List of appendices

Appendix A. Climate data sources

Table A1. Data sources

Hazard category	Variables	Historic data sources	Projected data sources
Temperature	• Maximum annual daily temperature average • Maximum summer daily temperature average • 1-in-20-year hottest day (summer) • 1 in 20-year coldest day (winter) • Average days over 35°C	Moorabbin Airport weather station	Victorian Climate Projections 2019 (VCP19) Southern Slopes Cluster Report (CSIRO & BOM, 2015)
Precipitation and flooding	• Maximum rainfall average	BOM 6.1.2Online – Koo Wee Rup weather station	VCP19
Bushfire	• Severe Fire Danger Days	Baseline from CSIRO & BOM - Southern Slopes Report 2015	Southern Slopes Cluster Report
Coastal hazards	• Sea Level Rise • Sea surface temperature • Coastal erosion	Observed sea level rise from: Southern Slopes Cluster Report	Coast Adapt, 2017
Storms, wind and hail	• Annual average wind speed	BOM Climate Data Online – Moorabbin Airport weather station	VCP19
Solar radiation	• Annual solar radiation • Spring solar radiation		VCP19

Appendix B. Flood, bushfire and sea level rise maps

Figure A1.Figure B1Figure A1.Figure B2 and Figure A1.Figure B3 have taken Council asset data and overlayed the LSIO, BMO and sea-level rise layers (respectively) over the top to demonstrate the effect the impact these climate change events have on Council assets.

Figure B1. Land subject to inundation (LSIO)

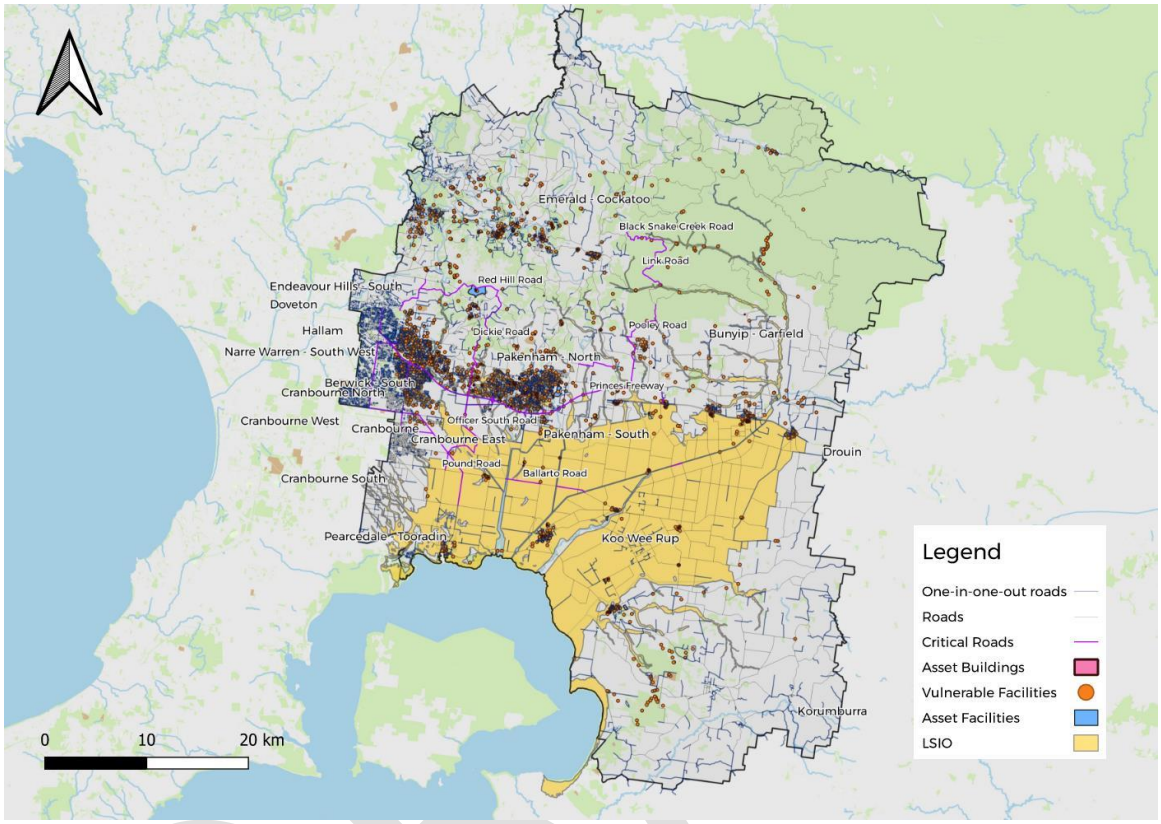


Figure B2. Bushfire management overlay (BMO)

