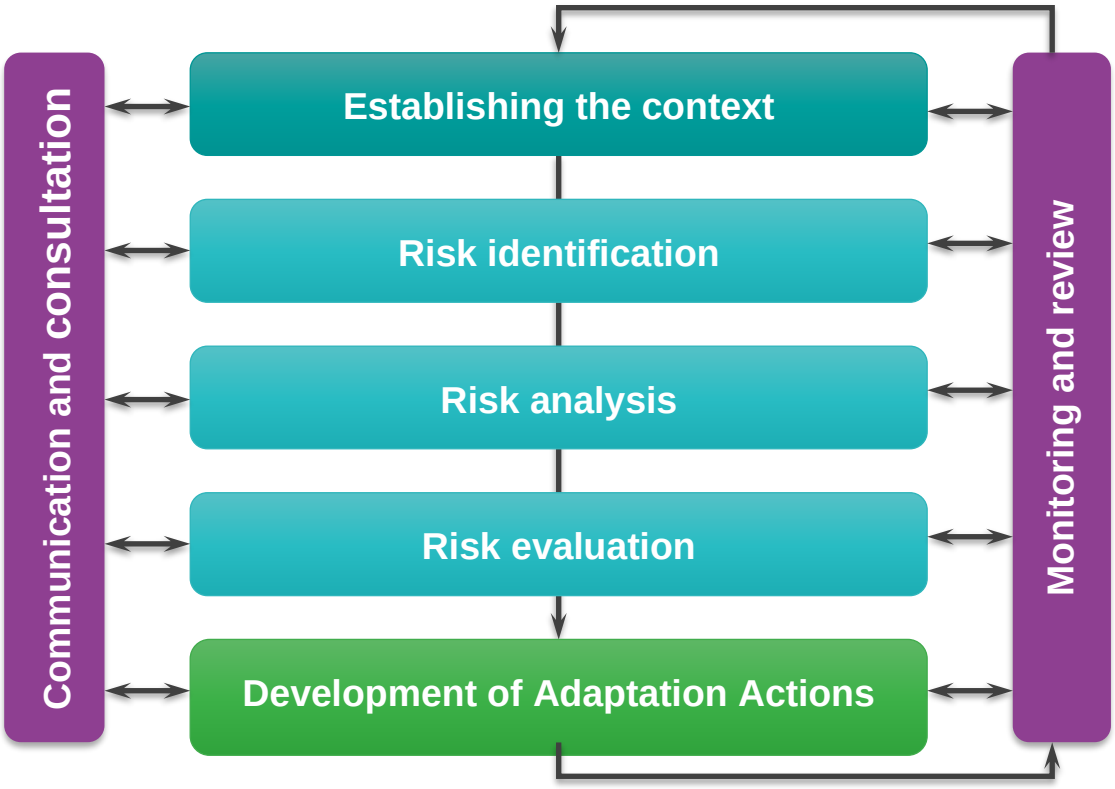
3.1 Overview

This report aligns with the following standards for applying climate change risk assessment to infrastructure and property assets:

- ISO 31000:2009 Risk Management – Principles and Guidelines; and
- AS5334:2013 – Climate Change Adaptation for Settlements and Infrastructure – A Risk Based Approach.

The diagram below (Figure 2) shows how each project phase of the CCA aligns with the requirements of the standard risk management process and identifies the interlinkages between them.

Figure 2: The AS5334:2013 Risk Management Framework



3.2 Climate Context

To understand the potential risks associated with the Study Area, this this report analyses the historical historic and projected future climate conditions of the Sydney region. Bankstown Airport weather station was used as it is the closest weather station, located approximately 7 km from the Study Area. The sections below describe the key elements of the climate research.

3.2.1 Historic Climate

Understanding the historic climate context in this study involved characterising temperatures, rainfall patterns and important weather events from Bankstown Airport weather station. Due to

the potential for significant impacts on the built environment, the following climatic variables were of key interest for the risk analysis:

- Temperature;
- Rainfall;
- Sea level rise; and
- Extreme weather events (droughts, heatwaves, floods, storms and bushfires).

Historic climate information was gathered from the Bureau of Meteorology (BOM) database (2020), with an overview of historic climate contained in Section 4.2.

Table 1 below describes key extreme weather events and their potential impacts on the Riverwood Renewal project.

Table 1: Extreme Weather Events Summary

Extreme weather event	Description and potential impacts
Heatwaves & hot days	Heatwaves are defined as three or more consecutive days of hot days (greater than 35°C)[1] and are of key concern due to their potential impacts upon built infrastructure and occupant comfort. Increased electricity demand for cooling is a key risk to local grid integrity and can impact building cooling systems.
Drought	Droughts are defined as prolonged periods that are abnormally dry, when available water is not sufficient to meet the needs of society[2]. An adequate water supply is crucial for many processes within transport infrastructure construction and operations, and low water supplies can increase water costs.
Floods	Floods occur during periods of increased rainfall and/or storm surge and can lead to significant damage to property and infrastructure. Floods can result in complex economic and environmental impacts upon the built environment and is thus a key consideration for this CCNHRA.
Storms	Storms refer to periods of severe weather, resulting in any combination of increased rainfall, high winds, lightning and ocean storm surges. Storms are of concern for the built environment due to structural and access-related impacts.
Hailstorms	Hailstorms refer to storms that produce hailstones with a diameter larger than 5mm[3]. Hail can cause serious damage to the built environment, including building facades, windows and roofing.
Bushfire	Bushfires occur throughout Australia and pose significant fire risk to property near to bushland areas and users of transport infrastructure in these areas. Indirect impacts include smoke and particulate matter release into the atmosphere, which can have significant environmental health implications in buildings and transport vehicles through fresh air intakes.

3.2.2 Future Climate Projections

The below sections outline the methodology used to identify appropriate future climate projections, with an overview of future climate conditions contained in Section 4.3.

3.2.2.1 Climate Modelling Background

Current understanding of projected climate change is based on the climate system, its historical trends, and the output from model simulations on the impacts of greenhouse gas (GHG) concentrations in the atmosphere. Climate models are mathematical systems that represent physics, fluid motion and chemistry of key climate system components such as the atmosphere,

[1] In line with The Centre for Australian Weather and Climate Research (A partnership between the Bureau of Meteorology and CSIRO) Defining heatwaves: CAWCR Technical Report No. 060 https://www.cawcr.gov.au/technical-reports/CTR_060.pdf

[2] Australian Bureau of Statistics Drought definition: https://www.abs.gov.au/ausstats/abs@.nsf/2f762f95845417aeca25706c00834efa/81A2E2F13AA7994BCA256DEA00053932?opendocument#:~:text=While%20the%20Bureau%20of%20Meteorology,of%20water%20(BOM%202003a).

[3] National geographic hail definition: https://www.nationalgeographic.org/encyclopedia/hail/

the hydrosphere, the cryosphere and the lithosphere. Climate models are routinely evaluated through comparison with historical climate information (IPCC, 2014).

The climate projections used in this CCA are based on the Representative Concentration Pathways (RCP) developed by the Intergovernmental Panel on Climate Change (IPCC) in the Fifth Assessment Report. As this is a risk assessment, the worst-case climate projections (RCP 8.5) have been used, see for more details.

