Resilient Asset Management Program

Pilot Project Phase 2 report

Resilient South

November 2023

aurecon

Bringing ideas to life

RAMP pilot risk workshop, 17 May 2023

Contents

Document control

Report title		Phase 2 report			
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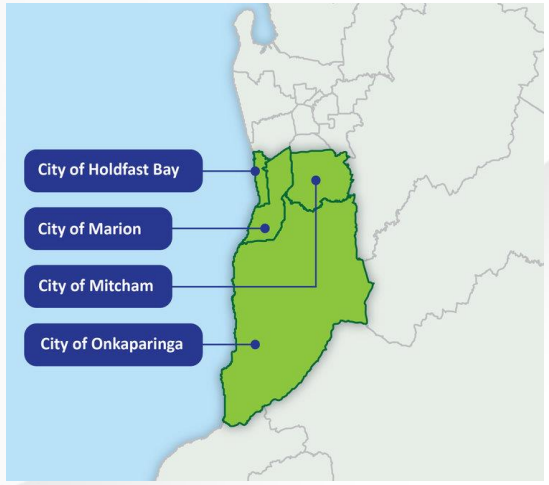
About Resilient South

Resilient South is a partnership of the Cities of Marion, Mitcham, Holdfast Bay and Onkaparinga.

It is about strengthening southern Adelaide so that our businesses, communities and environments can bounce back from the challenges of climate change, and stay productive, connected, and strong. The impacts of a changing climate are already being felt across southern Adelaide.



About the delivery team

Aurecon is a design, engineering and advisory company that brings ideas to life to create a better future for people and the planet. Aurecon is responsible for delivering the first three phases of the RAMP pilot. They will also be supporting the delivery of Phase 4.

Phase 4 will be led by **CSIRO & Value Advisory Partners,** who have developed the Enabling Resilience Investment methodology. This approach will be applied to identify the best opportunities for climate adaptation.

The RAMP has received financial support from the Resilient South councils, CSIRO, the LGA SA Research and Development Scheme, and the Disaster Risk Reduction Grants Program funded by the Australian Government and the South Australian Government*.

* Views and findings associated with this project are expressed independently and do not necessarily represent the views of the State and Commonwealth funding bodies.

Executive summary

The Resilient Asset Management Program (RAMP) pilot aims to improve the resilience of the southern Adelaide region and communities by integrating climate risk into council asset management processes.

In Phase 2 of the RAMP pilot, Resilient South engaged Aurecon to undertake a climate risk assessment for five asset classes:

- Bridges
- Major buildings
- Roads
- Open space and coastal
- Stormwater

This report presents the approach and key findings.

Climate risks

Climate change both creates and multiplies risks to the built environment, infrastructure, people, the natural environment and the economy. Increasingly frequent and severe events already impact the operation and maintenance of assets. These extreme events are likely to increase in a climate-affected future and be compounded by the impacts of chronic and acute climate hazards. Climate risks can be thought of as physical and transition risks.

Physical risks can be acute (extreme weather events like bushfires or floods), chronic (longer-term climatic changes like temperature increase) and compound (arise from multiple events occurring simultaneously, such as extreme heatwaves occurring during drought).

Transition risks arise from the policy, legal, technological and market changes necessary to meet mitigation and adaptation needs.

Risk assessment approach

This climate risk assessment considers physical and transition hazards to selected asset classes, under two plausible climate scenarios. The climate scenarios were developed in Phase 1 of the RAMP pilot.

Physical risks are assessed at 2030, 2050 and 2090 time horizons. Transition risks were assessed for 2030 and 2050, as the level of uncertainty increases significantly as horizons extend.

As shown to the right, the Phase 2 risk assessment scope included context setting, risk identification, analysis and evaluation. Risk treatment, in the form of controls or adaptation options, is the focus of Phase 3 of the RAMP pilot project.

This approach has been documented as a repeatable methodology, to enable councils to undertake risk assessments for other asset classes or update this risk assessment as new climate data becomes available.

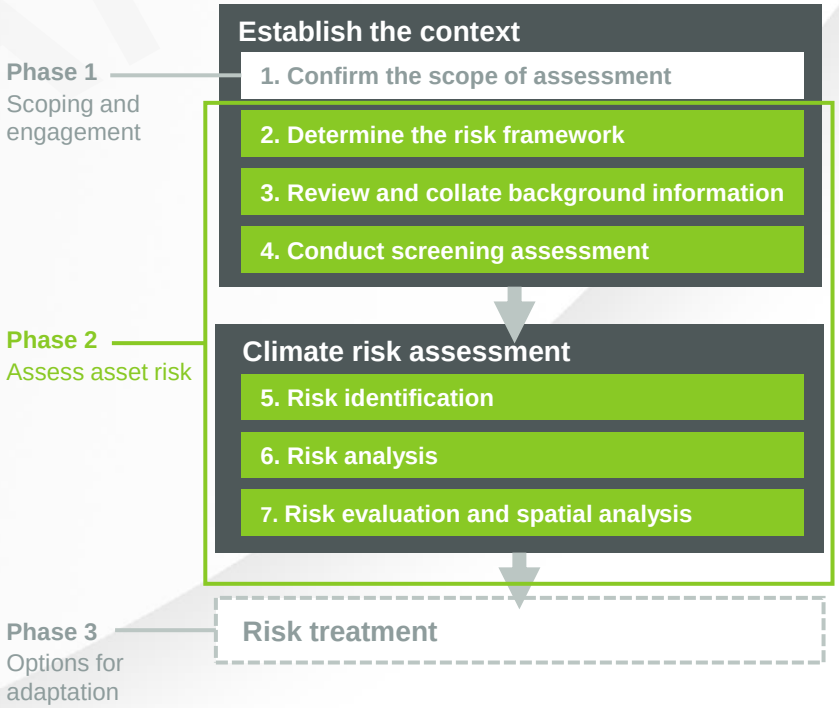
Climate context

Two climate scenarios, adopted from internationally recognised frameworks, were used in the Phase 2 risk analysis.

The sustainability pathway, the Green Path, envisions a future where coordinated global action shifts energy systems to renewables and economic values towards sustainable development, limiting physical climate change impacts beyond 2050.

The Highway scenario assumes a continuation of fossil-fuelled development, where high economic growth and intensive resource consumption is prioritised over environmental concerns, resulting in significant physical climate challenges and inequalities.

These climate scenarios represent likely extremes of physical (the Highway) and transition (the Green Path) risks. They are the plausible boundary conditions of the future. This risk assessment analyses hazards against both scenarios to provide a thorough understanding of how hazards interact and change in uncertain futures.



ABOVE Phase 2 risk management process, adapted from ISO31000:2018

Key findings: considering climate risks at 2050 and 2090

Council assets are vulnerable to a range of impacts from physical and transition climate hazards. Roads, major buildings, and open space and coastal assets will face more high and very high physical and transition risks in 2050, under both scenarios, than bridges or stormwater assets (see top right).

Results from each scenario's risk assessment need to be considered together. In 2050, levels of very high risk are similar under both scenarios. However, assessed over time, the risk assessment demonstrates that the severity and number of risks are reduced under the Green Path scenario. If climate change mitigation does not occur (as in the Highway), physical risks will increase significantly, with 85 percent more physical risks at 2090 in the Highway scenario compared to Green Path.

Four physical risks and two transition risks are rated very high at 2050, under both scenarios (see bottom right). Three of these risks apply to major buildings, all relating to energy supply. As these six risks could occur in both scenarios, these should be prioritised for treatment.

Spatial analysis

The climate risk assessment was extended and visualised to determine the spatial distribution of physical climate risks and vulnerabilities. Created for the RAMP pilot, the online geoportal:

- maps asset data and their associated vulnerability to climate hazards,
- links the climate risk register to spatial asset data, and
- rates and prioritises risks to individual assets, based on the relationship between asset class level risks (from risk register), asset location and physical climate hazard mapping.

This allows users to identify at-risk assets in vulnerable locations and immediately link to associated risks from the risk register.

Recommendations and next steps

Resilient South councils can use Phase 2 outputs in the short-term to:

- integrate very high climate risks under both climate scenarios into council Risk Registers
- ensure climate risk assessment results can be adapted into council systems
- identify specific assets at risk
- identify existing treatments for high and very high climate risks.

Phase 3 of the RAMP pilot will will identify and assess options to address the high and very high risks identified in Phase 2. Adaptation options will inform the development of action plans for each council and the region, based on an adaptation pathways approach that ensures adaptation options are robust and low regret. These plans will identify opportunities to provide assets and services in a way that is sustainable, climate-compatible, disaster-resilient and contributes to realising the community-defined vison for the region.

TOP Quantity of high and very high risks under the Green Path and Highway scenarios at 2050, with affected asset class

Scenario	The Green Path		The Highway	
Risk level	High	Very High	High	Very High
Bridges	12	3	14	2
Major buildings	39	6	41	8
Open space and coastal	35	1	36	1
Roads	33	3	36	5
Stormwater	15	1	15	2
TOTAL	**134**	**14**	**142**	**18**

BOTTOM Very high physical and transition risks at 2050 under both the Green Path and Highway scenarios, with related climate hazard and affected asset class

Risk type	Asset class	Climate hazard category	Risk statement
Physical	**Bridges**	**Wet**	Increased damage and replacement of bridges due to climate change impacts from heat, storms, flooding and bushfire impacts
	Major buildings	**Dry**	Loss of electricity supply for 2 days to 2 weeks from extreme events generating widespread disruption to Council services and community
	Open space and coastal	**Heat and cold**	Increased risk of heat-related health impacts on visitors
	Stormwater		Power lost to water pumps during extreme heat events
Transition	**Major buildings**	**Technology**	Improved energy efficiency required of buildings
			Transition from gas infrastructure to electric and solar heating

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RAMP pilot background

1.1 Introducing the Resilient Asset Management Program

The Resilient Asset Management Program (RAMP) is a collaboration, between the four Resilient South councils – Cities of Marion, Mitcham, Holdfast-Bay and Onkaparinga – and the South Australian Government, in collaboration with the CSIRO and Value Advisory Partner's Enabling Resilience Investment initiative. The RAMP pilot represents the third step of the broader program, which began in July 2021.

The primary aim of the pilot is to develop an approach to assess and mitigate climate-related risks to council assets, in the context of the services they provide. These approaches will be able to be adapted by other South Australian councils over time.

Research in recent years has found that a systems approach is needed to achieve resilience. This means thinking beyond the resilience of assets themselves to how assets contribute to the resilience of the system. This requires consideration of how to strengthen the asset and network as well as the place, city and region.

Using the outcomes of the pilot is part of the Regional Climate Action Plan. Resilient South councils will work together to *embed climate risk considerations into infrastructure decision-making, via the Resilient Asset Management Program (RAMP)*.*

**The draft Regional Climate Action Plan 2024-2029 has been informed by broad stakeholder engagement. Community feedback on the draft is currently being sought and will be integrated into the final plan.*

The pilot aims to contribute to the vision for the region:

> **Southern Adelaide is climate resilient, with healthy and diverse natural environments, low emissions and connected communities.***

Aurecon is working in collaboration with the Resilient South councils, CSIRO and Value Advisory Partners to deliver the first three phases of the RAMP pilot.