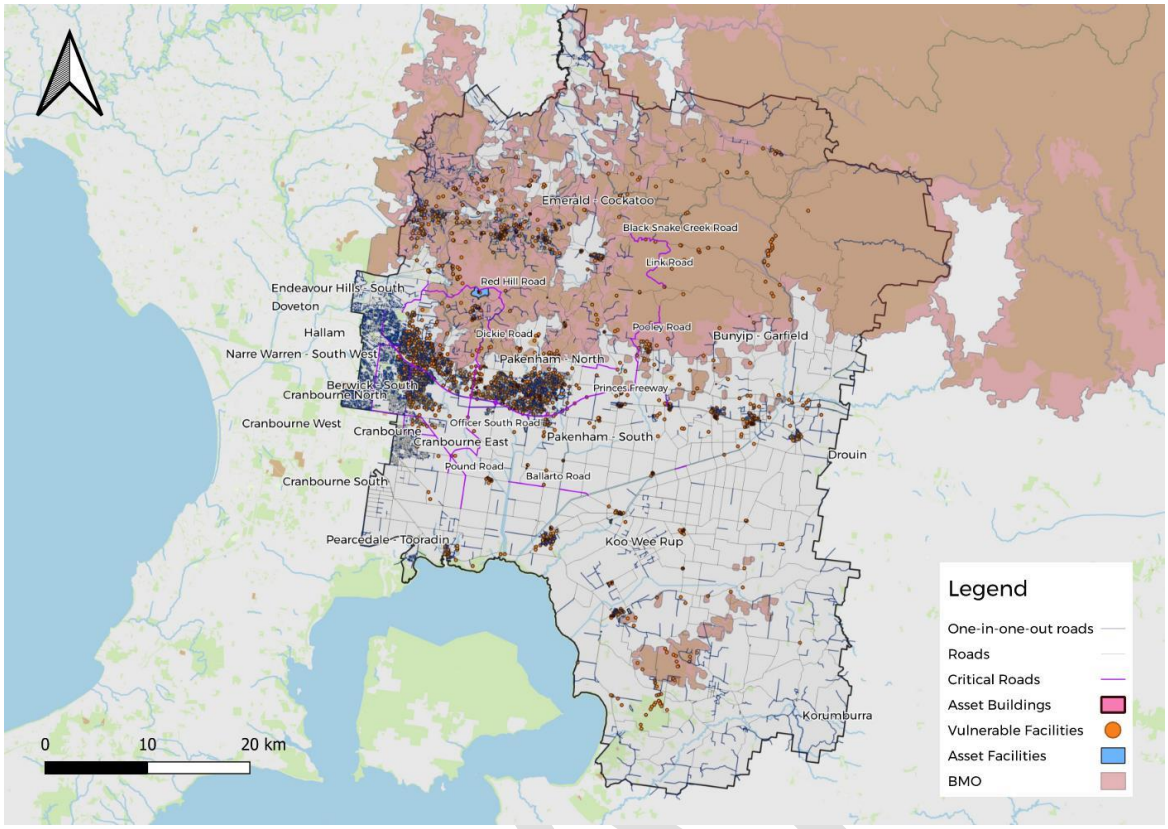
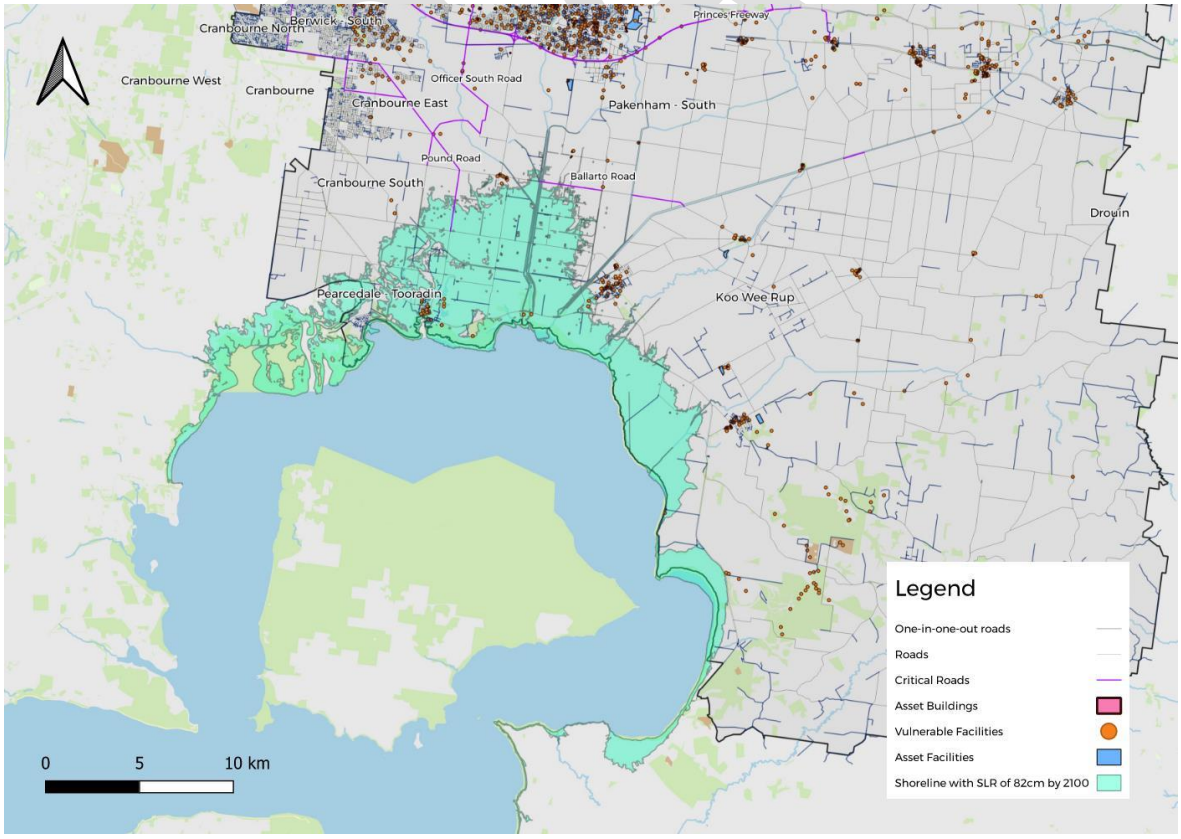