Table 2: Summary of Emissions Scenario Characteristics and Justification

Scenario	Characteristics	Justification for Employment
RCP 4.5	• Carbon emissions peak mid-century at 520 ppm, then decline rapidly towards 30% of 2000 levels; and • More optimistic in terms of future emissions reductions.	Not used for this CCA.
RCP 8.5	• Rapid increases in emissions; • Atmospheric CO2 levels reach 950 ppm by 2100; and • Worst-case, high emissions and rapid global development scenario.	Worst-case scenario employed to describe the projected climate given a business as usual approach to managing climate change in the long-term

3.2.2.2 Overview and Modelling

Making use of downscaled climate projections, it is possible to understand regionally specific climate change impacts. These projections can then be used to perform risk analyses on aspects of the built environment. This CCA employs two sets of locally relevant climate projections for New South Wales as outlined below.

3.2.2.3 NSW and ACT Regional Climate Modelling (NARCLiM) Projections

This study employed the NARCLiM projections. NARCLiM projections were built by combining projections from four CMIP3 global climate models for the SRES A2 emission scenario (comparable to RCP8.5) and downscaling them using Weather Research and Forecasting model (WRF) to a 10 km resolution for south-east Australia and 50 km resolution for the rest of Australia. The information is available for the near future (2029-2039) and far future (2060-2079).

3.2.2.4 CSIRO Projections

The second set of projections was obtained from the modelling conducted by CSIRO and BOM in 2015 (CSIRO, 2015). They used a combination of projections from 40 CMIP5 global climate models and downscaling them to a 25 km resolution. The projections incorporate various emission scenarios according to IPCC fifth assessment report. The downscaled CSIRO projections conducted by Ekstrom et al. (2015) are more recent, and offer greater insight into the more broad, regional changes to the climate system in SA. The timescales selected in this study (2030 and 2090) are relevant for the asset types being assessed. This study focuses on the following two RCP scenarios:

- RCP 8.5 (for 2030 projections) – Rapid increases in emissions through early-mid 2000s. Atmospheric CO2 levels reach 950 ppm by 2100. This scenario represents the worst-case, high emissions scenario; and
- RCP 8.5 (for 2090 projections) – Rapid increases in emissions through early-mid 2000s. Atmospheric CO2 levels reach 950 ppm by 2100. This scenario represents the worst-case, high emissions scenario.

3.2.2.5 Projection Analysis

Analysis of projected climate changes involved summarising the key impacts that are likely to arise due to a changing climate. As mentioned in Section 3.2.1, the following climate variables are of key concern due to their potentially significant impacts on Riverwood Renewal project assets:

- Temperature – including average temperature increases and heat waves;
- Rainfall – including average rainfall and intensity projections;
- Sea level rise; and
- Extreme events – including projections for changes in droughts, floods, storms and bushfires.

3.2.2.6 Limitations and Uncertainty

It is important to note that although the climate models and their projections used in this report are based on the most up-to-date climate research, there is inherent uncertainty associated with using statistical models to project climate change. This may arise due to:

- Natural variations in the climate system - particularly at the local and regional scale;
- The actual trajectory of anthropogenic GHG emissions; and
- Uncertainty around feedback mechanisms that can impact how the climate system responds to the increased GHG concentrations in the atmosphere.

The uncertainty surrounding climate projections reveals important limitations to the projections used in this study. Future changes to climate may thus be more or less extreme than described in this report. The uncertainty surrounding climate projections highlights the need for climate risk analyses to consider a broad range of future climate scenarios.

4 Current and Forecast Climate

4.1 Overview

This section of the CCA summarises the climate context of the Riverwood Renewal project. The Bankstown Airport weather station is being used due to its proximity to the Project site. Bankstown Airport is located approximately 7 km west-southwest of the Study Area (Figure 3). Key climate variables examined in this section include the historic and projected future temperature, rainfall and extreme weather events.

Figure 3: Bankstown Airport (23 km West of Sydney)

Table 3 below summarises BOM weather stations used in the study to provide historical climate information. The Bankstown weather station has been recording data since 1968.

Table 3: Table BOM Weather Station Location

BOM ID	Name	Nearest City	Latitude	Longitude
66137	Bankstown Airport AWS	Sydney	-33.91° S	150.99° E

4.2 Current (Historical) Climate

4.2.1 Average Temperature and Hot days

For Bankstown Airport January is the hottest month, with an maximum average daily temperature of 28.5 degrees celcius, while the coldest month is July, with a maximum average daily temperature of 17.4 degrees celcius (BOM, 2019). The highest daily maximum temperature at Bankstown of 46.1 degrees celcius was recorded on 18th of January 2013. Daily maximum temperatures from 1968-2019 are shown in Figure 4. On average, Bankstown experiences 9.4 days above 35 degrees celcius per year and 1.3 days above 40 degrees celcius.

Figure 4: Historical Daily Maximum Temperature for Bankstown Airport AWS (1968-2019)

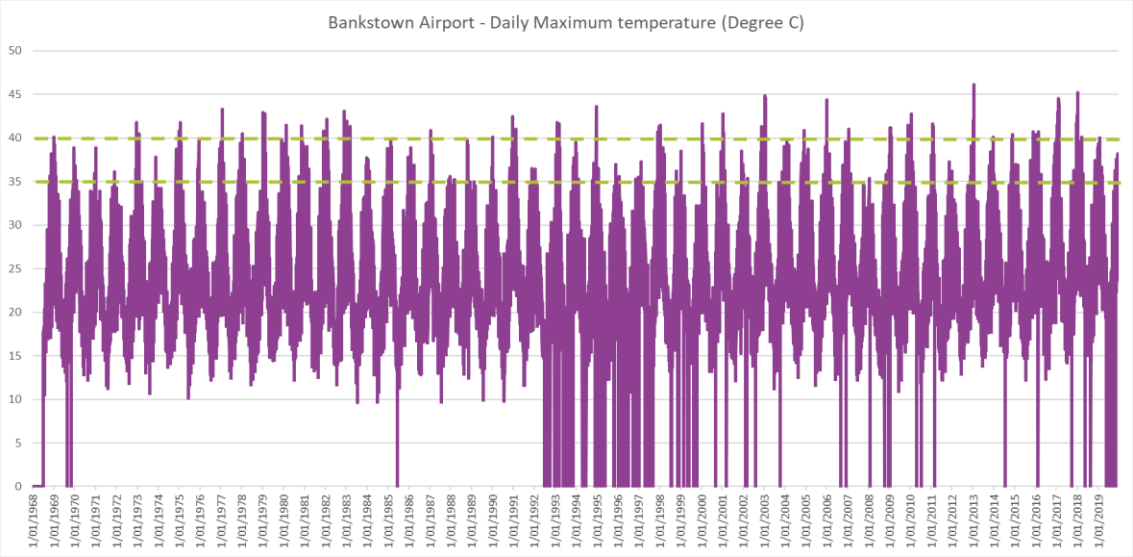


Table 4: Bankstown Airport AWS hot days (1968 – 2019)

Location	Annual Hot days	
	Av. Annual days above 30°C	**Av. Annual days above 40°C**
Bankstown (1968 – 2019)	38.9	1.3

4.2.2 Rainfall

Average annual rainfall is approximately 862 mm, with February typically the wettest month (101 mm) and July the driest month (43 mm) on average. Daily rainfall from 1968– 2019 is shown in Figure 5 below, with peak 24-hour rainfall events up to 243 mm (1986) recorded (BOM, 2019).

Figure 5: Rainfall (mm) Recorded at Bankstown Airport AWS 1968 – 2019.