Phase 1: Scoping and engagement

The first phase of the pilot, focused on scoping the project and engaging internal stakeholders in the project, was completed in February 2023. Section 1.3 (p.9) provides an overview of key outcomes.

Phase 2: Assess asset risk and vulnerability

Phase 2 of the RAMP pilot developed an approach to assess climate risks to council assets at different scales and under different climate scenarios. Examining different asset classes across the four councils allows the project to be scaled and adapted to the other councils. The selected assets are council roads, for all four councils, major buildings (City of Marion), bridges (City of Mitcham), open space and coastal assets (City of Holdfast Bay) and stormwater (City of Onkaparinga).

The methodology has been documented so it can be adapted and repeated across additional asset classes, both across Resilient South councils and other Australian organisations. This report summarises the process and key findings to date and outlines next steps.

About the Phase 2 report

This report presents the key findings from the RAMP pilot Phase 2 outputs:

- RAMP Climate Risk Register (excel)
- Resilient Asset Management climate risk assessment methodology: guidance note
- RAMP geoportal (online).

Section 1 provides background to the RAMP pilot and Phase 1 outcomes. Section 2 outlines the climate risk assessment methodology and key findings. The spatial analysis and geoportal development is outlined in Section 3 and Section 4 contains recommendations.

Phase 3: Options for adaptation

The risks identified in Phase 2 are key inputs into the next phase of the RAMP. Phase 3 will begin in October 2023.

This phase will identify and assess options to address the risks identified in Phase 2. Adaptation options should go beyond protecting assets in place and seek to contribute to regional resilience and bring additional benefits to local communities.

The options will be assessed and prioritised using multi-criteria analysis, informing the development of an Action Plan for each council and the region. This will be based on an adaptation pathways approach, to ensure adaptability and that actions are low regrets. These plans will identify opportunities such as how service delivery can be provided in a way that is sustainable, climate-compatible, disaster-resilient and contributes to realising the RAMP mission and community's vision for the region.

Phase 4: Support for resilience investment

The final phase of the pilot aims to support investment decision making. Even when risk mitigation and adaptation options have been identified and prioritised, experience across Australia has shown that obtaining funding or investment to deliver these options can be difficult. Phase 4 will be delivered by CSIRO and Value Advisory Partners, with Aurecon providing support and knowledge from previous phases.

1.2 Drivers for the pilot

Climate change affects both communities and the environment. It is creating and multiplying the risks to infrastructure, people, the environment, and the economy. The frequency and severity of extreme weather events will increase in the future, leading to compounding impacts on a council's assets and intensifying demands on asset management teams and budgets.

Councils are finding it increasingly difficult to manage and mitigate the impacts of climate change. The need to shift from a predominantly reactive approach to a proactive one is becoming apparent. Local governments must consider the impact that climate change has on physical assets and the services they provide to the community, along with transition risks that arise from the shift towards a lower-carbon economy. Investment should be made into reducing vulnerability and identifying a broader set of options that can reduce the effects of climate risk.

Performing a climate risk assessment is a crucial first step to understand, prepare for and respond to climate-related risks. This project's risk assessment supports the overall RAMP mission. It will assist councils to make proactive, responsible decisions to deliver and manage climate-ready assets and services, supporting a safe, connected and thriving resilient southern region.

Why conduct a climate risk assessment?

The impacts of climate change are broad, affecting the natural environment, human health, infrastructure, transportation, energy, food, water supplies, and local and global economies. Climate risk assessments can proactively identify, analyse and evaluate the potential impacts of climate change. Developing an understanding of physical and transition climate risks can support councils to:

- provide reliable, high-quality services to its community
- reduce costs associated with reactively responding to climatic events and maintain insurability
- prevent stranded assets
- assess relative risks to assets using a methodology that is replicable and reliable
- develop informed risk treatment strategies to respond to identified climate risk, for example through controls, adaptation, retreat or protection of assets
- maintain business continuity and meet regulatory requirements in the face of changing market and policy landscapes
- provide pathways to change current systems and processes, to achieve more strategic, adaptable and resilient approaches to climate disaster risk assessment and reduction
- identify resilience investment pathways.

Where to next? Identifying adaptation options in Phase 3

Climate risk assessments can identify and prioritise areas of highest risk. These risks should be treated, through controls, system improvements or adaptation measures.

Adaptation is the process of incremental or transformational adjustment in response to current or projected climate change and its potential effects, in order to minimise threats and deliver opportunities.

Climate resilience comes from effective adaptation. Resilience is the capacity of a system or organisation to cope with a hazardous event/trend/disturbance and respond or reorganise in ways that maintain essential function as well as capacity for learning and transformation.

Phase 3 will develop adaptation options for risks identified in this phase of the RAMP.

BOX 1

Physical climate impacts

Increases in average temperature, and number of hot days

Increase in heavy rain days and frequency of drought

Increase in storm intensity

Increase in very high and extreme forest fire danger days

Assets at risk

- Damage from extreme storms and weather
- Increased stress on stormwater systems from increased intensity of rainfall events
- Increased degradation of components and finishes, from higher temperatures

1.3 Phase 1 outcomes

RAMP pilot mission statement

Phase 1 focused on ensuring all stakeholders are aligned on the project's ambition and scope, developing plausible future scenarios, and a project mission statement. Developed through workshops with Resilient South staff, the RAMP pilot adopted a mission statement, which frames how Resilient South councils will work towards achieving the community-defined regional vision (in development):

Making proactive, responsible decisions to deliver and manage climate-ready council assets and services, supporting a safe, connected and thriving resilient southern region

Developing future scenarios

Scenarios can help frame decision-making in the face of multiple uncertain futures. They are an important tool that represent plausible futures and allow for the comparison of outcomes under different climate or socio-economic conditions. They should not be treated as forecasts or predictions, instead they help to imagine what that future looks like in a changing climate. Climate scenarios can help an organisation explore uncertainties and identify the full range of options available to an organisation.

The scenarios developed for the RAMP are derived from internationally recognised frameworks: Shared Socio-Economic Pathways Scenarios (SSPs), linked with Representative Concentration Pathways (RCPs) (see Phase 1 report for further detail). These four global scenarios were enhanced with local data, from Australian demographics, regional climate data, and council insights.

Figure 1 shows the four climate scenarios, framed around emissions on one axis (challenges to mitigation) and sustainability and equity on the other (challenges to adaptation).

The graphs show results from a workshop with council stakeholders. This workshop sought to test and validate the global frameworks and draw on staff expertise to add detail to the scenarios. It also aimed to demonstrate that moving down a different pathway, towards a safer, more resilient future, will require significant levels of change from current practice (the Green Path) compared to continuing along our current trajectory (the Highway).

Two scenarios, the Green Path and the Highway were used in the Phase 2 risk analysis. These climate scenarios represent likely extremes of physical and transition risks. They are the plausible boundary conditions of the future and provide organisations with an understanding of how risk events or controls interact with potential futures.

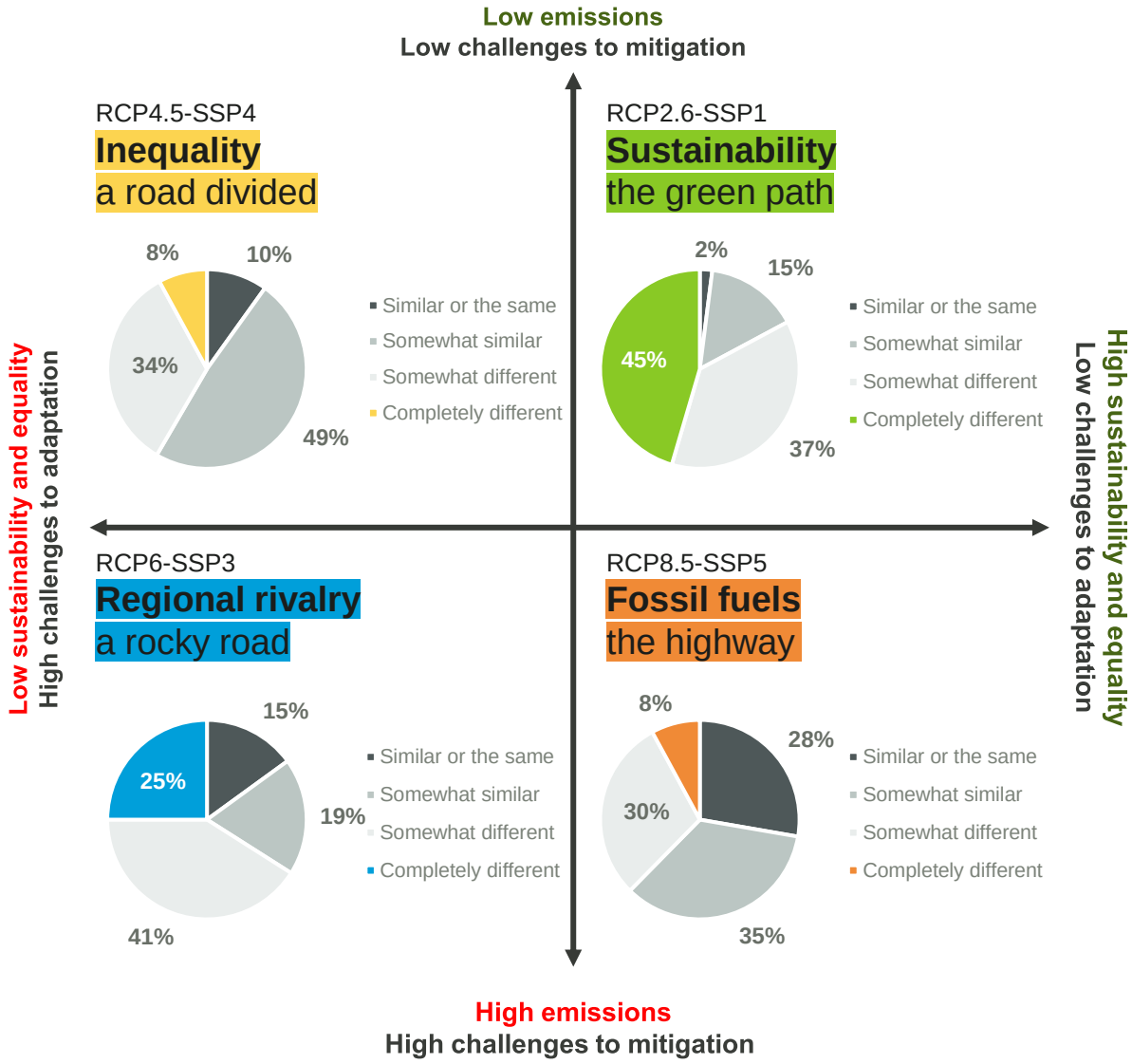


Figure 1 Summary of global socio-economic trends (SSPs) and climate projections (RCPs) adapted for the RAMP pilot

Adapted from Fuss et al. 2014 & O'Neill et al. 2015

1.4 Climate scenarios

This page presents a summary of the scenarios used in Phase 2: a snapshot of the scenario narrative coupled with council insights. Through workshops with councils, we sought to understand how local communities, services and assets could change in 2050.
Details on the scenarios and their development process can be found in the Phase 1 report.