Figure B3. Change to shoreline with a sea rise level of 82cm by 2100



Appendix C. Historic climate – related events with major impacts

Table C1. Historic climate events in Cardinia Shire

Year	Location	Indecent	Impact	Source
1891	Regional	Major rainfall and flooding	Major flooding	Municipal Emergency Management Plan (MEMP)
1900	Koo Wee Rup	Two-day period of rainfall	Crop loss and inundation	MEMP
1901	Koo Wee Rup	Three-day period of rainfall	Extensive flooding	MEMP
1911	Upper Catchments	Heavy rainfall	Flooding to depth of 1.5m Koo Wee Rup	MEMP
1923	Cora Lynn	Flood event	Crops destroyed and inundation 2m at Cora Lynn	MEMP
1924	Koo Wee Rup	Heavy rainfall	300mm most of Koo Wee Rup Swamp over 2 metres	MEMP
1934	Koo Wee Rup	Flooding	Major flooding	MEMP
1937	Koo Wee Rup	Heavy rainfall	Excess rainfall over 152.4mm. Koo Wee Rup flooding	MEMP
1939	Eastern Victoria	Bushfire (Black Friday)	2 million hectares/71 deceased	MEMP
1956	Cardinia Shire	Heavy rainfall	Heavy rain and flooding	MEMP
1959	Cardinia Shire	Heavy rainfall	Widespread flooding / upper catchments	MEMP
1971	Swamp area	Flooding	Significant flooding	MEMP
1978	Pakenham	Heavy rainfall	Widespread flooding in Pakenham CBD	MEMP
1983	Cardinia Shire	Bushfire (Ash Wednesday)	180 homes destroyed/21 deceased	MEMP
1991	Koo Wee Rup	Extensive flooding	Flooding of the Koo Wee Rup swamp	MEMP
1996	Koo Wee Rup	Widespread flooding	Damage to crops, riverbanks overflowing Iona	MEMP
2008	Cardinia Shire	Severe Windstorm	Widespread damage across Southern metro region	MEMP
2009	Bunyip State Park	Bushfire (Black Saturday)	45% of park burnt by wildfire	MEMP

