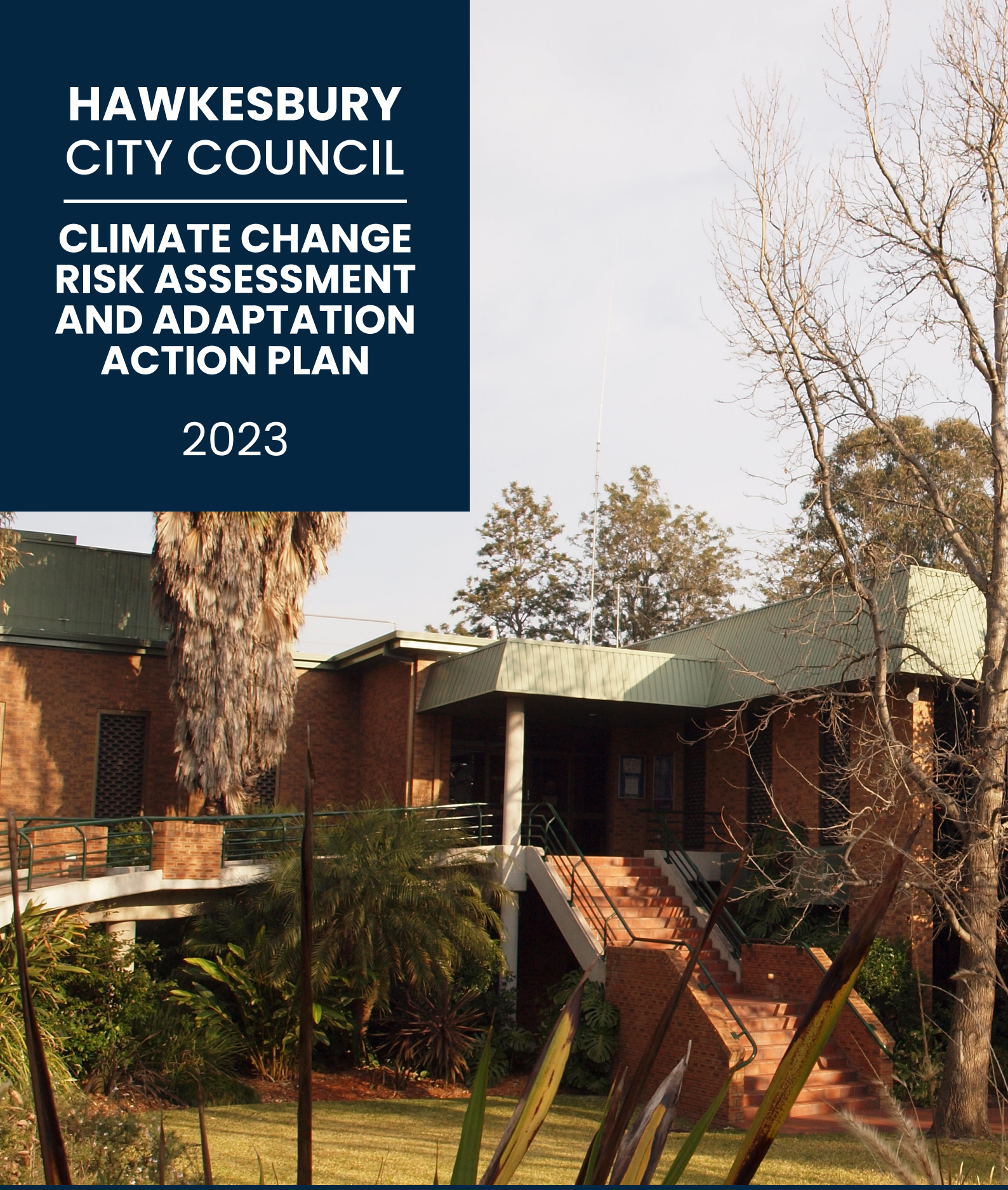
HAWKESBURY CITY COUNCIL

CLIMATE CHANGE RISK ASSESSMENT AND ADAPTATION ACTION PLAN

2023



Hawkesbury City Council

www.hawkesbury.nsw.gov.au

STATEMENT OF COMMITMENT TO FIRST NATIONS PEOPLES

Council acknowledges the Darug and Darkinjung peoples as the Traditional Custodians of the land throughout the Hawkesbury.

Council recognises the continuing connection of First Nations people to their Country and respects the cultures and histories of Aboriginal and Torres Strait Islander peoples as the first peoples of this land.

IMAGE CREDIT: DESTINATION NSW

Contents

Glossary

BAU = Business as usual
BoM = Bureau of Meteorology
CMIP = Coupled Model Intercomparison Project
CSIRO = Commonwealth Scientific and Industrial Research Organisation
DPE = NSW Department of Planning and Environment (formally DPIE, Department of Planning, Industry and Environment)
ENSO = El Niño Southern Oscillation
GCM = General Circulation Model
GOVT = Government
HCC = Hawkesbury City Council
IPCC = Intergovernmental Panel on Climate Change
IT = Information Technology
LGA = Local Government Area
NARCLiM = NSW and Australian Regional Climate Modelling
RCPs = Representative Concentration Pathways
SAM = Southern Annular Mode
UNDRR = United Nations Office for Disaster Risk Reduction
WSROC = Western Sydney Regional Organisation of Councils

Executive Summary

The need for a systems-based approach to climate change

This Climate Change Risk Assessment and Adaptation Action Plan (the Plan) provides a foundation and reference point for Council to discuss, negotiate and continuously review their approach to responding to climate risks.

As the floods of 2021 and 2022 and Black Summer bushfires made starkly apparent, the rate of change and uncertainties mean that Council must plan for the long term while still recovering from the immediate impacts of recent extreme weather events. Business as usual is no longer an option; urgent transformation to reduce exposures and vulnerabilities to climate hazards is needed. Planning for that needs to start now.

While this Plan follows on from and incorporates elements of Council's original adaptation plan from 2016 and risk assessment from 2012, it presents a new way of dealing with the increasing and complex impacts of climate change. The aim is to enhance Council's adaptive capacity, rather than respond to or "treat" risks individually. Consistent with the Climate Change Risk Ready NSW Guide, this entails an emphasis on the strengthening of Council's ability to manage complex risks that interact in different ways over time and under uncertain circumstances. This also entails a focus on those aspects of climate risk that are in Council's direct control.

This Plan takes a systems-based approach to climate risk assessment, focusing on the complex and cascading adverse consequences that may impact Council's service delivery and capacity to progress the community's vision and aspirations as set out in the Hawkesbury City Council Community Strategic Plan 2022-2042. A systems approach considers the interrelationships between assets, activities (e.g. community events, programs and support services) and people (staff) that produce valued services for the community, and the consequences of a changing climate and extreme weather events for Council's integrated and coordinated provision of these valued services.

The risk assessment informs the identification of adaptation measures that are foundation of the adaptation plan. The measures directly address Council's specific exposures and vulnerabilities and foster improved resilience in Council.

The implementation of this Plan will integrate with other key strategies, including but not limited to Council's Enterprise Risk Management Framework (in drafting), Net Zero Emissions and Water Efficiency Strategy and the Resilience Strategy (in drafting), in providing a whole of Council approach to continuously plan for and respond to the climate risks identified in this Plan.

Understanding climate risk

The basis for this Plan is an understanding of climate risk as defined as: "*when a hazard creates the potential for negative consequences due to the exposure and vulnerability of human or ecological systems. These consequences can include impacts on lives, livelihoods, health and wellbeing, economic, sociocultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species*"[1]

'Climate risk' refers to the potential for adverse consequences from a climate related hazard.[2] Climate related hazards include drought, heatwaves, bushfires, storms that bring wind and hail, extreme rainfall, flooding, storm tides and sea level rise. These hazards can have adverse consequences on livelihoods and economies, ecosystems and natural assets, social and cultural services, health and wellbeing and infrastructure.

In technical terms, adverse consequences arise when assets, activities or people are exposed to a climate related hazard and are particularly vulnerable[3] to its affects. (See Appendix 1 for a glossary of climate related concepts).

As shown in Figure 1, ''climate risk'' is a result of interaction of climate related hazards (e.g. extreme weather events such as drought, storms, heat, floods and fires); exposure (e.g. what ''gets in the way of the hazard"); and vulnerability of human and natural systems (e.g. what make the impacts from the events worse).

As climate hazards are very difficult to control, this Plan focusses on those aspects of climate risk that are within Council's control: exposure and vulnerabilities of services.

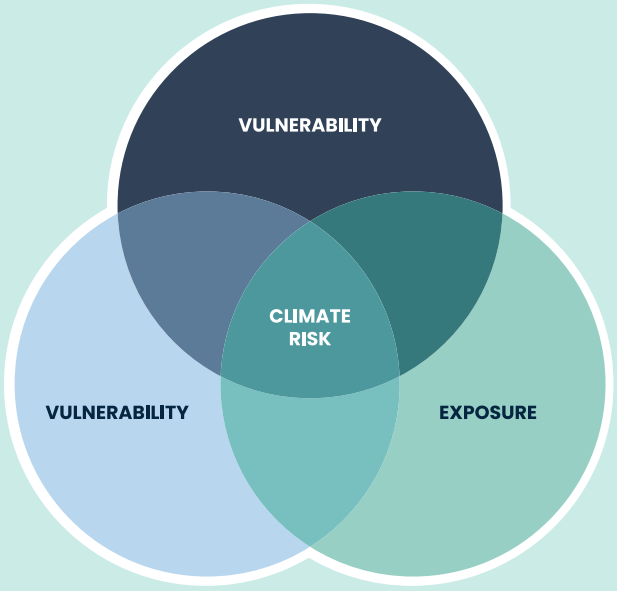


Figure 1 Climate Risk conceptualisation
(adapted from IPPC)

Climate risks are closely related to disaster risks. Disaster risks arise from exposure and vulnerability to current hazards in the present day, whereas climate risks emerge from exposure and vulnerability to more severe and frequent climatic events that are likely to occur in close succession in the future. Understanding and managing climate risks proactively now is essential to avoiding future disaster costs, which are estimated to almost double over next 40 years.[4]

As Australia and other regions around the world have experienced more extreme climate related events, and disaster losses have increased significantly, the focus of climate risk assessment has increasingly shifted.

It is now understood that "*risk assessment and management in the context of climate change* ***requires a comprehensive, systemic perspective on risk and its underlying drivers*** *due to the complex and partly systemic nature of climate-related risks" (UNDRR 2022, page 4). The Climate Risk Ready NSW Guide notes that the increased uncertainties about the precise nature, timing and effect of climate changes ''reinforce the need for an* ***adaptive management approach*** *that utilises evidence as it becomes available to maximise risk management and adaptation outcomes over time (DPIE 2020, page 19)*". (Our emphasis).

While the potential adverse consequences of climate risk are at the forefront of adaptation planning, it is important to emphasise that proactive action to manage climate risks also offer significant opportunity. Many of the changes that need to be made to prepare for climate change impacts can bring other benefits too, in building a strong economy, valuing and protecting environment and history, and creating a great place to live.

A changing climate

Rising temperatures, changing rainfall patterns, higher frequency of extreme fire weather days and extreme weather events are increasing as a result of climate change and these trends are predicted to continue for at least several decades.[5] The most recent (2021) report of the Intergovernmental Panel on Climate Change (IPCC) provides new estimates of the chances of crossing the global warming level of 1.5°C in the next decades, and finds that unless there are immediate, rapid and large scale reductions in greenhouse gas emissions, limiting warming to close to 1.5°C or even 2°C will be beyond reach.[6] This will result in further changes with temperatures and extreme weather we have not experienced before.

Extreme weather events brought about by climate change can impact all aspects of lives and livelihoods in the Hawkesbury. With projected increases in temperatures and number of days where maximum temperatures will reach or exceed 35°C in the Hawkesbury, risks associated with heat as well as drought and bushfires will have profound impacts on the whole of the community and hence significantly put pressure on Council service provision. Heat is an often underrated hazard however has some of the most profound impacts on quality of life and mortality.[7]

Similarly, the risks and likely impacts of storms and floods have been, and will continue to be, significant and carry significant implications for Council that require urgent attention to long term planning. The NSW Flood Inquiry (2022) found that if a flood of an historical scale and similar to the largest flood in Hawkesbury's history (in 1867) were to occur today in the Hawkesbury-Nepean Valley, some 90,000 people would require evacuation from across the catchment, with hundreds of residents being unable to safely evacuate. Approximately 15,500 dwellings in the catchment would flood, with an estimated damages bill of $9 billion.[8] The report identifies specific flood ''hotspots'' in the Hawksbury LGA which can become isolated ''flood islands'' when roads are inaccessible. These include Windsor, Richmond, Bligh Park and McGraths Hill.

With the majority of Council services and facilities located on the south side of the Hawkesbury River, this division significantly exposes Council to climate risks; the community is essentially ''divided by the river'', with the community to the north of the river or in flood hotspots being unable to access essential services.

Council's role

Council plays a fundamental role in helping address some of the economic and social impacts of climate risks, for example by reducing disruptions to public services such as waste management, facilitating transportation access across the region, providing urban spaces that enable refuge from hazards such as heat, and protecting the valued natural places that the community uses to gather, connect, and form strong social bonds.

Council also plays an important role in coordinating preparedness, response and recovery initiatives through facilitating contact and bringing different stakeholders together in disaster planning. The focus in this Plan is on the adaptation measures, with disaster planning being the focus areas of the Resilience Strategy (in drafting) and Enterprise Risk Management Framework (in drafting) which this Plan sits alongside.

In 2019, Council resolved that:

"Council recognises that we are in a state of climate emergency that requires urgent action by all levels of government, that human induced climate change represents one of the greatest threats to humanity, civilisation, and other species and that it is still possible to prevent the most catastrophic outcomes if, and only if, societies take emergency action."

It is important to note, that during the preparation of this plan Council already has been undertaking changes to improve preparedness, response and recovery initiatives, including migrating our corporate IT systems to the cloud, and the development of an Environmental Sustainability Strategy and Resilience Strategy (in drafting).

Compounding and cascading impacts on Council services

Climate change hazards (e.g., floods, fires, heat waves, storms and drought) are rarely experienced as discrete events, neatly disrupting 'business-as-usual' one by one with a return to normality in between. Since the original adaptation plan was prepared in 2016 to the time of writing of this Plan (January 2023), the Hawkesbury LGA experienced several major natural disasters, including drought, heat, bushfires, storms and floods, compounded by the outbreak of COVID-19 in 2020. Recovery from previous events was still underway as new hazard events set in. The lived experience in the Hawkesbury LGA is one of compounding events, occurring in close succession, which has the effect of exacerbating and accentuating impacts.

Similarly, cascading impacts significantly magnifies the overall consequences resulting from an extreme climate related weather event. For example, when critical infrastructure such as electricity and telecommunications fail, Council's digital and information platforms that support service areas are likely to experience disruption (unless adequate backup measures are in place). Similarly, any failure of bridges across the Hawkesbury River will have cascading effects on Council service delivery as the network of Council owned roads on the northern side of the river becomes inaccessible from the south.

Impacts may also cascade from one service area to another within Council; for example, repeated cancellation of community events may undermine social capital which in turn may increase demands on Council for emergency assistance during events. Or persistent flooding impacts to parks and gardens may have implications for planners in providing climate resilient urban spaces as overflows from sewage treatment works and public toilets shut parks and gardens, and closures to roads limits access for regular waste collection.

The frequency and severity of the climate events experienced by Council to date has had profound and lasting effects on the economic, environmental, and social wellbeing of the community and natural environment. They have also placed increased external and internal financial, social, and cultural pressures on Council as an organisation. The events of recent years have led to an increase in demand for Council services, whilst Council has simultaneously experienced a significantly increased cost burden, both in financial and human resources terms. During the engagement for this Plan, staff reported on the impacts to mental health and wellbeing as a result of the frequent and severe climate events.

Overview of climate risks and key adaptation measures

Figure 2 on page 13 provides a summary of the climate risk assessment and the identified intermediate consequences and climate risks. These form the basis for identification of adaptation measures and actions, as described on pages 54-62 of this Plan. The key adaptation measures to respond to the identified risk and intermediate consequences are listed in the text box below (specific actions are identified in pages 54-62 of this Plan).

The key adaptation measures are:

- **M1** Relocate critical Council services
- **M2** Improve organisational governance, planning and processes for climate risk management
- **M3** Assess and accelerate progress on implementation of selected adaptation measures identified in Hawkesbury City Council's prior plan (Climate Change Adaptation Action Plan – Planning for Climate and Natural Hazards, 2016)
- **M4** Build partnerships and advocacy capacity
- **M5** Strengthen 'supporter' and 'facilitator' activities
- **M6** Improve green and blue infrastructure across the region

CLIMATE HAZARDS

Highly variable weather conditions with extremes, seasonality, and intensity of weather events necessitating adaptive planning for both very dry/hot and very wet weather patterns

- **Storms, wind & lightning** Increasing frequency
- **Flooding** More extreme events
- **Drought** Prolonged periods of dry weather
- **Heatwave** Increased temperatures and more hot days over 35 degree
- **Bushfires** More extreme and longer bushfire season

EXPOSURES

- Activities
- Assets
- People

VULNERABILITIES

- Reliance on critical infrastructure
- Divided by the river
- Service design and standards
- Council capacity
- Community knowledge and expectations

IMMEDIATE CONSEQUENCES

1.1 Closure of physical sites due to debris or pollutants, or unsafe operating limits

1.2 Closure of river crossings leading to isolation of one side of the river from service provision

1.3 Cancellation of outdoor work and services

1.4 Shut down of services due to critical infrastructure failures

2.1 Stress and fatigue from community pressures, complains and litigation with increasing climate events

2.2 Increasing staff absences as a result of physical illnesses from smoke, pollutants, disease vectors, heat-stress conditions

2.3 Lower morale from larger workloads and other intermediate impacts

3.1 Increasing repair and replacement costs due to asset damages

3.2 Rising costs of insurance and loss of insurance

3.3 Increased costs of maintenance, reduced asset capacity and asset life

3.4 Costs of re-scheduling projects and 'business-as-usual acitivities' extra administration, contract variations, and staffing

3.5 Rising costs of fines for regulation breaches and remediation costs

3.6 Increase in costs associated with litigation

4.1 Increased event management, clean-up assistance, and waste collection and management for the community

4.2 Additional development applications for rebuilds and more frequent revisions and updates to strategic plan and associated overlays

4.3 More patronage of pool, library, museum as heat refuges

4.4 Reliance on Council for water supplies

CLIMATE RISK

1. Disruption to Council Services

2. Declining workforce wellbeing and productivity

3. Increased costs of service provisions

4. Extra demand per capita for Council services

Decline in quality of Council services

Compromised ability to meet objectives in Community Strategic Plan

1. Great place to live
2. Protected environment and valued history
3. Strong economy
4. Reliable Council

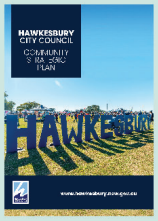


Figure 2 Overview of climate risks

Introduction

Background

Previous climate change risk planning

Council has been active in climate change risk management for more than a decade. In 2012, Council developed a climate risk assessment report, *Planning for Climate and Natural Hazards – Risk Assessment* (GHD, 2012). The purpose of the study was to Identify and assess the risks that a changing climate may pose to Council meeting its legislative and strategic objectives as well as aspirations set out in the Hawkesbury Community Strategic Plan 2010-30. The report also identified nine adaptation planning themes and approaches.