RCP2.6-SSP1

Sustainability – the Green Path

Narrative snapshot In 2050, southern Adelaide is a green and well-connected region. Following global trends of the last 25 years, it has moved away from fossil fuels and towards renewable energy sources. People live in well-connected urban and suburban areas with ample shared green spaces. Self-sustaining communities are linked to regional centres. Jobs, food and recreation all are found close to home. This means there is less travel overall. Active transport along green corridors is the preferred mode of transport. Where longer trips are required, an electrified mass transport system services compact communities. Though the worst climate change has been prevented average and extreme temperatures have increased rapidly to 2050 and are stabilising in the second half of the century.

Workshop summary Participants thought following the **green route** may mean very significant shifts from the way we do things now**.** Across all factors, **almost no one thought things would stay the same as they are today.**

RCP8.5-SSP5

Fossil-fuelled development – the Highway

Narrative snapshot Leading up to 2050, national governments have remained focused on economic growth and ongoing resource extraction. Though energy use is high, there is limited uptake of renewables with demands met by fossil fuels**.** Life in southern Adelaide is not dissimilar to what it is today. The population is wealthy and able to fund material intensive lifestyles. The region has benefited from investments in health, education and high levels of migration, which result in diverse and well-educated communities in southern Adelaide. Lack of global actions on climate change results in end-of-century temperature increases of 5.5°C. The climate impacts are far beyond those experienced in the present. Average and extreme temperatures have drastically increased and expected to continue.

Workshop summary Communities, transport and council activities **may look fairly similar to today**. While councils expected some change to current systems, participants expected this scenario would result in the **least change.**

Community and housing	Transport network	Vales and governance	Council asset management
Lifestyles are likely to substantially change by 2050, particularly our housing, urban spaces and social interactions. More than a third of workshop participants thought the community looked **completely different.**	Our **transport network** is likely to be **completely different** in 2050 – according to almost 60% of participants – with low or no-carbon options the norm.	**Values and governance** may shift significantly, with localised, equitable and holistic solutions prioritised. Half of participants thought councils' roles and responsibilities would be **completely different.**	Resilient, considered design and maintenance of **council assets** and urban spaces may prevail in 2050. Around 40% thought councils' asset management processes and systems need to be **completely different.**
Lifestyles are largely similar to today in 2050, with technological changes supporting high levels of consumption. Around a third thought the community would look the **same as today.**	The **transport network** will undergo few changes, with private vehicles continuing as the primary mode of transport, with over half thinking transport will be the **same as today.**	There is a shift in **values and governance** by 2050. Individualism may dominate in both social and political settings. Participants largely thought there would be **some changes** to councils' roles and responsibilities.	In this scenario, the biggest change may be in **council asset maintenance**, as it responds to increased climate hazards. Over 40% thought that councils' asset management processes and systems need to **somewhat different** to today.

2

Climate risk assessment

2.1 Climate risk

Climate change both creates and multiplies risks to the built environment, infrastructure, people, the natural environment, and the economy. Increasingly frequent and severe events already impact the operation and maintenance of assets. These extreme events are likely to increase in a climate-affected future and be compounded by the impacts of chronic and acute climate hazards.

Climate-related hazards can have serious consequences for assets, affecting factors including ongoing costs, physical and structural strength, level of service, and user confidence. Climate risks can be thought of as physical and transition risks.

Climate risk assessments can be used to understand and prepare for climate change impacts and prioritise adaptation and resilience actions. Climate risk assessments that consider different climate scenarios, timeframes and hazard typologies can help councils to determine risk treatment approaches that are resilient to multiple uncertain futures. This can enable councils to develop practical plans, management strategies and adaptation options that are robust and low regret.

Physical risk

Physical risks resulting from climate change may have financial implications through direct damage to assets and indirect impacts from supply chain disruption. These may include changes in water cost, availability, sourcing, and quality; food security; and extreme temperature changes affecting assets, operations, supply chain, transport needs, and employee safety. Physical risks from climate change can be:

- *Acute risks:* these are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods.
- *Chronic risks,* from longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves.
- *Compound risks* arise from multiple events occurring simultaneously. These can include extremes in several variables occurring simultaneously or a short-term extreme event occurring during a longer-term trend change, such as extreme heat days occurring during an extended drought.

This assessment examines physical hazards and their impact on assets, and asset operation and service delivery. Table 2 (p. 15) summarises the physical hazard categories used in this risk assessment.

Transition risk

Transition risks arise from the policy, legal, technological and market changes necessary to meet mitigation and adaptation needs. Transition risks arise from changes to:

- *Laws and regulations,* for example legal liability, including from the failure of organizations to mitigate the impacts of climate change, failure to adapt to climate change, and insufficient disclosure of material financial risks; and policies and regulations that attempt to constrain actions contributing to the adverse effects of climate change, or policy actions that seek to promote adaptation to climate change.
- *Markets* being affected by shifts in supply and demand for certain commodities, products, and services as climate-related risks and opportunities influence supplier and community preferences.
- *Stakeholder* reputational risks from shifting community perceptions of the transition to a low carbon economy.
- *Technology* improvements or innovations that support the transition to a lower-carbon economy impacting community members and asset managers.

Table 3 (p.15) outlines potential asset vulnerability markers for transition risks.

Terminology

In this assessment:

- *Risk* is the potential for consequences where something of value is at stake and where the outcome in uncertain. Risk is often represented as the likelihood of a hazardous event or trend occurring, rated or multiplied by the impacts, should these occur. Risks result from the interaction of vulnerability, exposure, and hazard.
- *Vulnerability* is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
- *Exposure* speaks to the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.
- *Hazard* is the potential occurrence of a natural or human-induced impact, that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environment resources, or financial, legal or reputational damage to councils.

2.2 Climate risk assessment approach

Phase 2 of the RAMP pilot focused on assessing the risk and vulnerability of selected council assets. This required assessing physical and transition risks to assets and the services they provide to local communities. Part of this phase was developing a repeatable methodology for the risk assessment and undertaking the spatial analysis.

Context

The Resilient South region covers around 28% percent of metropolitan Adelaide and is home to more than 360,000 residents. The region includes more than 50km of coastline, as well as foothills and urban areas. Its northern boundary extends to inner urban areas like Mitcham, Glandore and Plympton and encompasses agricultural lands including McLaren Vale to its south. Western coastal attractions include Glenelg and Hallett Cove, which bring visitors from across the region, city and beyond.

Its major activity centres are located at Marion and Noarlunga, and key hospitals are Flinders Medical Centre, the Repat Health Precinct and Noarlunga Hospital.

The Onkaparinga River is the region's primary river, which feeds the Mt Bold and Happy Valley reservoirs and discharges at Port Noarlunga.

Scope

This risk assessment included risk identification, analysis and evaluation. Risk treatment, in the form of controls or adaptation options, is the focus of Phase 3 of the RAMP pilot project.

This climate risk assessment considers physical and transition hazards to five asset classes, under two plausible climate scenarios.

Climate change hazards

The risk assessment considered both physical and transition climate change hazards, under the following categories (further detail on page 13):

- *Physical hazards:* Heat and cold, Wet, Dry, Wind and storms, Coastal
- *Transition hazards:* Technology, Legal and regulatory, Market, Stakeholder

Assets

Table 1 lists asset and sub-asset classes considered during the risk assessment.

Scenarios

The risk assessment used the Green Path (RCP2.6-SSP1), the accelerated transition scenario (see p.9), and the Highway (RCP8.5-SSP5), the high physical climate change scenario. These represent the likely extremes and boundary conditions of physical risks (the Highway) and transition risks and opportunities (the Green Path).

Physical risks were identified under both scenarios at 2030 (current), 2050 (short-term) and 2090 (long-term) time horizons. Transition risks were only identified at 2030 and 2050, as the level of uncertainty increases significantly as horizons extend.

Table 1 Assets classes and subtypes considered during the climate risk assessments

Asset class	Asset count	Council	Sub-asset class	Exclusions
Roads	16,885	All	Arterial roads Sealed local roads Unsealed local roads Carparks Pathway/bikeways Ancillary services	
Bridges	90	Mitcham	Pedestrian bridge Vehicle bridge	
Major buildings	72	Marion	Administration and Operations Community Facilities Sports and Recreation Facilities Commercial Facilities	Sheds, public toilets, minor structures
Open space and coastal	1,381	Holdfast Bay	Cultural Parks and Recreation Marine Ancillary Services	Heritage trees, natural assets
Stormwater	52,707	Onkaparinga	Civil Infrastructure Stormwater network Water Pump Stations	

2.3 Methodology

Aurecon gathered inputs from councils and was guided by national and international standards to develop a methodology aligned with the regional context and best-practice. The risk assessment methodology, outlined in Figure 2, is aligned with AS 5334:2013, AS ISO 31000:2018 and IPWEA International Infrastructure Management Manual.

Risks were identified through:

- *Desktop study:* high-level assessment of the exposure to climate drivers and the potential impacts was undertaken using publicly available information, existing climate data, and insights from scenarios workshop with council staff.
- *Risk workshop with council staff:* this provided the opportunity to identify gaps in the desktop risk assessment, and provided valuable context relating to existing asset condition and performance, impacts of previous climate events and operational readiness to manage assets and deliver services in the event of a climate-related event (p.14).

Risk framework

The RAMP risk framework was informed by Resilient South councils' frameworks and international standards:

- Likelihood table (Table C1) from AS 5334-2013 establishes likelihood measures for climate events and is used throughout Australia
- Consequence table was adopted from the City of Onkaparinga risk framework as it was the most comprehensive and allowed Aurecon to ensure consequence appetite aligned with local expectations
- The risk rating matrix was adopted from IPWEA IIMM. Developed for public works, this industry standard ensured alignment across councils.

BOX 3

Creating a repeatable methodology

As part of Phase 2, Aurecon developed a Resilient Asset Management climate risk assessment methodology guidance note. This documented methodology ensures the risk assessment can be extended to additional asset classes or be updated as new data becomes available. This resource can also be used by other South Australian councils seeking to understand climate risks.