Year	Location	Indecent	Impact	Source
2009	Lakeside/ Pakenham	1-in-100-year storm event	180 mm rainfall in 24 hours 4–5 Feb 2009	MEMP
2010	Cardinia Shire	Hailstorm	Heavy rain, large hail and flash flooding over 6th and 7th of March 2010	MEMP
2011	Pakenham/Officer	Heavy rainfall	Over 150mm in eight hours causing extensive flooding	MEMP
2012	Koo Wee Rup area	Heavy rainfall/flooding	Widespread flooding Koo Wee Rup and surrounds	MEMP
2016	Cardinia Shire wide	Significant storm event	Severe wind event leaving 40,000 homes without power across the 3 Metro regions	MEMP
2016	Metropolitan areas	Thunderstorm Asthma	21-22nd November, unprecedented surge in respiratory and asthma related illness affected thousands of Victorians	MEMP
2016	Cardinia Shire wide	Flood event	Widespread rainfall up to 80mm in a short period of time causing flash flooding, landslips and traffic management concern	MEMP
2019	Bunyip State Park	Bushfire	29 houses destroyed and 2 houses damaged, over 100,000 ha burned	ABC News 2019, Cardinia Shire Council (CSC) records
2019	Cardinia Shire wide	Flood event	Flooding of multiple facilities requiring repair works	CSC records
2020	Cardinia Shire wide	Storm event	Jan & Feb storm events 14 Council owned facilities affected	CSC records
2020	Cardinia Shire wide	Flood event	Flooding of multiple facilities requiring some repair works	CSC records

Appendix D. Weather stations used for baseline climate data

Table D1. Weather stations used for baseline data

Observed weather data	Weather station	Rationale
Daily temperature and wind	Moorabbin airport	The Moorabbin Airport location and CSC are in the same climate zone: Zone 6. This zone is characteristically mild in temperature and ranges from low diurnal temperature variation near the coast to high diurnal variation inland. Despite being further away to the CSC than other weather stations, the Moorabbin station represents similar conditions to the large percentage of the Shire whilst providing the most appropriate data set for historic climate data analysis. This weather station is also the closest station to the Cardinia Shire (reference point) with a consecutive year-to-year record of daily temperature over the baseline. Other temperature weather stations near the Shire lack full temperature records for the baseline period used in the assessment.
Daily rain	Koo Wee Rup	Koo Wee Rup is the nearest weather station with daily precipitation data for the baseline period and appropriate representation of environmental conditions for a large proportion of the Shire. Suitable baseline precipitation data for other localities in the Shire is not available, although it can be concluded anecdotally that more mountainous areas receive greater annual rainfall on average.

Appendix E. Past and present adaptation initiatives and actions undertaken by Council

1. Council Climate Emergency Declaration
2. Council Climate Pledges
3. Council asset climate vulnerability assessment
4. Bushfire vulnerability council asset case study
5. Domestic violence awareness and training for staff to identify and response to family and domestic violence
6. Cardinia Coast Defence Project
7. Financial Risk Adaptation Planning
8. Enhance natural buffers and structures such as shelterbelts and bio links
9. Train council staff in first aid and mental health
10. Establish emergency management/ evacuation plans for councils' facilities in high threat areas
11. Formalise internal processes and procedures in response to specific hazard events
12. Raise community disaster Awareness and Preparedness
13. Strengthen existing partnership and foster new ones with support organisations and community groups
14. Engagement of the broader community (networks, clubs, sporting associations, committees) to demonstrate an understanding that everyone is responsible for promoting awareness on domestic violence
15. Gardens for wildlife program
16. Update of open-air burning laws to reduce instances with low levels of smoke
17. Advice and inform community with up-to-date information
18. Deliver community tree planting and giveaway events
19. Direct development away from away of high bushfire risk with important biodiversity
20. Direct development away from away of high flood risk with important biodiversity
21. Biodiversity Conservation Strategy
22. Biolinks plan
23. Integrated Water Management Plan
24. Weed Management Plan
25. Aspirational Energy Transition Plan
26. Sustainable Environment Strategy
27. Climate Risk in Governance speaker
28. Liveability Plan
29. Heat Health Action Plan
30. The Food Circles program
31. Metal health training for staff
32. Emergency Procurement Policy
33. Financing Physical Risk Infrastructure

Appendix F. Existing strategies and plans

The Council plans and strategies in Table F1 were used as references in the preparation of this strategy, to ensure consistency with existing strategies and regional plans.

