Climate Change Adaptation Strategy
2022–33

Cardinia

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Prepared by:

Cardinia Shire Council
Environment and Heritage Unit

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ABN: 32 210 906 807
20 Siding Avenue, Officer

PO Box 7, Pakenham Vic 3810
(DX 81006)

Phone: 1300 787 624
Email: mail@cardinia.vic.gov.au
Web: cardinia.vic.gov.au

1. Executive summary

The Climate Change Adaptation Strategy (CCAS) outlines how Cardinia Shire Council will work towards increasing the climate resilience and adaptive capacity across the shire. In response to the strong local community engagement and the scientific consensus on rising global temperatures, Council declared a climate emergency in September 2019. The declaration makes the important commitment of emphasising climate change adaptation and mitigation actions as key priorities in the Council Plan 2021-25. Development of this strategy, to address and mitigate the climate change impacts and risks to Cardinia Shire, is a significant action to meet this commitment.

Building on the past initiatives and actions undertaken by Council as outlined in Appendix E, this strategy will direct climate change adaptation planning in the shire between 2023-2033. The development of this strategy has been informed by stakeholder engagement and the latest climate science including projections from the Bureau of Meteorology and the national science body, CSIRO, as well as a climate change impacts and risks (CCRI) assessment for the shire.

This strategy has at its heart an ethos that the best and most cost-effective approach for climate change adaptation is embedding relevant actions into Council's existing service delivery. It includes a 10-year costed action plan that will enable Council to manage identified risks and provide co-benefits.

The four overarching themes of this strategy:

1. Plan for and manage the risks of climate change and the associated extreme weather events.
2. Seek opportunities for partnerships and collaboration with stakeholders and the community that support climate change adaptation.
3. Use the natural environment to build our adaptive capacity.
4. Encourage future proofing design – foster places capable of adapting to change and responding to current and future risks.

2. Overview

Cardinia Shire is one of the fastest growing regions of metropolitan Melbourne. Located 45 kilometres east of Melbourne CBD, the shire extends from the Dandenong Ranges in the north to Western Port Bay in the south, the shire comprises of diverse landforms and landscapes. Vegetation types include wet grassland, woodlands, and plains, with the Koo Wee Rup swamp being a dominant landscape feature of the region.

Cardinia Shire Council recognises that the climate is changing, and adaptation planning is fundamental to mitigating the adverse impacts associated with climate change. The shire has experienced changes to the intensity of rainfall, an increase to the number of bushfire risk days as well as more severe and frequent storms. Changes to the climate are predicted to continue, so it is important to understand and plan for these climate impacts to ensure that Council and the community are adequately prepared to respond to the likely risks. The Climate Change Adaption Strategy (CCAS) and the linked 10-year Action Plan focusses on addressing the most urgent climate change risks to council's business continuity and the Cardinia Shire community. This strategy aims to enable our people, businesses, infrastructure, and environment to cope with an increasingly variable climate. Given the potential broad-ranging impacts of climate change in the shire adaptation is essential. The CCAS presents data on the likely extent of future extreme weather events in the Shire as well as pathways to embed adaptation in the community and strengthen the resilience of the council to continue its service delivery despite the localised climate change impacts.

This strategy has been developed through rigorous consultation with community and internal stakeholders to establish a 10-year adaptation action plan. This Action Plan provides a suite of actions that are focused on addressing the priority climate risks between 2023 to 2033. The actions will strengthen the resilience of the community and increase the adaptive capacity of Cardinia Shire to the adverse impacts of climate change.

The CCAS 10-year Action Plan prescribes resources and initiatives to lessen the risks associated with the localised impacts of climate change in Cardinia Shire. The Action Plan is not a plan for community action, however there are several actions focused on the community, as reducing risk and the sensitivity of the community to climate change is fundamental to Council's role. The CCAS Action Plan has a 10 year life and will be reviewed at the 5 year mark. Subsequent action plans will build upon the resilience outcomes achieved and adaptation pathways established in the first 10-year Plan. In response to the strong local community engagement and the overwhelming scientific consensus on rising global temperature, Cardinia Shire Council declared a climate emergency in September 2019. This declaration has demonstrated the intent of Council to consider climate change adaptation and mitigation as organisational priorities.

3. Purpose

Climate change is a global challenge that is caused by the increased concentration of carbon dioxide and other greenhouse gases in the atmosphere. Human activities such as the burning of fossil fuels like coal, gas and oil have fundamentally increased the atmospheric greenhouse gases and contributed to global warming. Since the industrial revolution, these gases have accumulated in the atmosphere creating an insulating layer that inhibits daytime surface heat from dispersing back into the atmosphere at night. Decades of warming across the surface of the earth has manifested in climate change with localised impacts. These impacts have adverse effects on the social, economic and environmental systems we depend on for our livelihoods, recreation and social cohesion. Adapting to this change requires taking actions to lessen the adverse consequences of climate change and increase capacity to withstand the stresses and shocks associated with natural hazards and extreme weather events.

Adaptation in Cardinia Shire presents an opportunity to empower our communities to be healthy, connected, and resilient. Investing in climate change adaption helps to embed economic, social, and environmental resilience to protect the most vulnerable to the consequences of climate change. This strategy supports the creation of liveable spaces and places as well as the protection of the local economy, built and natural assets and biodiversity. Adaptation planning strives to support our community to reduce their vulnerability to climate change whilst boosting the resilience of the local environment, social and economic systems for future generations.

3.1 Vision

Cardinia Shire is climate resilient, while sustaining the community's liveability, biodiversity and financial stability.

3.2 Objectives

This strategy aims to drive actions and initiatives to reduce the sensitivity of the Cardinia shire community to the adverse impacts of climate change. Adapting to climate change will safeguard Cardinia Shire's diverse communities from these adverse impacts whilst managing the natural and built environments for present and future generations.

The objectives for the strategy are to support the community and Council to become more resilient to the localised impacts of climate change by addressing the identified priority risks over the next 10 years.

Objective 1:
Communicating the key local impacts of climate change and how this will affect the economic, social, and environmental sustainability.

Objective 2:
Mainstreaming climate risk considerations and adaptation actions in the Council policies, programs, and service delivery.

Objective 3:
Identifying action pathways for Council, the community, businesses, environmental groups, private landowners and other stakeholders to increase the adaptive capacity and foster timely opportunities to strengthen climate change resilience across the shire.

4. Climate challenges we face

The severity and frequency of future hazard events such as heatwaves, floods and fire weather are dependent on the extent of climate change. The magnitude of these climate impacts can be mitigated by eliminating greenhouse gas emissions today and keeping global temperatures below 2ºC. Therefore, climate change projections are not precise predictions – rather, they present plausible future scenarios based on clearly defined assumptions.