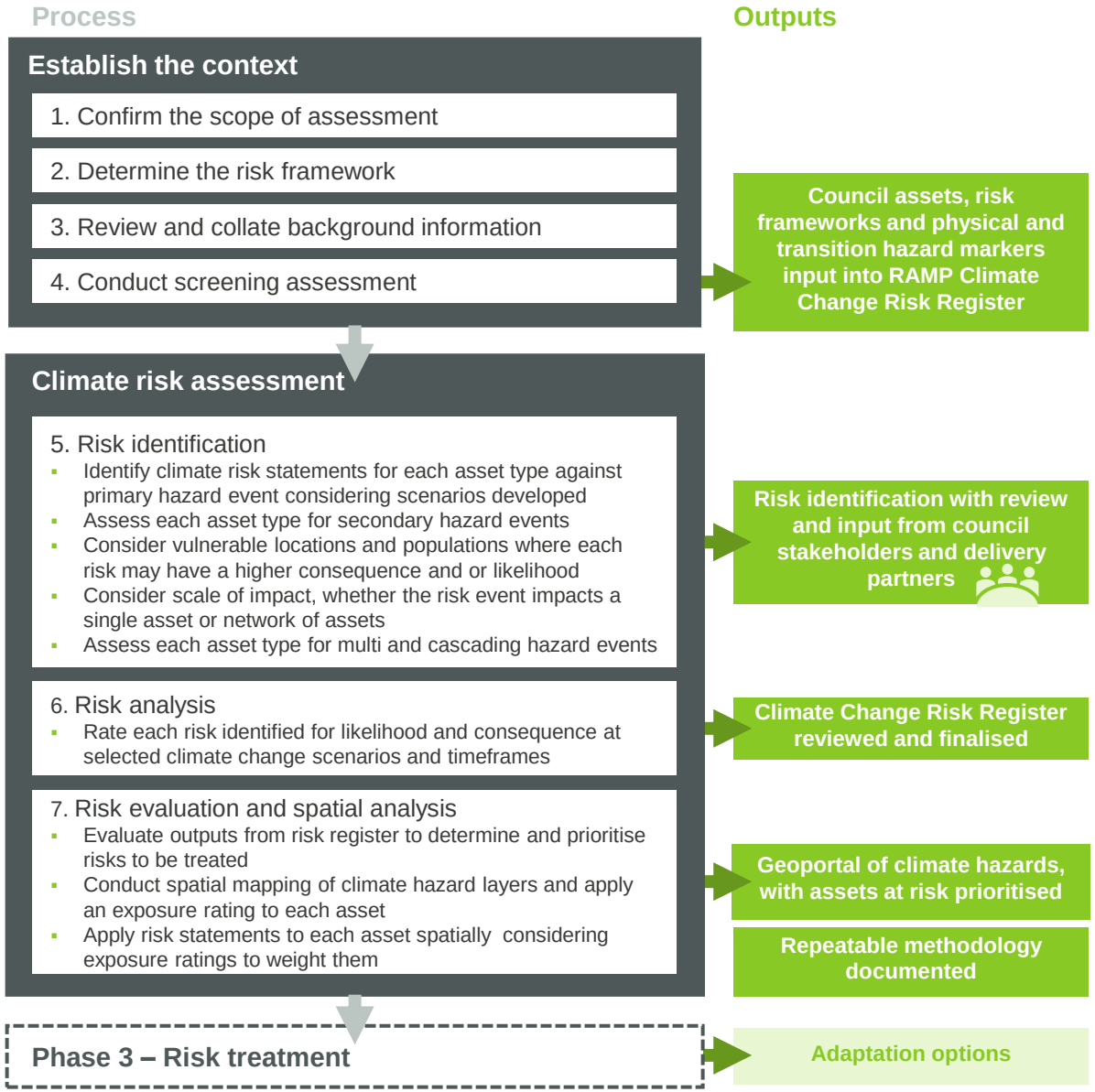


Figure 2 Risk assessment process and outputs

2.4 Climate change hazards

Grouping climate change conditions based on hazard characteristics or drivers provides a structured way to identify and understand risk events and outcomes.

Physical climate hazard categories

Table 2 lists the physical hazard categories and climate impact drivers included in this assessment, adapted from Intergovernmental Panel on Climate Change Sixth Assessment Reports.

Regional climate projection data was sourced from the International Panel on Climate Change (IPCC) and the SA Department of Environment and Water (SA DEW). Climate projections for the years 2030, 2050, and 2090 in South Australia for both the Green Path and the Highway scenarios were developed.

Using climate projections provides insight into an asset's future physical vulnerability and risk exposure.

Transition climate hazard categories

Transition hazard categories were adapted from the Task Force on Climate-Related Financial Disclosures. Table 3 lists these categories and potential vulnerability markers for assets.

These are provided to assist users in identifying transition hazard impacts, as these is an emerging area of investigation. Transition risks can relate to community lifestyles and expectations, transport patterns, building and planning regulations, energy supply, environmental protections and increasing costs.

Table 2 Physical hazard categories

Physical hazard	Climate impact drivers
Heat and Cold	Increase or decrease to mean air temperature; extreme heat and heat stress; increase in freshwater temperatures; cold spell; frost; increase in atmospheric carbon dioxide (CO2).
Wet	Increase to mean precipitation; river flood; heavy precipitation; pluvial flood; landslide.
Dry	Decrease to mean precipitation and increase to aridity; hydrological drought; agricultural and ecological drought; fire weather; increase in air pollution weather; increase in ultraviolet (UV) radiation.
Wind & Storms	Either increases or decreases in intensity and/or frequency of mean wind speed; convective storms; severe wind storm; ex-tropical cyclones; sand and dust storm; lightning
Coastal	Within 10km of coast or tidal waters and less than 5m AHD. Sea level rise and storm surge; increases in relative sea level; coastal flood; coastal erosion; saline intrusion; marine heatwave; ocean acidity and change in splash zone.

Table 3 Transition hazard categories

Transition hazard	Asset vulnerability marker
Technology	Dependence on emission intensive technology; potential for technology change across the value chain, impacting service demand or type; retrofit ease (e.g. for move towards distributed renewable energy or potential repurposing)
Legal and regulatory	Impact of emissions reduction requirements including building regulations linked to energy efficiency; impact of renewable energy requirements; asset viability under cost increases; value chain emissions intensity indicating potential for disruption (e.g. fossil fuel transport); impact of cost increases; potential of legal action against councils
Market	Depreciation of asset due to energy demands, cost of service provision vulnerable to increasing costs; capital write down potential for altered demand; requirements for new council services in scenario; dependency of asset operation on ability of community to pay rates; insurance exposure linked to purpose
Stakeholder	Population demographics dependency altering asset/service requirements; alignment of purpose/service to a low carbon scenario; ability to alter design or asset to align to low carbon choices

2.5 Stakeholder involvement in Phase 2

Involving Resilient South stakeholders

Council staff from the cities of Marion, Mitcham, Holdfast Bay and Onkaparinga were engaged throughout the risk assessment process to ensure outputs – the risk assessment methodology and climate risk register – were robust and aligned to councils needs. Table 4 outlines engagement activities that were conducted throughout Phase 2.

Table 4 Types of engagement activities and outcomes

Engagement	Purpose / Outcomes	Stakeholders
Emails	▪ used to communicate key information ▪ used to collect data from councils	Selected staff from each council
Working Group meetings	▪ aligned project team and working group on Phase 2 objectives ▪ discussed project updates ▪ confirmed decisions on project tasks, including risk management approach	RAMP Working Group
Risk workshop	▪ aligned participant understanding of risk assessment ▪ tested risk rating with key council stakeholders ▪ identified of gaps in the risk assessment ▪ increased council staff capacity	Council staff from risk, strategy, asset management, environment and sustainability teams
Risk register reviews, including online meetings	▪ ensured identified risks and impacts are relevant for councils ▪ aligned risk assessment with councils' individual assessments ▪ aligned understanding of physical and transitional risks affecting council areas	Selected members from each council including selected staff from risk, strategy, asset management, environment and sustainability teams

BOX 3

Risk workshop

Council staff from finance, risk, strategy, asset management, environment, and sustainability teams were invited to participate in the risk workshop on 17 May 2023.

The risk workshop was designed to draw on staff experience and gather input on the risk assessments and provide an opportunity for capacity building. Participants were taken through the risk assessment process to identify, analyse and evaluate physical and transition risks.

Participants reported that a key take-away was building understanding of transition risks and opportunities.

Figure 3 RAMP risk workshop, 17 May 2023

2.6 Key findings

Following the review of the RAMP climate risk register by councils, feedback was incorporated and the register was finalised. The final RAMP climate risk register contains 277 risk statements (provided to RAMP Working Group as Excel). Each risk is analysed for likelihood and consequence, and given a risk rating for each scenarios. The risk breakdown is:

- 172 physical climate risks
- 98 transition climate risks
- 7 catch-all risks (see p. 24).

While there is some variation in Resilient South council's risk appetites, generally high and very high risks require prioritised treatment. These risks have been extracted from the risk register and findings are summarised in the following pages, divided into physical climate risks and transition climate risks. On this page Tables 5 and and Figures 4 and 5 present these risk types together. From this analysis, we note the following:

Physical risks: Under both scenarios, the number of and level of physical risk increases over time. However, the severity of the physical risks increases more significantly in the Highway.

The shape of the physical risks across the timeframes changes dramatically. Physical risks in both scenarios increase from 2030 to 2050. In 2050, very high physical risks are almost triple (11) under Highway conditions compared to the Green Path (2).

This trend continues into 2090. In the Green Path scenario, very high risks increase linearly with 7 very high risks in 2090. In the Highway scenario these risks increase exponentially, to 46 very high physical risks in 2090.

Transition risks: While levels of high physical and transition risks are comparable in both scenarios, the quantity of very high risks are lower. There are no very high transition risks in 2030. In 2050, Green Path conditions result in 3 additional very high transition risks compared to the Highway, arising from councils needing to shift in line with changing technologies, policies and regulations, and community expectations.

Summary: Both risk types and scenarios need to be considered together. In 2050, levels of very high risk are similar under both scenarios. However, if climate change mitigation does not take place now (as in the Highway) – physical risks will increase significantly through to 2090.

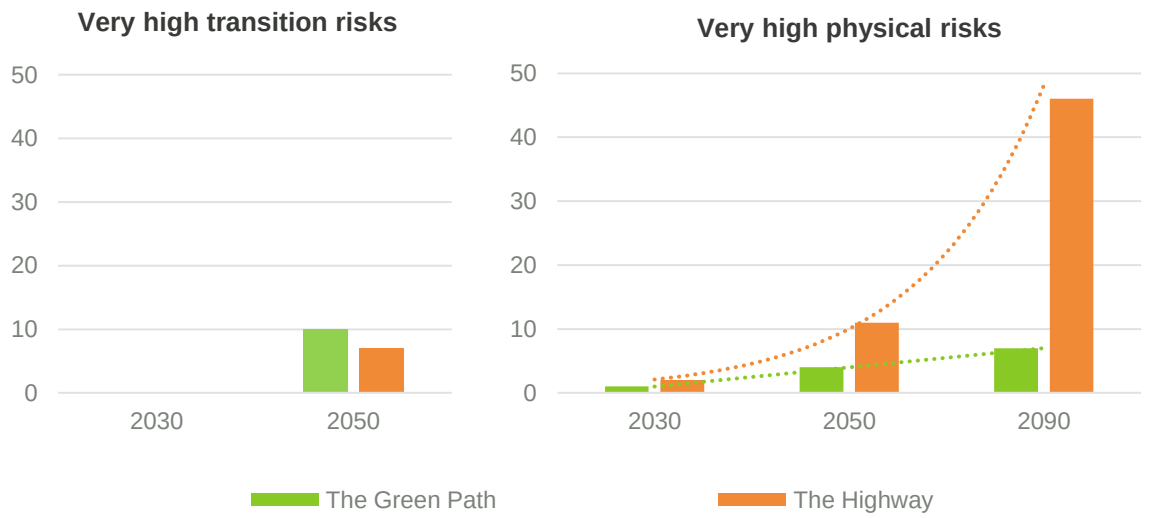
The risk assessment demonstrates that if councils choose the Green Path transition pathway (in alignment with the rest of the world), the number of physical risks are reduced. In a Green Path scenario, there are 85% less physical risks at 2090, compared to the Highway scenario.