In an extension of this initial study, Council developed the *Planning for Climate and Natural Hazards – Adaptation Action Plan in 2016* (Cardno, 2016), where adaptation actions were structured into the nine themes originally identified in the risk assessment.[9] These plans have been considered in undertaking the current risk assessment and formulating the new adaptation plan.

This Plan

This new plan considers risks to Council services holistically and identifies a new suite of adaptation measures that addresses the overall capacity of the system to manage climate risks (vis a vis identifying and treating individual risks individually). To do this, it has been necessary to reframe the structure and theming originally put forward in the 2012 risk assessment and followed through in the 2016 action plan. While both reports have been considered during the development of this Plan, the theming and focus area have changed. It should also be noted that a formal review of progress in implementing the 2016 adaptation plan has not been conducted but is identified as an action in this Plan.

Scope

Council services are the means through which Council is able to influence achievement of the long term objectives in Council's Community Strategic Plan. Clearly focusing on what can Council control, as opposed to what Council can influence, and what Council has concern for, is a critical part of climate risk assessment. It is also consistent with the Climate Risk Ready NSW Guide which understands climate risk as '*the effect of uncertainty on organisational objectives from acute and chronic climate change*' (page 72 of the Climate Risk Ready NSW Guide).

The diagram below from the City of Sydney's Adapting for Climate Change strategy (2016) illustrates Council's spheres of influence.

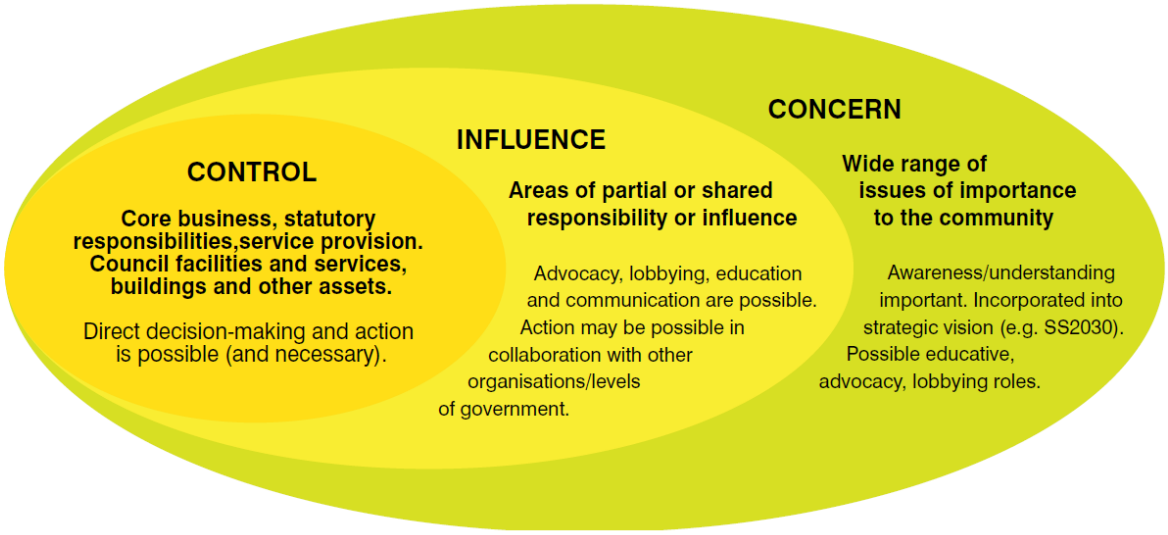


Figure 3 Council spheres of influence (source: City of Sydney)

The scope for this Plan is defined to Council's service delivery and does not consider risks to the community or the environment.[10] There are three reasons for this:

1. Ability to control risks

The focus of this Plan is on climate related risks where Council has direct control (its service delivery).[11] Community wellbeing, liveability, biodiversity, natural and cultural heritage, and the economy are at risk from a changing climate and remain a priority for Council. The pathway through which councils have control over the climate related risks to these outcomes is through delivery of their services, ranging from planning and development to community events and programs, from parks and gardens to local transportation networks, from natural assets portfolios and programs to major project delivery. This approach to climate risk assessment and management is known as an 'impact pathways' approach.[12]

2. Criticality for society's functioning

Council services are critical to support the activities and overall health and wellbeing of residents, businesses, and visitors across the region as well as protect the natural environment and enhance biodiversity. Council activities are foundational to the services upon which others depend. For example, businesses rely on well connected transport networks; the wellbeing of residents, visitors and ecosystems is dependent on effective waste services; cleverly planned and designed urban spaces foster and support the social engagement that generates social cohesion and capital; and parks and gardens, community events and arts and cultural services a key in making the region a great place to live.

3. Opportunities for transformation and innovation

A focus on Council service delivery overall, rather than e.g. a focus on defending or delivering assets, encourages a focus on opportunities for innovation and transformation in responding to the complexity of climate risks and continuously changing circumstances. It directs attention to the value Council provides to the community through coordinated and integrated services, and to the need to maintain and improve that value through creative and diverse service design and delivery models, rather than e.g. protection of individual assets for their own sake.

Some important climate risks which are out of the direct control of Hawkesbury City Council, such as the risk of declining river ecosystem health, will have significant cascading impacts on Council services, such as through reduced quality of parks and gardens recreation spaces. These have been captured as vulnerabilities (as causes of risks to Council services) only in so far as they can be directly attributed to specific intermediate consequences for Council services.

Policy Context

Climate change adaptation and mitigation requires a collaborative approach across each level of government, and between different stakeholders and the community. Each level of government (international, national, state and local levels) have developed their own response to climate change. At a local government level, the Community Strategic Plan (CSP), Resourcing Strategy and Delivery Program are key guiding documents for climate change adaption planning and implementation. Developed on the basis of the community's long term aspirations for the future of the LGA, the CSP is the guiding strategic document for Council's service delivery and is therefore critical in terms of understanding and identifying potential impacts of climate change. The ten year Resourcing Strategy, the four year Delivery Program, and the annual Operational Plans provide the avenues for funding and implementing Council projects and actions, including the adaptation actions identified in this Plan.

Key policy and strategy documents for each level of government are shown in Figure 4 below. This is not an exhaustive list but provides an overview of key strategies and plans that provide specific direction for Hawkesbury's climate change adaptation planning.

Figure 4 Key policy context documents

Method

Basis for the risk assessment approach

The compounding and cascading nature of climate risks calls for a systems-based approach to climate risk assessment and adaptation planning that considers:

- how assets, activities and people interact in a coordinated and integrated manner to produce valued services for the community, and
- the consequences of a changing climate for these valued services.

A systems-based approach contrasts with previous standard climate risk assessment methods, which fundamentally tend to rest on an understanding of climate risk as being a direct result of exposure of (tangible and physical) assets and infrastructure to individual hazards. However, as assets alone do not produce valued services, activities and people must also be taken into account to provide a holistic view of the interdependencies between assets, activities and peoples in delivering a service to the community. For example, staff must conduct maintenance and upgrade activities for roads, bridges, and drainage networks, deliver community events in parks and gardens, maintain historical buildings, the library and museum, and provide crucial information services on significant regional issues, and increasingly utilising critical infrastructure managed by third parties. Many Council services also rely upon other Council services, creating interdependencies between different service areas.

Similarly, previous asset focused climate risk approaches have tended to limit their focus to asset based adaptation responses (e.g., building/upgrading roads, seawalls etc). However, protecting assets in-situ may not reduce risks to Council services if staff remain exposed to hazards, such as environmental pollutants or heat, at levels that require service shutdown for workplace health and safety reasons. Further, upgrading or retrofitting assets in-situ, such as parks or associated roads, may be counterproductive if it encourages continued use of high exposure areas by vulnerable community members, and therefore increases the demand on Council during emergencies or prolonged periods of chronic hazards (such as drought).

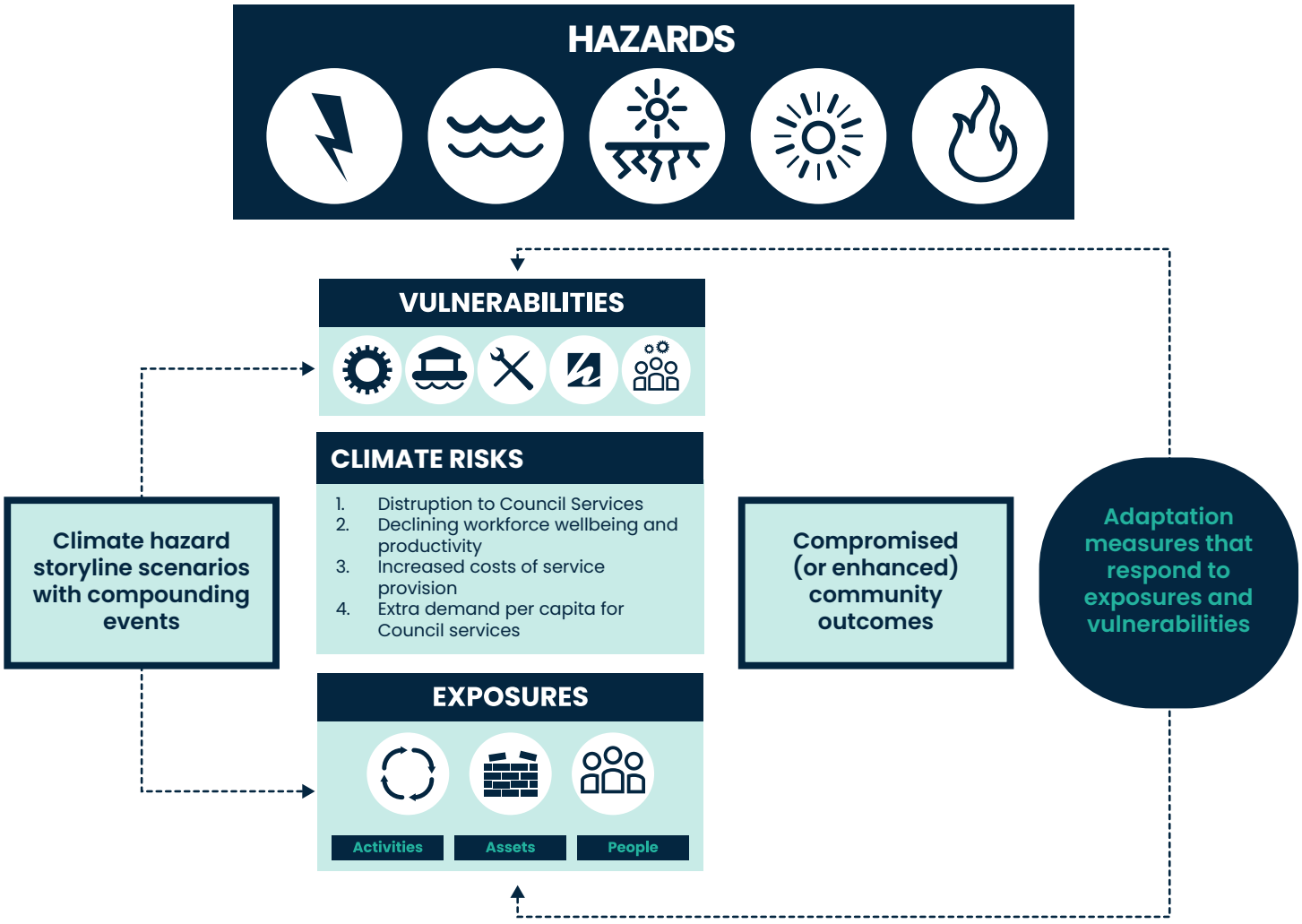
It should also be noted that the focus on (physical/structural) asset based solutions tend to limit climate related planning focus to flood related impacts, as it is during floods that the most structural damage to buildings tend to occur (over e.g., damages caused by heat, drought, storms or even fires), with these risks then drawing more attention from insurance companies to policy makers. The recent Uninsurable Nation – Australia's Most Climate-Vulnerable Places cautions against being blindsided by flood risks and asset based solutions: "*[…whilst extreme heat has killed more Australians than all other natural hazards combined (Coates et al. 2014; Coates et al. 2022), extreme heat does not significantly affect the structural integrity of buildings. Likewise, although declining rainfall in some parts of Australia will significantly affect agricultural yields and ecosystems, it will have a marginal impact on the structural integrity of buildings.*[13]

The risk assessment for this plan therefore considers the high level potential consequences of climate hazards for Council services, identifying the main categories of potential consequences that are most likely to impact Council's ability as an organisation to deliver these valued services to the community and drive the implementation of the Community Strategic Plan (2022 - 2042) and other strategic documents that set direction for overall service delivery.

The four key Outcome areas for overall Council service delivery are defined in the Community Strategic Plan. These outcome areas will all be affected if Council's ability to adapt and respond to climate change risks is not enhanced:

- Community Outcome 1: Great Place to Live
- Community Outcome 2: Protected Environment and Valued History
- Community Outcome 3: Strong Economy
- Community Outcome 4: Reliable Council

Figure 5 provides an outline of our approach to applying the systems-based approach to the Hawkesbury, described further below.[14]



STEP 1: HAZARDS
Understanding climate hazard projections in the Hawkesbury context

STEP 2: COMPOUNDING RISK SCENARIOS
Based on climate projections, development of storyline scenarios, illustrating compounding events that may plausibly occur in the region

STEP 3: SPATIAL TOOL
Development of interactive mapping tool.

STEP 4: ENGAGEMENT
Based on risk scenarios and spatial tool, engagement with internal and external stakeholders to identify vulnerabilities and exposures

STEP 5: RISK ANALYSIS AND EVALUATION
Based on stakeholder input and research, qualitative evaluation of intermediate consequences to indentify priority risks to Council's service delivery

STEP 6: ADAPTATION MEASURES
Defining adaptation measures for Council to address the complex and compounding climate risks in a systemic way, focusing on addressing vulnerabilities and exposures

Figure 5 Applying the systems-based approach to the Hawkesbury

Step 1:

Understanding climate hazard projections in the Hawkesbury region

An initial desktop study was conducted to understand the key climate hazards and climate projections in the Hawkesbury region, including extreme rainfall (and floods), storms (rain/hail/wind), drought, heatwaves and bushfires. The consultancy Climate Comms was contracted to provide expert advice on the climate science to inform the risk assessment and engagement. The study incorporated climate projections from Global climate models (GCMs) and dynamically downscaled regional climate models for Australia (i.e. NARCLIM 1.0) for high (RCP8.5) and low (RCP4.5) emission scenarios where available. Inclusion of climate projections from a wide range of climate models and multiple emission scenarios provides a broad range of sampling of the future climate change space. A summary of the suite of data portal and climate model outputs used in this study is summarised in Table 1 in Appendix 2 and a short description of the GCMs provided in the text box below.

About Global Climate Models

Global climate models (GCMs) are essential for investigating climate change[a], but their coarse spatial resolution scale limits their capability for climate adaptation planning at the regional scales. The coarse spatial resolution (~200 km horizontal grid) of a GCM does not resolve local factors that influence regional climate in the Hawkesbury region, such as complex topography (e.g. higher rainfall on the eastern slopes of the Great Dividing Range), land/sea contrasts (e.g. sea breeze) and convective processes (e.g. thunderstorms) [b]. Regional climate models (e.g. The NARCLiM project) with increased spatial resolution (~10 km horizontal grid) and improved representation of topography and land/sea interactions are used to dynamically downscale a subset of GCM models[a].

In regions such as the Hawkesbury where local factors strongly influence climate, downscaled models can improve the regional climate projects. However, due to the large computational requirements of downscaling, only a limited number of GCMs (<5 models) are used to produce the downscaled results which reduces the range of uncertainty in plausible projected change suggested by the ensemble of GCMs (>30 models)[b]. It is also important to consider the ability of GCMs to represent large scale climate drivers that influence temperature and rainfall variability in the Hawkesbury region, such as El Niño Southern Oscillation and the Southern Annular Mode when considering near future (up to 2050) climate hazards.

Step 2:

Compounding risk scenarios (storylines) and timeline

The future climate projections, in combination with historical information on climate and hazard events specific to the Hawkesbury region, were used to develop five future plausible climate hazard event scenarios and timeline for use in the risk assessment. The scenarios incorporated descriptions of the plausible high level spatial exposure of the Hawkesbury region to potential future flooding, drought, bushfires and extreme heat. These short qualitative storyline scenarios, written with specific references to the Hawkesbury region, were used in Step 4 in engagement to support stakeholders to imagine relevant local futures of personal relevance and identify potential impacts to Council specifically. An associated timeline of recent climate extremes and plausible future events was developed to enable stakeholders to consider compounding impact variability in extremes (e.g. rapid/frequent change between dry and wet periods), which reflects the current and plausible climate future in the Hawkesbury region. The scenario development was led by Climate Comms, with input from Mosaic Insights, Alluvium Consulting and Council project staff. The scenarios were used for the engagement with internal and external stakeholders during the development phase of the Plan and are not included in this document.

Step 3:

Spatial tool development

The climate projections, past extreme events and plausible future climate scenarios formed the basis for the development of an interactive spatial tool to help inform engagement. The spatial tool included base layers to show current asset data relating to infrastructure, facilities, land use as well as data relating to the recent (March 2022) flood event (See also Appendix 3 for list of data sources). The spatial tool included a recording function whereby participants could draw polygons (colour coded into the assets, activities and people categories) and enter specific detail, using a survey form regarding identified localised risks. A full list of datasets used in the spatial tool is available in Appendix 3. Initial concept maps to indicate plausible hotspots and stimulate further discussion is provided in Appendix 4. It should be emphasised that while informed by scientific climate projections (NARClim) the concept maps only represent one interpretation.

Step 4:

Engagement for risk identification

Engagement with internal and external stakeholders to support risk identification was conducted in several sessions using both the climate hazard event scenarios and the interactive spatial mapping tool. Systems mapping activities were undertaken with a wide range of Council staff from all major functional service areas to identify the relevant potential impacts to Council services now and in the future, as well as the locally specific exposures and vulnerabilities of the Hawkesbury Local Government Area that result in these potential impacts. Inter-service area discussions enabled the gathering of data on compounding and cascading potential impacts throughout Council and assisted in understanding interdependencies between Council service areas.