To allow for comparability and consistency between different models, the Intergovernmental Panel on Climate Change (IPCC) published four greenhouse gas concentration trajectories known as Representative Concentration Pathways (RCP). Each RCP reflects different possible future climate scenarios based upon the rate at which efforts to reduce human attributed greenhouse gas emissions will proceed over coming decades. Adapting and planning for the adverse impacts of climate change considers these greenhouse gas emissions trajectories to identify the likely future impacts and risks to the community and Council.

The four concentration pathways are 2.6, 4.5, 6.0 and 8.5 (Table 1). When undertaking a climate change risks assessment for adaptation planning in Cardinia Shire, RCPs 4.5 and 8.5 were considered. These concentration pathways represent an optimistic and extreme emission scenario. RCP 4.5 is considered as this most closely aligns with the goal of the Paris Climate Change Agreement, to limit global warming to an average of 2°C by 2050 compared to pre-industrial levels. RCP 4.5 broadly represents an optimistic pathway with temperature increase limited to 1.1 to 2.6 degrees Celsius as the global emissions peak in the year 2040 and then declines.

RCP 8.5 closely represents the current trajectory of unabated emissions from human activities and offers a most conservative approach for climate change risk assessment. Under this “business-as-usual” emission scenario a temperature increase of between 2.6 and 4.8 degrees Celsius by the year 2100 is expected. Both the RCPs 4.5 and 8.5 are considered as a guideline when planning to effectively adapt to the upper and lower extent of the adverse impacts of climate change.

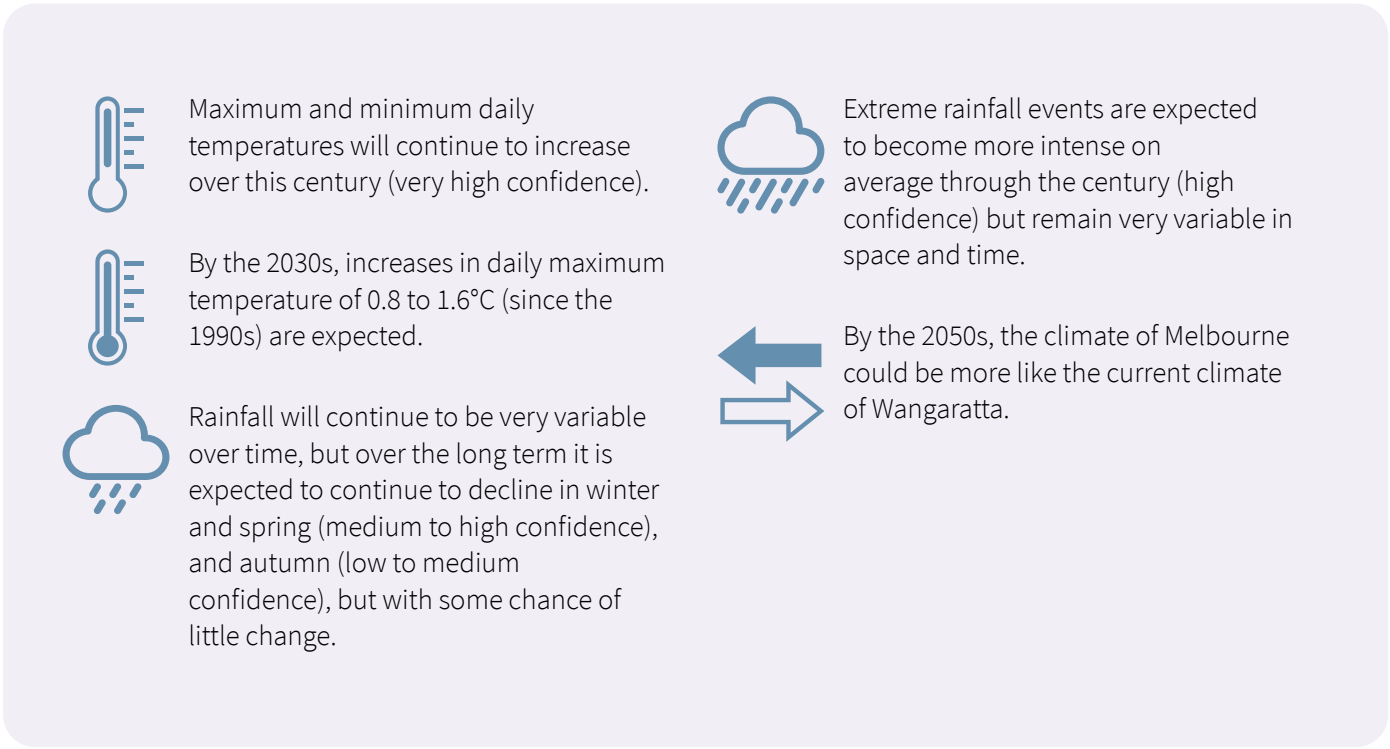
Table 1. Representative concentration pathways (IPCC)

Scenarios		Global warming (mean and likely range oC)
RCP 2.6	• Significant and rapid efforts to reduce emissions. • Emissions peak by 2020, then decline substantially. • CO2 concentration of 420ppm by 2100.	1.0°C (0.3 to 1.7)
RCP 4.5	• Major efforts to reduce emissions. • Emissions peak around 2040, then decline. • CO2 concentration of 540ppm by 2100.	1.8°C (1.1 to 2.6)
RCP 6.0	• Some efforts to reduce emissions, which peak around 2080. • CO2 concentration of 660pm by 2100.	2.2°C (1.4 to 3.1)
RCP 8.5	• Limited efforts to curb emissions, which continue to rise throughout the 21st century. • CO2 concentration of 940ppm by 2100.	3.7°C (2.6 to 4.8)

4.1 Climate change projections

The Victorian Climate Projections 2019 (VCP19) developed by the Department of Environment, Land, Water and Planning (DELWP) and Commonwealth Scientific and Industrial Research Organisation (CSIRO) identify changes to the climate of Greater Melbourne. Figure 1 below shows the high-level projected change to temperature and rainfall for Greater Melbourne.

Figure 1. Greater Melbourne Climate Projections 2019[1]



4.2 Temperature

Cardinia Shire experiences mild to warm summers with an average temperature of around 23.8°C. Projections for temperature related variables in Table 2 indicate a median increase in maximum daily temperature of 1.97°C by 2070 under a moderate RCP 4.5 emissions scenario, while an increase of over 4°C cannot be ruled out under a high RCP 8.5 scenario.