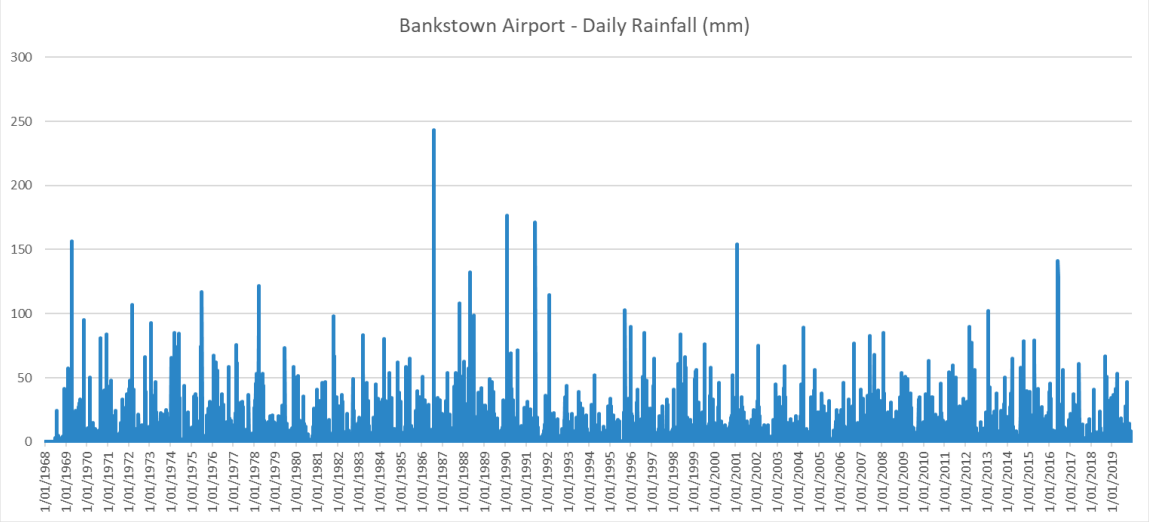


Table 5: Bankstown Airport AWS Annual rainfall (mm)

Av. Annual Rainfall (mm)	Lowest Annual Rainfall (mm)	Highest Annual Rainfall (mm)
868	493.4	1397.4

4.2.3 Wind

Mean wind speeds for the site ranged between 7.9 km/h (recorded at 9 am) up to 19.5 km/h (recorded at 3 pm). Mean wind speeds were generally lower in the morning than the afternoon. Maximum wind gusts in each month frequently (nine months of the year) exceed 110 km/hr with warmer months typically recording the greatest wind speeds (up to 150 km/hr in November and December 2018) (BOM, 2019).

According to BoM, for Bankstown Airport AWS, between July 1968 to June 2019 the records are 65.6 percent complete with 121 single days missed, and 202 full months missed.

4.2.4 Extreme Weather Events

The following climatic events have occurred in the Bankstown region, and require consideration for their potential impacts and risks upon the Project. Data was taken from the Bureau of meteorology's severe storm archive (BOM, 2019):

- ***Hail storms:*** Eight severe hail events have been recorded in the region since 1976 with the last major event happening in 2002. On Sunday 18th March 1990, a savage hailstorm devastated regions of areas from southwest Sydney to near Dee Why. Hailstones the size of cricket balls and in some case larger pummelled vehicles and punctured holes in house roofs across many suburbs particularly Liverpool, Bankstown, Bass Hill, Auburn and Lidcombe;
- ***Floods and storms:*** Eight severe rain events have been recorded since 1976, last in 2018;
- ***Wind events:*** 24 severe wind events have been recorded since 1976, last in 2018; and
- ***Bushfires and fire weather:*** Although the Bankstown metropolitan area and wider Sydney is not located in a high bushfire risk zone, bushfires may indirectly impact upon the Project site. Bushfires pose a significant health risk to the metropolitan area through a reduction in air quality as experienced in the December 2019/January 2020 bushfires to the north, west and south of Sydney.

4.2.5 Current (Historical) Climate Summary

A summary of the current and historical climate conditions are detailed in the below Table 6.

Table 6: Current Climate Summary, Bankstown Airport AWS

Highest Daily Maximum Temp	Average Daily Maximum Temp	Av. Annual days above 30°C	Av. Annual days above 35°C	Av. Annual days above 40°C	Av. Annual Rainfall	Highest Daily Rainfall	Max Wind Gust speed
46.1°C	23.3°C	38.9	9.4	1.3	868mm	243 mm	~150 km/h

4.3 Future Climate

Understanding future climate projections requires careful review of the most recent climate change emissions scenarios, and their related impacts on the climate system. Making use of downscaled climate projections, it is possible to understand regionally-specific projections, which is more useful for conducting risk analyses on the infrastructure assets.

This study uses the latest projections available from the NARCliM Metropolitan Sydney climate change snapshot (NSW OEH, 2017).

The timescales selected from NARCLiM and predominately used in this CCA are the following:

- 1990 to 2009 (base);
- 2020 to 2039 (near future - 2030); and
- 2060 to 2079 (far future - 2070).

Analysis of projected climate changes involved summarising the key impacts that are likely to arise due to a changing climate. Temperature, rainfall and extreme weather events are of key concern due to their potentially significant impacts on the Project. Climate projections are described below and are summarised in Table 8.

4.3.1 Temperature & Hot days

From NARCliM climate projections for the Bankstown region (NSW OEH, 2014) the number of days over 35 degrees celcius are predicted to:

- Increase by 1-5 days for 2030; and
- Increase by 5-10 days for 2070.

The climate projections also predict that the average maximum temperature will:

- Increase by 0.5-1°C for 2030; and
- Increase by 1.5-2°C for 2070.

Overall, fewer cold nights and more hot days are projected by these models.

4.3.2 Rainfall

The NARCliM climate projections predict that the Summer (Dec-Feb) rainfall will:

- Increase by 1 % for 2030; and
- Increase by 10 % for 2070.

The climate projections predict that Autumn rainfall (Mar-May) will:

- Increase by 10 % for 2030; and
- Increase by 15 % for 2070.

The climate projections predict that Winter rainfall (Jun-Aug) will:

- Decrease by 5 % for 2030; and
- Increase by 5 % for 2070.

The climate projections predict that Spring rainfall (Sep-Nov) will:

- Increase by 1 % for 2070.

Overall projections for the region's annual average rainfall range from a decrease (drying) of 13 percent to an increase (wetting) of 18 percent by 2030 and still span both drying and wetting scenarios (–9 to +24 percent) by 2070.

4.3.3 Sea Level Rise

Sea level on the East coast of Australia is projected to rise between 0.08 – 0.18 m by 2030 and 0.44 to 0.88 m by 2090 (RCP 8.5). This projection is made with very high confidence (CSIRO, 2015).

4.3.4 Extreme Weather Events

Future climate change is likely to increase the intensity and severity of extreme climatic events. Importantly, the relationship between climatic averages and the frequency of extreme events is often non-linear, illustrated by climate projections that associate dramatic increases in very hot days with small increases in mean temperature (AGO, 2006). Non-linear responses to climate variables make the development of reliable projections for extreme events such as storms and droughts very difficult.

Key extreme climate projections and sources are discussed below in Table 7.