Table 5 High and very high risks in the Green Path

The Green Path			
Timeframe	**2030**	**2050**	**2090**
Physical Risks			
High	*55*	*67*	*81*
Very High	*1*	*4*	*7*
Transition Risks			
High	*26*	*67*	
Very High		*10*	
Total			
High	**81**	**134**	**81**
Very High	**1**	**14**	**7**

Table 6 High and very high risks in the Highway

The Highway			
Timeframe	**2030**	**2050**	**2090**
Physical Risks			
High	*61*	*80*	*91*
Very High	*2*	*11*	*46*
Transition Risks			
High	*27*	*62*	
Very High		*7*	
Total			
High	**88**	**142**	**91**
Very High	**2**	**18**	**46**



Figures 4 and 5 Very high risk comparisons over time

2.7 Physical climate risk assessment

For both scenarios, this section summarises:

- **high and very high physical risk counts** at 2030, 2050 and 2090 (below, Tables 7, 8)
- **very high physical risks statements** at 2050 (p.18)
- physical hazard breakdown of **high and very high physical risk counts** to asset classes (p.19)

The physical risk assessment identified physical climate risks to assets, including impacts on services and community. In 2050 in both scenarios, global temperatures will have increased and there will be increases in climate-related disasters. Table 2 (p.14) shows the climate impact drivers that were considered as physical hazards.

Table 7 and Table 8 summarise the quantity of high and very high physical risks to assets. Appendix A (p.31) shows this breakdown with physical hazard categories. Interrogating the quantity of risks in tandem with risk statements (using the risk register) shows similar risk profiles for all asset classes under both scenarios. Up to 2050, impacts will be similar under both scenarios.

The nature of the physical risk is the same under the Green Path and the Highway. It is the severity and quantity that intensifies over time (to 2090) under a Highway scenario. The most severe risks are less likely in a Green Path future, where climate change has been mitigated.

Examining 2090 risks at the asset class level, under the Highway scenario shows:

- **Bridges**: the number of very high physical risks increases four-fold compared to the Green Path. These risks relate to loss of vehicle bridges and injury or loss of life due to extreme weather events.
- **Major buildings**: there are 10 very high physical risks, five times the number at 2050. These risks mostly arise from acute or compounding hazard events, for example a flood event causing irreparable damage to poorly maintained assets. The consequences of these very high risks are largely financial.
- **Open space and coastal assets**: there are 13 very high physical risks, more than half of which are caused by coastal impacts like sea level rise or coastal flooding from storm surges. There are 4 risks assigned as public safety consequences, relating to health and safety risks from direct exposure to extreme weather (e.g. heat stroke from prolonged sun exposure, slip and fall incidents during wet weather).
- **Roads**: the very high risks at 2090 mostly have financial consequences for councils. Coastal hazards are slightly more dominant, around a third of very high risks. For most councils, this would only apply to a small proportion of roads (if any).
- **Stormwater**: while stormwater has lower numbers of high and very high risks compared to other asset classes, all the stormwater risks are rated high or very high at 2090. More than a third of these risks relating to water pump station failure, causing flood impacts or disrupting the community's water supply.

Table 7 Quantity of high and very high physical risks, with affected asset class and timeframes under the Green Path

Scenario	The Green Path					
Timeframe	2030		2050		2090	
Risk level	High	Very High	High	Very High	High	Very High
Bridges	9	0	8	1	8	1
Major buildings	14	0	17	1	19	0
Open space and coastal	6	1	12	1	18	4
Roads	19	0	22	0	24	1
Stormwater	7	0	8	1	4	1

Table 8 Quantity of high and very high physical risks, with affected asset class and timeframes under the Highway

Scenario	The Highway					
Timeframe	2030		2050		2090	
Risk level	High	Very High	High	Very High	High	Very High
Bridges	8	1	8	2	8	4
Major buildings	15	0	20	2	25	10
Open space and coastal	9	1	21	1	20	13
Roads	21	0	23	5	3	14
Stormwater	8	0	8	2	8	5

2.7.1 Very high physical risks at 2050

Table 9 lists the very high physical risk statements at 2050, mapped to the Green Path and the Highway scenarios. It shows:

- Greater numbers of very high physical risks under the Highway scenario. Only 4 of the very high physical risks apply in the Green Path scenario.
- Very high physical risks in 2050 are predominately triggered by acute weather events, such as storms or heatwaves.
- The greatest number of very high physical risks in 2050 are to roads (5), with major buildings and stormwater demonstrating an equal number of very high risks (2) and only one very high risk for bridges and open space and coastal asset classes.
- Around half the very high physical risks centre on impacts to the asset itself (damage or loss of asset increasing maintenance spending). These mainly have financial consequences for councils.
- The other half focus on with disruption to services the asset provides, with consequences for service delivery and impacts to community health and wellbeing impacts.

Most of these very high risks are acute, resulting from extreme weather events.

Treatment options must consider extreme event protocols to protect community and employee health and wellbeing as well as clean-up procedures and physical asset interventions.

Table 9 Very high physical risk statements at 2050 mapped to Green Path and Highway scenarios, with related climate hazard and affected asset class

Asset	Hazard	Risk statement	Green Path	Highway
Bridges	**Wet**	Increased damage and replacement of bridges due to climate change impacts from heat, storms, flooding and bushfire impacts	●	●
Open space and coastal	**Heat and cold**	Increased risk of heat-related health impacts on visitors	●	●
Major buildings	**Dry**	Loss of electricity supply for 2 days to 2 weeks from extreme events generating widespread disruption to Council services and community	●	●
	Heat and cold	Increased damage and replacement of buildings due to climate change impacts impacting critical services		●
Roads	**Coastal**	Sea level rise impacting all roads within coastal zone		●
	Heat and cold	Increasing repair costs to sealed road surfaces due to heatwave damage		●
	Wind & Storms	Risk to public safety due to debris after extreme wind and storm events		●
		Risk to public safety due to increased debris after extreme wind and storm events		●
		Impact on road service delivery due to debris after extreme wind and storm events		●
Stormwater	**Heat and cold**	Power lost to water pumps during extreme heat events	●	●
	Wet	Insufficient capacity of water pump stations and storm water networks during extreme rain causing greater flood impacts		●

2.8 Transition climate risk assessment

For both scenarios, this section summarises:

- **High and very high transition risk counts** at 2030, 2050 and 2090 (below, Tables 7, 8)
- **very high transition risk statements** at 2050 (p.21)
- transition hazard breakdown of **high and very high transition risk counts** to asset classes (p.22)

The Green Path assumes a global shift towards a sustainable future, through decarbonisation of energy systems and infrastructure, to mitigate the increasing impacts of climate change. Local councils will need to shift their operations to align with this economic, environmental and social trajectory. This transition brings risks.

The risks that arise from this transformation increase slightly more in the Green Path scenario. This is expected, as this scenario represents the greatest level of technology, legal and regulatory, market and stakeholder change.

Tables 10 and 11 show high and very high transition risks for each scenario. Appendix A (p.32) shows this breakdown with physical hazard categories.

While the number and distribution of high risks is similar under both scenarios, the distribution of very high risks is different under the two scenarios. Under the Green Path, there are three (3) additional very high risks at 2050.

The types of transition risks under the Green Path are similar across asset classes, with major buildings and open space and coastal assets facing the most unique risks. **Major buildings** transition risks are dominant, and relate to the costs of shifting to renewable energy technology.

Open space and coastal risks relate to state-based policies requiring councils to increase environmental protections, and provide more open spaces. Transition risks to **bridges** and **stormwater** assets are minimal, with no very high risks at 2050.

The transition hazards in the Green Path scenario result in similar high risks, to all asset classes. Organised by transition hazard, these are summarised here:

- **Legal and regulatory** risks cover introductions of state government regulations that specify minimum requirements for sustainable materials in construction and/or maintenance of all assets; and energy and water efficiency/reduction requirements.
- **Technology** risks relate to innovations resulting in increased costs for materials/maintenance, decarbonisation; provision of new services meeting changing community uses.
- **Market** risks include increased recycling and reuse of materials in assets; increasing costs of more sustainable construction materials; increasing value of shared assets resulting in increased use of council assets.
- **Stakeholder** risks arise from changing community lifestyles, demands and expectations for example increasing demand of shared green spaces and safe active transport systems.

Councils need to manage both transition risks and physical risks simultaneously. We will experience both at the current time until one scenario becomes more dominant.

Table 12 Quantity of high and very high transition risks, with affected asset class and timeframes under the Green Path

Scenario	The Green Path			
Timeframe	2030		2050	
Risk level	High	Very High	High	Very High
Bridges	3	0	4	2
Major buildings	11	0	22	5
Open space and coastal	7	0	23	0
Roads	5	0	11	3
Stormwater	0	0	7	0

Table 11 Quantity of high and very high transition risks, with affected asset class and timeframes under the Highway

Scenario	The Highway			
Time frame	2030		2050	
Risk level	High	Very High	High	Very High
Bridges	3	0	6	1
Major buildings	12	0	21	6
Open space and coastal	7	0	15	0
Roads	5	0	13	0
Stormwater	0	0	7	0

2.8.1 Very high transition risks

Table 12 lists the very high transition risk statements at 2050, mapped to the Green Path and the Highway scenarios. It shows:

- The dominate hazard category in the Highway scenario is **stakeholders**. These risks relate to increasing use of community roads, services and spaces. These increased demands have financial consequences for council, in terms of increased maintenance costs (major buildings) and new infrastructure spending (bridges, roads).
- **Technology** is the dominate hazard category in the Green Path scenario, with risks related to adoption of renewable energy systems (major buildings) and compliance with changed construction standards and recycling practices (bridges, major buildings, roads).
- There are no very high transition risks at 2050 for **open space and coastal** assets or **stormwater** assets.

Bridges

- Very high risks for bridges are markedly different under each scenario, the Green Path resulting in introductions of minimum material requirements in construction and the Highway requiring significant capital expenditure to build new vehicle bridges.

Major buildings

- The most affected asset category for both scenarios is major buildings, with risks relating to changing use patterns (the Highway) and compliance with new energy technologies (the Green Path).
- In the Highway scenario, community demand for services provided at major council buildings may increase because of population increase, community members seeking refuge during extreme climate events, or due to an inability to access private services due to costs.
- In the Green Path scenario, the energy transition could require significant capital expenditure spending from councils, to shift to renewable energy technology.

Roads

- All very high transition risks to road assets are in the Green Path scenario. These risks relate to innovations in construction materials increasing costs to councils, and uptake of electric vehicles requiring councils to provide charging stations in carparks.

Unlike physical risks in the Highway scenario, the severity of transition risks may decrease over time depending on the nature, speed, and timing of the transition. Transition risks have the most severe consequences during the change process. Prioritising transformation at the right time will help councils manage transition risks.