Community feedback gathered through responses to the 2021 Liveability Plan Survey found that around 38% of the community felt that they were extremely or very prepared for a heatwave while 23% of the community were extremely or very prepared for a drought. The highest recognised preparedness to heatwaves and drought was in Bunyip Ward with 59% and 39% of respondents from this area feeling like they were extremely or very prepared for a heatwave or drought.

[1] VCP19 Regions (CSIRO and DELWP, 2019)

Table 2. Projections for temperature-related variables – RCP 4.5 and RCP 8.5

Variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Maximum Daily Temperature (°C)	Annual average: 19.5°C	+0.92°C (+0.79 to +1.30)	+1.19°C (+0.98 to +1.55)	+1.97°C (+1.61 to +2.37)	+2.94°C (+2.41 to +4.02)
Maximum Daily Temperature (°C) - Summer	Summer average: 23.8°C	+0.93°C (+0.56 to +1.96)	+1.13°C (+0.78 to +1.91)	+1.96°C (+1.63 to +2.81)	+2.95°C (+2.19 to +4.54)
Average Days over 35°C	8.6 days per year (based on 30-years of daily data from 1981-2010)	11.57 days/yr (10.83 to 12.9)	11.77 days/yr (10.5 to 13.27)	14.37 days days/yr (13.37 to 16) 2090: 14.99 (13.07 to 16.9)	18.22 days/ yr (14.77 to 21.83) 2090: 23.56 (18.23 to 30.03)
1-in-20-year Hottest Day (°C) - Summer	44.3°C in January 2003 (highest recorded temperature over baseline period) 46.7°C in February 2009 (highest recorded temperature since 1971)[2]	+0.42°C (-0.62 to +2.89)	+0.28°C (-0.91 to +3.93)	+1.83°C (+0.85 to +3.50)	+3.47°C (+1.28 to +4.36)
1 in 20-year Coldest Day (°C) - Winter	-3.8°C in July 1997 (lowest daily temperature recorded over baseline period)	+0.36°C (-0.35 to +1.06)	+0.46°C (+0.09 to +0.57)	+1.01°C (0.36 to +1.14)	+1.37°C (+1.12 to +2.05)

Under RCP 4.5 scenario, a warming climate is likely to increase the intensity and frequency of heatwaves, drought, bushfire danger days, storm events and the extent of sea level rise. The impacts associated with these natural hazard events will affect the built and natural environments, with the flow-on effects often disproportionally affecting socio-economically disadvantaged communities as well as vulnerable individuals and households. Higher temperatures also impact the future viability of soil quality, water resources, vegetation cover as well as activities already vulnerable to hotter conditions, such as summer sports and certain types of agriculture. A warmer climate may also present opportunities to grow new crops not previously produced in the region.

Under RCP 8.5 scenario, climate models show that the number of days above 35°C may more than double in the century (2090). An increased occurrence of days above 35ºC and heatwaves will have compounding negative implications for the Shire. In addition to the impacts under RCP 4.5, the extreme heat events and consecutive days above 35ºC in a RCP 8.5 scenario, will increase the energy and water demands, placing energy security concerns and additional financial burden on households, industries, business and building operators. A climate reality of RCP 8.5 would also place additional pressure on health services, which are disproportionately used by residents with underlying vulnerabilities and health conditions.

4.2.1 Rainfall and flooding

Under a moderate RCP 4.5 and high RCP 8.5 scenario the intensity of 1-in-20 heavy rainfall events is likely to increase even when the average annual rainfall is projected to decline. The projections for rainfall related variable are presented in Table 3. The 2021 Liveability Plan Survey found that around 21% of the community felt that they were extremely or very prepared for a flood. The highest recognised community preparedness to flood was in Beacon Hills Ward with 35% of respondents responding that they were extremely or very prepared for this event.

[2] Recorded on Saturday 7 February 2009, Victoria's Black Saturday bushfires

Table 3. Projections for precipitation-related variables – RCP 4.5 and RCP 8.5

Variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Annual Rainfall Average (%)	789.0mm	-4.14% (-12.70 to +1.95)	-8.60% (-13.71 to -2.23)	-9.20% (-11.96 to -4.27)	-11.08% (-28.36 to -3.89)
Summer Average (%)	171.5mm	-4.69% (-11.06 to +4.15)	4.07% (-9.22 to +11.98)	-7.73% (-21.99 to +19.17)	-0.52% (-26.75 to +11.38)
Autumn Average (%)	163.6mm	-1.69% (-19.20 to +9.35)	-8.18% (-27.92 to +2.05)	-6.39% (-13.74 to +1.94)	-14.78% (-28.56 to -4.04)
Winter Average (%)	218.5mm	-6.36% (-9.58 to -0.02)	-10.64% (-13.20 to -2.15)	-6.90% (-11.91 to +0.90)	-14.24% (-22.01 to +0.30)
Spring Average (%)	236.8mm	-9.13% (-16.37 to +12.90)	-15.29% (-19.68 to +1.72)	-14.54% (-19.67 to -4.08)	-17.94% (-41.47 to +4.62)

An increased occurrence of intense rainfall can lead to disruption of essential infrastructure and property (e.g. roads and rail, energy supply, water and sewerage, communications) due to inundation of stormwater infrastructure and the potential damage of electrical infrastructure. Future intense rainfall and flooding events can also impact road network access, potentially limiting emergency response.

4.2.2 Bushfire

According to CSIRO analysis, there is high confidence that climate change will result in more incidences of severe bushfire danger. By 2090, severe fire danger days are projected to become twice as frequent under an RCP 8.5 high emissions scenario. Table 4 presents bushfire projections based on an increase in the number of fire danger index days.

Community response to the 2021 Liveability Plan Survey, identified that around 24% of the community felt that they were extremely or very prepared for a bushfire. The highest recognised preparedness to bushfire was in Bunyip Ward with 47% of respondents from this area feeling like they were extremely or very prepared for this event.

Table 4. Projections for bushfire (Severe Forest Fire Danger Index days) – RCP 4.5 and RCP 8.5

Specific variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Severe Fire Danger Days (FFDI > 50)	2.7 days (1995 baseline)	3 to 4.2 days per year + 11% to +55% (over baseline)	2.8 to 3.5 days per year +19% to +30%	3.5 to 3.9 days per year +30% to +44%	3.7 to 5.8 days per year +37% to +115%

Increased incidence of bushfire weather and the number of severe fire weather days could result in loss of life and injury, direct damage to essential infrastructure, increased bushfire-related air pollution and dust impacting building ventilation systems and as well as the long-term health and safety of the Cardinia Shire community.