Table 7: Climate Change Projections for Bankstown - Other Climate Variables

Variable	Projection
Droughts	As with rainfall projections, there is *low confidence* in predicting changes in the frequency and longevity of extreme droughts in the future. There is *medium confidence* that under a high emissions scenario, the Sydney region is likely to experience increased time under drought conditions (Ekstrom, et al., 2015). Greater time spent in meteorological drought is projected with *medium confidence* by late in the 21st century under RCP8.5. An increase in the frequency and duration of extreme drought is projected with *low confidence* (CSIRO, 2015).
Floods and storms	The Sydney region currently experience considerable rainfall variability across the region, from season-to-season and from year-to-year, and this variability is also reflected in the projections (NSW OEH, 2014). There is *high confidence* that the intensity of heavy rainfall events will increase. The magnitude of change, and the time when any change may be evident against natural variability, cannot be reliably projected. There is generally *medium confidence* in a decrease in extreme wind speeds, noting that this is broadly consistent with projected changes to the large-scale circulation at these latitudes (CSIRO, 2015).
Bushfires and Fire weather	From NARCliM projections, Bushfire risk via the Forest Fire Danger Index is predicted to increase by 0-1 by 2030 and increase by 0-1 by 2070. Metropolitan Sydney is expected to experience an increase in average and severe fire weather in the near future and the far future (NSW OEH, 2014).
Hailstorms	There is *low confidence* in the magnitude of change associated with hail intensity and size, although the projected increase in storm intensity could lead to increased impacts from hailstorms (CSIRO, 2015).

4.3.5 Summary of Climate Change Projections

Table 8: Climate Change Projections

Variable	Current (1968-2019)	Units	Near Future (2030)	Far Future (2070 or 2090)	References
Temperature – average annual maximum	23.3	ºC	+ 0.5 to 1	+ 1.5 to 2	(NSW OEH, 2014)
Temperature – Hot days	9.4	Average days over 35°C per year	+ 1 to 5	+ 5 to 10	(NSW OEH, 2014)
Rainfall – Annual mean	868	mm	-13 to +18 %	-9 to +24 %	(NSW OEH, 2014)
Bushfire and Fire Weather	-	Forest Fire Danger Index (FFDI)	+ 0 to 1	+ 0 to 1	(NSW OEH, 2014)
Sea level Rise	-	m	+ 0.08 to 0.18	+ 0.44 to 0.88	(CSIRO, 2015)

5 Adaptation Considerations

Based on the context above, it is important to design a neighbourhood that is more resilient against increased temperatures, heatwaves, extended droughts and heightened bush fire conditions, intense storm events and more variable precipitation patterns. These adaptation considerations aim to take into account other factors such as human comfort, building and infrastructure resilience and in situ and downstream ecological and water system resilience.

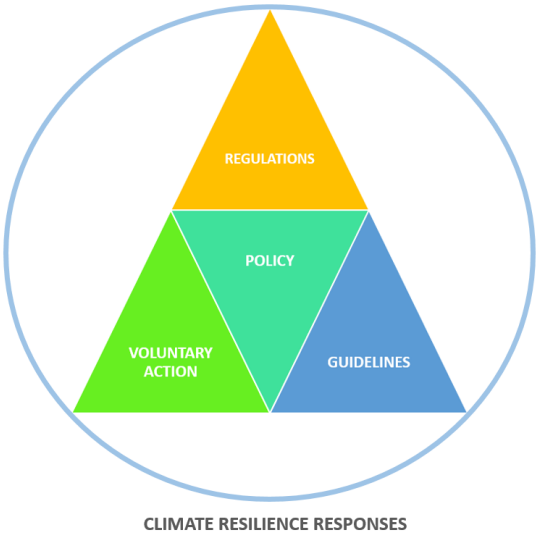
At this juncture, it is important to reinforce the distinction between mitigation and adaptation solutions: while mitigation solutions would consider how to reduce the carbon footprint of - for example - a development, adaptation solutions consider the *resilience* of that development to cope with extreme weather events and its ability to continue functioning well into the future with little (or no) maintenance required.

A range of adaptation considerations are available to the Riverwood Renewal project. These can principally be broken down into:

- Policy and Guidelines;
- Regulatory Requirements (i.e. guiding minimum requirements);
- Adaptation Options for Consideration as Development Controls (i.e. proposed requirements based on applicable, global best practice); and
- Voluntary Actions (i.e. which either government or private developers may wish to explore due to additional benefits such as advocacy, operational efficiency, and/or reputational advancement).

While policy is an important founding/baseline element in organising the rhetoric and response to climate change; guidelines, regulations and voluntary actions are considered mutually reinforcing to this policy, while the evolving global sentiment on climate change ring-fences all of this action. Where applicable, the policy, guidelines and regulations considered in this report have informed the various responses that are proposed in Sections 4.3 and 4.4.

Figure 6: Mutually Reinforcing Drivers and Enablers of Climate Change Adaptation in Planning and the Built Environment



Source: Mott MacDonald, 2017

5.1 Policy and Guidelines

5.1.1 Climate Change Adaptation for Settlements and Infrastructure - A Risk Based Approach

Standards Australia has recently been involved in developing a National Standard entitled *"Climate change adaptation for settlements and infrastructure - a risk based approach"* (AS 5334-2013).

This Standard provides a general and widely applicable approach and framework for decision-makers in all organizations that play a role in the commission, design, planning, approval, construction, maintenance, management, operation and decommission of settlements and infrastructure. The Standard provides guidance on managing climate change risks and includes implementation plans for suitable and effective adaptation (treatment).

The objectives of this Standard are to:

a. Provide principles and generic guidelines on the identification and management of risks that settlements and infrastructure face from climate change; and
b. Describe a systematic approach to planning the adaptation of settlements and infrastructure based on the risk management process.

This Standard provides principles and generic guidelines on the management of the risks that settlements and infrastructure face from the consequences of climate change. In particular, it describes a systematic approach to planning the adaptation of settlements and infrastructure based on the risk management process given in AS/NZS ISO 31000:2009.

While the Standard provides guidance on embedding CCA into planning urban environments, it is not intended as a means of obtaining certification.

Importantly, Section 8.3 of the Standard considers the process of selecting adaptation options. Factors that should be considered in the selection of adaptation options include the following:

a. Effectiveness and robustness of the adaptation-over the life of the settlement or infrastructure including flexibility of the option in terms of its ability to respond to changing conditions of use and climate and the impacts from climate change;
b. Practicability of implementation and ease of maintenance including technical capability, availability of human resources. Compatibility with existing systems within the settlement or infrastructure;
c. Economic efficiency of operation and ongoing maintenance including funding options and their availability for adaptation and whether the adaptation can, itself, generate revenue;
d. Co- benefits over and above those that come from the direct treatment of the risks from climate change; or net benefits under a range of plausible future climates;
e. Equity implications of the adaptation options for all potentially affected stakeholders; and
f. Greenhouse gas emission implications of adaptation options.

This National Standard on increasing the resilience of infrastructure and communities in Australia will soon be supplemented by broader International Standards to be developed in which are expected to apply to all sectors and organisations in future.

These International Standards on climate change are being developed by Working Group 7 (ISO/TC 207/SC 7) which is responsible for the development of standards to manage and mitigate GHG emissions, as well as to adapt to the effects of climate change and in support of sustainability. Over the next five years, it is envisioned that SC 7 will be instrumental in the

development of standards to help governments and organizations to manage and mitigate GHG emissions, as well as to adapt to the effects of climate change.

Note: Because Riverwood is likely to be developed over a 15 to 20-year time horizon, it is not possible to predict what requirements may be legislated in terms of future guidelines. Instead, this report reflects what is currently best practice.

5.1.2 The Australian Green Infrastructure Council (AGIC) Guideline for Climate Change Adaptation

This guideline was developed in 2011 to inform industry on climate change risks and opportunities presented for new infrastructure projects and existing assets. It provides a roadmap for developing appropriate adaptation measures. It outlines hazards and proposed responses for infrastructure such as:

- Transport and built infrastructure;
- Energy generation and transmission; and
- Water management.