Table 12 Very high transition risk statements at 2050 mapped to Green Path and Highway scenarios, with related climate hazard and affected asset class

Asset	Hazard	Risk statement	Green Path	Highway
Bridges	Legal and regulatory	State government regulations for bridges change the standard to use x% of SCM content in concrete as a minimum requirement	●	
	Stakeholder	Poor management of urban development during population growth results in increased road traffic and demand for new bridges		●
Major buildings	Market	Increased energy costs from not transitioning from gas to electric / solar		●
		Increased recycling facilities required	●	
	Stakeholder	Increased use of community spaces results an increase in maintenance required		●
		Increased use of community services (kindys, gyms, aged care) results in increase in maintenance required		●
		Increased use of community spaces results in increase in maintenance required		●
		Increased cost for new local recycling facilities and buildings	●	
	Technology	Decarbonisation of existing building stock will require a move away from fossil fuels to electrification.	●	
		Transition from gas infrastructure to electric and solar heating	●	●
		Improved energy efficiency required of buildings	●	●
Roads	Market	Increased recycling and reuse of materials in roads	●	
		Increased cost to reduce embodied carbon in roads	●	
	Stakeholder	Increased use of electric vehicles impacts carport ancillary services	●	

2.9 Very high risks at 2050 – under both scenarios

Physical and transition risks

The table below summarises the risk statements that were rated very high under both the Highway and the Green Path in 2050. As these risks could occur in both scenarios, these are priority risks and should be treated accordingly by councils.

Physical impacts of climate change will be similar in both scenarios until 2050. Uptake of renewable energy technologies in wealthy nations is likely in both scenarios, resulting in financial impact on councils.

Regardless of the climate scenario, councils could face significant impacts to their community, operations and assets if the below risks are not treated.

Catch-all risks

During the risk workshop with council staff on May 17 2023, several high risks that apply under both scenarios were identified but are neither physical or transition risks. these risks are existing enterprise risks that will be exacerbated by climate change.

These have been defined as ‘catch-all’ risks – as they cover all assets and all types of hazards. These risks will impact councils under any future scenario.

These risks were not captured by the risk assessment methodology, as they are neither physical or transition risks and have been excluded from the reporting and analysis on previous pages. Due to their importance, they have been included in the risk register and are presented here below.

Table 13 Very high physical and transition risks at 2050 under both the Green Path and Highway scenarios, with related climate hazard and affected asset class

Risk type	Hazard category	Asset class	Risk statement
Very high physical and transition risks at 2050, under both scenarios			
Physical	**Wet**	Bridges	Increased damage and replacement of bridges due to climate change impacts from heat, storms, flooding and bushfire impacts
	Dry	Major buildings	Loss of electricity supply for 2 days to 2 weeks from extreme events generating widespread disruption to Council services and community
	Heat and cold	Open space and coastal	Increased risk of heat-related health impacts on visitors
		Stormwater	Power lost to water pumps during extreme heat events
Transition	**Technology**	Major buildings	Improved energy efficiency required of buildings
			Transition from gas infrastructure to electric and solar heating
Very high catch-all risks at 2050, under both scenarios			
Catch-all	**All**	All	Loss of insurance coverage or large increase in premiums in response to increase in natural disaster events
			Delay and diversion of resources from capital, operations and maintenance due to disaster recovery
			Increased degradation and reduced life of assets due to increased climate events
		Open space and coastal	Decreased usage and availability of open space and coastal assets and an increase in maintenance due to damage from climate change events
	Market	Not assigned	Decreased income for council
	Stakeholder	Not assigned	Decreased capability development in traditional council operational areas due to competing interests
		All	Failure to adopt sustainability frameworks and standards into council-controlled standards and frameworks

3

Spatial analysis

3.1 Mapping the climate risk assessment

The climate risk assessment was extended and visualised to understand how physical climate risks are distributed across the region. The results from spatial analysis can be used to prioritise mitigation strategies for the most vulnerable assets and their locations.

Geospatial analysis is a tool used to analyse the spatial distribution of physical climate risks and vulnerabilities. The geoportal:

- maps asset data and their associated vulnerability to climate hazards,
- links the climate risk register to spatial asset data, and
- rates and prioritises risks to individual assets, based on the relationship between asset class level risks (from risk register), asset location and physical climate hazard mapping.

This allows users to investigate the relationship between individual assets and associated risks from the risk register and identify high-risk locations via the map and understand the hazards affecting assets.

The geoportal shows asset-level associations with both physical and transition risks. However, the spatial risk rating and prioritisation is based solely on physical hazard data. It is assumed transition risks apply to all assets in the region.

Developing the geoportal

Once the climate risk register was finalised, assets were all mapped spatially and moderated against the physical hazard layers that are spatially different across the region. These are primarily riverine flooding, coastal flooding and bushfire.

This data is presented in the geoportal where the assets can be viewed overlayed with the hazard layers alongside the moderated risk assessment for each asset

Organising data inputs

Using a qualitative process, risk rating assignments were performed to standardise the risk rating categories for each hazard.

Linking risk register to asset data and physical climate hazard data

To integrate the outputs of the spatial analysis with the risk register, we developed a coding system whereby any asset contained in the GIS layers could be connected to the risk register to identify, link, and display the physical and transition risk profiles related to that specific asset. This coding system incorporates the asset type, as well as the identified physical and transition risks and risk scores for each asset based on the results of the spatial risk analysis.

When linking assets to the risk register, the Generic Risk Ratings (from the risk register) were adjusted to align with the risk scores based on the spatial analysis for each asset. For example, if a risk for a particular asset type in the risk register was identified as a medium bushfire risk but an attached asset was in a very high-risk bushfire area, then that risk would be increased to be high or very high based on the specific hazard level

With the number and severity of risks identified for individual assets, we evaluated the priority order across all assets within an asset class. Assets were ranked in order of priority based on the number of risks applicable to each asset, at each level of risk (Very High, High, Medium, and Low). The priority ranking was calculated for RCP 2.6 and RCP 8.5 scenarios independently.

For risks that could not be related to a spatial hazard layer, the value of 3 was assigned to that risk. This would ensure that the Generic Risk Rating of any identified risks would not be adjusted. This approach potentially allows for these risks to be included in the future if spatial data were to become available.

Assumptions and limitations

The spatial mapping reflects the quality of the data inputs. While the project did its best to source the most up-to-date data, this was not always accessible. The spatial analysis should be validated, through direct consultation with asset managers or operational staff.

Appendix B in the *Resilient Asset Management climate risk assessment methodology: guidance note* provides further guidance on how to integrate the outputs of a risk assessment with spatial hazard data and asset data.

Geoportal access is coordinated by Aurecon and the RAMP Working Group. For access, please contact your council's RAMP Working Group members.

3.2 Using the geoportal

The Resilient South Asset Management Program geoportal application contains three sections:

- **Information** provides an overview of the Resilient South Asset Management Program.
- **Climate Risk Assessment** collates climate hazard data related to bushfire, flooding and coastal inundation risks alongside asset and location data. The interface is a simple web map where users can explore spatial trends across the study region and investigate risks at specific locations. It provides a strategic view of climate hazards and their risks to assets. Data is sourced from state and local government, and publicly available data.
- **Asset Risk Assessment** is the key interface for assessing the associated risks for individual assets. This section is primarily for asset managers to inspect assets at a more detailed level, alongside the asset risk register developed for RAMP. Individual asset risks are associated with the climate hazard mapping to generate a risk priority score, symbolised through green (low risk) to dark red (high risk). Selecting an asset in the web map on the left-hand side of the web application will display the risks associated with that asset on the right. Asset data is sourced from the individual councils, with the risks for each hazard type applied to each individual asset to calculate and display the associated risks.

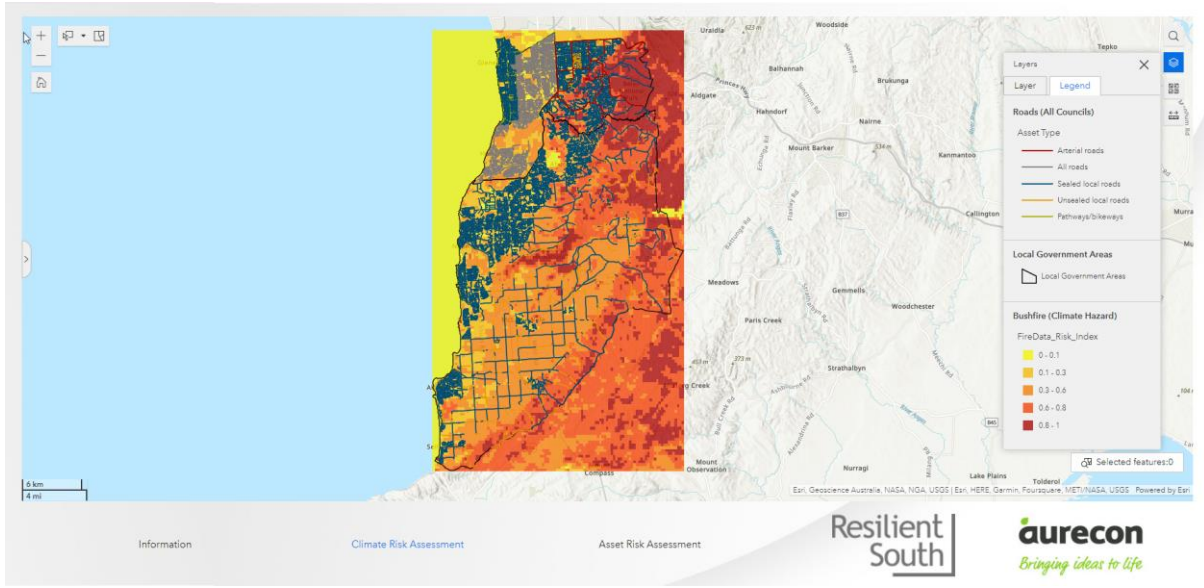


Figure 4 RAMP geoportal – Climate Risk Assessment section

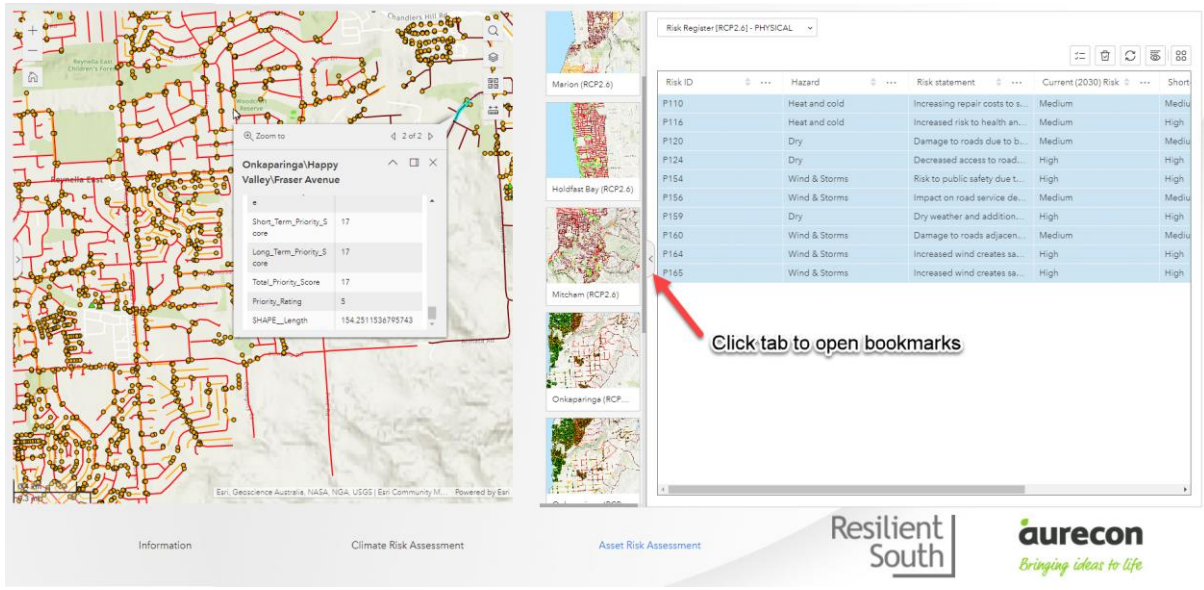


Figure 5 RAMP geoportal – Asset Risk Assessment section

3.3 Identifying focus areas

Figure 7 shows potential focus areas for each council moving into the next phase of the RAMP pilot. These areas were determined using the geoportal, examining physical hazard layers (Climate Risk Assessment section) and asset-level risk prioritisation (Asset Risk Assessment section).