4.2.3 Coastal hazards

Rising sea levels are expected to result in an increased risk of coastal erosion and inundation. Table 5 illustrates that in the upper range of projections, under an RCP 8.5 scenario, sea level is projected to increase by 0.81m by the end of the century, potentially affecting large coastal agricultural areas. A rise of such magnitude could lead to salt-water intrusion and increase soil salinity across coastal agricultural land. It can also reduce the capacity of low-lying drainage networks, leading to inundation events and potential disruption of transport link services.

Table 5. Projections for coastal variables – RCP 4.5 and RCP 8.5

Specific variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Sea Level Rise (m)	-	+0.11 m (+0.07 to +0.16)	+0.12m (+0.08 to +0.17)	+0.44m (+0.27 to +0.61)	+0.58m (+0.38 to +0.81)
Sea Surface Temperature (°C)	Annual average (1961-1990): approx. 16°C	+0.5°C (+0.4 to +0.7)	+0.6 °C (+0.3 to + 0.9)	+1.1°C (+0.8 to +1.7)	+ 2.3°C (+1.9 to +3.8)

4.2.4 Projection data

Climate projections have been prepared using Victorian Climate Projection 2019 results. The climate data used in this risk assessment represents the projected changes relative to 1986-2005 (1995) baseline for on the Greater Melbourne region.

Two greenhouse gas emissions scenarios were used as the context to identify potential impacts and assess risks to Council from changes in climate. These were the same emissions scenarios used in the Victorian Climate Projection 2019 project and describes how the climate of Victoria may respond to global warming under the IPCC's medium and high emissions scenarios (RCP 4.5 and 8.5). These scenarios were chosen to provide a range of possible futures to assess the risks of climate change and inform appropriate adaptation decisions for the context of Cardinia Shire.

A medium 2030 emissions scenario (RCP 4.5) assumes growth in global annual carbon emissions to remain steady. A high 2070 emissions scenario (RCP 8.5) assumes a business as usual approach to mitigating carbon emissions with considerable growth in global annual carbon emissions by the year 2070. Information on the climate data sources, including weather stations, is found in Appendix A and E. Additionally, maps of bushfire, flood and heat threat in Cardinia Shire are contained in Appendix C.

[2] Recorded on Saturday 7 February 2009, Victoria's Black Saturday bushfires

“We are the first generation to feel the effect of climate change and the last generation who can do something about it.”

– Barack Obama, Former US President

5. Policy context

5.1 International response

Changes in the earth's climate has been observed in every region and across the whole global climate system. According to the intergovernmental panel on climate change (IPCC) report released in August 2021, the global levels of CO2 emissions were higher in 2019 than any time in at least two million years. Moreover, levels of methane and nitrous oxide, second and third-highest contributors of climate change, behind CO2, were higher in 2019 than at any time in at least 800,000 years.

The IPCC report demonstrates that the emission of greenhouse gases from human activities are responsible for approximately 1.1°C of warming between 1850-1900. Therefore, unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming close to 1.5°C or 2°C will be beyond reach.

The IPCC report projects that in the coming decades, climate changes will increase in all regions. For 1.5°C of global warming, there will be an increase in heat waves, longer warm seasons, and shorter cold seasons. At 2°C of global warming, heat extremes would likely reach critical tolerance limits for health and agriculture resulting in the decline in yields of maize, rice, wheat, and potentially other cereal crops. The evidence in the IPCC report makes it clear that carbon dioxide is the main driver of climate change and that human actions to mitigate emissions still has the potential to determine the future course of climate and lessen the adverse effects of climate change.

5.2 Australian Government policies

Australia is already experiencing the impacts of climate change, which vary across the country. Australia's climate is projected to continue to change into the future due to the historic and ongoing emission of greenhouse gases.

Under international climate agreements, Australia has two targets to reduce greenhouse gas emissions.

- 5% below 2000 levels by 2020 (under the Kyoto Protocol) and
- 26-28% below 2005 levels by 2030 (under the Paris Agreement)

The emissions reduction fund (ERF) is the centrepiece of the Australian Government's current policies to limit greenhouse gas emissions. The Government is relying on the ERF, as well as several other policies, to reduce our greenhouse gas emissions, and meet the 2030 climate target. These policies are designed to reduce emissions, increase energy productivity, and boost the uptake of renewable energy.

The Australian Government has released the National Climate Resilience and Adaptation Strategy in late 2021. The Climate Resilience and Adaptation Strategy recognises that adaptation is a shared responsibility that requires sustained and ongoing action. The strategy operates across four domains, natural, built, social and economic and provides pathways for a resilient Australia by:

- setting out what the Australian Government will do to support efforts across all levels of government, businesses, and the community to manage physical climate impacts (such as floods, bushfires, droughts, sea level rise and marine heatwaves)
- showcasing national adaptation and resilience efforts.

5.3 Victorian Government policies

The Victoria Government's Climate Change Strategy provides the pathway for reducing emissions and building resilience to the impacts of climate change. The Climate Change Strategy is a roadmap to net-zero emissions and a climate resilient Victoria by 2050.

The initiatives of the Climate Change Strategy will support communities and businesses to make the changes needed to reduce the impacts of climate change and continue to support sustainable economic growth. Victoria's Climate Change Strategy has identified the following climate resilience objectives for 2050:

1. Climate-resilient built and natural environments
2. Prosperous, liveable, and healthy communities
3. An orderly and just adaptation process

Prior to Victoria's Climate Change Strategy, the State Adaptation Plan 2017-2020 identified roles and responsibilities for all sectors of the Victorian economy. The preceding State Adaptation Plan 2017-2020 prescribed the following roles and responsibilities, identified in Table 6, specific to local government as well as the community and individuals.

Table 6. Roles and responsibilities- Victorian Climate Change Adaptation Plan 2017-2020

Agency	Role and responsibilities
Local governments	• Provide leadership and good governance, represent the needs and values of local communities, and foster community cohesion • Manage climate change risks to council community services and assets, with support from the Victorian Government. • Identify the needs and priorities of the municipality and communicate these to Victorian Government where needed. • Develop and deliver locally appropriate adaptation responses. • Build the resilience of local assets and services. • Plan for emergency management at the municipal level, provide relief and recovery services, and support emergency response operations. • Help the Victorian Government understand localised impacts and responses. • Work with the community to help people understand and get involved in climate change adaptation. • Help connect the Victorian Government with the community
Communities and individuals	• Understand and actively manage their own risks: • Plan and act responsibly to reduce the exposure of their own person, families, private property and livelihoods to risks caused by climate change impacts. • Develop innovative local responses to climate change risks. • Explain to government and decision-makers what the community needs and values. • Support and encourage adaptation efforts on the ground.