The spatial mapping tool was used to elicit information about geographical hotspots of potential impacts, as well as information on impacts, exposures and vulnerabilities for people and activities that are dynamic in the landscape (as well as assets, which are static). The stakeholders included:

- Internal stakeholders: Council staff from across all major functional service areas including, waste management, resource recovery, infrastructure services, cultural services, parks and recreation, strategic planning, corporate services and governance, regulatory services, building services, resilience and emergency, and community planning and partnerships.
- External stakeholders, including State Emergency Services, Police, Royal Australian Air Force, NSW Ambulance, St John Ambulance NSW, Nepean Blue Mountains Local Health District, Health/Western Sydney & Nepean Blue Mountains Sector, Endeavour Energy, Local Land Services, Department of Planning and Environment, Transport for NSW, Sydney Water
- Hawkesbury's Local Emergency Management Committee

Step 5:

Risk analysis and evaluation

Data from the desktop review and engagement was analysed to identify patterns of potential impacts experienced within and across service areas. Rather than focusing on single hazard impact chains (as in 'risk from bushfire', seen as a discrete issue), the focus was on understanding multiple hazard events, processes, and trends with compounding and cascading impacts that have shared intermediate consequences for the system as a whole. Key exposures and vulnerabilities that drive each intermediate consequence category were identified. Intermediate consequences combine to produce potential consequences for the quality and reliability of Council service provision in several key categories, expressed as key risks.

Best practice climate risk assessment has moved away from traditional risk matrices that rate risks by likelihood and consequence because it is "often difficult, impossible, or simply not appropriate to describe the likelihood of a consequence" (UNDRR, p62[15]), for complex adverse consequences. Instead, a qualitative evaluation of intermediate consequences was undertaken for prioritisation using materiality, scalability and strategic importance as the primary criteria, as outlined in the Climate Risk Ready NSW Guide, to support a systems based approach. Materiality considers whether there is significant impact on delivery of critical services, scalability prioritises potential consequences that affect multiple areas of the organisation, and strategic importance considers whether the potential consequences affect key areas of the organisation. Geographical hot spots of exposure were also considered using the spatial mapping.

Step 6:

Identification of adaptation measures

The development of the adaptation action plan was based on the risk assessment conducted in the prior steps. The identification of adaptation measures was driven first and foremost by reducing the causes of climate risks to Council services. This involved selecting measures that address the exposures and vulnerabilities identified as significant risk drivers for Council specifically. A direct line of sight between risks and measures is necessary to have confidence that activities will generate desired risk reduction outcomes. Council's various roles as outlined in the Hawkesbury Community Strategic Plan (p23) were considered to identify actions that can be undertaken primarily by Council versus those which will require Council to work closely with others.

The time horizon over which each adaptation measure manages climate risks was a second key consideration in its selection. For example, asset retrofitting measures may be suitable to manage some climate risks in the short term. However, as the climate continues to change and extreme hazard events become more frequent, especially in the medium longer term, retrofits will not be sufficient to reduce risks to a tolerable level in areas where exposure becomes severe. Considering the 'lifespan' of adaptation options helps to avoid a narrow focus on adaptation measures that only address short or medium term risks. The aim is to ensure Council is not 'locked in' to intolerable levels of risk in the longer term.

The third principle applied to the selection of adaptation measures was the requirement for a diverse range of options to manage risk, spanning 'hard' solutions such as technologies and infrastructure as well as 'soft' measures such as education and capacity building and land-use policy. Consistent with the Climate Risk Ready NSW Guide, organisational improvements to governance processes were considered as integral aspects of strengthening adaptive capacity.

A fourth and final lens was applied in considering adaptation options, focusing on whether the adaptation measure fosters resilience in Council systems. Council cannot mitigate all climate risks. Capacity to cope, and to adapt to changing risks into the future, must be a key pillar of Council's approach to adapting its services to a changing climate. The following six principles of resilient enterprises identified in the Harvard Business Review[16] were used to identify if and how the adaptation measure may contribute to building resilience as a Council.

1. Diversity – a range of different responses to avoid catastrophic failure from over reliance on one measure;
2. Modularity - a structure that allows part of the system to fail without the whole system collapsing;
3. Redundancy – slack or extra capacity in the system, allowing the organisation to adjust to extra loads as events occur;
4. Adaptability – built in flexibility that enables the organisation to learn through trial and error;
5. Prudence – measures that foster a precautionary and risk informed approach to decision making;
6. Embeddedness - alignment of the goals and activities of the organisation with others on which it is dependent, and which dependent on it.

Finally, each adaptation measure was categorised using the typology in the Climate Risk Ready NSW Guide, as shown in the text box below (source: Climate Risk Ready NSW Guide, page 53).

Types of adaptation actions

Adaptation actions may range from incremental to transformational, and may include simple improvements to an organisation's adaptive capacity, to major infrastructure projects that require significant lead time for planning and design. Commonly used categories of adaptation actions include:

- **no/low regrets or win/win options** are low risk responses that deliver economic benefits and should be implemented as a priority
- **accommodate** the risk by including provisions that reduce the consequence of impacts
- **retreat**, for example by relocating assets and people to safe areas
- **defend** existing and new structures against climate change affected hazards using largely structural measures, and
- **co-exist or adapt** through a combination of innovative measures including planning (Sinay and Carter 2020).

Climate hazards and projections

The main climate hazards in the Hawkesbury region include storms, floods, droughts, heatwaves, and bushfires. These climate hazards are influenced by multiple climate variables, including daily minimum and maximum temperature, rainfall, wind speed and relative humidity. Figure 6 below provides a summary of projected climate change variables and their impact on climate hazards for the Hawkesbury.

Changes in the extremes of these climate conditions are more important than mean climate changes for understanding climate hazards and determining climate risk to Council services. This section describes climate variability before outlining the observed and projected changes in temperature, rainfall and fire weather.

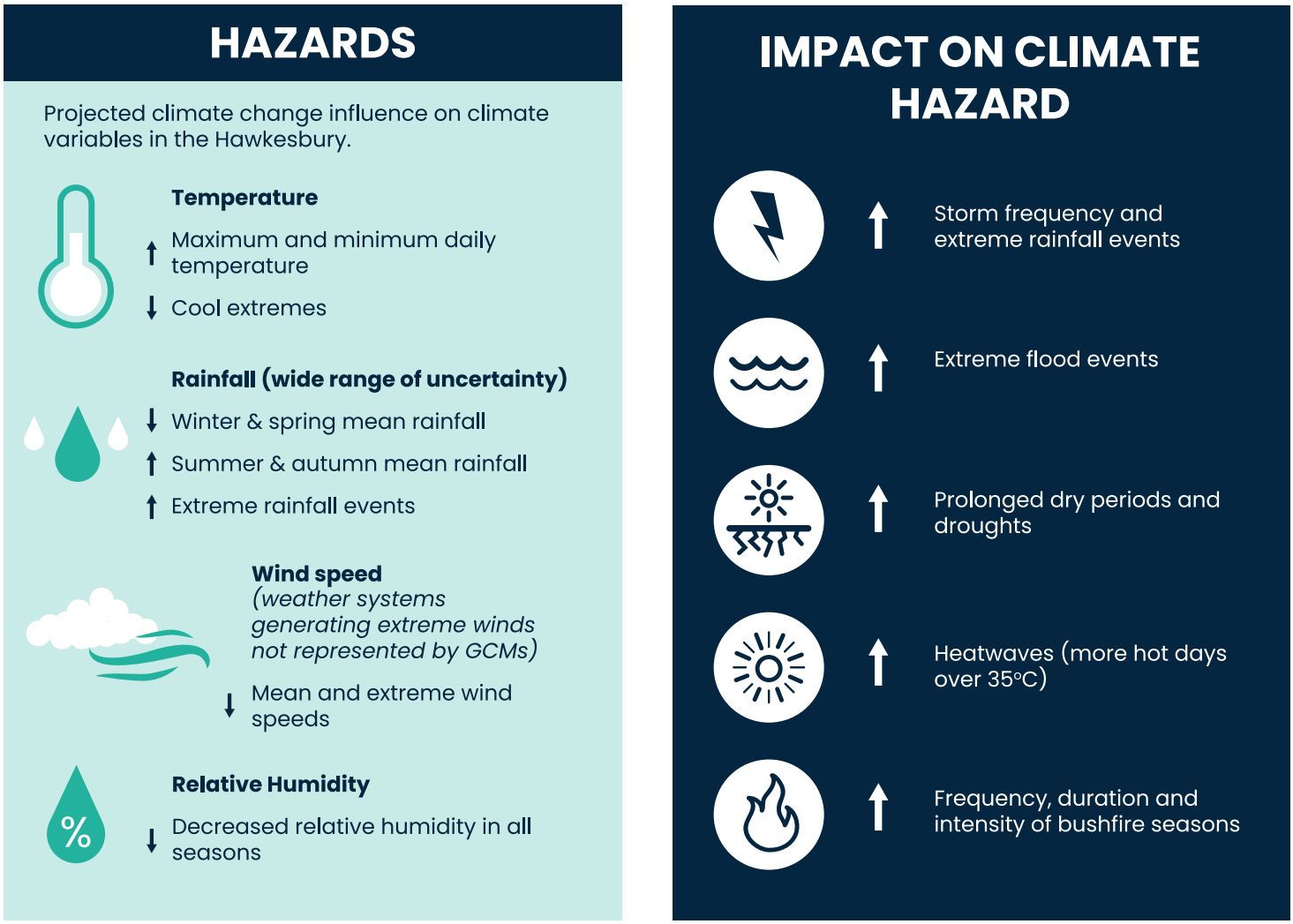


Figure 6 Summary of projected changes in climate variables and climate hazards in the Hawkesbury / eastern Australia region (sourced from results from NARCLiM, CSIRO/BoM and IPCC summary reports)

A highly variable climate

The climate of the Hawkesbury region is highly variable over seasonal, interannual and decadal timescale due to large scale climate drivers such as the Southern Annular Mode, El Niño Southern Oscillation and the Interdecadal Pacific Oscillation. In conjunction with these modes of natural climate variability, observed and projected changes in climate due to greenhouse gas emissions are increasing the frequency, duration and intensity of climate hazards. The combined influence of ENSO and climate change on global temperatures has resulted in a La Niña year at time of writing (February 2023), which are usually cooler than El Niño conditions yet warmer than an El Niño year in the 1980's (Figure 7; State of Climate, 2022).

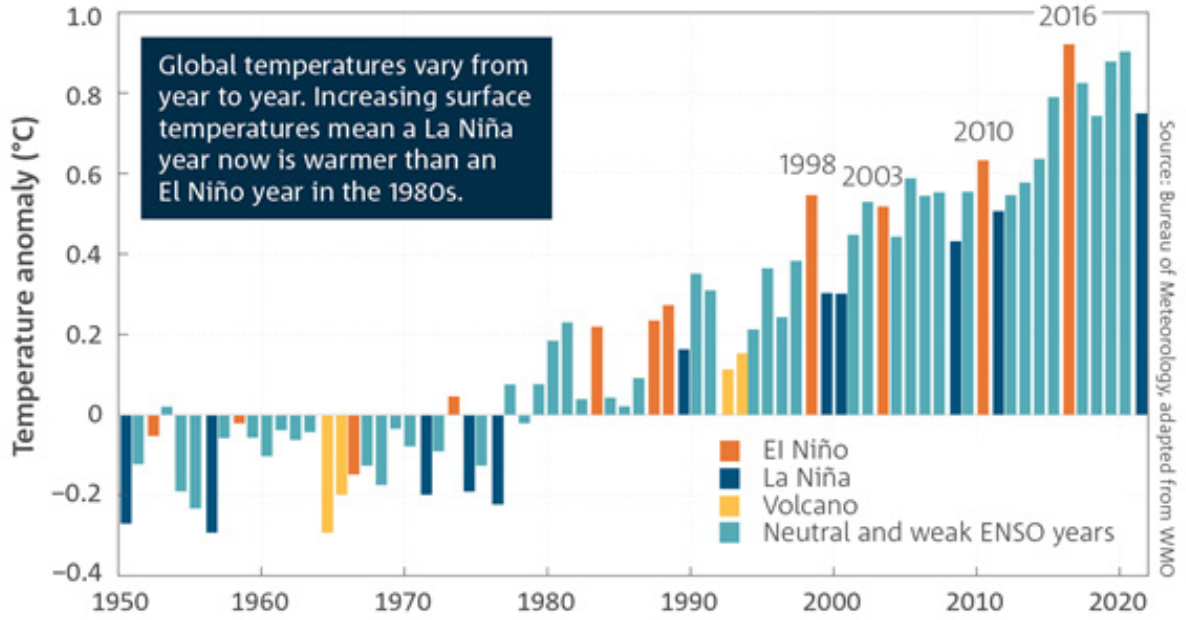


Figure 7: Annual global surface temperature anomalies (land and ocean) from 1950-2021 (anomalies calculated based on climate standard period: 1961-1990). Major tropical volcanic eruptions are associated with cooler global temperatures. Strong El Niño events are associated with warmer temperatures, while La Niña typically results in cooler temperatures. Source: State of Climate, 2022; www.bom.gov.au/state-of-the-climate

Significant projected increases in temperature and number of hot days

The average, maximum and minimum temperatures in the Sydney (including Hawkesbury) region are projected to continue increasing due to continued greenhouse gas emissions. Both downscaled climate models (i.e. NARCLiM models) and global climate models (i.e. CSIRO/BoM and IPCC ensembles) project similar increases by 2030 in annual mean daily maximum and minimum temperature and number of days above 35°C (See Table 2 in Appendix 2). It should be emphasised that projections only present various plausible variables and are not certain; and by extension there are different projections on plausible increases in temperatures. While projections may vary, the overall trend is of increasing temperatures and number of hot days for the Hawkesbury.

The NARCLiM 1.0 projections under the RCP 8.5 emission scenario (subset of CMIP3 GCM's) project a lower increase in annual mean daily maximum temperature (+0.3°-1°C) than the ensemble of GCMs used in the BOM/CSIRO Climate Change in Australia projections (CMIP5 GCMs) and the latest CMIP6 GCM ensembles (IPCC Atlas). In comparison, BOM/CSIRO project a +0.7°-1.4°C increase while the latest CMIP6 GCMs project an increase of +0.8°-1.5°C. The NARCLiM 1.0 project and BOM/CSIRO east coast region summary have similar projections for the increase in number of days above 35°C (+5-10 NARCLiM; +5-9 BOM/CSIRO) but are lower than the latest CMIP6 projections (+6-16.6; IPCC Atlas).

These increases are more likely to occur in spring and summer (Figure 8) and geographically focussed over the Hawkesbury and Western Sydney regions. The difference in projected temperature increases is likely due to different versions of GCMs (CMIP3, CMIP5 and CMIP6), downscaled vs global models and the spatial domain used to calculate model average (e.g. NARCLiM 10km grid over the Sydney / Hawkesbury region, BOM/CSIRO over the East Coast NRM cluster and CMIP6 over the IPCC Eastern Australia domain).

Increased intense short-duration rainfall events and high variability

Seasonal and annual rainfall in the Hawkesbury and surrounding regions is highly variable. Over the observational record there is no significant long term trends in seasonal or annual rainfall, however there has been intermittent periods of wetter and drier conditions and an increase in the intensity of short-duration (hourly) heavy rainfall events (State of the Climate, 2022).

Projected seasonal and annual rainfall changes for the Sydney region cover a wide spread of potential changes from 14% drier to 18% wetter (e.g. Figure 9) due to the challenges in modelling weather systems that generate rain in both GCMs and downscaled climate models. The NARCLiM 1.0 (subset of CMIP3 downscaled models) annual mean rainfall projections generally indicate wetter conditions (-14% to +18% change compared to 1986-2005) compared to the drier conditions (-11% to +6%) indicated in the BoM/CSIRO (CMIP5) and IPCC Atlas (CMIP6) projections, likely due to the differences in the projected seasonal rainfall in autumn and winter across the modelling results (Table 2, Appendix 2).

The summer seasonal mean rainfall projections are more consistent across all three modelling result platforms (See Table 2 in Appendix 2). On average, summer and autumn rainfall is projected to increase while winter and spring rainfall is projected to decline. However, it is important to note the large spread in model projections across all seasons (Figure 9) and the dry bias in GCMs over eastern Australia when compared to historical climate (Di Virgilio et al, 2022). There is also high confidence that natural climate variability will remain the major driver of rainfall changes in the next few decades in the Hawkesbury and surrounding regions (20 year mean changes of -15 to +10 annually; Climate Change in Australia, 2015). The above considerations highlight the importance for planning for both wet and dry periods.

The last few years which have switched from very dry and hot to very wet and cool conditions further emphasise the need to plan for both wet and dry extremes despite the uncertainty in future climate change projections.

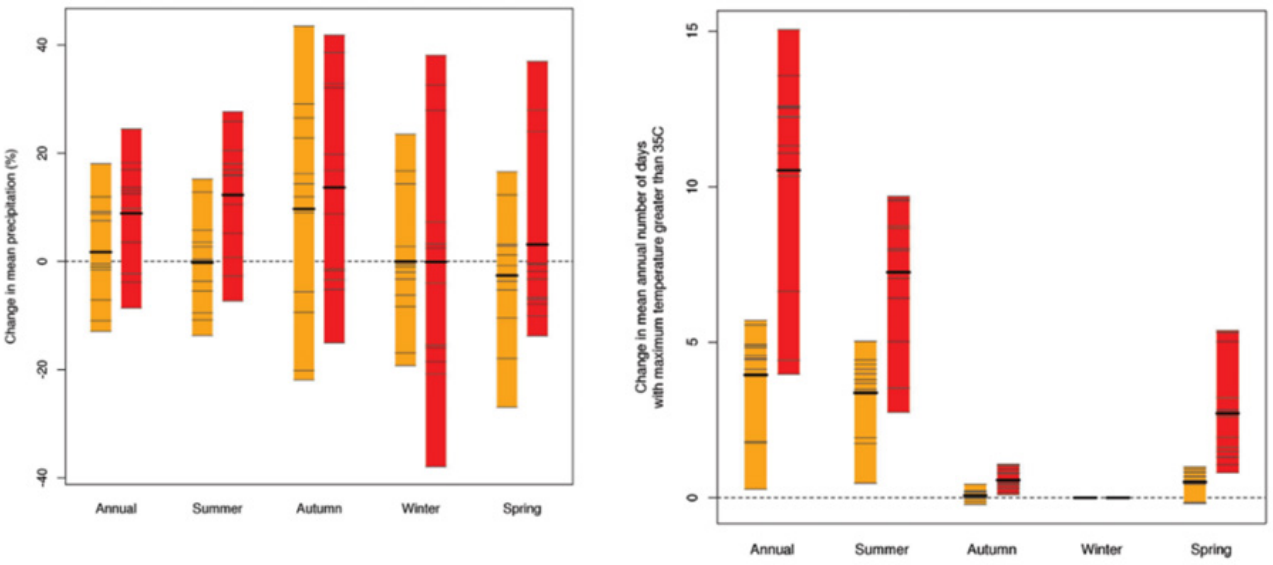


Figure 8: Projected annual and seasonal change in the number of hot days (with daily maximum temperature > 35°C) for the Sydney metropolitan region from the NARCLiM 1.0 project (Source: OEH, 2014).