The guideline also recommends use of the following six criteria in guiding decisions:

1. **Commitment**: This criterion relates to the commitment of the key project or asset stakeholder(s) in recognising climate change risks and opportunities in all aspects of a project and taking the necessary actions to avoid or manage the risks;
2. **Capability**: This criterion relates to the technical capability and experience of those responsible for managing climate change risks to the project or asset;
3. **Climate Change Projections**: This criterion relates to the credibility and appropriateness of the climate change projections used to assess project specific climate change risks;
4. **Climate Change Risks Assessed**: This criterion relates to the range of climate change risks assessed – how narrow or broad - and the appropriateness of the risk assessment methodology used;
5. **Adaptation Options Assessed**: This criterion relates to the quality of the assessment of adaptation options identified. It includes consideration of the extent and depth options identified and explored, documentation of the decisions made, the timing of implementation, flexibility and innovation; and
6. **Adaptation Measures Designed or Implemented**: This criterion relates to the effectiveness of the adaptation measures designed or implemented to address the climate change risks. The measures include assessing the extent of priority risks treated; the integration, systemization and timing of adaptation measures as well as the adaptive capacity of project or asset operators.

The guideline also endorses the use of the ISO 31000:2009 Risk Management Standard providing principles and generic guidelines on risk management.

5.1.3 Technical Guidelines for Urban Green Cover in NSW

The NSW Government's Environment and Heritage Office (2014) has produced *Technical Guidelines for Urban Green Cover in NSW* to provide practical advice on best practice. The purpose of these guidelines is to increase the resilience of NSW settlements and communities to climate change, specifically to increasing temperatures in urban settings and specifically targets the reduction of the 'urban heat island' (UHI) effect. Green cover strategies discussed in the guidelines to minimise urban heat island effect include integration of the following into design:

- Green roofs and cool roofs – vegetated roofs and light coloured and reflective roof surfaces;

- Green walls – vegetated systems that are grown on the vertical facade of the building envelope;
- Green streets – opportunistic street tree planting with shade providing canopy combined with permeable and/or light coloured, highly reflective surfaces on roads, pavements and car parks; and
- Green open spaces – canopy trees and shade provision to parks, cycleways, footpaths, amenities and forecourts, as well as green infrastructure such as bio-swales, raingardens, soft-landscaped detention basins, de-channelisation of hard engineering (concrete culverts).

These guidelines have been instrumental in terms of the recommendations of this report.

5.1.4 202020 Vision

The Hort Innovation's 202020 Vision is a national initiative to create 20 percent more urban green space in Australia by 2020. It has created momentum within local councils to pursue more environmental and urban greening opportunities.

5.1.5 NSW Government Architect Greener Places Framework

Greener Places is a design framework for urban green infrastructure. The Draft Greener Places Design Guide (2020) provides information on how to design, plan and implement green infrastructure in urban areas throughout NSW. It provides a consistent methodology to help State and local government, and industry create a network of green infrastructure.

5.1.6 NSW Climate Change Policy Framework (2016)

The *NSW Climate Change Policy Framework (2016)* was developed by the Office of Environment and Heritage (OEH) with the aim to maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change.

The NSW Government's emissions savings objective and adaptation objectives aim to:

- Attract investment by providing policy certainty;
- Guide public and private sector decision making, particularly for long-lived assets; and
- Ensure consistency of NSW Government policy with the international and national policy context and the likely long-term direction of government and private sector action on climate change.

5.1.7 NARCliM

The NARCliM Project is a research partnership between the NSW and ACT governments and the Climate Change Research Centre at the University of NSW.

NARCLiM projections were built by combining projections from four CMIP3 global climate models for the SRES A2 emission scenario (compatible to RCP8.5) and downscaling them using Weather Research and Forecasting model (WRF) to a 10 km resolution for south-east Australia and 50 km resolution for the rest of Australia. The information is available for the near future (2029-2039) and far future (2060-2079).

5.2 Regulatory Requirements

Adaptation to climate change in Australia is typically siloed within a single department, and is neglected elsewhere within government structures. Adaptation currently occurs more ubiquitously through the provision of policy, guidelines, and recommendations, and rarely through the force of law.

However, adaptation-related opportunities and insights into current planning and building sector requirements in Australia and (where applicable) New South Wales, are considered below.

5.2.1 Planning

Planning for climate resilience is embedded non-comprehensively within a suite of regulations. According to the National Climate Change Adaptation Research Facility (Macintosh *et al,* 2013), once a land use is lawfully commenced, the power or 'right' of government to control that existing use through the planning system is lost. Accordingly, there is a key opportunity at this phase of planning to influence the degree to which adaptation is considered, controlled and implemented in the Riverwood Renewal project in future.

As an example, planning approvals may be required prior to constructing a building in a bushfire prone area. The planning approval could then set specific conditions requiring a minimum amount of 'defendable space' coupled with important building design features to ensure the safety of occupants in a bushfire event.

Event-dependent approvals are another innovative type of planning approval process that is (and can increasingly be) used to address climate-related hazards. These can be defined as "approvals that make regulatory interventions or requirements contingent upon a specified trigger-event". They are a type of approval that imposes a requirement to modify a development in a particular way - or to "carry out specific works if a predetermined trigger-event occurs (e.g. raising floor levels or constructing a defensive seawall in the event that the mean sea level reaches a certain point)," (Macintosh *et al,* 2013).

Certain existing laws, however, have a very clear relation to addressing climate change related risks, such as the Environmental Planning and Assessment Act 1979 and the Rural Fires Act 1997 which promotes bush fire protection through the development assessment process, while the Environmental Planning and Assessment Act establishes a system for requiring bush fire protection measures on bush fire prone land at the development application stage.

5.2.2 Building Codes and Standards

5.2.2.1 National Construction Code (NCC)

The NCC is an initiative of the Council of Australian Governments (COAG) developed to incorporate all on-site construction requirements into a single code. The code provides the minimum necessary requirements for safety and health; amenity and accessibility, and sustainability in the design, construction, performance and liveability of new buildings (and new building work in existing buildings) throughout Australia. It is a uniform set of technical provisions for building work and plumbing and drainage installations throughout Australia that allows for variations in climate and geological or geographic conditions.

The NCC is comprised of the BCA, Volumes One and Two; and the PCA, Volume Three.

- NCC Volume One primarily applies to Class 2 to 9 (multi-residential, commercial, industrial and public) buildings and structures;
- NCC Volume Two primarily applies to Class 1 (residential) and 10 (non-habitable) buildings and structures; and
- NCC Volume Three applies to plumbing and drainage for all classes of buildings.

5.3 Adaptation Options for Consideration in Future Development Controls

The future Riverwood housing area will include spaces that are publicly owned and maintained, as well as those that are privately owned and maintained. The table below highlights a range of possible adaptation options based on future climate change impacts to the area, and attempts to

split the responsibility to the relevant project proponents accordingly. These are based on global best practice (e.g. CIRIA, 2013, BREAAM, 2014, UNFCCC, 2014 and Architecture 2030's '2030 Palette', 2017) and should be considered for inclusion in planning controls, where appropriate.

In several cases, the responsibility would need to be shared between both governmental and private parties and on-going negotiations would be required in this regard.

These potential adaptation options also need to be considered in light of the requirements set out in the Design Guidelines to ensure future dwellings within the precinct are designed to address, where possible, the proposed adaption options.

Those adaptation items with added co-benefits are highlighted in the table below for emphasis. These are win-win adaptation options (i.e. those that have a mitigation angle or an added social benefit).