5.4 Local environmental policies, strategies, and plans

Council has developed a framework of environmental plans and strategies over the last 8 years that focus on biodiversity, climate change, waste and water. Figure 2 outlines the framework of the Sustainable Environment Policy 2018-29 and how it links back to both the Liveability Plan and Council Plan.

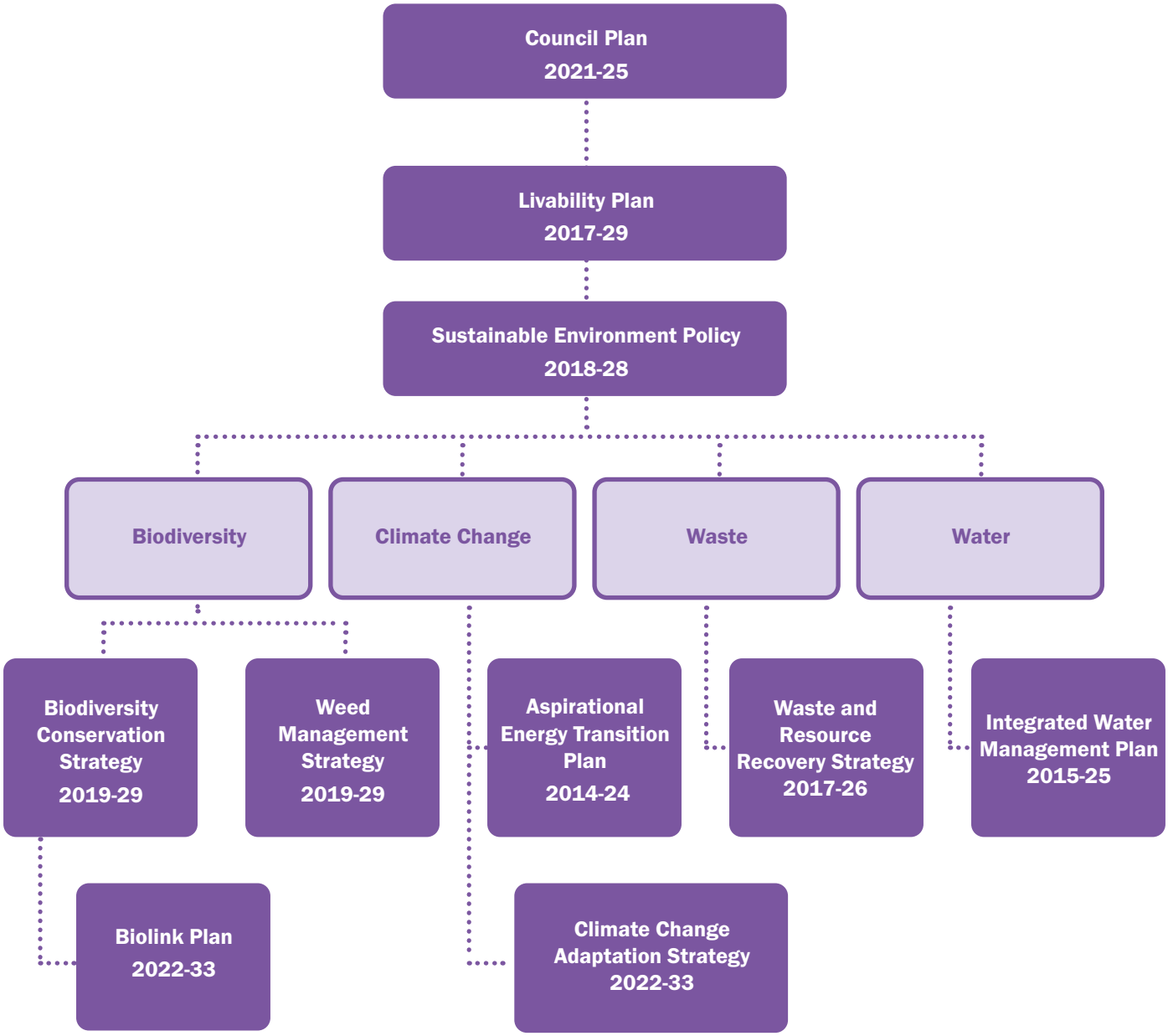
Responding to the overwhelming scientific consensus on rising global temperatures, council declared a climate emergency in September 2019. The declaration made the important commitment of 'ensuring climate change adaptation and mitigation actions are emphasised as key priorities in the Council Plan 2021-25. Developing a Climate Change Adaptation Strategy to address the localised climate change impacts and risks to Council and the Cardinia shire community is a critical step in meeting Council's commitments, as well as meeting its legislative obligation under the Local Government Act 2020 to plan for climate change risks.

The Council Plan 2021-25 commits Council to develop an Environmentally Sustainable Design (ESD) Policy and incorporate ESD into the planning scheme. This Council Plan initiative will support long term adaptation benefits by raising the resilience of the built environment system to the accelerating impacts of climate change. Furthermore, climate change is a fundamental feature of the Liveability Plan as managing the natural environment, and mitigating the adverse impacts of climate change, is regarded as an underlying element to support a healthy and resilient community in the shire.

Council's Aspirational Energy Transition Plan was endorsed in 2014. The 10-year plan sets the emission reduction targets for Council and the community to mitigate the severity of climate change and rising global temperatures. These targets include a 36% reduction in per capita community emissions based on levels in 2012 and a net zero emission goal for Council emissions by 2024. Council initiatives prescribed through the Plan are continuously mitigating greenhouse gases to reduce council's role in generating further emissions. By limiting organisational emissions council has aligned itself with the global initiative to reduce greenhouse gases to net zero and limit the severity of future extreme weather events.

Council has committed over $13m of funding through the Biodiversity Conservation Strategy, Weed Management Strategy and the Biolink Plan to improve the health of the biodiversity in the shire, directly addressing risk 7: the decline and loss of environment protection and biodiversity conservation. Appendix H outlines the environmental strategies and plans and how they align with climate change adaptation.

Figure 2. Sustainable Environment Policy framework



6. Climate change risks and opportunities

The dynamic nature of climate change means that some risks can apply across several categories. Organisational sensitivity and existing community vulnerabilities are only exacerbated by climate change; the stresses and shocks associated with disasters, extreme weather and pandemics are compounding. Strategically addressing these climate change risks will reduce the adverse impacts of climate change on the economic, social, and environmental systems in Cardinia Shire.