Regardless of the uncertainty in annual and seasonal rainfall projections, increased extreme rainfall projections are much clearer due to a warmer atmosphere holding more moisture (Figure 9; Sherwood et al, 2010). The amount of moisture the atmosphere can hold increases by 7% per degree of warming. This relationship is projected to cause increased likelihood and intensity of heavy rainfall events as the atmosphere continues to warm, even if the seasonal or annual average rainfall in the region is expected to decrease. This will lead to a complex mix of effects on streamflow, and associated flood and erosion risks, including increased risk of small scale flash flooding. (State of the Climate 2022).

Annual mean maximum daily rainfall is projected to increase in the Hawkesbury region in nearly all models under RCP 8.5 (See Table 2 in Appendix 2). Additionally, the projected increase in extreme rainfall is not linear, with larger extremes (i.e. 5% annual exceedance / 20yr return period event) likely to experience a higher relative change than the annual maximum daily rainfall events (Figure 9).

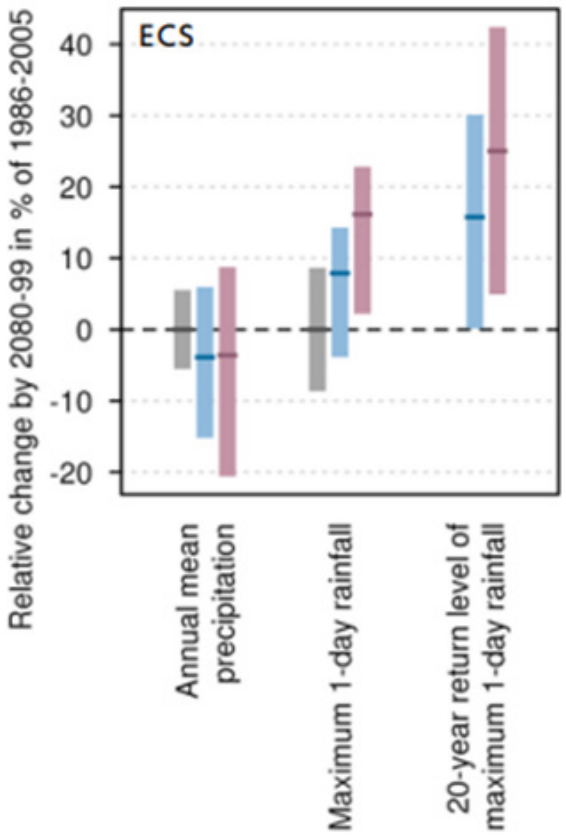


Figure 9: Projected changes in mean rainfall and extreme rainfall (maximum 1 day rainfall and 20-year return period (5% chance in any year) maximum 1 day rainfall) for the east coast south region in the BOM/CSIRO projections. Changes are relative to the 1986-2005 mean. Grey bar represents natural variability, blue is RCP4.5 and purple is RCP 8.5. Source: Climate Change in Australia.

Temperature and rainfall extremes are two of the main climate factors that influence fire weather, along with wind speed and relative humidity. Increased fire danger is associated with high daily maximum temperatures, low rainfall (both recent and prolonged periods of drought), high wind speed and low relative humidity.

The frequency of dangerous fire weather days has increased significantly in recent decades across Australia, with the Hawkesbury region one of the hotspot regions for increased danger. Climate change has contributed to these observed changes in fire weather through its impact on temperature (State of the Climate 2022). The climate change influence on recent severe droughts (e.g. Tinderbox drought; 2017-2019) and lack of rainfall contribution to the Black Summer fires is difficult to disentangle from the considerable year to year variability in rainfall due to large scale modes of climate variability (e.g. ENSO, SAM).

Observed and projected changes in wind speed and relative humidity in the Hawkesbury region are also difficult to determine due to limited temporal data availability. Annual mean windspeed and relative humidity are both projected to decline by 2030 (Table 2, Appendix 2). However, the annual projected decrease in wind speed is unlikely to represent potential changes in wind speed extremes that influence fire weather as this scale of weather systems (e.g. cold fronts) are not resolved in GCMs or downscaled climate models.

Implications for adaptation planning

Despite the inherent uncertainties in climate and weather projections, we can say with confidence that the overall trends and projections show that adaptation planning needs to consider extreme and fluctuating weather events, conditions and seasonality, as well as the compounding and cascading risks associated with different weather events taking place simultaneously or in close succession. Put simply, projections indicate that during periods of hot weather, temperatures are likely to be hotter still, and there are likely to be more days where temperatures are above 35C. Similarly, cold and wet weather patterns and seasons are likely to show decreases in temperatures to even colder conditions as well as plausible increased intensity of rainfall. This means that Council needs to be prepared to plan for extreme heat and drought even during times of cold and wet weather and floods and vice versa. It will be increasingly important to be aware of any ''blind spots'' and consider worst case scenarios that include compounding and cascading risks in ongoing risk monitoring and management.

During staff and stakeholder engagement, scenarios and a timeline of past and plausible events were developed to assist Council in thinking through what plausible future weather events may look like for the Hawkesbury. These scenarios helped inform the risks assessment. The scenarios were developed by Climate Comms and were informed by the climate projections provided in Appendix 2.

Risk assessment

Summary

This section provides the risk assessment completed for the key climate related risks to Council's service delivery.

The climate risks have been identified on the basis of:

- the interplay between climate hazards and major vulnerabilities and exposures
- the impact on key organisational service delivery functions of Council (across activities, people and assets).

The risk assessment for each of the four major risks is provided in more detail in tables below and covers:

- climate risks,
- intermediate consequences, including identification priority
- contributing hazards, and
- major exposures as related to key Council service delivery areas and as per the assets, activities, people categorisation
- vulnerabilities as related to the assets, activities, people categorisation.

An overview of climate risks and intermediate impacts is provided in Appendix 5. The appendix provides additional detail on how the exposures and vulnerabilities have been categorised for the purposes of the risk assessment.

The compounding effect of these climate risks is an overall decline in the reliability and quality of services that Council is able to provide, unless measures are taken to improve Council's adaptive capacity (as described in the following section 'Adaptation Plan').

RISK 1: Disruption to Council services

Risk assessment (Risk 1)

Intermediate Consequences and indicative priority (H/M/L)

1.1 Closure of physical sites. This could be due to debris or pollutants, or unsafe operating limits (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning, bushfire, drought and heat

Major Exposures

Community & Recreation

Assets: Richmond Pool, both libraries, Windsor museum, Council service centre, sporting fields, Hawkesbury Showground, main parks especially Pugh's Lagoon (Smiths Park) Richmond, Governor Phillip Park Windsor, Macquarie Park Windsor; community halls

Infrastructure & Property

Assets: Council depot

Waste & Environment

Assets: HCC landfill, temporary transfer station at Richmond Rd, sewage treatment plants and related infrastructure McGraths Hill, Pitt Town, Windsor, South Windsor, public toilets, animal shelter

Major Vulnerabilities

Service design and standards

Activities	People	Assets
Legacy policies allowing continued land use and development in hazard prone areas	N/A	Landfill, sewage treatment works and public toilets not designed to avoid overflow/leaching in floods/ droughts
		Age and conditions of buildings, infrastructure, facilities and assets

Intermediate Consequences and indicative priority (H/M/L)

1.2 Closure of river crossings leading to isolation of one side of the river from service provision (high priority)

Contributing Hazards

Rainfall, floods and fire

Major Exposures

Community & Recreation

Assets: Richmond Pool, both libraries, Windsor museum, Council service centre all on one side of the river only

Activities: Community events, workshops, support services such as community transport

Infrastructure & Property

Assets: Main Council offices and Council depot only on one side of the river

Activities: Maintenance repairs and upgrades on one side of the river

Waste & Environment

Assets: Access to HCC landfill and temporary transfer station at Richmond Road

Activities: Waste collection, especially the western side of the river

Major Vulnerabilities

Reliance on critical infrastructure

Activities	People	Assets
Limited river crossings; one road in one road out	N/A	N/A

Divided by the river

Activities	People	Assets
Staff don't live on the same side of the Hawkesbury River	Centralised workforce in admin building on southern side of the Hawkesbury River	Single Council depot, landfill, service centre; assets located on the southern side of the river

Intermediate Consequences and indicative priority (H/M/L)

1.3 Shut down of services due to critical infrastructure failures (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning, heat and drought

Major Exposures

Only a very small number of assets and activities are supported by backup power, telecommunications, and water; the rest remain exposed.

City Planning & Corporate Services

Activities: Council payments and receipts; digital and information platforms; work-from-home

Major Vulnerabilities

Reliance on critical infrastructure

Activities	People	Assets
Limited river crossings; one road in one road out	Working from home as a resilience strategy limited by internet/power failures and lack of staff phones	Limited/ if any power backup for administration and many operations

Intermediate Consequences and indicative priority (H/M/L)

1.4 Cancellation of outdoor work and services (medium priority)

Contributing Hazards

Heat, drought and flood

Major Exposures

Community & Recreation

Activities: Outdoor community events; maintenance of parks and gardens

Infrastructure & Property

Activities: Maintenance, repairs, upgrades

Waste & Environment

Activities: Environmental works

City Planning & Corporate Services

Activities: Site visits

Major Vulnerabilities

Reliance on critical infrastructure

Activities	People	Assets
Limited river crossings; one road in one road out	N/A	Insufficient water security measures to avoid asset losses in drought

Service design and standards

Activities	People	Assets
Timing of national/ international events inappropriate for Hawkesbury climate	Temperatures may be beyond human tolerance	N/A

RISK 2: Declining workforce wellbeing and productivity

Risk assessment (Risk 2)

Intermediate Consequences and indicative priority (H/M/L)

2.1 Stress and fatigue from external pressures/complaints/litigation due to increasing climate events (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning and bushfire

Major Exposures

All staff

Major Vulnerabilities

Service design and standards

Activities	People	Assets
State/Federal Government constraints on planners' ability to manage risks	N/A	N/A
Council boundaries not reflective of risk and management scales needed (e.g. need for regional coordination)		
Insufficient info/guidance to manage/balance specific multi hazard risks (e.g. urban heat /storms)		

Community knowledge and expectations

Activities	People	Assets
Community risk reduction, preparedness and sustainability low in part due to repeated cancellation of Council and other education events	Differing needs and diverging opinions on priorities (e.g. for service delivery or asset protection services)	N/A
Low levels of social capital and social cohesion with more frequent events and disruptions to Council services, especially cultural and community services	Managing external expectations regarding capacity of Council, e.g. waste management, landfill, cooling of public spaces	

Intermediate Consequences and indicative priority (H/M/L)

2.2 Lower morale from larger workloads and other intermediate impacts (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning, heat and drought

Major Exposures

All staff

Major Vulnerabilities

Reliance on critical infrastructure

Activities	People	Assets
Resilience not integrated clearly into Council systems, policies, procedures	Inadequate spare staff capacity to manage changing workloads and shifting priorities	Inadequate disaster risk reduction budget, stuck in recovery cycle, so not prepared to build back better
Procurement bottlenecks and time delays in approvals for work	Many council staff also part of emergency services	Assets managed by 3rd parties - limited Council control
Limited resources to apply for, and manage any State Government grant opportunities	Effects on staff morale	
	Use of smaller suppliers with limited resilience and reliance on contractors, especially for clean up	

Intermediate Consequences and indicative priority (H/M/L)

2.3 Increased staff absences as a result of physical illnesses from smoke, pollutants, disease vectors, heat stress conditions (medium priority)

Contributing Hazards

Heat, drought and floods

Major Exposures

All staff but especially those in manual and outdoor jobs

Major Vulnerabilities

Service design and standards

Activities	People	Assets
Legacy policies allowing continued land use and development in hazard prone areas	Staff accustomed to dressing for cool weather rather than the heat Staff ability to change daily work priorities based on events (e.g. smoke, heat, etc.)	Landfill, sewage treatment works and public toilets not designed to avoid overflow/ leaching in floods/droughts Age and conditions of buildings, infrastructure, facilities and assets ('tin sheds' not suitable to retrofit with air con)

RISK 3: Increased costs of service provision

Risk assessment (Risk 3)

Intermediate Consequences and indicative priority (H/M/L)

3.1 Increasing repair and replacement costs due to asset damages (bridges, roads, stormwater, buildings, sports fields, parks and gardens, historical, cultural, and natural assets) (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning, bushfire and drought

Major Exposures

Community & Recreation

Assets: Richmond Pool, both libraries, Windsor museum, Council service centre, sporting fields, Hawkesbury showground, main parks especially Pugh's Lagoon (Smiths Park) Richmond, Governor Phillip Park Windsor, The Terrace Carpark Windsor, Macquarie Park Windsor; community halls

Infrastructure & Property

Assets: Locally administered road network and stormwater infrastructure

Waste & Environment

Assets: HCC landfill, temporary transfer station at Richmond Road, sewage treatment plants and related infrastructure; public toilets, animal shelter; other natural and historical assets

Major Vulnerabilities

Service design and standards

Activities	People	Assets
Legacy policies allowing continued land use and development in hazard prone areas	N/A	Age and conditions of buildings, infrastructure, facilities and assets
Criticality of access to, and timing of, disaster preparedness and response information		Low levels of regulating and supporting ecosystem services due to direct environmental impacts from hazards
Insufficient capacity to complete repairs before next event happens, amplifying damages		
Insufficient info/guidance to manage/balance specific multi hazard risks e.g. urban heat/storms		
State/Federal Government constraints on planners' ability to manage risks		
Council boundaries not reflective of risk and management scales needed (e.g. need for regional coordination)		

Council capacity

Activities	People	Assets
N/A	N/A	Insufficient operational budget to cover asset damages; reliant on recovery funding

Intermediate Consequences and indicative priority (H/M/L)

3.2 Rising costs of insurance and loss of insurance (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning and bushfire

Major Exposures

Community & Recreation

Assets: Richmond Pool, both libraries, Windsor museum, Council service centre, sporting fields, Hawkesbury showground, main parks especially Pugh's Lagoon (Smiths Park) Richmond, Governor Phillip Park Windsor, The Terrace Carpark Windsor, Macquarie Park Windsor; community halls, Council owned/managed bushland

Infrastructure & Property

Assets: Locally administered road network and stormwater infrastructure

Waste & Environment

Assets: HCC landfill, temporary transfer station at Richmond Rd, sewage treatment plant and related infrastructure; public toilets, animal shelter; other natural and historical assets

Major Vulnerabilities

Service design and standards

Activities	People	Assets
Legacy policies allowing continued land use and development in hazard prone areas	N/A	Age and conditions of buildings, infrastructure, facilities and assets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Intermediate Consequences and indicative priority (H/M/L)

3.3 Increased costs of maintenance, reduced asset capacity and asset life, including environmental works such as pest and weed management and restoration of failed revegetation (high priority)

Contributing Hazards

Heat and drought

Major Exposures

Community & Recreation

Assets: Richmond Pool, both libraries, Windsor museum, Council service centre, sporting fields, Hawkesbury showground, main parks especially Pugh's Lagoon (Smiths Park) Richmond, Governor Phillip Park Windsor, The Terrace Carpark Windsor, Macquarie Park Windsor; community halls

Infrastructure & Property

Assets: Locally administered road network and stormwater infrastructure

Waste & Environment

Assets: HCC landfill, temporary transfer station at Richmond Rd, sewage treatment plant and related infrastructure; public toilets, animal shelter; other natural and historical assets

Major Vulnerabilities

Council capacity

Activities	People	Assets
Resilience not embedded into Council systems, policies, procedures e.g. asset management framework	Inadequate spare staff capacity to manage changing workloads and shifting priorities	Inadequate disaster risk reduction budget, stuck in recovery cycle, so not prepared to build back better
Lack of inventories of asset characteristics to inform climate risk management planning	Use of smaller many suppliers with limited resilience and reliance on contractors	Assets managed by 3rd parties – limited Council control
Tyranny of distance, large physical area to service		

Major Vulnerabilities

Service design and standards

Activities	People	Assets
Insufficient info/guidance to manage/balance specific multi hazard risks e.g. urban heat/ storms	N/A	Age and conditions of buildings, infrastructure, facilities and assets
Council boundaries not reflective of risk and management scales needed (e.g. need for regional coordination)		Low levels of regulating, supporting, and cultural ecosystem services due direct environmental impacts from hazards

Intermediate Consequences and indicative priority (H/M/L)

3.4 Costs of rescheduling projects and 'business-as-usual activities', extra administration, contract variations, and staffing (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning, bushfire, drought and heat

Major Exposures

All **activities** listed as exposed in the table for Risk of disruptions to Council services

Major Vulnerabilities

Council capacity

Activities	People	Assets
Inability to fully mitigate disruptions to Council services	Inadequate spare staff capacity to manage changing workloads and shifting priorities	Inadequate disaster risk reduction budget, stuck in recovery cycle, so not prepared to build back better
	Use of smaller many suppliers with limited resilience and reliance on contractors	Assets managed by 3rd parties – limited Council control

Intermediate Consequences and indicative priority (H/M/L)

3.5 Rising costs of fines for regulation breaches and remediation costs (low priority)

Contributing Hazards

N/A

Major Exposures

Waste & Environment

Assets: HCC landfill, sewage treatment plant; stormwater infrastructure

Major Vulnerabilities

Service design and standards

Activities	People	Assets
N/A	N/A	Landfill, sewage treatment works and public toilets not designed to avoid overflow/leaching in floods/droughts

Intermediate Consequences and indicative priority (H/M/L)

3.6 Increase in costs associated with litigation, especially relating to planning and development decisions (low priority)

Contributing Hazards

N/A

Major Exposures

This risk results from the exposure of private assets rather than Council owned assets

Major Vulnerabilities

Service design and standards

Activities	People	Assets
Legacy policies allowing continued land use and development in hazard prone areas	N/A	N/A
Insufficient info/guidance to manage/balance specific multi hazard risks e.g. urban heat/storms		

Intermediate Consequences and indicative priority (H/M/L)

4.1 Increased event management, clean up assistance, and waste collection and management for the community (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning and bushfire