Table F1. Council plans and strategies

Document title	Description
Council Plan 2021-25	**Aim** Directs Councils approach to tackling and preparing for the challenges while maximising the opportunities for the shire to thrive in the long term. **Objective** • tackle climate change as it continues to be one of the greatest challenges of our time • foster strong communities, liveable places, thriving environments and proposers' economies.
Liveability Plan 2017-29 (Cardinia Shire Council 2017)	**Aim** Strategically planning and maintaining opens spaces and places – ensure safety, accessibility, appealing and connected. **Objectives:** • Plan for the effects of climate change on the health and wellbeing of the community • Protecting and enhancing the environmental quality of open spaces and places. • Identify and address community concerns in relation to climate change impacts on liveability
Sustainable Environment Policy 2018-28 (Cardinia Shire Council 2018)	**Aim** Identifies the challenges facing the municipality, and outlines the plans and strategies already in place and those required to address them. **Objectives:** • Provides the roadmap for the future direction of Council's environmental and sustainability strategies, plans and activities • Plan for the adverse effects of climate change and take the appropriate action to prevent or minimise the damage it may cause • Support the community to adapt to climate change
Aspirational Energy Transition Plan 2014-24 (Cardinia Shire Council)	**Aim** Direct Council actions to mitigate climate change and accomplish pre-set targets for emission reduction. **Objectives:** • Recue council emissions and limit the onset of severe climate change • Achieve carbon neutrality for council activities by 2024

Document title	Description
Biodiversity Conservation Strategy 2019-29 (Cardinia Shire Council 2019)	**Aim** Strategic and planned approach to sustainably manage the shire's natural environment, so it is resilient, healthy and valued by the community **Objectives:** • Protect native flora, fauna and habitats (i.e. waterways); • Enhance the quantity and quality of indigenous flora and fauna on private and public land; • Connect native flora and fauna across landscape through Biolink corridors and steppingstones; and • Engage and educate the local communities to safeguard and project natural assets.
Draft Biolink Plan 2022-33 (Cardinia Shire Council)	**Aim** Increase the connectivity across the natural assets and structures to support movement of biodiversity across the landscape **Objectives:** • Create vegetation corridors • Link pockets of vegetation to improve the ability for species to disperse • Support biodiversity to inhabit best quality habitats • Connectivity of habitats supports resilience of threatened species
Weed Management Strategy 2019-29 (Cardinia Shire Council 2019)	**Aim:** Council, agencies and community working collaboratively to protect Cardinia Shire's landscape, biodiversity and agriculture from the negative impacts of weeds **Objectives:** • Protect Cardinia Shire's landscape, biodiversity and agriculture from the threat of invasive weeds • Manage – strategically allocate resources to local weed priorities consistent with regional, state and national priorities • Engage and empower our community to motivate them to collectively address weed issues
Integrated Water Management Plan 2015-25 (CSC 2015)	**Aim** Deliver a framework to guide Council towards a more sustainable approach to water management to decrease the reliance on potable water and enhance ecological health of receiving waterways. **Objectives:** • Quantify and minimise stormwater flows, and pollutant loads to waterways • Ensure efficient use of potable water within Council facilities and encourage community to reduce usage • Reduce Councils reliability on potable water by identifying and using alternative water sources • Contribute to sustainable groundwater management (including exploring the option of alternative sources for agriculture) • Reduce the impact on the environment • Protect the shires waterway values and open these assets up to the community.

Appendix G. Community feedback

Significant community engagement was undertaken in the preparation of a CCIR assessment and the CCAS. This was done through a range of methods including:

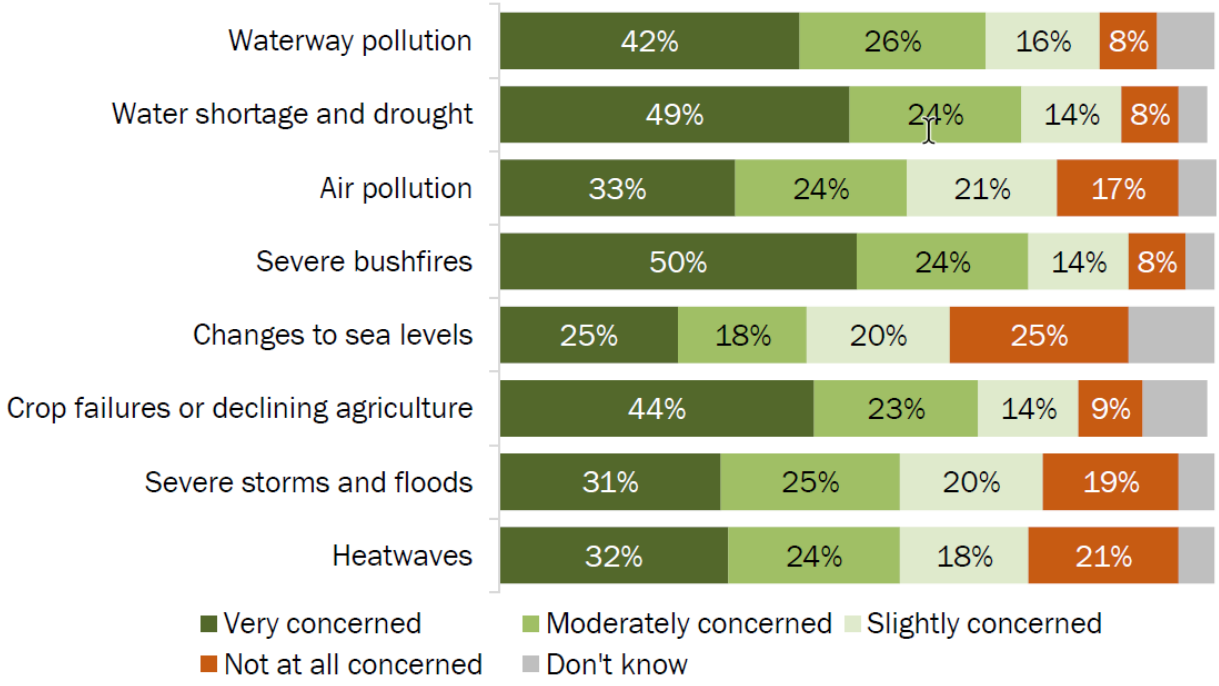
- Online surveys and questionnaires
- Climate risk workshop with community representatives
- A CCIR assessment drawing on community and stakeholder identification of risks and an analysis of weather data on climate change in Cardinia Shire.

Liveability Plan survey

Climate change is an underlying determinant to the liveability of our communities. Understanding the adverse impacts of climate change on the community is key to successfully addressing climate risks. The Liveability Plan survey conducted by Council in 2019, identified community concerns on climate change. Through the engagement process for the *Liveability Plan* trends in community perception of climate impacts and risks emerged.

The survey results show a greater concern for bushfires over the next ten years amongst the shire's population, with 74% of respondents in the shire having concerns about severe bushfires, compared to only 68% across Victoria. This sentiment can likely be attributed to the large areas of bushfire-prone land in the shire and the recent Bunyip Complex Bushfires. **Error! Reference source not found.** represents a snapshot of the community's climate concerns for the next 10 years.

Figure H1. Snapshot of the community's concerns over next 10-years



Community risk workshop

A community workshop held in February 2021 included external stakeholders representing community interests, such as township committees, local health services, community support groups an environmental interest group, and a major local business.

The workshop attendees were introduced to the assumptions that underpin the use of climate projections, followed by a summary suite of projections depicting the conditions Cardinia Shire may face in 2030 and 2070. Participants then undertook a structured discussion to validate, refine and build upon the list of 41 risk descriptors based on their personal knowledge of the shire and Council operations. This activity was followed by a group exercise to prioritise top risks by 2070 based on likelihood and consequence.

The external workshop provided opportunity for community representatives to articulate the following:

- Values: aspects of life in Cardinia Shire that are important to communities (e.g. industries, natural assets, mental wellbeing), with the potential to be affected by climate change
- Vulnerabilities: characteristics of communities within Cardinia Shire that may increase their susceptibility to adverse impacts from climate-related hazards
- Strengths: characteristics of communities within Cardinia Shire that may assist in them in surviving and thriving when faced with climate-related hazards (i.e. reducing vulnerability).

Internal meetings and risk workshop

Internal consultation meetings with key stakeholders were held in November 2019 and a broader capacity building workshop and consultation with representation from across the organisation was held in January 2021.

The aims of this workshop were to:

- collaboratively identify and prioritise the climate-related risks facing Cardinia Shire and delivery of council services
- determine risks within Council's sphere of influence
- begin to identify practical actions that Council can take to adapt to climate-related risks
- seek input on how Council can support the broader community to adapt

Throughout these internal meetings information was collected and analysed to create an understanding of localised past climate events, critical service functions of Council, climate concerns and potential opportunities to support resilience in the shire. The internal workshop took a structured approach to validating and prioritizing localised climate-related risks.