6.1 Identification of climate risks

Council carried out a climate change impacts and risks (CCIR) assessment to determine how projected climate change would impact the community as well as Council's assets, and service delivery. The assessment aligned with Australian Standard (AS) 5334-2013 Climate change adaptation for settlements and infrastructure—a risk-based approach. The CCIR assessment identified that in the coming decades, Cardinia Shire can expect increasingly hotter and drier conditions with impacts under the categories described in Table 7.

Table 7. Categorising climate risks

Topic	Issue	Projected climate
Heat	Increased frequency, duration, and severity of heatwaves	• Number of hot days increase • Frequency of warm nights will increase
Bushfire	Significant increase in bushfire danger days and fuel loads	• Fire season to start earlier and end later • Extreme fire days increase by 12-38% by 2020 and 20-135% by 2050.
Flood and storm	Less frequent but more intense storm and rainfall events	• More extreme rainfall events • Change in flood patterns • High wind events
Drought	Decreased average rainfall with more severe, prolonged drought conditions	• Decrease in average rainfall • Increase in severity and duration of droughts
Sea-level rise	Rising sea levels resulting in coastal erosion and inundation	• Salt-water intrusion and increase soil salinity • Reduced capacity of low-lying drainage networks

The findings of the CCIR assessment are based on a mixture of desktop research, focus groups with key Council staff, spatial analysis of existing hazard and Council asset datasets, and two risk workshops attended respectively by Council staff and community representatives. Through this assessment a total of 51 discrete risks linked to climate change were identified across Cardinia Shire. Of these 51 risks 7 risks have been identified as a priority for immediate action in the next 10–years.

6.2 Climate impacts and risk – what does the evidence reveal?

The CCIR assessment identified local risks associated with climate change for both near-future (2030) and far-future (2070) time horizons. A risk rating category consisting of, extreme, high, medium, and low was used to categorise identified climate risks. The final CCIR report presents 51 risks across the shire in 2070. Table 8 summarises the results of the assessment and the distribution of the identified risks for both near-future (2030) and far-future (2070) time horizons.

Table 8. Number of risks identified per risk rating and time horizon

Risk rating	Recommendation	Number of risks	
		2030	2070
Extreme	An action plan to reduce the risk is to be developed immediately.	0	1
High	An action plan to reduce the risk is to be developed.	7	31
Medium	A risk treatment may be used.	35	19
Low	Monitor and review risk annually	9	0

The 7 risks identified with a high risk rating for near future (2030) identified through the CCIR assessment have been central to the development this Climate Change Adaptation Strategy and the connected 10-year Action Plan (2023-2033). The CCIR assessment identified that hotter and drier conditions combined with an increase in the frequency, severity and extent of extreme weather events is likely to multiply existing risks faced by Council and the community. Some risks have broader impacts and require a coordinated response across council, the community, partner organisations, and intergovernmental agencies.

Adaptation planning and the associated actions to reduce the shire's vulnerability to these climate related risks will increase community preparedness and organisational resilience to the adverse impacts of climate change. The 2021 Liveability Plan Survey identified the major community perceived impact of climate change was directed toward damage to public infrastructure, while 63% of respondents selected a human-health related impact and 25% identified a mental health impact attributed to climate change and extreme weather. Appendix G provides data on the community responses to council survey questions focused on climate change and extreme weather completed in 2019 and 2021.

Seven of the 51 climate related risks have been identified as a priority for action by 2030. The 7 risks associated with a high-risk rating in 2030, as well as Council's level of influence in treating each risk are outlined in Table 9. The compounding impacts of climate hazard events demonstrates the urgent need for coordinated efforts to reduce Council sensitivity and community vulnerability to these risks and the adverse impacts of climate change. To address these risks a costed 10-year action plan has been developed, with adaptation actions or initiatives to treat each of the 7 highly rated risks for 2030. Prescribing risk treatment actions for these 7 high risks pathways is likely to lessen the risk ratings of the other 44 locally identified risks for 2030.

Table 9. Risks rated high in 2030 and Council's sphere of influence

No.	Risk	Description	Hazard	2030 risk rating	CSC sphere of influence
1.	Increased demand on Council to respond to climate related hazard events resulting in disruption to service delivery	Increased demand on Council emergency response function results in delays to usual service delivery and health impacts to vulnerable community members	Bushfire; heatwaves; storm; floods	High	Control
2.	Adverse climate impacts resulting in loss of life or physical injury among Council staff and/ or community members	Increased incidence of loss of life or physical injury among Council staff and/or community members due to extreme events and population growth in at-risk areas	Bushfire; flood; storm; heatwaves	High	Influence
3.	Mental stress and illness among community and Council staff	Increased incidence of mental illness for community and Council staff due to trauma from preparing for, and dealing with the impact of, extreme event(s)	Bushfire; heatwaves; flood; storms; drought	High	Influence
4.	Increased incidence of family violence influenced by climate and weather	Family violence following natural disasters due to trauma and pressures from extreme events and the increase in hot days when alcohol consumption rises	Bushfire; heatwaves; flood; storms	High	Influence (White Ribbon campaign)
5.	The increased incidence of bushfire or dust storm related pollution	Increased incidence of bushfire-related pollution and/or dust storms, resulting in adverse health impacts for residents, particularly those with underlying health issues	Bushfire; drought	High	Influence
6.	Contamination of tank water supplies during and following major bushfires	Prolonged disruption to domestic water supplies due to pollution of household tank water supplies during and following major bushfires	Bushfire	High	Concern
7.	The decline and loss of Environment Protection and Biodiversity Conservation (EPBC) Act 1999 and Flora and Fauna Guarantee (FFG) Act – listed populations and species	Decline/loss of EPBC and FFG Act-listed populations and species, resulting in fewer populations and greater emphasis on protecting remaining populations. Species conservation status may be raised, resulting in stricter controls and higher costs associated with managing surviving populations within the shire.	All	High	Limited influence


Hills Hub

7. Adaptation planning

Early planning and action help to reduce the adverse consequences associated with climate change and extreme weather events on the social, economic, built and natural environment systems. Reducing exposure to impacts and the sensitivity of the community and Council to the adverse effects of climate change will significantly support positive adaptation outcomes across the shire. Adaptation planning begins with the identification of climate impacts and risks in order to consider potential action options and their co-benefits. Adaptation options can range from actions that build general adaptive capacity to other specific actions that directly address key climate related risks.

7.1 Guiding principles for adaptation action

There are 3 key guiding principles for adaptation as outlined in Table 10. These focus on specific aspects attributed to climate risk and its mitigation. Reducing the exposure to climate hazards ensures that priority services and functions of the community and Council can continue to function. Reducing the sensitivity of specific sectors, industries, communities, individuals, and organisations reduces the susceptibility to the adverse effects of climate hazards, while increasing the adaptive capacity raises the ability to cope with and adjust to the consequences of climate related hazard events.