Major Exposures

This risk results from the exposure of private assets rather than Council owned assets

Major Vulnerabilities

Community knowledge and expectations

Activities	People	Assets
Community risk reduction, preparedness and sustainability low in part due to repeated cancellation of Council and other education events	Differing needs and diverging opinions on priorities (e.g. for service delivery or asset protection services)	N/A
Low levels of social capital and social cohesion with more frequent events and disruptions to Council services, especially cultural and community services	Unrealistic expectations from community regarding capacity of Council, e.g. waste management, landfill, cooling of public spaces	

Intermediate Consequences and indicative priority (H/M/L)

4.2 Additional development applications for rebuilds and more frequent revisions and updates to strategic plan and associated overlays (high priority)

Contributing Hazards

Rainfall, floods, storms, wind, lightning and bushfire

Major Exposures

This risk results from the exposure of private assets rather than Council owned assets

Major Vulnerabilities

Service design and standards

Activities	People	Assets
Legacy policies allowing continued land use and development in hazard prone areas	N/A	N/A
Insufficient info/guidance to manage/balance specific multi hazard risks e.g. urban heat/storms		
State/Federal Govt constraints on planners' ability to manage risks		
Council boundaries not reflective of risk and management scales needed (e.g. need for regional coordination)		

Intermediate Consequences and indicative priority (H/M/L)

4.3 Increased patronage of pool, library, museum as heat refuges (medium priority)

Contributing Hazards

Heat

Major Exposures

This risk results from the exposure of private assets rather than Council owned assets

Major Vulnerabilities

Council capacity

Activities	People	Assets
Lack of information on demand changes to inform climate risk management planning	Inadequate spare staff capacity to manage changing workloads and shifting priorities	Age and conditions of buildings, infrastructure, facilities and assets
Resilience not embedded into Council systems, policies, procedures to manage demand spikes		
Insufficient operational budget to manage demand increases		

Intermediate Consequences and indicative priority (H/M/L)

4.4 Reliance on Council for water supplies (low priority)

Contributing Hazards

Drought

Major Exposures

This risk results from the exposure of private assets rather than Council owned assets

Major Vulnerabilities

Community knowledge and expectations

Activities	People	Assets
Community risk reduction, preparedness and sustainability low in part due to repeated cancellation of Council and other education events	Differing needs and diverging opinions on priorities (e.g. for service delivery or asset protection services) Unrealistic expectations from community regarding capacity of Council, e.g. of regarding provision of potable water	N/A


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Adaptation Action Plan

For Council to reduce climate risks to its services, it must address the **exposures and vulnerabilities** of its assets, activities and people that make a significant contribution to its risks. It is not within Council's control to reduce the climate hazards it will face. A collective global effort is required to reduce emissions to halt the changes to the global climate system that are causing the current and projected changes in climate hazards for the Council's commitments to emissions reduction are articulated in the *Net Zero Emissions and Water Efficiency Strategy* (2021) and the *Environmental Sustainability Strategy* (in draft, 2023). Similarly, Council has already committed in the 2022-2023 Operational Plan a range of actions to reduce greenhouse gas emissions under the goal of *2.6.1 Implement strategies to achieve Council's net-zero emissions targets*.

Six key adaptation measures have been identified to reduce Council's key climate risks through a reduction of exposure and vulnerability. The overarching measures are listed in the text box below and outlined in the following tables, which provide further actions to address each measure. In the tables, the reference to 'advocacy', 'supporter' and 'facilitator' roles in measures 4. and 5. is a reference to Council's roles as described on page 23 of the Community Strategic Plan.

The key adaptation measures are:

- **M1** Relocate critical Council services
- **M2** Improve organisational governance, planning and processes for climate risk management
- **M3** Assess and accelerate progress on implementation of selected adaptation measures identified in Hawkesbury City Council's prior plan (Climate Change Adaptation Action Plan – Planning for Climate and Natural Hazards, 2016)
- **M4** Build partnerships and advocacy capacity
- **M5** Strengthen 'supporter' and 'facilitator' activities
- **M6** Improve green and blue infrastructure across the region

How to read the action plan

The adaptation action plan has been laid out as outlined below in Figure 10. An explanation of each column is provided in this section. Notes have been provided for each of the risk areas in the Explanatory text.

Adaptation Measure	Priority Actions	Risks addressed	Exposures or vulnerabilities addressed	Type and Timeline	Resilience Principles Addressed	Lead agency (Council to determine)
Explanatory text						

Figure 10. example layout of the adaptation action plan

Adaptation Measure – outlines the adaptation measure. The selection of measures has been completed in a way that is important to ensure that Council is not 'locked in' to actions that could constrain Council's capacity to adapt into the long term in the face of uncertainty.

The plan includes a mix of measures acknowledging the need for both incremental and transformational changes in the region. It acknowledges that Council will not be working 'from a blank slate' and must make changes in the context of existing settlement patterns that are a legacy of historical development.

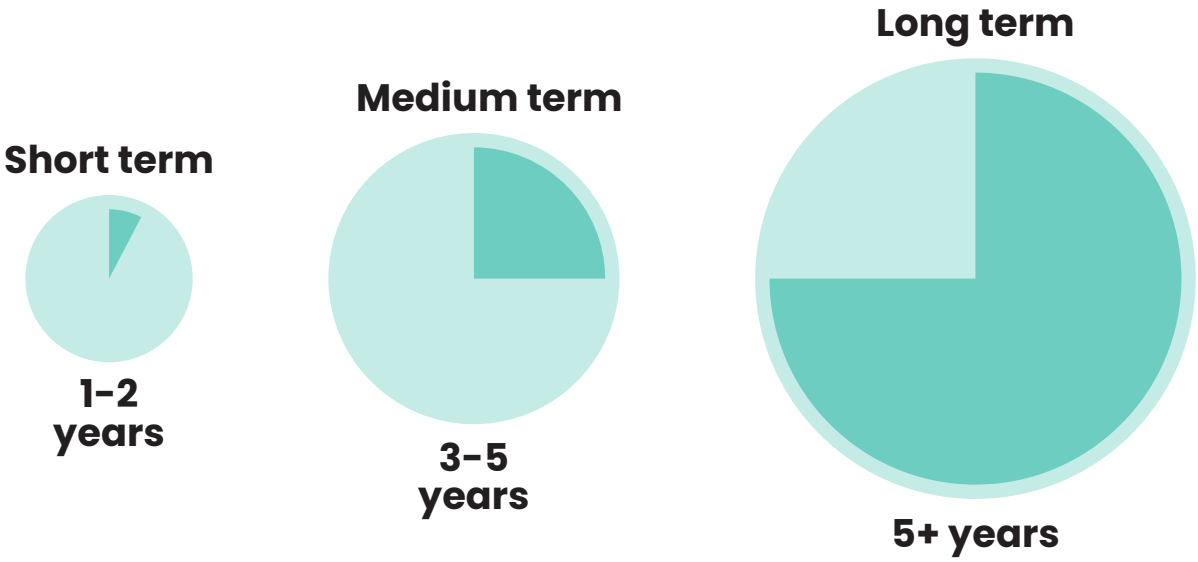
A final resilience lens was applied in selecting the adaptation measures. In contrast to considering risk reduction, the aim of applying a resilience lens was to identify which features of systems known to be associated with improved ability to cope and capacity to adapt would be supported by the adaptation measure.

Priority Actions – provides the priority actions for each adaptation measure. Progress against implementing these actions will need to be monitored and evaluated, and the priority actions updated to ensure continued progress towards fully implementing the overall adaptation measure over time.

Risks addressed - identifies the specific key risks that the measure will help to address, although it should be noted that each adaptation measure only addresses some aspects of those risks.

Exposures or vulnerabilities addressed – outlines whether the measure addresses exposure or one or more of the five main categories of vulnerabilities. Looking down this column, it is evident that all six adaptation measures are needed to address the five main categories of vulnerabilities. A systems based approach highlights that ignoring any one of these categories of vulnerability will make it difficult to achieve the reduction in risks necessary to meet Council's objectives for quality, reliable services as outlined in the Community Strategic Plan.

Type and Timeframe – provides an indicative timeline (short/medium and long term) of action commencement and to suggest duration of the undertakings. All measures need to commence as a matter of urgency; however, the timeframe provides a realistic action plan. Measures that are classified as short or medium term may be important to continue in the long term but will not be sufficient to manage the scale of climate risks that may emerge under climate change projections.



Resilience Principles Addressed – includes the NSW Climate Risk Ready Guide's commonly used categories of adaptation actions to note whether the adaptation measure is a low regrets/win-win, accommodate, retreat, defend or coexist/adapt solution.

Lead agency – outlines the service area within Council to be leading the implementation of the measure and actions, noting that all measures require a whole of Council approach (see Section 6).

Adaptation Measure	Priority Actions	Risks addressed	Exposures or vulnerabilities addressed	Type and Timeline	Resilience Principles Addressed	Lead agency (Council to determine)
M1 Relocate critical Council services	M1.A1 Commission a project to identify priority services for relocation, including considering the interdependencies between different Council services (e.g. community events held in river frontage parks and garden) M1.A2 Commission a project to investigate options to decentralise Council services at multi purpose sites, including 'pop-up' options for less asset intensive services, distributed across both sides of the river (based around outcomes of the relocation project) M1.A3 Location, design and construction of future Council assets should consider avoidance to mitigate the impacts of flooding. Where it cannot be avoided, consideration should be given to observance of relevant legislation, policies or guidances to minimise the impacts of flooding.	Risk of disruptions to Council services Risk of increased cost of service provision Risk of declining workforce wellbeing and productivity Risk of extra demand per capita for Council services	Exposure	Retreat Medium-Long Term	Modularity Prudence	

Council's service provision is currently centred in the southern part of the region, around the parts of the Hawkesbury River most heavily exposed to riverine flooding and heat (see concept maps in Appendix 4). The magnitude of consequences from future rainfall/flooding hazards in this area is considered extremely significant (NSW Flood Inquiry 2022). The size and scale of flooding hazards, which present one of the greatest concerns, cannot be mitigated by Council (due to the nature of the hazard as well mitigation decisions and response measures being determined by third parties such as utilities). In addition, increasingly severe, frequent and longer duration heat hazards are also of particular concern for this area within the region, noting that the Hawkesbury Local Emergency Management Plan 2017 prioritises risk from current present day heatwave hazards as 'Extreme'.

Stakeholders reported that the cost of historical asset damages alone is already very significant for Council, even without information on the cost of service disruptions, pushed back workstreams etc, and without considering worsening hazards with climate change. Recovery funding is critical yet is reportedly frequently delayed or inconsistent. Even if external funding is secured the management of recovery activities and projects places pressure on Council staff to coordinate and monitor these whilst continuing BAU activities.

Engagement identified that the age and condition of many assets in this area would make them extremely expensive to retrofit to reduce vulnerability to any significant extent (if at all possible, in some cases), especially when considering the multiple hazards relevant in this area, noting that to retrofit for flooding of the extent that already occurs requires a different suite of measures to the asset retrofits needed to reduce vulnerabilities to heat hazards. In addition, even if assets could be retrofitted to reduce asset damage from rainfall/flooding as a primary hazard, this would still leave significant risks to workforce wellbeing from direct heat exposure as the climate changes, as well as potential disease vectors and environmental pollutants common with flooding, and the likelihood of necessary service closures to minimise risks to the community using Council services.

This adaptation measure will reduce overall climate risk by addressing exposure of Council assets, activities and people and is consistent with the findings from the 2022 NSW Flood Inquiry. Though the time horizon is long, it is critical that planning for relocation commences as a matter of urgency.

Adaptation Measure	Priority Actions	Risks addressed	Exposures or vulnerabilities addressed	Type and Timeline	Resilience Principles Addressed	Lead agency (Council to determine)
M2. Improve organisational governance, planning and processes for climate risk management	M2.A1 Undertake a high level governance project to review organisational goals, responsibilities, processes and systems for managing climate risks including monitoring and evaluation and accountability and transparency mechanisms M2.A2 Incorporate climate and disaster workforce management into Councils Workplace Flexibility policies and procedures M2.A3 Develop a database of existing asset inventories for climate related risk management. Once developed, identify decision making steps at which these databases will be used to improve adaptation measures. M2.A4 Establish a backup and/or shared services supplier list and review standard procurement procedures and contract terms to enable greater flexibility to manage events and shifting business as usual schedules M2.A5 Establish database of disaster costs that includes service disruption, staffing etc across all service areas to inform future service redesign	Risk of disruptions to Council services Risk of increased cost of service provision Risk of declining workforce wellbeing and productivity	Vulnerabilities: - Service design and standards - Council capacity	Coexist/ Adapt Short-Medium Term	Adaptability Prudence	

Council's self assessment of its climate risk management maturity using the Climate Risk Ready NSW Guide tools identified scope for improvement across all four aspects of climate risk management, from establishing context, identifying, analysing and evaluating risk and treating risk, to monitoring and evaluation. This plan acknowledges that developing climate risk management capability takes time and requires continuous improvement. The Implementation section of this Plan suggests recruitment of a climate change coordinator that can drive the process, potentially recruited through external funding.

In light of this, the specific actions for Council have been identified, each responding to a critical vulnerability in service design and standards, or council capacity, that will impede further progress in improving climate risk management capability if they are not addressed. These actions collectively recognise:

- the need for improved whole of Council climate risk governance to reflect the whole of Council nature of the key risks
- proactive workforce management that integrates climate consideration in supporting Council staff, strengthening management capability, and retaining corporate knowledge
- the need for new and improved information to support staff decision making that incorporates climate risk considerations
- the importance of introducing a climate risk lens into Council's relationships with other parties, especially suppliers on which it is critically dependent
- the value of improved data on the costs of climate hazard events to Council services to develop more compelling business cases

Adaptation Measure	Priority Actions	Risks addressed	Exposures or vulnerabilities addressed	Type and Timeline	Resilience Principles Addressed	Lead agency (Council to determine)
M3 Assess and accelerate progress on implementation of selected adaptation measures identified in the prior plan	M3.A1 Conduct an assessment of implementation of measures identified in the 2016 climate change adaptation plan for Council assets and activities, namely: • Provision of off-grid utilities at safe refuge areas and at key Council properties (action 1) • Retrofitting of existing buildings for insulation and cooling (action 4) • Implementation of Water Sensitive Urban Design standards (action 7) • Adoption of fire resilient property standards and installations (action 9) • Erosion control and rehabilitation of watercourses (action 12) • Water quality monitoring (action 13) • Utilisation of greywater systems (action 15) • Uptake of stormwater harvesting systems (action 16) M3.A2 Develop an implementation plan to accelerate progress on rolling out measures identified in the 2016 Climate Change Adaptation Plan for Council assets and activities, in coordination with the service relocation project M3.A3 Work with NSW Government to identify options to address main risks from the layout of the road network and improved public transport options, in coordination with the service relocation project, noting 2016 plan action 11 was Relocation of key asset crossing locations	Risk of disruptions to Council services Risk of increased cost of service provision Risk of declining workforce wellbeing and productivity Risk of extra demand per capita for Council services	Vulnerabilities: - Reliance on critical infrastructure - Divided by the river - Service design and standards	Defend Accommodate Short-Medium Term	Modularity Redundancy Prudence	
This plan acknowledges the previous 2016 adaptation plan that was prepared for Hawkesbury City Council and the ongoing relevance of many of the adaptation measures identified within. In particular, these measures are aimed at reducing the vulnerability of assets and reducing dependence on critical infrastructure. An assessment of progress on implementing these measures is recommended, alongside a plan to accelerate roll out of these measures, noting that this must be coordinated with the actions under Adaptation Measure 1. Relocate Council services. In addition, it is noted that major vulnerabilities remain due to the limited river crossings, and it is recommended that Council engage with the NSW Government to identify options to address this fundamental issue. Again, this work must be coordinated with the actions within the Plan, and namely under Adaptation Measure 1. Relocate critical Council services.						

Adaptation Measure	Priority Actions	Risks addressed	Exposures or vulnerabilities addressed	Type and Timeline	Resilience Principles Addressed	Lead agency (Council to determine)
M4 Build partnerships and advocacy capacity	M4.A1 Establish cross Council and agency partnerships for climate risk management to: • Invest in research, planning, policy and management framework • Share lessons learned and address cross boundary risks • Develop planning controls consistent across Council boundaries • Identify formal staff sharing arrangements to manage fluctuations in workloads and peak workloads (e.g. such as relating to disaster planning, response and recovery)	Risk of disruptions to Council services Risk of increased cost of service provision Risk of declining workforce wellbeing and productivity Risk of extra demand per capita for Council services	Vulnerabilities: - Service design and standards - Council capacity	Low regrets/ win-win Medium-Long Term	Embeddedness Low-regrets/ win-win	

Vulnerabilities in service design and standards and Council capacity relating to insufficient information and guidance to support climate risk informed decision making by staff are addressed in this adaptation measure. In the engagement for this Plan, Council staff identified a range of specific needs and potential improvements to information and guidance that would greatly improve climate risk management in their services, however they emphasised that in practical terms, the resource investment required to fund projects to fill these gaps is not currently identified in Council's budget and would require external funding. In addition, many of the specific risk issues Council is facing are shared by neighbouring Councils, offering opportunities for achieving synergies and economies of scale of different types of investment. Similarly, decisions made by each Council may affect climate risks and responses in the broader region and hence require a partnership approach.

Collaborating with other Councils on a range of specific climate risk initiatives has the potential to deliver significant benefits to Council for a much lower investment than tackling these issues alone and could enable a wider range of risk reduction measures to be implemented as a consequence. Improved coordination across boundaries is essential for longer term climate risk management and will also enable Councils to have a greater 'voice' in advocating to other levels of government for the resources and support needed to adapt.

Adaptation Measure	Priority Actions	Risks addressed	Exposures or vulnerabilities addressed	Type and Timeline	Resilience Principles Addressed	Lead agency (Council to determine)
M5 Strengthen 'supporter' and 'facilitator' activities	M5.A1 Undertake a community engagement and education program to develop shared understanding of the need for improved planning controls and the processes through which they would help to control risk to both Council services and the community M5.A2 Undertake a community engagement and education program to realign expectations of what Council can and will do and what community members should do – establish as an ongoing rolling program with invites issued automatically to new residents	Risk of declining workforce wellbeing and productivity Risk of extra demand per capita for Council services	Vulnerabilities: - Community knowledge and expectations	Low regrets/ win-win Short-Medium Term	Embeddedness	
Climate risks across the region are not wholly under the responsibility or control of Hawkesbury City Council to manage. Other parties including government agencies, businesses, community groups and residents are also responsible for managing climate risks. Improvements in the climate risk management of these parties will have positive knock on effects for Council by reducing important vulnerabilities relating to community knowledge and expectations. There is therefore a strong case for Council to support and facilitate the development of capacity in others, as acknowledged in the 'Council's Role' section of the Hawkesbury City Council's Community Strategic Plan. In addition, councils, as opposed to other levels of government, have unrivalled knowledge of their communities and the relationships necessary to play these crucial supporter and facilitator roles. Stakeholder engagement identified that there are knowledge imbalances between parties regarding climate risks and the potential tools and strategies for managing these risks at a local level. These imbalances influence expectations and understandings of shared roles and responsibilities for risk prevention, preparation, response and recovery. The two actions above are designed to help address these knowledge imbalances and foster a collaborative approach to region wide climate risk management.					