These locations identify clusters of very high risks to roads and each council's selected asset class. Other considerations included:

- Physical climate hazard layers
- Availability of alternate access points
- Proximity to community infrastructure
- Cultural significance
- Contribution to local or regional resilience

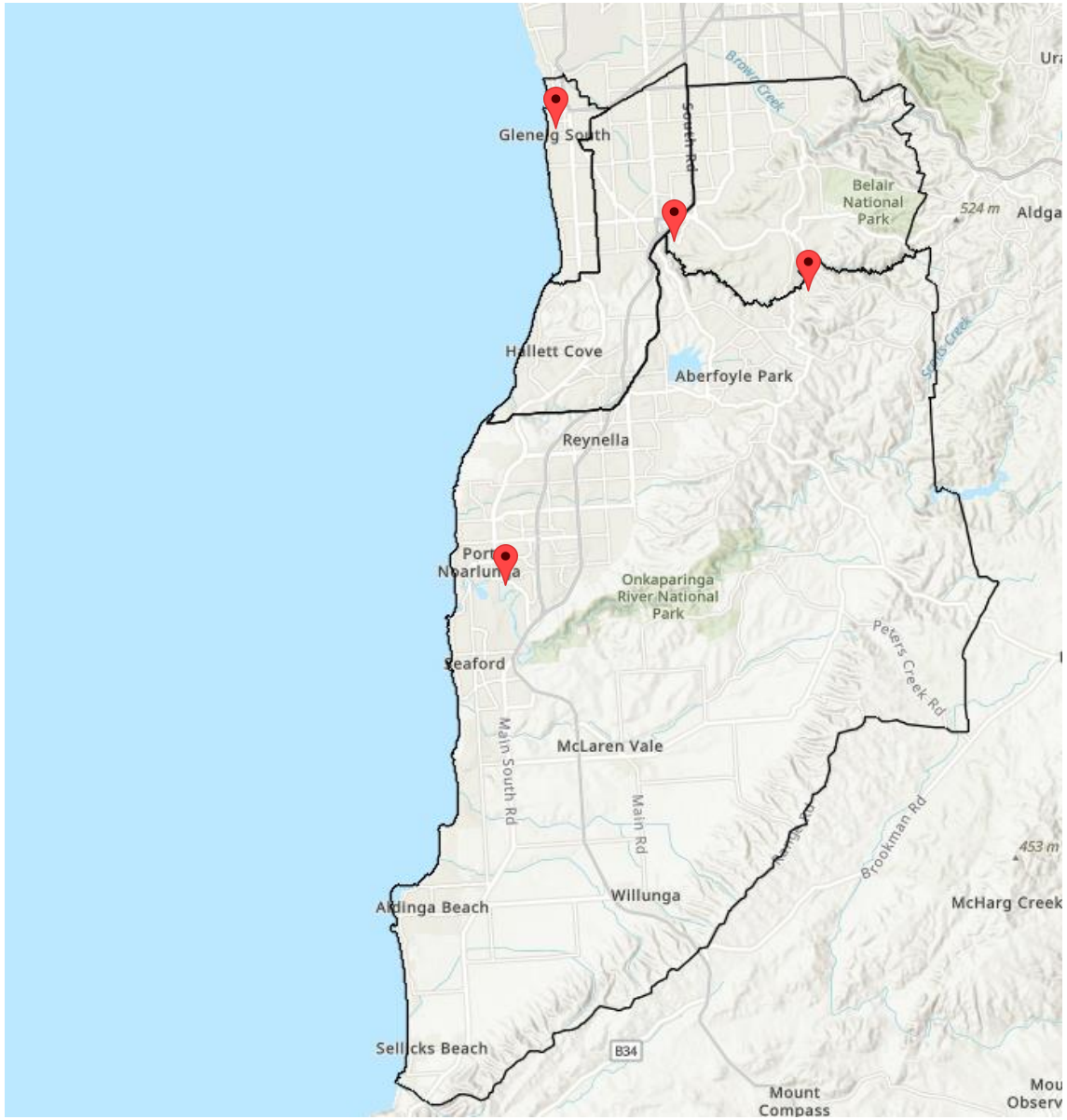


Figure 7 Hotspot risk locations in each council area, identified using the geoportal

Hotspot risk areas

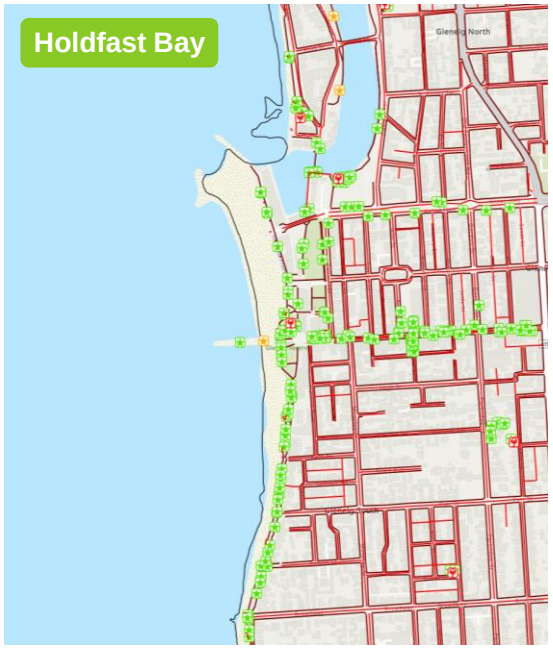


Figure 8 City of Holdfast Bay hotspot location

The location of the Glenelg Reserve/Moseley Square was selected for the City of Holdfast Bay council due to the risk of coastal flooding.

This area contains pathways/bikeways, seating and playgrounds.

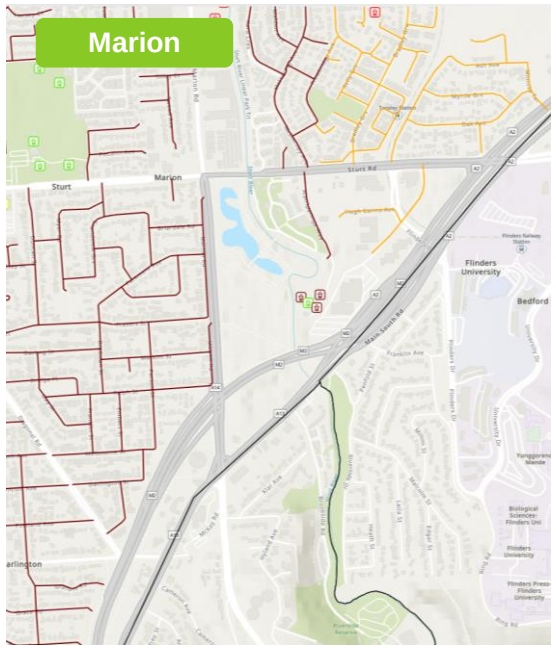


Figure 9 City of Marion hotspot location

The location of Living Kaurna Cultural Centre was selected for the City of Marion council due to the combined impact of Sturt River flooding and bushfire risks.

This area contains very high risk, single-entry roads and multiple community facilities.

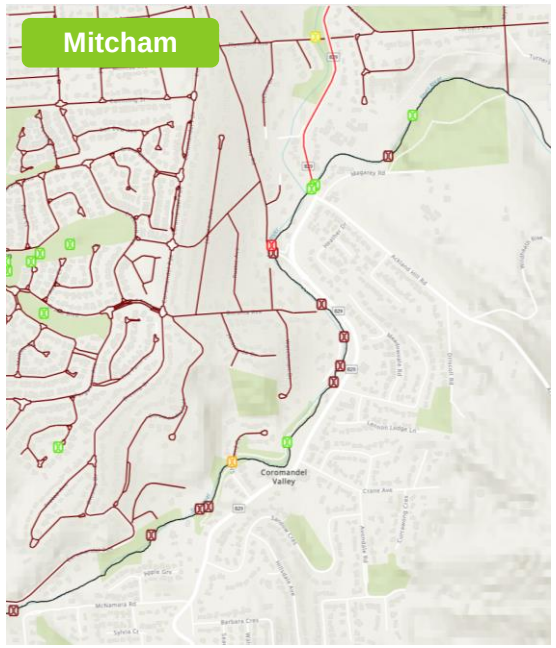


Figure 10 City of Mitcham hotspot location

The location of a cluster of bridges along the Sturt River as it follows Main Rd was selected for the City of Mitcham council due to the combined impact of Sturt River flooding and bushfire risks.

This area contains both pedestrian and vehicle bridges along with very high risk roads.

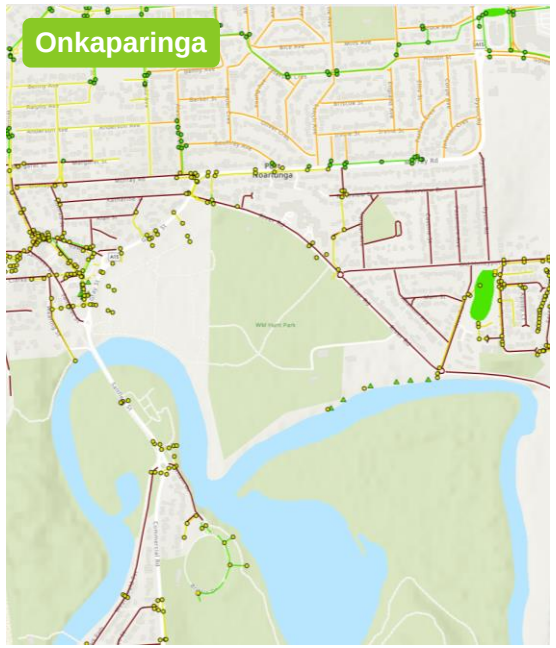


Figure 11 City of Onkaparinga hotspot location

The location of WM Hunt Park was selected for adaptation options within the City of Onkaparinga council due to the overlapping risks of coastal flooding, riverine flooding from the Onkaparinga River and bushfire.

This area has numerous assets including stormwater structures, stormwater pits, stormwater drains and roads.