Table 9: Proposed Range of Proposed Adaptation Options and Applicable Proponents

CATEGORY	HIGH LEVEL ADAPTATION OPTIONS / CONSIDERATIONS	CO-BENEFITS / WIN-WINS	PART OF NSW URBAN GREEN COVER TECHNICAL GUIDELINES	APPLICABLE STAGE/ PROPONENT*
INCREASED TEMPERATURES AND MORE HEATWAVES	Consider increasing roof overhangs (eaves) and incorporating more shaded balconies/verandas.	Improved indoor-outdoor living conditions for residents.	No.	Developer at built form stage.
	Consider more insulated roofing or green roofing.	Green roofing is comparatively more functional than ordinary roofs as it can absorb up to 85% of annual precipitation and cool a roof surface by up to 30°C. it also comes with a range of co-benefits (e.g. carbon sequestration, water and air purification, reduced urban heat island effect, wind protection barrier effects, improved local biodiversity, etc).	Yes - green roofing.	Developer at built form stage.
	Developments should consider more hard-wearing materials that can withstand temperature extremes which may cause warping, bending, blistering, fading or melting through specifying: • More durable materials; • Materials with longer design life; and • Materials with better performance in hot temperatures.		No – although mentioned as being complementary to these guidelines.	Developer at built form stage.
	Consider lighter coloured paving of roads/sidewalks, as well and lighter coloured roofs and/or walls to reduce the heat island effect.		Yes.	Developer at built form stage.
	Consider insulating / protecting critical services infrastructure (e.g. linear services such as telecommunications/pipelines).		No.	Developer at built form stage.

CATEGORY	HIGH LEVEL ADAPTATION OPTIONS / CONSIDERATIONS	CO-BENEFITS / WIN-WINS	PART OF NSW URBAN GREEN COVER TECHNICAL GUIDELINES	APPLICABLE STAGE/ PROPONENT*
	Consider passive cooling and through air flow and explore innovative and renewable sources of heating and cooling.	Reduced energy usage and carbon emissions, reduced electricity costs and improved thermal comfort for residents.	No.	Developer at built form stage.
	Increase tree canopy for shading and cooling ambient temperatures with native species that have lower fire risks and are drought tolerant.	Planting trees comes with a range of co-benefits (e.g. improved aesthetics, amenity, carbon sequestration, air purification, reduced urban heat island effect, wind protection barrier effects, improved local biodiversity, etc).	Yes.	Developer at built form stage.
HIGHER INCIDENCE OF DROUGHT	Select more drought resistant plants where irrigation is not to be undertaken.	Lower maintenance landscaping	Yes.	Developer at built form stage.
	Ensure robust geotechnical investigations which consider shrinkage/swelling of soils and impacts on foundations.		No.	Developer at built form stage.
	Consider deeper ponds/water bodies and storage of grey water for landscaping/re-wetting paved areas during drought periods.	Water savings, reduced running and maintenance costs	Yes.	Developer at built form stage.
	Consider additional stormwater detention to be used for estate landscape irrigation for sporting fields, parks, street tress and landscaping.	Mandate rainwater tanks (or smart water tanks) for all residential homes.	No.	Developer at built form stage.
INTENSE STORM EVENTS	Consider elevated first floor/raising building on columns, or plan for garage/utility/storage space with any utility services placed higher up walls that can withstand flooding. (Note: Salt Pan Reserve in general provides this buffer/setback)	Cars can park beneath and be shaded by building, and require less overall hardened area which would ordinarily be required for parking lots.	No.	Developer at built form stage.
	Move all critical infrastructure (pumps, transformers etc…) to a higher level to account for 1% AEP + 20-30% climate change factor.	Future proofing buildings, providing climate change proof refuge points and increased safety to pedestrians.	No.	Developer at built for stage.
	Consider increased buffers/setback lines from rivers/floodplains/wetlands subject to assessed risk based on flood modelling – and noting a prescribed minimum of 30m from Salt Pan Creek and 40m from wetlands (NSW Office of Water, 2012). Linked to this, consider building 'up' rather than 'out' – densifying.	More greenery and overall amenity.	No.	Developer at built form stage.
	Consider raised kerbs and /or flood defence barriers in key areas.		No.	Developer at built form stage.

CATEGORY	HIGH LEVEL ADAPTATION OPTIONS / CONSIDERATIONS	CO-BENEFITS / WIN-WINS	PART OF NSW URBAN GREEN COVER TECHNICAL GUIDELINES	APPLICABLE STAGE/ PROPONENT*
	Consider green roofing to absorb heavy precipitation and reduce the amount and rate going into drains.	As per above, green roofing is comparatively more functional than ordinary roofs as it can absorb up to 85% of annual precipitation and cool a roof surface by up to 30°C. it also comes with a range of co-benefits (e.g. carbon sequestration, water and air purification, reduced urban heat island effect, wind protection barrier effects, improved local biodiversity, etc).	Yes.	Developer at built form stage.
	Consider increasing on site attenuation for improved flood neutrality (linked to this could be WSUD considerations, attenuated parking lots, etc).	WSUD, much like tree planting, comes with a range of co-benefits (e.g. improved aesthetics, amenity, carbon sequestration, air purification, reduced urban heat island effect, improved local biodiversity, etc).	Yes.	Developer at built form stage.
	Consider insulating / protecting / reinforcing critical services infrastructure (e.g. linear services such as telecommunications / pipelines)		No	Developer at built form stage.
	Consider planting hardy, native tree and plant species that can withstand violent winds and/or root inundation (and ideally drought conditions too). Linked to this, plan adequate setbacks from critical structures in case of trees falling.	As per above, plants come with a range of co-benefits (e.g. improved aesthetics, amenity, carbon sequestration, air purification, reduced urban heat island effect, wind protection barrier effects, improved local biodiversity, etc).	Yes	Developer at built form stage.
	Consider extra structural reinforcements and more hard wearing materials that can withstand strong winds and excessive precipitation through initiatives such as: • Design horizontal surfaces to deal with hail impact; and • Design more cover for pedestrians to limit time exposed in a hailstorm.		No – although mentioned as being complementary to these guidelines.	Developer at built form stage.
VARIABLE PRECIPITATION PATTERNS	Consider robust geotechnical and soil tests to control against possible subsidence / ground movement due to fluctuating water tables.		No.	Developer at built form stage.
	Consider rainwater harvesting for increased water 'independence' for users.	Reduced utility bills for users.	No – although mentioned as being complementary to these guidelines.	Developer at built form stage.
INCREASED FIRE RISK	Consider use of fire retardant materials/linings in buildings.		No.	Developer at built form stage.
	Consider landscaping elements that are not a fire risk,		No – although mentioned as being	Developer at built form stage.

CATEGORY	HIGH LEVEL ADAPTATION OPTIONS / CONSIDERATIONS	CO-BENEFITS / WIN-WINS	PART OF NSW URBAN GREEN COVER TECHNICAL GUIDELINES	APPLICABLE STAGE/ PROPONENT*
	particularly along the site's periphery.		complementary to these guidelines.	
	Consider installation of a central fire warning system/siren (which could be used for warnings of violent weather events too).		No.	Developer at built form stage.
SEA LEVEL RISE	Move all critical infrastructure (pumps, transformers etc…) to a higher level and out of range of sea level rise and storm surge water levels.	Future proofing buildings and infrastructure.	No.	Developer at built for stage.
	Consider increased buffers/setback lines from rivers/floodplains/wetlands subject to sea level rise and storm surge. Noting current buffer zones of 30m from Salt Pan Creek and 40m from wetlands (NSW Office of Water, 2012).	More greenery and overall amenity.	No.	Developer at built form stage.
ALL RISKS TO BUILDINGS	Consider robust building insurance.		No.	Developer at built form stage.