Adaptation Measure	Priority Actions	Risks addressed	Exposures or vulnerabilities addressed	Type and Timeline	Resilience Principles Addressed	Lead agency (Council to determine)
M6 Improve green and blue infrastructure across the region	M6.A1 Prepare a flood plain management strategy to plan for transition of flood plain public areas to safe, environmentally healthy, and productive community uses that can accommodate repeated and severe flooding. Seek community and Traditional Custodians input to the strategy development to understand cultural and social values and practices associated with the floodplain. M6.A2 Collaborate with Traditional Custodians to integrate cultural burning knowledge into bushfire management planning M6.A3 Apply a climate risk and resilience lens in developing the urban greening strategy and coordinate this with the flood plain management strategy and bushfire management planning developed for actions M6.A1 and M6.A2 above	Risk of disruptions to Council services Risk of increased cost of service provision	Vulnerabilities: - Service design and standards - Divided by the river	Co-exist/adapt Medium-Long Term	Diversity Redundancy	

The Hawkesbury River and its surrounding natural and cultural landscapes are at the heart of the region, defining the historical and ongoing cultural, social and economic fabric of the settlements where the community lives, works and plays.

Given that the first adaptation measure (M1) is focused on relocating critical services away from the highly exposed areas around the river in the southern region of the Council, this adaptation measures provides a balancing set of actions to support continued use of the region's important landscapes, but in a transformational way that responds to long term sustainability and risk management needs. Incorporating and prioritising community and Traditional Custodians' knowledge of this region to develop both a flood plain management strategy and bushfire management strategy is essential to ensure the strategies and plans are aligned with community values. Collaborative engagement with the community will be needed to develop innovative ways to retain connection to these places whilst minimising risks.

In addition, Council has recently commissioned an urban greening strategy and it is recommended that a climate risk and resilience lens is applied in the implementation of this strategy, if adopted. It should also be coordinated with the floodplain management strategy and bushfire management planning to address multi hazards risks in a strategic manner, noting that the problem of managing risks from heat hazards through urban greening without exacerbating risks from storm and bushfire hazards was identified as a significant issue that would benefit from cross Council and agency research partnerships.

Implementation

Located in a region colloquially referred to as "Sydney's bathtub", and with 70% of its land area being bushland, the Hawkesbury LGA is extremely exposed and vulnerable to the effects of climate change, and namely flood and heat hazards. As recognised in the 2022 NSW Flood Inquiry, adapting to the challenges ahead requires transformational change; business as usual is not an option, with human and economic costs of inaction being potentially catastrophic.[17]

Transformational change is required to address the complex challenges associated with climate change. While the adaptation action plan describes specific measures and actions to address the identified climate risks to Council services, this section outlines an approach (governance structure and roadmap) for Council to commence the organisational change required to implement this Plan.

Governance

A proposed governance structure (incl. monitoring and review) for the implementation of this Plan in an integrated way is proposed in Figure 11 below. A whole of organisational approach with strong leadership from the executive is critical. The proposed structure therefore identifies the General Manager as the change leader and proposes that a Project Control Group with representation from across Council be formed to oversee progress, and to effectively drive the process and enable effective collaboration internally and externally. Grant funding will need to be sought for a staff member to manage the Project Control Group.

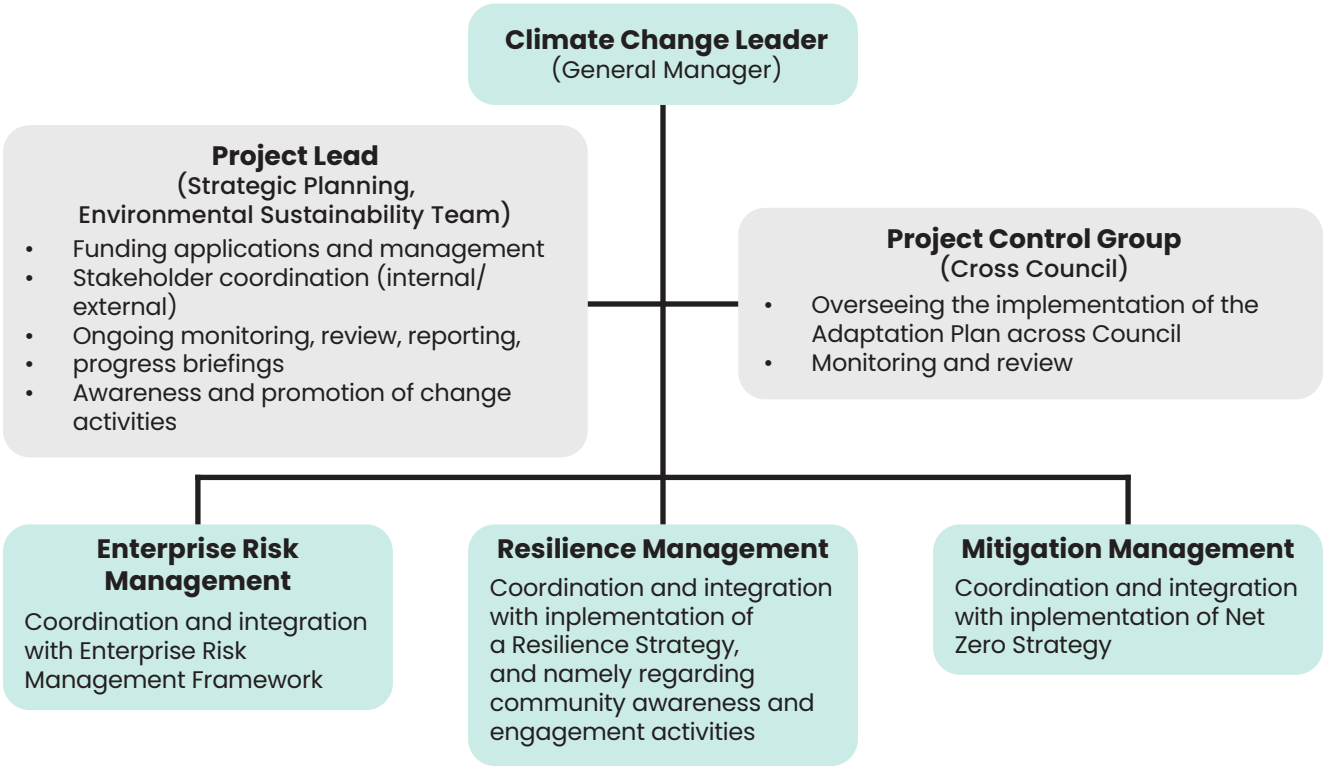


Figure 11: Proposed governance structure

Implementation Roadmap

An outline of the proposed next steps for Council to implement this Plan is provided in Figure 12 below. The roadmap outlines the organisational changes needed to make sure the Plan achieves broad buy-in and support from across the organisation and externally.

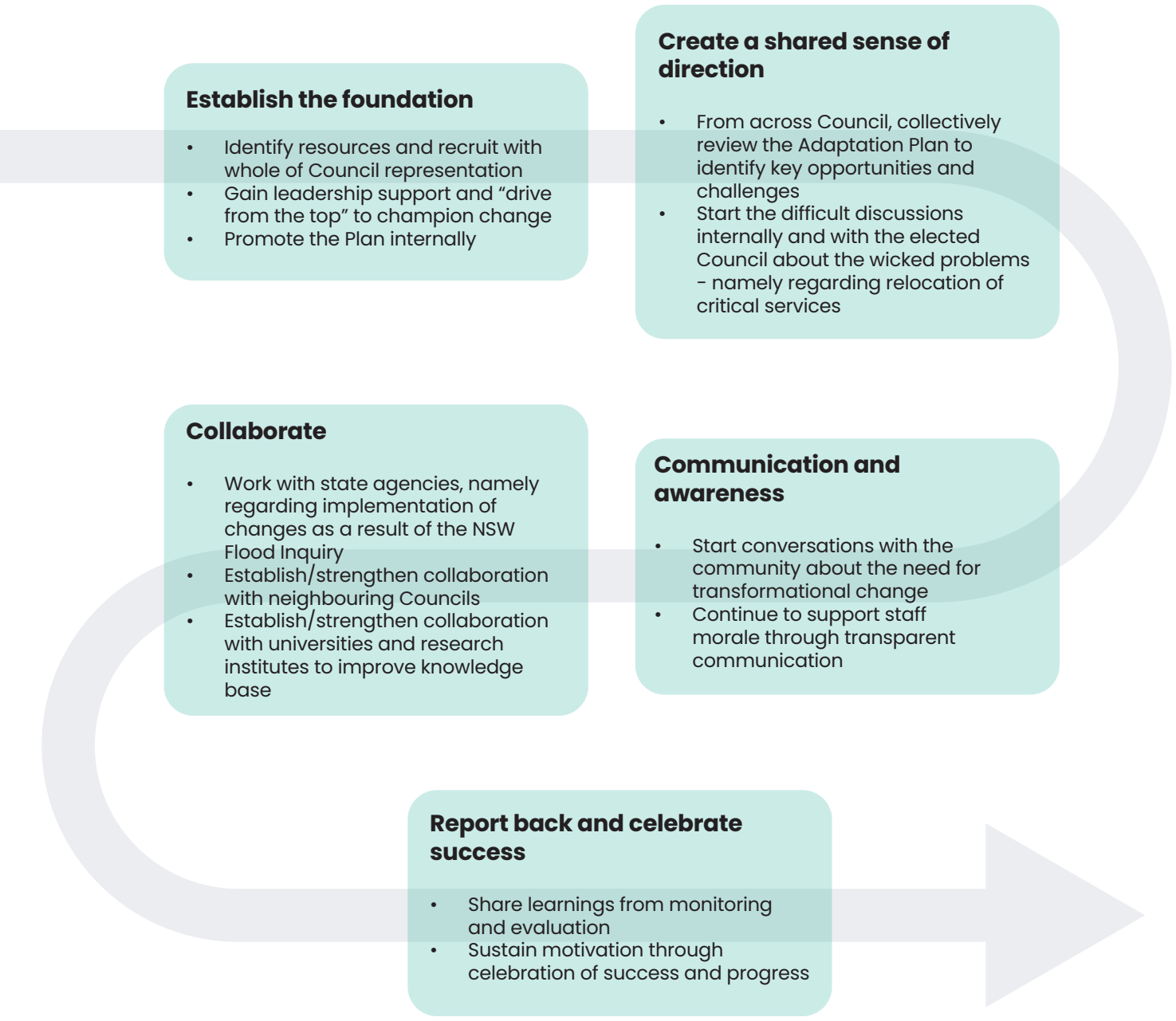
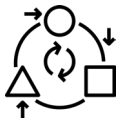
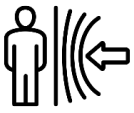


Figure 12: Organisational change process

APPENDIX

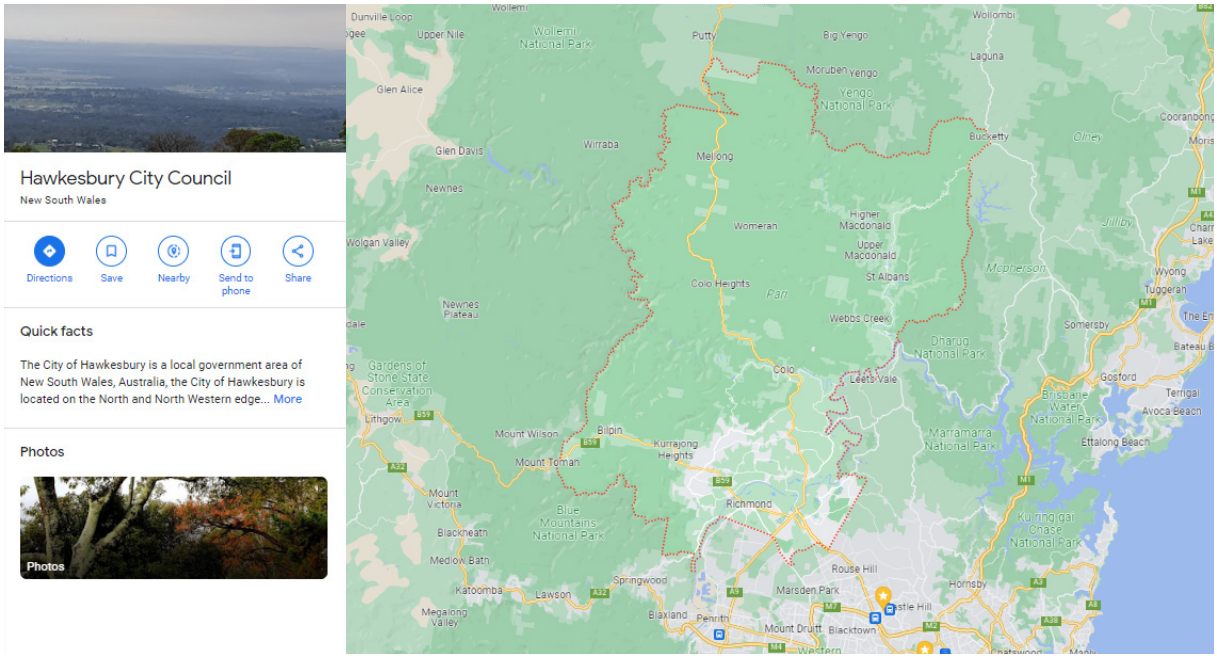
Appendix 1: Key concepts and definitions

	Concept	Definition
	Climate change adaptation	Adjustment to the actual or expected effects of climate change. Adaptation plays a key role in reducing exposure and vulnerability to climate change, and can be proactive, reactive, incremental or transformational (IPCC, 2022a).
	Climate change hazard	A potential natural or human-induced physical event, trend or disturbance with negative consequences (IPCC, 2018).
	Climate change impact	The consequences of climate change. Impacts are when potential changes, risks or opportunities become reality (IPCC, 2018).
	Climate change mitigation	Actions that reduce the rate of climate change. This includes actions that limit or prevent greenhouse gas emissions and activities that remove these gases from the atmosphere (IPCC, 2022b).
	Climate change projections	The simulated response of the climate system to a scenario of future greenhouse gas emissions or concentration of greenhouse gases and aerosols. Generally, climate change projections are created using climate models (IPCC, 2018).
	Climate change resilience	The capacity of systems (including social, economic, engineered, natural and ecosystems) to cope with a hazardous event, trend or disturbance. Coping means responding in ways that maintain the essential function, identity and structure of a system (as well as biodiversity in the case of ecosystems) (IPCC, 2022a).
	Climate change risk	When a hazard creates the potential for negative consequences due to the exposure and vulnerability of human or ecological systems. These consequences can include impacts on lives, livelihoods, health and wellbeing, economic, sociocultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species (IPCC, 2021b).

Source: NSW Climate Change Adaptation Strategy (2021)

Appendix 2: Climate projections for Hawkesbury City Council

The Hawkesbury Council region is shown in the map below.



Climate projections for this region can be sourced from

- NarClim 1.0 Metropolitan Sydney climate change snapshot.pdf (nsw.gov.au)
- NarClim 1.5 Climate Data Portal (nsw.gov.au)
- CSIRO and BoM Climate change in Australia | East Coast cluster report
- IPCC Interactive Atlas IPCC WGI Interactive Atlas

A comparison of features from each source is shown in Table 1. A comparison of projections from each source is shown in Table 2. Selected NarClim1.0 figures are shown below.

Main conclusions:

- CSIRO & BoM projections are similar to IPCC projections for most climate variables, except days over 35 C and annual mean maximum daily rainfall
- NarClim projections are lower than CSIRO & BoM and IPCC for maximum and minimum temperature
- NarClim projections are similar to CSIRO & BoM for the number of days over 35 C and the number of days below 2 C
- NarClim annual mean rainfall projections indicate a tendency for wetter conditions while CSIRO & BoM and IPCC indicate a tendency for drier conditions
- NarClim summer mean rainfall projections are consistent with CSIRO & BoM and IPCC
- NarClim autumn mean rainfall projections indicate a tendency for wetter conditions while CSIRO & BoM indicate little change and IPCC indicates a tendency for drier conditions
- NarClim winter mean rainfall projections indicate a tendency for wetter conditions while CSIRO & BoM and IPCC indicate a tendency for drier conditions
- NarClim spring mean rainfall projections indicate a tendency for drier conditions, similar to CSIRO & BoM, while IPCC indicates a tendency for wetter conditions
- NarClim and CSIRO & BoM indicate a tendency for more extreme fore weather days
- CSIRO & BoM indicate a stronger tendency than IPCC for increased daily maximum rainfall
- CSIRO & BoM indicate a tendency for lower relative humidity, soil moisture and windspeed, and more solar radiation

Table 1: Comparison of features from 4 climate projection sources

Features	NarClim1.0	NarClim1.5	CSIRO & BoM	IPCC Atlas
Release year	2014	2020	2015	2021
Timeframes	2020-2039, 2060-2079	1951-2100	2020-2039, 2080-2099	2021-2040, 2041-2060, 2081-2100
Climate variables	mean and extreme temperature, mean rainfall, and fire weather	temperature, rainfall, humidity, windspeed, solar radiation, soil moisture	mean and extreme temperature and rainfall, relative humidity, windspeed, solar radiation, soil moisture, drought, fire weather	max and min temperature, days above 35 C, days above 40 C, frost days below 0 C, average rainfall, maximum daily rainfall, and a drought index
Emission scenarios	SRES A2 (superseded but similar to the current RCP8.5, which is a high scenario)	RCP4.5 (low) and RCP8.5 (high)	RCP2.6 (very low), RCP4.5 (low) and RCP8.5 (high)	RCP2.6 (very low), RCP4.5 (low), RCP7.0 (medium) and RCP8.5 (high)
Climate models	4 CMIP3 global climate models downscaled using WRF	3 CMIP5 global climate models downscaled using WRF	30 to 40 CMIP5 global climate models	about 30 CMIP6 global climate models (the most recent models)
Region	Hawkesbury Council to Bargo	data on a 10km grid can be downloaded from the Climate Data Portal, but there are no regional summaries	Eastern Australia from Rockhampton to Eden, up to 200 km inland	Eastern Australia from Rockhampton to Sydney, up to 300 km inland
Comments	Projections are readily accessible, but the emission scenario and climate models have been superseded, 4 models is a small sample, and the selection of climate variables is limited (e.g. no projections for drought, wind, solar radiation, soil moisture, etc)	Projections for Hawkesbury Council are not readily accessible. Data on a 10 km grid must be downloaded and analysed using GIS software. The 3 global climate models are biased toward the hotter and drier end of the full range of possibilities.	Good sampling of uncertainty due to different emission scenarios and climate models, but the region is much larger than Hawkesbury Council. Summary projections are readily available for a sub-region south of Coffs Harbour.	Summary tables are easy to download. The East Australian region is much larger than Hawkesbury Council.