Table 10. Guiding principles for adaptation

Approach	Description	Examples
Reducing exposure	Ensuring that key activities, resources, products, services and assets are located out of hazard zones.	• Relocating valuable items, assets and resources to somewhere not at risk
Reducing sensitivity	If it is not practical to eliminate exposure to a risk, we can often take measures to reduce susceptibility to harm.	• Behavioural change programs • Improving asset management and maintenance regimes • Nature-based solutions, such as greening to reduce urban heat island effect
Increasing adaptive capacity	Improving the ability to cope with and adjust to change	• Backup power systems • Purchasing insurance, which provides council with recovery options in the event of an impactful event

7.2 Embedding adaptation

Through the CCIR assessment 51 climate related risks have been identified from now till 2070. A risk rating classification consisting of, extreme, high, medium and low was used to categorise the 51 climate risks (2070). These risks have been considered for both near-future (2030) and far-future (2070) time horizons as well as the level of influence Council has in addressing each specific risk.

Adaptation calls for increasing resilience to the adverse effects of climate change. Council will address climate sensitivities to successfully adapt to the unprecedented stresses and shocks associated with climate change. In the review of the 51 risks, the following themes were identified: drainage and flooding, financial impacts, asset damage, health and wellbeing, open space, biodiversity, water security, service demand, service disruption and insurance. These themes provide a way to consider and address Council's long-term risk profile.

When the next opportunity arises, consideration should be given to updating all council policies to ensure the inclusion of climate change adaptation measures and supporting climate resilience across the organisation and community. Table 11 lists the existing Council policies to be considered for priority updating based on climate risks theme. Reducing the climate sensitivity of the community and Council will lessen the adverse effects of climate change on service delivery and liveability across the shire.

Table 11. Council climate change risk themes and associated Council policies

Approach	Description	Council policy
Financial impacts	Financial impacts, including increasing maintenance and operating costs and reduce asset lifespans	• Financial Plan 2021-31 • Asset Management Policy
Drainage and flooding	Key risk areas for Council around stormwater runoff and flooding, including rainfall and flooding cause infrastructure damage and pollution	• Asset Management Strategy • Cardinia Shire Planning Scheme • Community Safety Plan • Municipal Strom and Flood Plan
Asset damage	Current building design standards are not adequate for projected climate conditions, including for assets that provide the most critical services to the community.	• Cardinia Shire Planning Scheme • Enhanced Standard: Sustainable Buildings 2020- 2026
Insurance and business continuity	Rising insurance premiums and liability issues for local government.	• Council Risk Register • Risk Management Policy • Business Continuity Planning Policy
Health and wellbeing	Direct and indirect health impacts to Council staff and community. Direct health impacts occur at the same time and place as a weather event – for example, floods may cause injury, and heatwaves can cause physiological effects.	• Cardinia Shire Planning Scheme • Liveability Plan • Municipal Heat Health Plan
Open space	Increasing heat exposure poses risks to people using Council sport facilities and active outdoor spaces such as hardening of sportsgrounds	• Open Space Asset Management Plan • Cardinia Shire Planning Scheme • Precinct Structure Plans
Water security	Reduced water availability leads to greater demand for and costs of irrigation.	• Integrated Water Management Plan • Precinct Structure Plans
Natural Environment	Indigenous flora and fauna become more threatened or extinct.	• Biodiversity Conservation Strategy • Biolink Plan • Weed Management Strategy
Bushfire	Increase in hot dry weather increases fuel loads along with increased in bushfire danger days. Risk to human life, also risk to loss of biodiversity through fire prevention management on public and private land.	• Cardinia Planning Scheme • Municipal Fire Management Plan • Biodiversity Conservation Strategy • Biolink Plan • Shelterbelt guidelines • Community Safety Plan

Planning Scheme and Municipal Strategic Statement (MSS)

The Victorian Planning Provisions (VPP) set the state-wide reference framework for the development of all local government planning schemes and Municipal Strategic Statements (MSS). Specific Strategies presented in the VPP are a reference for inclusion through the planning policy updates of local governments to minimise the impacts of natural hazards and climate change at a local level.

Forthcoming versions of the Cardinia Shire Planning Scheme and MSS will integrate the strategic framework provided by the VPP that aims to lessen the impacts of natural hazards and climate change on current and future generations of the Shire. As directed by the VPP, these updates to the Cardinia Shire Planning Scheme and Municipal Strategic Strategy will embed risk-based planning, which prioritises the protection of human life from natural hazards and climate change.

Municipal Environmentally Sustainable Design (ESD) Policy

Decision making and actions taken today are fundamental to building the long-term capacity of the Shire to adapt to climate change. A local ESD policy represents planning policy reform that will increase the standard and performance requirements for new buildings in the Shire. Improving these requirements will raise the capability of a building to withstand harsher future weather conditions, deliver health benefits, slashes energy bills, as well as making homes and officers more comfortable. The future development of a Municipal ESD Policy and incorporation into the Cardinia Shire planning scheme would support the long term sustainability and longevity for new buildings, subdivisions, and precincts.

A future Municipal ESD policy will strengthen the climate change resilience of the community by requiring the submission of permit applications that demonstrate higher levels of insulation, energy and water efficiency, renewable energy generation, urban ecology, stormwater management, double glazing, and airtightness. These are some examples of ESD considerations that will ensure an improved level of internal thermal comfort for occupants, reduced operational costs and the increased uptake of renewable energy through the integration of solar photovoltaic and battery technology. The future incorporation of an ESD policy into the local Planning Scheme will increase the capability of buildings to provide adequate protection for inhabitants from the physical impacts of climate change.

Through the future development of an ESD policy, risk based planning for adaptation to the localised impacts of climate change can be integrated into the planning, design, and development of new subdivisions and across the built environment of Cardinia Shire. A municipal ESD policy is therefore an underlying resource for Cardinia Shire's planners, urban designers, developers, and those engaged in creating sustainable communities in the context of the localised climate change impacts.

8. Action planning

Developing a 10-year costed action plan that incorporates the evaluation, review and assessment of the delivered initiatives will ensure Council remains flexible in its approach to adapting the systems in the shire to climate change. The dynamic nature of climate change is determinant on the increase or reduction in the concentration of atmospheric greenhouse gases emissions. It is appropriate that a midterm review of progress towards the action plan be completed to ensure the adaptation planning considers the most up to date and accurate data available in identifying the most urgent risks and adaptation priorities for both the community and Council.