Source: Mott MacDonald 2017

**NSW to review development applications accordingly*

It is ultimately the planners, engineers, architects and council members and their professional judgements to influence the extent of which these adaptation options are incorporated into the design.

The detailed climate projections for the Study Area contained in Appendix A give the upper and lower ranges of temperature and rainfall changes which should be used by technicians to inform the extent to which the above considerations are implemented.

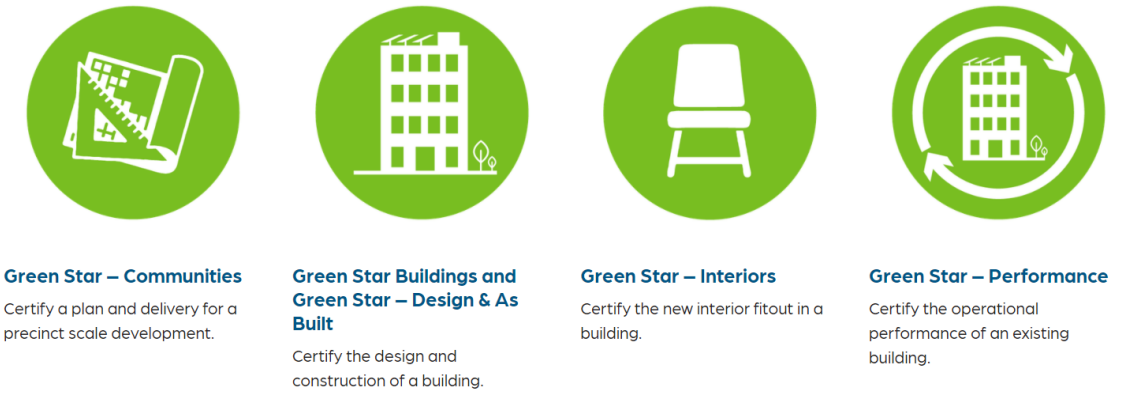
Further design detail and practical advice on best practice particularly on the urban green cover aspects in the table above can be found in the Technical Guidelines for Urban Green Cover in NSW mentioned in Section 4c above.

5.4 Stretch Actions

There exists a multitude of more aspirational, yet voluntary adaptation options available which would be positive actions in showcasing responsive climate adaptation actions and in generating support and improved reputation. The Project could consider any of the following:

1. Aim for Green Building Council Australia (GBCA) Green Star Rating(s) in planning/design and ultimately construction. Green Star is an internationally recognised sustainability rating system and Australia's largest voluntary and truly holistic sustainability rating systems. There are four Green Sar rating tools currently, each providing a mean to certify building design and construction, operation, fitouts and communities. They have been developed by the GBCA in close consultation with industry and government bodies and regularly updated to reflect the latest development in industry or regulations.

Figure 7: Current Green Star rating tools



The Green Star – Communities award is limited to the achievement of four, five or six Star ratings as the GBCA only recognises and rewards market leaders. The Green Star rating is determined by both the total number of points achieved overall, and the achievement of a minimum points score within each individual category (except Innovation);

2. Aim for five stars Green Star ratings for residential towers and townhouses with the Green Star Buildings tool v1;
3. The Project should consider making this a benchmark planning project which, apart from accreditation or certification, could win awards, set a positive example and ultimately set a new benchmark for housing in NSW/Australia. There is an opportunity to link with design excellence awards which could be aspired to; and
4. It may also be advantageous for the private developers to continue community engagement following the planning/design stage with involvement in the final design. This is good practice outside the realm of climate change, but it will also help to:
   - Increase their awareness of climate change, what they can do as individuals to adapt and why the precinct is being redeveloped in this way and helps assist rather than resist any planned changes and any on-going measures (builds the communities adaptive capacity); and
   - Increase chance of support/co-operation during the redevelopment and once completed the on-going use and maintenance of the precinct, and during any future extreme events.

6 Baseline Planning/Layout Options

At a more ‘scaled out’ level of planning, there are certain design options that are difficult to capture as purely ‘resilience’ based actions in terms of the future Riverwood Renewal project, but which will aid in a more efficient and liveable area, and one which is also inherently more adaptable to change. Some of these key planning options include:

- Incorporating neighbourhood and ‘liveability’ thinking into the master plan – i.e. incorporate mixed use and complete streets into planning so that residents can run errands safely and conveniently within their immediate living environment (this increases walkability, reduces unnecessary car use, and encourages getting to ‘know thy neighbour’ – which may lead to a more tight-knit community that bands together well in possible future emergency situations);
- Increasing development densities to allow for the presence of more open space (thus cooling the immediate environment) and less hardened surface area coverage/sprawl (thus reducing runoff); and
- Incorporate a natural corridor for micro-scale species migration (should vegetation/habitat patterns change over time). This could entail the inclusion of a parkway-like system traversing the site which would simultaneously improve both local recreation and the amenity of the area.

7 Maintaining Flexibility in Planning and Design

Building flexibility into a master planning process means that changing climatic conditions should be taken into account. The overall redesign of the Riverwood Renewal needs to incorporate pathways for future adaptation, which can be taken as needed without too much additional expense or further retrofitting. Examples of such ‘flexible adaptation pathways’ could include: ensuring that there is enough space remaining on the site to include extra water storage for changing water availability, or building more substantial footings under a deck so that it can easily take the weight of a roof if in future if more shade is needed around buildings as temperatures rise over time.

It is important to favour flexible options over those which are ‘locked’ and cannot be modified in future (in other words, to ensure ‘adaptive management’ of adaptation solutions as changes to the climate and the severity thereof become clearer over time). It is also important to ensure good maintenance of the development in future once operational – as this can avoid the decay of buildings over time leading to major yet unnecessary incidents.

8 Climate Change Adaptation Assessment and Implementation Plan

This section summarises the CCA initiatives that have been explored for the development. either a master plan initiative and/or planning controls for the Riverwood Renewal. The suggested planning controls and objectives have been governed requirements of Green Stars and the current DCP requirements highlighted in previous sections.

Mott MacDonald acknowledges that delivering effective CCA initiatives in public areas is less challenging than enforcing development controls on private developments. This presents a good opportunity to highlight Government leadership and therefore, where possible initiatives have focused on items in the public realm to increase the likelihood of CCA outcomes being delivered.

Generally speaking, the public realm initiatives are implemented by effective master planning as opposed to private built form initiatives that are generally implemented by planning controls or design guidelines. Therefore, where possible, focus has been placed on including initiatives in the master plan. Where inclusion in the master plan is not practical or appropriate, a planning control has been nominated and where design innovation should be explored, a possible procurement condition has been included to encourage developers to explore additional CCA measures that could not be otherwise feasibly delivered at this early stage of the project (these would need to be assessed for commercial feasibility at the tender stage of the project but also drives the industry to explore innovative solutions). In instances where implementation of the initiative is deemed outside the scope of the Riverwood Renewal project or is not considered viable at this stage, initiatives have been nominated as aspirational for future consideration.