Table 2: Comparison of projections for 2020-2040, relative to 1986-2005, that include the Hawkesbury Council region.

Climate variable	NarClim1.0		CSIRO & BoM		IPCC Atlas	
	RCP4.5	RCP8.5 (A2)	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Annual mean of daily maximum temperature	N/A	+0.3 to 1.0 C	+0.6 to 1.2 C	+0.7 to 1.4 C	+0.6 to 1.5 C	+0.8 to 1.5 C
Annual mean of daily minimum temperature	N/A	+0.4 to 0.8 C	+0.6 to 1.0 C	+0.7 to 1.2 C	+0.7 to 1.2 C	+0.7 to 1.3 C
Annual mean number of days > 35 C	N/A	+5 to 10	+4 to +7*	+5 to 9*	N/A	+6.0 to 16.6
Annual mean number of days < 2 C	N/A	-1 to 10	-2 to -9*	-3 to -10*	N/A	-0.1 to -2.7#
Annual mean rainfall	N/A	-14% to +18%	-10% to +6%	-11% to +6%	-10% to +7%	-11% to +6%
Summer mean rainfall	N/A	−14% to +15%	-10% to +15%	-13% to +14%	-15% to +15%	-11% to +14%
Autumn mean rainfall	N/A	−22% to +43%	-22% to +15%	-13% to +14%	-17% to +9%	-17% to +11%
Winter mean rainfall	N/A	−19% to +23%	-18% to +14%	-20% to +12%	-16% to +7%	-17% to +5%
Spring mean rainfall	N/A	−27% to +17%	-19% to +12%	-20% to +11%	-21% to +12%	-17% to +23%
Annual mean maximum daily rainfall amount	N/A	N/A	-3% to +14%	+3% to +23%	-4% to +10%	-4% to +9%
Annual number of extreme fire weather days (FFDI > 50)	N/A	-0.7 to +1.2	+0.1 to +0.2*	+0.2 to +0.4*	N/A	N/A
Annual mean relative humidity	N/A	N/A	-1.6% to +0.8%	-1.4% to +0.9%	N/A	N/A
Annual mean soil moisture	N/A	N/A	-10.2% to +2.0%	-9.9% to +2.5%	N/A	N/A
Annual mean windspeed	N/A	N/A	-2.9% to +0.5%	-2.3% to +1.9%	-2.0% to +0.5%	-2.4% to +0.8%
Annual mean solar radiation	N/A	N/A	-0.5% to +1.9%	-0.7% to +2.7%	N/A	N/A

* Richmond

days below 0 C

NarClim1.0 projections

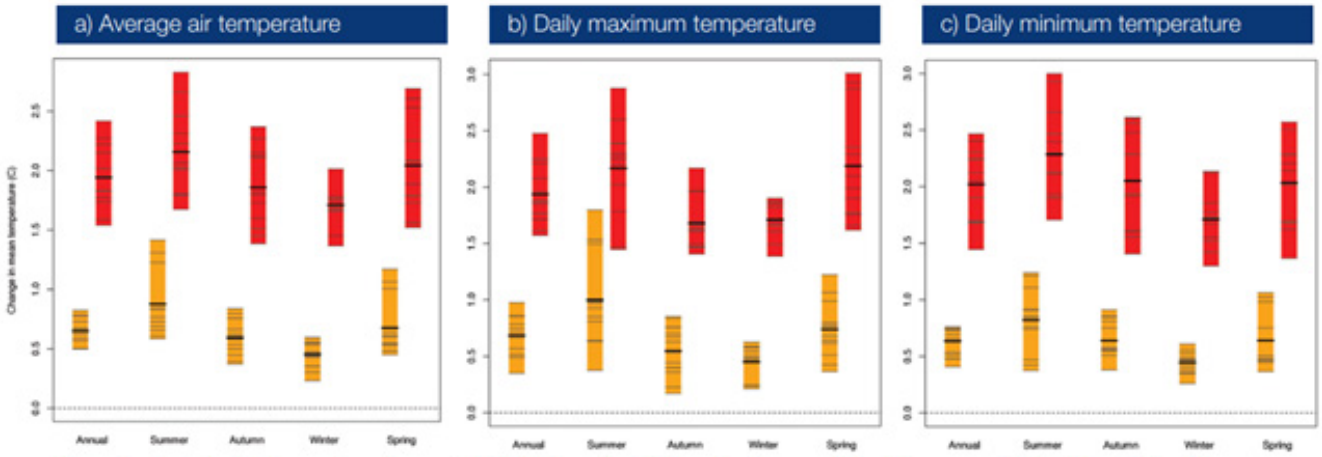


Figure 2: Projected air temperature changes for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red): a) average, b) daily maximum, and c) daily minimum. (Appendix 1 provides help with how to read and interpret these graphs).

expected to experience more hot days in the near future and in the far future (Figure 7).

The greatest increase is projected for Western Sydney and the Hawkesbury with an additional 5–10 days in the near future, increasing to over 10–20 additional hot days per year by 2070 (Figures 8 and 9).

The region, on average, is projected to experience an additional four hot days in the near future and 11 days more hot days in the far future (Figure 7).

These increases in hot days are projected to occur mainly in spring and summer although in the far future hot days are also extending into autumn (Figure 7).

Figure 8: Near future (2020–2039) projected changes in the number of days per year with maximum temperatures above 35°C.

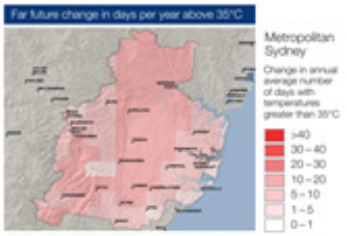


Figure 9: Far future (2060–2079) projected changes in the number of days per year with maximum temperatures above 35°C.

The greatest decreases are projected to occur in the south-west and in the Blue Mountains, with decreases of up to 20 nights by 2030 and more than 40 fewer cold nights by 2070 (Figures 11 and 12).

All models agree that the region as a whole will see a decrease in cold nights, with an average of approximately five fewer cold nights per year in the near future (ranging from 4–6 days across the individual models). The decrease in the average number of cold nights is projected to be even greater in the far future, with an average of 12 fewer cold nights per year (ranging from 10–13 across the individual models) (Figure 10).

Figure 11: Near future (2020–2039) projected changes in the number of nights per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

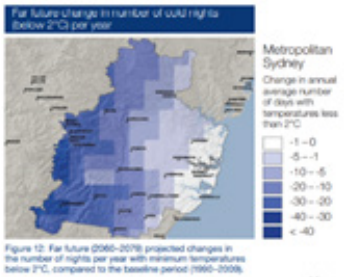


Figure 12: Far future (2060–2079) projected changes in the number of nights per year with minimum temperatures below 2°C, compared to the baseline period (1990–2009).

Appendix 3: References and data sources

Risk and Climate Change – reference documents and guidelines

National Climate Resilience and Adaptation Strategy 2021 – 2025

Attorney General's Department, National Strategy for Disaster Resilience: Community Engagement Framework, (2013)

Australian Disaster Resilience Index profiles: adri.bnhcrc.com.au/#!/

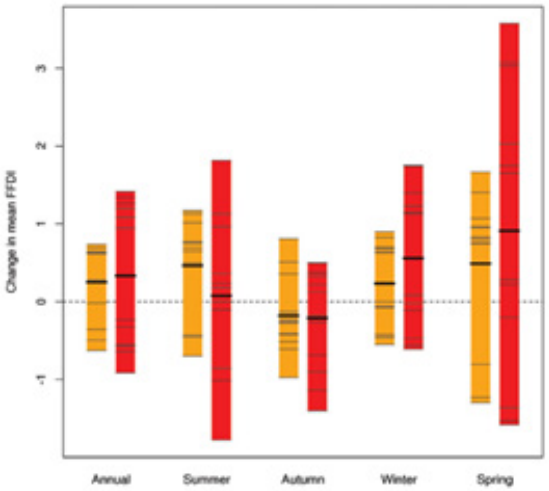


Figure 16: Projected changes in the average daily forest fire danger index (FFDI) for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red). (Appendix 1 provides help with how to read and interpret these graphs).

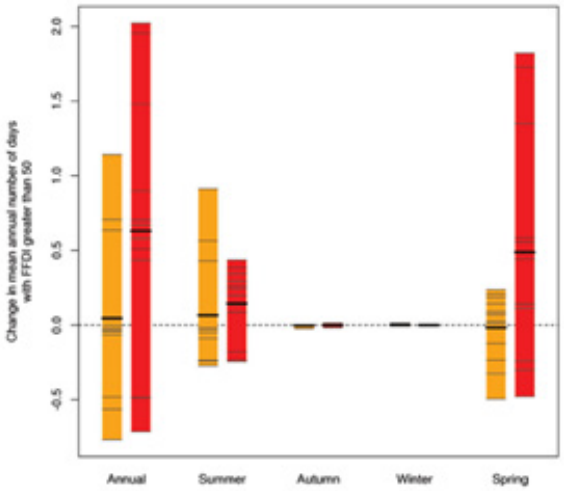


Figure 17: Projected changes in average annual number of days with a forest fire danger index (FFDI) greater than 50 for the Metropolitan Sydney Region, annually and by season (2030 yellow; 2070 red).

- Australian Disaster Resilience Handbook Collection, Systemic Disaster Risk, 2021
- Australian Disaster Resilience Handbook Collection, National Strategy for Disaster Resilience: Community Engagement Framework, 2013
- Climate Council, Uninsurable Nation: Australia's most climate-vulnerable places, 2022
- Department of Home Affairs, Climate and Disaster Risk Guidance on Prioritisation,2019
- Department of Planning, Industry and the Environment (DPIE), Climate Risk Ready NSW Guide, 2021
- Infrastructure New South Wales, Hawkesbury-Nepean Valley Regional Flood Study, 2019
- Natural Hazards Centre and Rio Partners, Research methodology for scenario development, 2021
- NSW Climate Change Adaptation Strategy
- NSW Climate Change Policy Framework
- NSW Flood Inquiry (2022)
- UNDRR (2022) "Technical Guidance on Comprehensive Risk Assessment and Planning in the Context of Climate Change", United Nations Office for Disaster Risk Reduction

Council plans specific to risk assessment, climate change planning and mapping

- HCC/Cardno Climate Change Adaptation Action Plan – Planning for Climate and Natural Hazards, 2016
- HCC/GHD, Planning for Climate and Natural Hazards Risk Assessment Report, 2012
- HCC/Kinesis, Net Zero Emissions and Water Efficiency Strategy, 2021
- HCC, Local Emergency Management Plan, 2017
- HCC, Flood Policy 2020
- HCC, Floodplain Risk Management Study and Plan, 2012
- HCC, Disaster and Emergency Dashboard: disaster.hawkesbury.nsw.gov.au
- HCC mapping tool: mapping.hawkesbury.nsw.gov.au/IntraMaps98
- Infrastructure NSW, Resilient Valley, Resilient Communities – Hawkesbury-Nepean Valley Flood Risk Management Strategy 2017
- WSROC, Urban Heat Planning Toolkit 2021

Other Council plans and strategies (context)

- HCC, Community Strategic Plan 2017- 2036
- HCC, Delivery Program 2022 - 2026

Risk and Climate Change – online resources, data portals and relevant literature

- AIDR Knowledge Hub, Guidance for Strategic Decisions on Climate and Disaster Risk: knowledge.aidr.org.au/resources/strategic-disaster-risk-assessment-guidance
- Australian Business Roundtable for Disaster Resilience and Safer Communities, australianbusinessroundtable.com.au
- Bureau of Meteorology Climate Data Online portal: www.bom.gov.au/climate/data
- CSIRO Climate Change in Australia: www.csiro.au/en/research/environmental-impacts/climate-change/climate-change-information
- ISET International, Climate Resilience Framework and various climate modelling and resilience resources: www.i-s-e-t.org/publications-and-resources-1
- NARCliM projections: www.climatechange.environment.nsw.gov.au/home
- NSW Treasury, risk management tools: www.treasury.nsw.gov.au/information-public-entities/governance-risk-and-assurance/internal-audit-and-risk-management/risk
- NSW Treasury, common planning assumptions (projections): www.treasury.nsw.gov.au/information-public-entities/nsw-common-planning-assumptions
- UNDRR Making Cities Resilient Roadmap, Toolkits & campaign: mcr2030.undrr.org
- State of the Climate, 2022: www.csiro.au/en/research/environmental-impacts/climate-change/State-of-the-Climate
- Sherwood, S. C., Roca, R., Weckwerth, T. M., and Andronova, N. G. (2010), Tropospheric water vapor, convection, and climate, Rev. Geophys., 48, RG2001, doi:10.1029/2009RG000301.
- Di Virgilio, G., Ji, F., Tam, E., Nishant, N., Evans, J. P., Thomas, C., et al. (2022). Selecting CMIP6 GCMs for CORDEX dynamical downscaling: Model performance, independence, and climate change signals. Earth's Future, 10, e2021EF002625. doi.org/10.1029/2021EF002625

COUNCIL DATA SETS

Data type	Data Sets
GIS layers	• Landuse • Council assets and infrastructure • Aboriginal heritage sites/potential areas (if mapped) • Flood prone lands • Bushfire prone lands • Biodiversity related layers
Impacts from flood events, and namely recent two significant events	Extent of impact including: • Aerial imagery and/or digitised flood extents • Surveyed flood marks • Anecdotal information and photos • Any other quantitative and qualitative information
Impacts from bush fire events, and namely Black Summer	• Extent of impact (spatial/quantitative/ qualitative data)

PUBLICLY AVAILABLE DATA SETS

Data type	Description (sources listed below)
NSW Common Planning Assumptions	NSW Common Planning Assumptions are the agreed information assets (data sets, parametres and assumptions, models and analytical tools) used by NSW Government and external stakeholders, to prepare proposals, business plans and strategies that rely on projections. Links to data sets on projected demographics, land use, housing targets infrastructure planning, transport, workforce and employment, and climate related data sets.
NSW Points of Interest	Provides the identification and location of places and services that supports people and the broader community. These include features related to Community, Education, Recreation, Transportation, Utility (Water Supply and Electricity Transmission lines), Hydrography, Physiography and Place
NSW Land Parcel and Property	Built up areas and building densities (derived from address points, land property ad parcels)

NSW Transport	Transport data is a representation of the land, water and air networks used to move people and goods, and deliver services, from one location to another. These include, but are not limited to: • Roads (by type/hierarchy): risks/ vulnerability can be different depending on the road hierarchy level • Transport Facility Points (parking, roadside rest, emergency phones, bus interchange, marina, heavy vehicles check station, etc • Bridges • Rail Infrastructure (railways, interchanges, terminals, and stations) • Fire trail • Traffic Control Devices • Transport Facilities
NSW Water	• Coastal line • Water courses • Inland Water bodies • Ancillary Hydro Points
Elvis Elevation Foundation Spatial Data[2]	• Point Cloud (Land Cover Information can be derived from LiDAR point) • Digital Elevation Model
NSW Planning and Environmental Spatial Data	Principal Planning Spatial Data[3]. These include: • Building heights and heritage. • Environmental Planning Instrument Layers • State Environmental Planning Layers and Local Provisions: identification of major infrastructure corridors, Aboriginal land and Aboriginal cultural significance areas, educational establishments, and childcare facilities, drinking water catchments, employment areas, etc. • Hazard Spatial Datasets (e.g., Bushfire prone land, flood prone land, landslide risk land) • Terrestrial Biodiversity • Environmentally Sensitive Land • Scenic Protection Land
NSW Emergency Services Spatial Data (if available)	Work in progress and to be released by open gov data. These layers will encompass all areas of emergency planning, response and recovery (spatial data for management, planning and mitigation of emergencies).
ABS Census (and id Profile)	Census of Population and Housing (various data pack will be used to map and analyse geographic areas for a number of social, economic and demographic characteristics and how these translate into resilience and/or vulnerability).

1. portal.spatial.nsw.gov.au/portal/apps/sites/#/home/pages/nsw-data-themes
2. elevation.fsdf.org.au
3. www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address

Appendix 4: Concept maps

The following concept maps were developed to assist in understanding current key climate hazards and facilitating discussion with Council regarding potential intermediate consequences and risk. These maps are indicative only, and it should be emphasised that mapping was not part of the scope for this project.

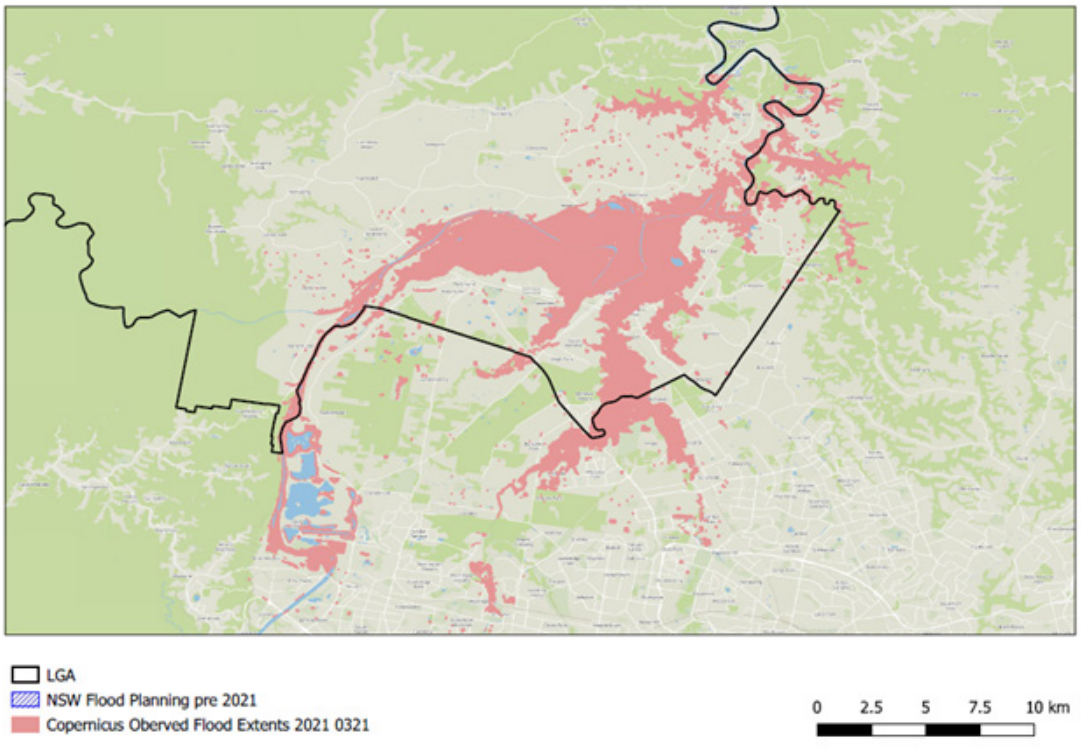
The following concept maps are provided:

- Map 1: Flooding – floodplan mapping (pre-2021) overlayed with actual flooding (2021) in the southern part of the LGA
- Map 2: Heat - change in number of days with temperatures above 35, Far Future (2060 – 2079)
- Map 3: Rainfall – change in precipitation (%) during autumn, Far Future (2060 – 2079)

It should be emphasised that the concept maps are simplifications and only show one realisation of many different variables and potential future scenarios. For example, a drier future on average is still a possibility based on the full range of GCMs (which is unlikely to be represented by a subset of downscaled models in NARCliM and is currently not represented on the concept map regarding precipitation).