A priority suite of actions has been identified to address the most urgent climate risks to Council and the community. The actions address the risks identified in the CCIR assessment that have a high rating for 2030. Table 12 summarises the action pathways to address each of the 7 high risk categories. These pathways were developed through the stakeholder deliberation at the workshop and during the consultation meetings. The pathways identify themes to mitigate the highest rated risks in Cardinia Shire.

Table 12. Summary: consultation adaptation action planning

	Risk	Treatment objectives	Adaptation action pathway
1.	The 10-year costed action plan has been developed to address the most urgent climate risks. Delivering the action plan over a period of 10 years will strengthen the adaptive capacity of the community and Council to the immediate and imminent localised risks associated with the intensifying impacts of climate change.	• Improve ability for Council to respond • limit service disruptions	• Build and design new council buildings to a high standard ESD • Increase resilience of the built environment • Plan and prepare for increasing frequency of climate hazard events • Dedicated resilience role • Emergency response training, planning and procedure
2.	Adverse climate impacts resulting in loss of life or physical injury among Council staff and/or community members.	• No loss of life/injury • Reduce risk of casualty • Limit climate impact	• Partner with other organisations • Increase the resilience of community use facilities • Urban greening • Community education and awareness workshops • Development in high risk areas
3.	Mental stress and illness among community and Council staff.	• Reduce trauma and pressure from extreme events & natural disasters • Reduce climate related stress	• Training of key staff in specific roles • Access and promote use of open space and bushland reserves • Relief and support for those involved– consideration of PTSD and triggers • Disaster awareness and preparedness • Increase mental health services • Financial coaching or assistance programs

	Risk	Treatment objectives	Adaptation action pathway
4.	The increased incidence of family violence.	• Reduce trauma and pressure from extreme events and natural disasters • Reduce climate related stress	• Access to community use facilities • Flexibility around service change decisions and primary contact • Council's White Ribbon campaign and initiatives
5.	The increased incidence of bushfire-related pollution.	• Reduce sensitivity of council facilities • Reduce the sensitivity of community and vulnerable groups	• Education and awareness • Alternatives techniques for burning off • facilities capable of functioning despite smoke/pollution
6.	Contamination of tank water supplies during and following major bushfires.	• Reduce the effects of pollution on water supply and storage • Improve water security for all sectors	• Water storage infrastructure- disconnection points, flush system • Community information and design solutions • Increased ability for facilities to capture and store water • Rural properties- best practice rainwater storage tanks with flush design
7.	The decline and loss of Environment Protection and Biodiversity Conservation Act 1999 and Flora and Fauna Guarantee Act – listed populations and species.	• Halt the decline/loss of biodiversity • Increase adaptive capacity of remanent populations and ecosystems	• Identify, protect and enhance key ecosystems and habitats • Reduce the use of single use plastics • Enhance and protect natural assets • Address pest animals and ecosystem degradation • Future proof open space and councils' natural reserves e.g. seedbank • Protect and enhance blue, teal and soil carbon ecosystems • Foster partnerships with other organisations • Protect habitat of threatened species

The 10-year costed action plan has been developed to address the most urgent climate risks. Delivering the action plan over a period of 10 years will strengthen the adaptive capacity of the community and Council to the immediate and imminent localised risks associated with the intensifying impacts of climate change.

9. Monitoring and evaluation

As this is Council's first adaptation strategy much of its focus is on 10-year action plan and integrating long term adaptation and climate resilience through the update of existing Council policies and plans in Table 11.

A mid-term review of the strategy will be undertaken in year 5 to monitor implementation progress, evaluate actions and continuously improve delivery of the action plan.

In year 10 a more detailed review of the entire strategy will take place, including a climate change impact and risks assessment to identify new and emerging climate risks for the next 10 years. This assessment is in preparation for the development of an updated climate change adaption strategy for the subsequent 10-year period.

Table 13 outlines the adaptation indicators that will be used to monitor the progress of the strategy and the strategy objectives the risk relates to.

Table 13. Adaptation indicators

	Risk	Indicators	Objectives
1.	Increased demand on Council to respond to climate related hazard events resulting in disruption to service delivery.	• Number of days with electricity service interruptions to council facilities • Number of assets strengthened and/or better managed to withstand the effects of climate change • Number of training sessions targeting staff and number of attendees	• Objective 2
2.	Adverse climate impacts resulting in loss of life or physical injury among Council staff and/or community members.	• Number of awareness-raising events targeting community and number of attendees • Number of SECCCA adaptation and resilience projects participated in • Number of school's education programs delivered at Deep Creek that focuses on climate change	• Objective 1 • Objective 2 • Objective 3
3.	Mental stress and illness among community and Council staff.	• Number of financial coaching and debt assistance sessions held • The extent to which a climate resilient agriculture program has developed and implemented	• Objective 1 • Objective 2 • Objective 3
4.	The increased incidence of family violence.	• no indicator	• Objective 2

	Risk	Indicators	Objectives
5.	The increased incidence of bushfire-related pollution.	• Number of smoke related disruptions to Council facilities • Suitability of alternatives techniques for burning off in bushland reserves	• Objective 1 • Objective 2
6.	Contamination of tank water supplies during and following major bushfires.	• The extent to which the investigation into best practice flush system have been completed	• Objective 3
7.	The decline and loss of Environment Protection and Biodiversity Conservation Act 1999 and Flora and Fauna Guarantee Act – listed populations and species.	• Number of coastal management plans developed on a voluntary basis for private land • Number of vulnerable ecosystems identified in bushland reserves • Identification of teal, blue and soil carbon assets in the Shire • The uptake of the gardens for wildlife program in growth areas • The number of local pest animal plans developed	• Objective 2 • Objective 3

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Abbreviations

Abbreviation	Definition
AS	Australian Standard
CCAS	Climate Change Adaption Strategy
CSC	Cardinia Shire Council
CCIR	Climate Impacts and Risks
ERF	Emissions Reduction Fund
IPCC	Intergovernmental Panel on Climate Change
RCPs	Representative Concentration Pathways
VCP	Victorian Climate Projections
EPBC	Environmental Protection and Environmental Conservation Act
FFG	Flora and Fauna Guarantee Act

Climate Change Adaptation Strategy
2022–33

Cardinia Shire Council

Civic Centre
20 Siding Avenue, Officer

PO Box 7
Pakenham 3810 (DX 81006 Pakenham)

Phone: 1300 787 624
Email: mail@cardinia.vic.gov.au
Web: www.cardinia.vic.gov.au

National Relay Service (NRS)
TTY: 133 677 (ask for 1300 787 624)
Speak and Listen (speech-to-speech relay): 1300 555 727 (ask for 1300 787 624)

Translator Interpretation Service
131 450 (ask for 1300 787 624)

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