Table 10: Summary of Implemented CCA Initiatives

POSSIBLE CCA INITIATIVE	MASTER PLAN ALLOWANCE	SUGGESTED PLANNING CONTROL/OBJECTIVE	POSSIBLE PROCUREMENT CONDITION
Consider more insulated roofing, and green roofing and/or white painted roofing. Additionally, enhanced glazing treatment, shutters to control solar gain.	The master plan documentation includes the provision of light coloured roofing and interspersed green roofing where achievable to reduce heat absorption and improve thermal efficiency. Future building design could include enhanced glazing treatment and additional shutters to limit solar gain above current standards.	This initiative could be reflected in a proposed planning control which aims to provide a more sustainable development. Draft planning controls could include: **Sustainable materials** Controls • External walls and roofs should be non-heat absorbing and light in colour; and • Insulated roofing should be provided for all buildings.	
Developments should consider more hard-wearing materials that can withstand temperature extremes which may cause warping, bending, blistering, fading or melting.		These initiatives could be reflected in proposed planning controls which aim to provide a more sustainable development which is resilient to changes in climate. Draft planning controls could include: **Sustainable materials** Controls	

POSSIBLE CCA INITIATIVE	MASTER PLAN ALLOWANCE	SUGGESTED PLANNING CONTROL/OBJECTIVE	POSSIBLE PROCUREMENT CONDITION
Consider extra structural reinforcements and more hardwearing materials that can withstand strong winds and excessive precipitation. Consider use of fire retardant materials / linings in buildings.		• Materials that are more resilient than traditional materials should be used for construction where appropriate; and • Fire-retardant materials that are more effective that traditional materials should be incorporated in buildings.	
Consider lighter coloured paving of roads/sidewalks, as well and lighter coloured roofs and/or walls to reduce the heat island effect.		This initiative could be included as a proposed planning control which outlines requirements for public open spaces. Draft planning controls could include: **Public Open Space** Controls • Light coloured pavements and road surfaces should be used to avoid heat absorption and retention.	This initiative could include part of an overarching procurement condition to mitigate the urban heat island effect.
Consider passive cooling and through air flow and explore innovative and renewable sources of heating and cooling.	The master plan documentation includes passive cooling and through air flow as a provision.	This initiative could be included as a proposed planning control which will outline sustainability in design requirements. Draft planning controls could include: **Sustainable materials** Controls • More insulation than standard practice is to be demonstrated for all buildings; and • Living environments are to incorporate natural ventilation and passive cooling	This initiative could include a procurement condition as follows: Sustainability Outline measures to promote improved building insulation and natural ventilation. As a minimum, demonstrate that more insulation will be used on buildings than is standard practice.
Increase tree canopy for shading and cooling ambient temperatures with native species that have lower fire risks and are drought tolerant. Select more drought resistant plants where irrigation is not to be undertaken.	The master plan documentation includes this as a provision. The master plan and landscape report shows a proposed net increase in trees/tree canopy. A minimum coverage of 30% has been proposed by the landscape architects - higher than the 15% average for Sydney.	This initiative could be included as a proposed planning controls which aim to promote planting of native plants and retain and maximise tree coverage across the site. Draft planning controls could include: **Public Open Space** Controls • Native plants which are drought tolerant and pose a low fire risk should be used in public open space areas. **Street Trees and Landscaping** Controls • Provide a minimum tree canopy coverage of 30%.	
Consider deeper ponds / water bodies and storage of grey water for landscaping/re-wetting	The master plan documentation and planning Control includes this as a provision.		This initiative could include a procurement condition as follows: Sustainability

POSSIBLE CCA INITIATIVE	MASTER PLAN ALLOWANCE	SUGGESTED PLANNING CONTROL/OBJECTIVE	POSSIBLE PROCUREMENT CONDITION
paved areas during drought periods.			Outline how additional WSUD initiatives could be implemented to promote healthy waterways and reduce potable water consumption. Explore opportunities to include rainwater capture and re-use for irrigation purposes. As a minimum, implement the WSUD strategy as outlined in Attachment I of the master plan.
Consider adopting a higher flood planning level based on an increased rainfall event and sea level rise over and above standard practice.	The master plan documentation includes this as a provision.	This initiative could be included as a proposed planning control for flooding which aims to allow for increased storm intensity resulting from climate change. Draft planning controls could include: **Stormwater and Water Sensitive Urban Design** Controls • The applicable flood planning level for residential, mixed use, and commercial developments shall be the 100 year ARI +15% climate change flood event with 0.5m freeboard.	
Consider green roofing to absorb heavy precipitation and reduce the amount and rate going into drains.	The master plan documentation includes this as a provision. The master plan shows light coloured roofing interspersed with proposed green roofs.	This initiative could be included as a proposed planning control which aims to provide green roofs to 30% of all buildings within the Riverwood Renewal project where possible. Draft planning controls could include: **Communal Open Space** Controls • Green roof spaces should be provided where practical in accordance with the master plan; and • All green roof designs should address roof maintenance and servicing, security, visual and acoustic privacy and wind impacts.	
Consider increasing on site attenuation for improved flood neutrality (linked to this could be WSUD considerations, attenuated parking lots, etc).	The master plan documentation includes this as a provision. Stormwater retention opportunities are denoted in the landscape plan and tree plantings/new open		This initiative could include a procurement condition as follows: Sustainability Outline how the development will consider more intense storm events

POSSIBLE CCA INITIATIVE	MASTER PLAN ALLOWANCE	SUGGESTED PLANNING CONTROL/OBJECTIVE	POSSIBLE PROCUREMENT CONDITION
	spaces in general are noted.		as a result of climate change. As a minimum, design all buildings for a 15% increase in rainfall intensity.
Consider planting hardy, native tree and plant species that can withstand violent winds and/or root inundation (and ideally drought conditions too). Linked to this, plan adequate setbacks from critical structures in case of trees falling.	The master plan documentation includes this as a provision. The tree palette is native and setbacks are apparent in the master plan.	This initiative could be included as a proposed planning control which aims to provide native plants throughout the Riverwood Renewal project. Draft planning controls could include: **Street Trees and Landscaping** Controls • Native plants should be provided on all north-south streets in accordance with the Indicative Plant Schedule.	
Consider rainwater harvesting for increased water 'independence' for users.		This initiative could be included as a proposed planning control which aims to reduce stormwater runoff generated by the development. Draft planning controls could include: **Stormwater and Water Sensitive Urban Design** Controls • Rainwater harvesting should be included for buildings without a green roof, to minimise stormwater runoff generated by the development and achieve BASIX requirements.	
Increasing development densities to allow for the presence of more open space (thus cooling the immediate environment) and less hardened surface area coverage/sprawl (thus reducing runoff).	The master plan documentation includes this as a provision. The master plan configuration shows a densification of the site with 3-12 storey buildings with a notable increase in open spaces from the present situation. The master plan calculations show an increase of approximately 2,900 dwellings whilst increasing open space area and tree coverage.	This initiative could be included as several proposed planning controls which would provide more open space and tree coverage across the Riverwood Renewal project. Draft planning controls could include: **Street Trees and Landscaping** Controls • Provide a minimum tree canopy coverage of 30%. **Site Coverage** Objectives • To provide adequate setbacks for landscaping, deep soil planting and communal open space. Controls • Building footprints must not exceed 60% of the total combined precinct site area.	This initiative could include part of an overarching procurement condition which would require public domain strengths be demonstrated in a master plan (planning proposal).

9 Conclusion

This report has considered climate change related impacts to the Riverwood Renewal project based on observational data, as well as global and downscaled projections. Based on this, numerous suggestions have been made in response to the range of future impacts. The above implementation plan has been cross referenced and included in master plan documents and planning controls. Procurement conditions will be included in the procurement documentation.

The preferred master plan and accompanying development controls propose to incorporate a significant number of the above initiatives. The extent to which initiatives have been included exemplifies government leadership in an otherwise largely unregulated environment.

The proposed climate adaption initiatives should be further considered during the procurement and future design phases of the project.

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