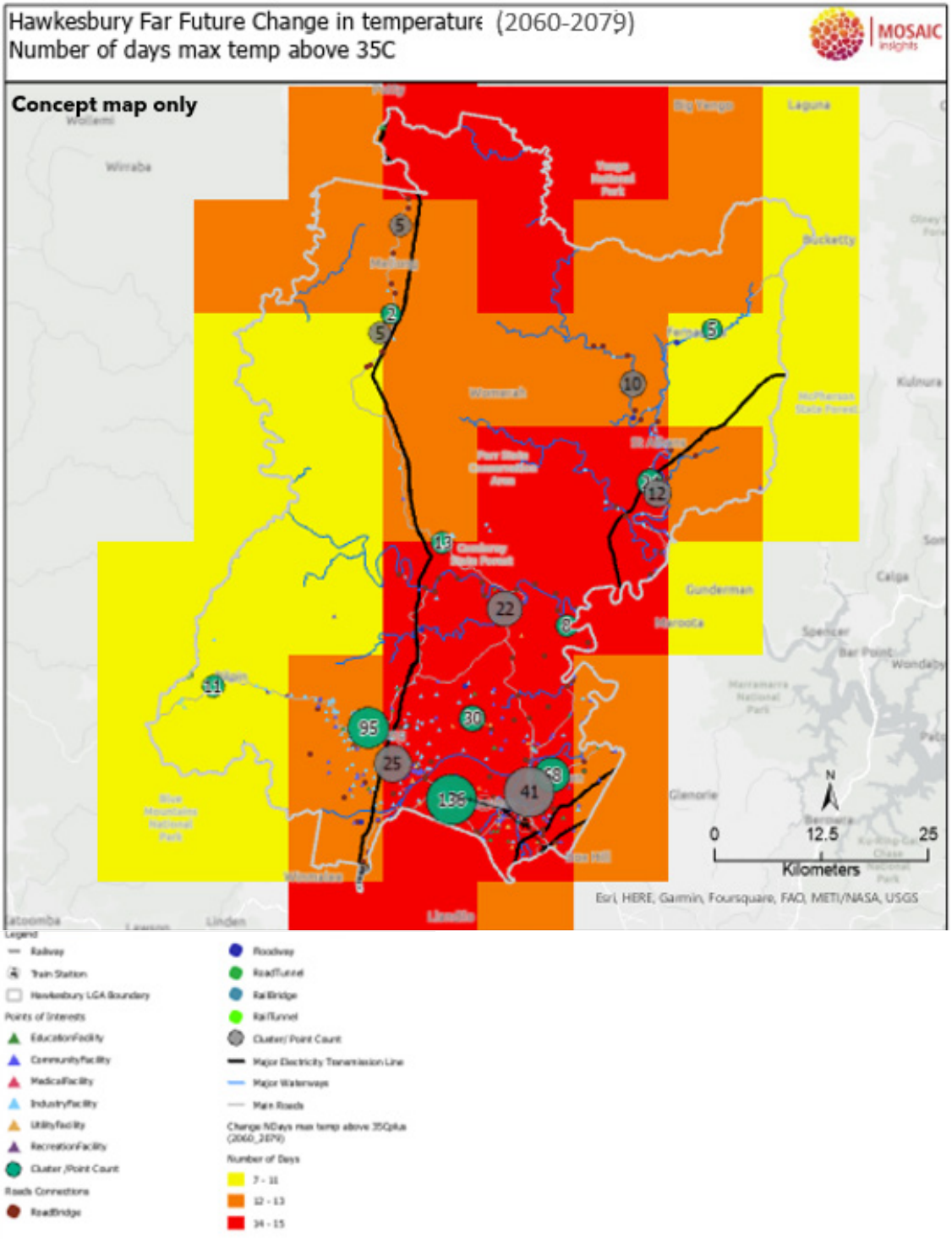
Map 1: Flooding (planning and 2021 flood event)

The following concept maps were developed to assist in understanding current key climate hazards and facilitating discussion with Council regarding potential intermediate consequences and risk. These maps are indicative only, and it should be emphasised that mapping was not part of the scope for this project.



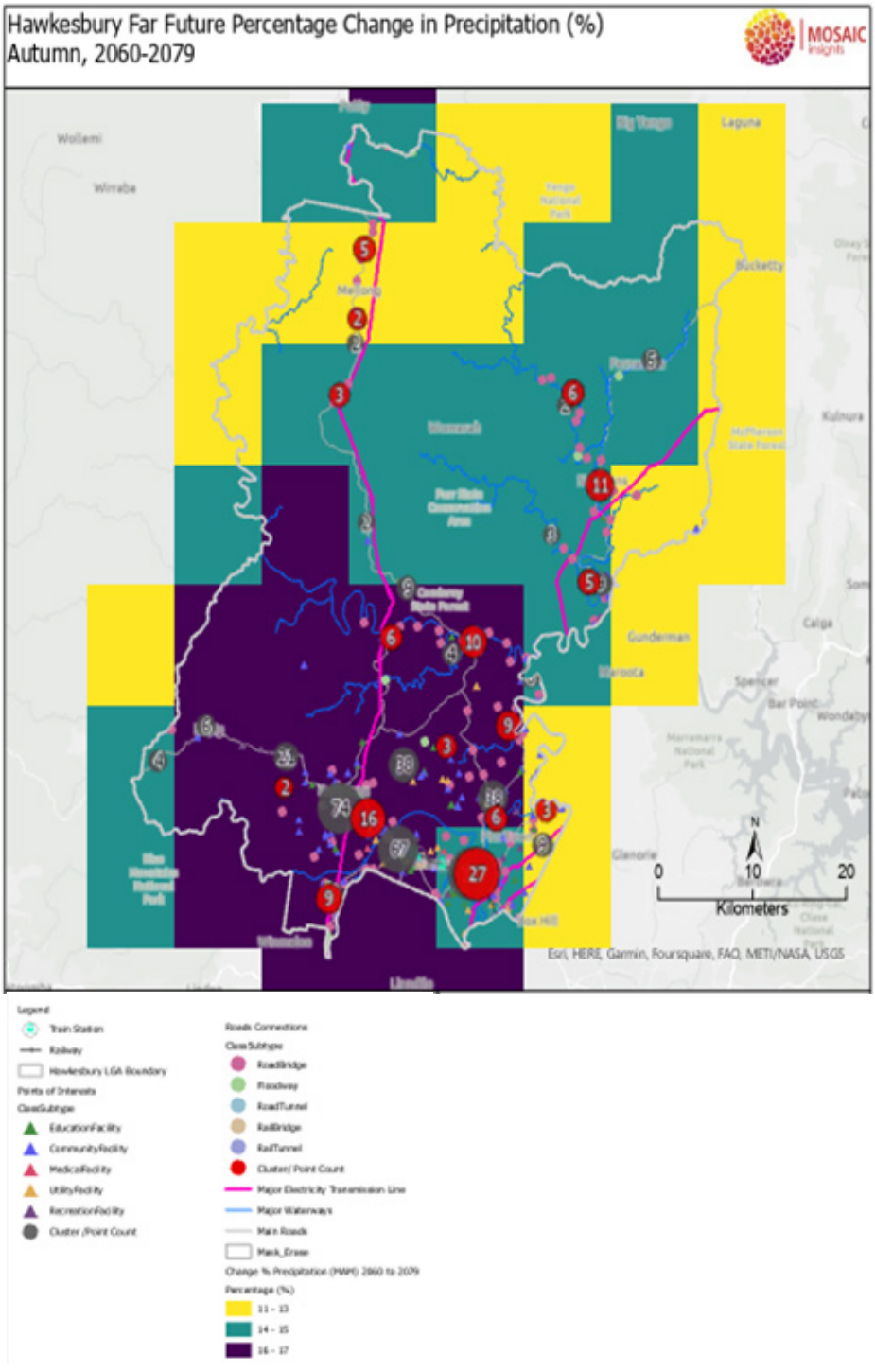
Map 2: Heat (Far Future Projections – 2060-2079)

As indicated on the concept map (with the circles and small dots), Council services throughout the LGA are exposed to heat, and especially in the southeastern part of the LGA. The influence of topography on temperature extremes is likely driving the increased number of heat extreme days in the southeastern part of the LGA. However, it is important to note that the results shown in the below concept map summarise only a subset of future climate projections that have been dynamically downscaled.



Map 3: Rainfall (Far Future Projections – 2060-2079)

Precipitation is inherently difficult to project and is dependent on a range of variables and seasonality. Further, the translation of rainfall to risks of flooding will be dependant on factors such as the precise location of the rainfall, the intensity of the event, and the saturation of the ground. The following concept map therefore needs to be interpreted with great caution. Its main point is to illustrate that increased precipitation in periods (here shown in autumn) is plausible in future scenarios, and that seasonal rainfall may intensity in the southern part of the Local Government Area, in the same area where Council services are concentrated, and where the Hawkesbury river potentially may cut off the northern part of the Local Government Area if breached.



Appendix 5: Summary of climate risks, exposures and vulnerabilities to Hawkesbury City Council

A summary of identified climate risks, vulnerabilities and exposures are provided below for ease of reference.

Climate risks and intermediate impacts

RISK 1: Disruption to Council services

1.1 Closure of physical sites due to debris or pollutants, or unsafe operating limits in heat/ drought conditions

1.2 Closure of river crossings leading to isolation of one side of the river from service provision

1.3 Cancellation of outdoor work and services

1.4 Shut down of services due to critical infrastructure failures

RISK 2: Declining workforce wellbeing and productivity

2.1 Stress and fatigue from community abuse, complaints and litigation with increasing events

2.2 Increased staff absences as a result of physical illnesses from smoke, pollutants, disease vectors, heat stress conditions

2.3 Lower morale from larger workloads and other intermediate impacts

RISK 3: Increased cost of service provision

3.1 Increasing repair and replacement costs due to asset damages (bridges, roads, stormwater, buildings, sports fields, parks and gardens, historical and natural assets)

3.2 Rising costs of insurance and loss of insurance

3.3 Increased costs of maintenance, reduced asset capacity and asset life, including environmental works such as pest and weed management and restoration of failed revegetation

3.4 Costs of rescheduling projects and 'business-as-usual activities' extra administration, contract variations, and staffing

3.5 Rising costs of fines for regulation breaches and remediation costs

3.6 Increase in costs associated with litigation, especially relating to planning and development decisions

RISK 4: Extra demand per capita for Council services

4.1 Increased event management, clean up assistance, and waste collection and management for the community

4.2 Additional development applications for rebuilds and more frequent revisions and updates to strategic plan and associated overlays

4.3 More patronage of pool, library, museum as heat refuges

4.4 Reliance on Council for water supplies

Exposures

The categories to describe the exposures and vulnerabilities respectively are outlined below. These are used consistently in the corresponding columns in the risk assessment.

The major exposures contributing to the identified climate risks, have been grouped into three key focus areas: Activities, Assets and People and are grouped under key Council service areas of:

- Community and Recreation
- Infrastructure and Property
- Waste and Environment
- City Planning and Corporate Services

These groupings were used as the basis for the engagement for this Plan. Note that while consistent with the overall teams within the existing (2023) Council organisational chart, the groupings have been adjusted for the purposes of better informing the risk assessment – e.g. being more relevant to understand the exposure of Council services.

The engagement and risk assessment found that Council services are strongly exposed in the southern part of the LGA, in the same areas where hazards of flood and heat are especially pronounced. Council staff identified the following key exposures:

	Community & Recreation	Infrastructure & Property	Waste & Environment	City Planning & Corporate Services
Assets (built and natural)	Pool, libraries, museum, Service centre, Sports fields, showgrounds, main parks	Main Council offices, Council depot, majority of locally administered road network, stormwater infrastructure	Landfill site, temporary transfer station, sewage treatment works, public toilets, animal shelter	
Activities	Community events, workshops, support services such as community transport	Maintenance, repairs, upgrades	Collection and treatment operations, environmental works	Site visits, working from home
People	Staff all based in this area; 'customers' have to come to this area too			

Vulnerabilities

Vulnerabilities have been grouped into five key types of vulnerabilities that emerged from the analysis: reliance on critical infrastructure; divided by the river; service design and standards; council capacity; and community knowledge and expectations.

For each intermediate consequence, vulnerabilities that contribute significantly to these consequences, as identified by stakeholders, have been listed. Within each of these categories, vulnerabilities have been identified as relating to features of Council assets, activities, or people.

Asset vulnerabilities: may relate to the design, capacity, materials, maintenance requirements, or construction processes for physical (built or natural) places, facilities, infrastructure including roads and stormwater, sewage treatment plants, community facilities, parks and gardens, and Council buildings.

Activity vulnerabilities: may relate to timing of activities, organisation or structure of internal tasks or external events, planning (or lack thereof), supporting information services and organisational knowledge for decision making, coordination of activities across Council, and reliance on complex supply chains, for example.

People vulnerabilities: relate to aspects of the Council workforce and volunteer network, as well as suppliers where labour is outsourced. In the case of community knowledge and expectations, vulnerabilities have been identified only where Council has high levels of influence on these aspects through Council service delivery.

COMMUNITY / ENVIRONMENT VULNERABILITIES

While it is not within the scope of this project to assess and respond to community risks, which falls under the Resilience Strategy (in draft). It is important to consider the vulnerabilities as this has a bearing on overall service delivery. In engagement with staff, community vulnerability came up as a strong theme, especially because community wellbeing had a direct bearing on Council staff.

- Private assets clustered in flood prone areas (response demands)
- Vulnerable populations especially exposed
- Health, police, education on one side of river
- Nursing & retirement villages on the other side
- River reliant businesses including turf, tourism, farming etc
- Natural assets, biodiversity and cultural heritage especially vulnerable in bushfire prone areas
- Animal safety, with only one animal shelter provided for the Hawkesbury and neighbouring LGAs

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Endnotes

1 IPCC, 2021 – as quoted in NSW Climate Change Adaptation Strategy (2021).

2 Definition adapted from the IPCC Glossary available at: Glossary — Global Warming of 1.5 ºC (ipcc.ch).

3 Vulnerability refers to the features or characteristics that make us more susceptible to being badly impacted by a climate related hazard, such as asset design, construction, or materials, the timing, structure, or organisation of activities, or socio-demographic or economic features such as older age, low income, geographic remoteness, or poor access to essential services.

4 Deloitte Access Economics, 2021. Special report: Update to the economic costs of natural disasters in Australia, Australian Business Roundtable for Disaster Resilience & Safer Communities

5 State of the Climate, Bureau of Meteorology and The Commonwealth Scientific and Industrial Research Organisation, 2020 quoted in National Climate Resilience and Adaptation Strategy (2021).

6 https://www.ipcc.ch/2021/08/#:~:text=The%20report%20shows%20that%20emissions,1.5%C2%B0C%20of%20warming

7 WSROC Turn Down the Heat Strategic and Action Plan (2018): page 2

8 NSW Flood Inquiry (2022), Appendix C, page 55. The Inquiry noted that the recent floods of March 2022 were deemed as a 1:20 flood event, where the 1867 floods were considered as 1:500.

9 The original themes were: Flooding of Urban and Built Areas; Building Resilience and Coordinated Management; Managing Development to Consider Climate Changes in Growth Areas; Bushfire Risk Management; Maintaining Roads and Bridges; The Natural Environment Response to Temperature, Rainfall and Other Climatic Changes; Protecting the Region's Heritage and Community Infrastructure, especially from Storms; Stormwater Drainage and Infrastructure and Water Quality; The Built Environment's Response to Temperature, Rainfall and other Climatic Changes

10 These are focus areas of other strategies and plan that are related to this plan, such as the Community Strategic Plan, Resilience Strategy (in drafting) and the Environmental Sustainability Strategy.

11 This is consistent with the Community Strategic Plan in which it is noted: 'While Council has a custodial role in initiating, preparing and maintaining the Community Strategic Plan on behalf of the Hawkesbury community, it is not wholly responsible for its implementation. Other partners, such as State agencies and community groups may also be engaged in delivering the long-term objectives of this Plan.' (page 22).

12 Pathways approaches are considered best practice in climate risk management. This Plan has adopted a pathways approach to map risk pathways from hazards to consequences. The latest IPCC AR6 report on Impacts, Adaptation and Vulnerability illustrates this approach, including the concept of climate resilient development pathways.

13 Climate Council 2022: page 5

14 Hawkesbury City Council Community Strategic Plan (2022 – 2042)

15 UNDRR (2022). Technical Guidance on Comprehensive Risk Assessment and Planning in the Context of Climate Change. United Nations Office of Disaster Risk Reduction.

16 Reeves, M. and Whitaker, K. 2020. A Guide to Building a More Resilient Business, Harvard Business Review.

17 For example, the NSW 2022 Flood Inquiry estimates that if a flood of a historical scale (1:500) were to occur today in the Hawkesbury-Nepean Valley, the estimated damages would be in the order of $9million, and requiring approximately 90,000 people to evacuate and 15,000 dwellings being flooded. (Hawkesbury-Nepean Casestudy, page 55).

a IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change[Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, doi:10.1017/9781009157896.

b Di Virgilio, G., Ji, F., Tam, E., Nishant, N., Evans, J. P., Thomas, C., et al. (2022). Selecting CMIP6 GCMs for CORDEX dynamical downscaling: Model performance, independence, and climate change signals. Earth's Future, 10, e2021EF002625. **doi.org/10.1029/2021EF002625**

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