Legend

Open space seating
Priority rating
1
2
3

Open space playgrounds
Priority rating
4
5

Major buildings
Priority rating
1
2
3
4
5

Roads (all councils)
Priority rating
3
4
5

Bridges
Priority rating
1
2
3
4
5

Local government areas
Boundary
Local Government Areas

Stormwater GPTs
Priority rating
1
2
3

Stormwater pits
Priority rating
1
2
3
4
5

Stormwater drains
Priority rating
1
2
3
5

4

Recommendations and next steps

4.1 Recommendations and next steps

Resilient South councils can start implementing the risk assessment results from Phase 2 into current risk assessment systems, as shown in Table 14.

These recommendations are prioritised into actions that can be completed now, using Phase 2 outputs, undertaken as next steps alongside Phase 3 activities, and those that can be completed later, after the completion of Phase 3.

Next steps

With Phase 2 of the RAMP pilot complete, Phase 3 is scheduled to start in October 2023 (see p.31).

Pilot Project – Phase 1
Scoping and engagement
September – February 2023

Pilot Project – Phase 2
Assess asset risk and vulnerability
February – October 2023

Pilot Project – Phase 3
Options to address risk and opportunity
Start scheduled in October 2023

Pilot Project – Phase 4
Support for resilience investment
Timing TBD – led by CSIRO & Value Advisory partners

Table 14 Recommendations for integrating and extending Phase 2 outputs, and supporting with future RAMP phases

Now	Next	Later
▪ Integrate very high climate risks under both climate scenarios into Corporate Risk Registers ▪ Ensure climate risk assessment results can be adapted into council systems and processes ▪ Use the geoportal to identify specific assets at risk ▪ Identify any existing treatments for high and very high climate risks ▪ Add climate hazard layers to council's spatial asset management tools ▪ Work in collaboration with other Resilient South councils to prioritise climate transformation at the right time, in alignment with global shifts and community expectations, to manage transition risks *Working together as a region can normalise the transformational shifts required and create economies of scale, supporting the transition towards a low-carbon future.*	▪ Extend the climate risk assessments to other asset classes, first reviewing other asset classes in risk register, next, undertaking spatial analysis for additional asset classes *Based on the climate risk assessment results, roads, major buildings and open space and coastal assets will face more high and very risks in 2050, in both risk categories under both scenarios. Extending the risk assessment in a phased approach, by addressing these gaps first, could help councils prioritise this task.* ▪ In Phase 3: provide guidance to Aurecon on asset management systems, roles and responsibilities; and review implementation pathways for adaptation options	▪ After Phase 3: implement Regional Asset Resilience Plan and Asset Resilience Action Plans, incorporating recommendations into asset design and construction, asset planning software, Asset Management Plans, Long Term Financial Plans, operations and maintenance plans, risk frameworks and budgeting processes ▪ In Phase 4: identify funding and finance options to implement actions and adaptation options

4.2 Next steps: options to address risks and opportunities in Phase 3

Phase 3 will identify and assess options to address the high and very high risks identified in Phase 2, in alignment with risk appetites of all Resilient South councils. It will seek to identify risk treatment controls and adaptation options that contribute to realising opportunities for benefit.

Adaptation options should be informed by a pathways approach to meet and align with councils' long-term objectives. Low-regrets adaptation options increase the region's resilience and capacity to cope with future climate risks and perform well under multiple scenarios. This means looking beyond options that only protect an asset in place, to avoid locking in perverse outcomes, and exploring transformational options as appropriate.

Options can vary from major capital expenditure projects, to changes in practice, and be implemented immediately or over the long-term.

Adaptation options identified in Phase 3 will inform the development of action plans for each council and the region, based on an adaptation pathways approach that ensures adaptation options are low regret. These plans will identify opportunities to provide assets and services in a way that is sustainable, climate-compatible, disaster-resilient and contributes to realising the community-defined vison for the region.

Table 15 Phase 3 risk prioritisation and treatment approach

Approach	**Addressing key risks for each asset class** This approach will develop generic adaptation options for high and very high risks, based on asset class.	**Addressing clusters of asset-based risks at regional hotspot locations** This approach determines adaptation options for 2-3 hotspot areas of regional significance where risks are clustered.
Focus	■ on maintaining assets in place ■ on protecting value at risk, through specific asset improvements and protection ■ on preventing loss of service at asset-level ■ on developing actions for council's Asset Resilience Action Plans	■ on ensuring groups of at-risk assets continue to provide community services ■ on protecting value at risk at hotspot locations, through targeted improvements to multiple assets ■ on developing 2-3 regional areas of focus for adaptation for the Regional Asset Resilience Plan
Adaptation options	■ apply to a single asset class	■ apply to multiple existing assets in hotspot locations ■ consider multiple, cascading risks
	■ order of magnitude costs to implement and maintain options ■ will be developed with consideration of effectiveness of reducing risk and co-benefits of adaptation options ■ will use a multi-criteria assessment to prioritise adaptation options and inform pathways	
Engagement approach	■ meetings and targeted interviews with key stakeholders from each council to test and validate draft adaptation action plans	

Table 15 outlines the risk prioritisation and treatment approach for Phase 3.

Appendices

Appendix A Asset and hazard overview: Physical risks

Table A1 Quantity of high and very high physical risks at 2030, 2050 and 2090 under the Green Path scenario, with related physical hazard and affected asset class

		The Green Path					
		2030		2050		2090	
Asset class	Hazard category	High	Very High	High	Very High	High	Very High
Bridges	**All hazards**	**9**		**8**	**1**	**8**	**1**
	Coastal						
	Dry	1		1		1	
	Heat and cold	2		2		2	
	Wet	5		4	1	4	1
	Wind & Storms	1		1		1	
Major buildings	**All hazards**	**14**		**17**	**1**	**21**	
	Coastal	1		2		3	
	Dry	6		6	1	6	
	Heat and cold	3		5		8	
	Wet	2		2		2	
	Wind & Storms	2		2		2	
Open space and coastal	**All hazards**	**6**	**1**	**12**	**1**	**15**	**3**
	Coastal	1		6		9	2
	Dry	3		3		3	
	Heat and cold	1	1	2	1	2	1
	Wet						
	Wind & Storms	1		1		1	
Roads	**All hazards**	**19**		**22**		**27**	**1**
	Coastal	1		2		8	1
	Dry	4		4		3	
	Heat and cold	3		5		5	
	Wet	5		5		5	
	Wind & Storms	6		6		6	
Stormwater	**All hazards**	**7**		**8**	**1**	**10**	**2**
	Coastal			1		1	1
	Dry	4		4		4	
	Heat and cold	1			1	1	1
	Wet			1		2	
	Wind & Storms	2		2		2	

Table A2 Quantity of high and very high physical risks at 2030, 2050 and 2090 under the Highway scenario, with related physical hazard and affected asset class

		The Highway					
		2030		2050		2090	
Asset class	Hazard category	High	Very High	High	Very High	High	Very High
Bridges	**All hazards**	**8**	**1**	**8**	**1**	**8**	**4**
	Coastal						
	Dry	1		1			1
	Heat and cold	2		2		1	1
	Wet	4	1	4	1	5	2
	Wind & Storms	1		1		2	
Major buildings	**All hazards**	**15**		**20**	**2**	**25**	**10**
	Coastal	1		2		8	1
	Dry	7		7	1	7	2
	Heat and cold	3		4	1	7	2
	Wet	2		3			3
	Wind & Storms	2		4		3	2
Open space and coastal	**All hazards**	**9**	**1**	**21**	**1**	**20**	**13**
	Coastal	2		7		4	8
	Dry	4		5		5	2
	Heat and cold	2	1	3	1	3	2
	Wet			2		3	1
	Wind & Storms	1		4		5	
Roads	**All hazards**	**21**		**23**	**5**	**30**	**14**
	Coastal	1		2	1	7	5
	Dry	4		4		4	2
	Heat and cold	4		5	1	6	2
	Wet	5		7		5	2
	Wind & Storms	7		5	3	8	3
Stormwater	**All hazards**	**8**		**8**	**2**	**8**	**5**
	Coastal			1		1	1
	Dry	4		4		3	1
	Heat and cold	1			1	1	1
	Wet	1		1	1	2	1
	Wind & Storms	2		2		1	1

Appendix A Asset and transition hazard overview: Transition risks

Table A3 Quantity of high and very high transition risks at 2030 and 2050 under the Green Path scenario, with related transition hazard and affected asset class

		The Green Path			
		2030		2050	
Asset class	Hazard category	High	Very High	High	Very High
Bridges	**All hazards**	**3**		**4**	**2**
	Market			2	
	Legal and regulatory	2		2	2
	Stakeholder	1			
	Technology				
Major buildings	**All hazards**	**11**		**22**	**5**
	Market	1		4	1
	Legal and regulatory	1		2	
	Stakeholder	3		7	1
	Technology	6		9	3
Open space and coastal	**All hazards**	**7**		**23**	
	Market	1		2	
	Legal and regulatory	5		12	
	Stakeholder	1		5	
	Technology			4	
Roads	**All hazards**	**5**		**11**	**3**
	Market	2		2	2
	Legal and regulatory			2	
	Stakeholder			3	
	Technology	3		4	1
Stormwater	**All hazards**			**7**	
	Market			1	
	Legal and regulatory			4	
	Stakeholder				
	Technology			2	

Table A4 Quantity of high and very high transition risks at 2030 and 2050 under the Highway scenario, with related transition hazard and affected asset class

		The Highway			
		2030		2050	
Asset class	Hazard category	High	Very High	High	Very High
Bridges	**All hazards**	**3**		**4**	**2**
	Market			2	
	Legal and regulatory	2		2	2
	Stakeholder	1			
	Technology				
Major buildings	**All hazards**	**12**		**21**	**6**
	Market	1		4	1
	Legal and regulatory	1		2	
	Stakeholder	4		5	3
	Technology	6		10	2
Open space and coastal	**All hazards**	**7**		**15**	
	Market	1		2	
	Legal and regulatory	5		9	
	Stakeholder	1		4	
	Technology				
Roads	**All hazards**	**5**		**13**	
	Market	2		5	
	Legal and regulatory			2	
	Stakeholder			2	
	Technology	3		4	
Stormwater	**All hazards**			**7**	
	Market			1	
	Legal and regulatory			4	
	Stakeholder				
	Technology			2	

Appendix C References

Aurecon, March 2023, *Resilient Asset Management Program Phase 1 Report*.

City of Marion, 25 February 2020, *Risk Management Framework.*

City of Onkaparinga, 31 October 2022, *Risk Management Framework V1.0*.

Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)], IPCC 2022: *Climate Change 2022: Impacts, Adaptation, and Vulnerability*, Cambridge University Press, Cambridge, UK and New York, NY, USA.

Department for Environment and Water, November 2022, *Guide to climate projections for risk assessment and planning in South Australia*, Government of South Australia.

Fuss, S., Canadell, J., Peters, G., Tavoni, M., Andrew, R., Ciais, P., Jackson, R., Jones, C., Kraxner,F., Nakicenovic, N., Quere, C., Raupach, M., Sharifi, A., Smith, P., & Yamagate, Y., 21 September 2014, *Betting on negative emissions,* Nature Climate Change, vol. 4, pp.850–853.

Institute of Public Works Engineering Australia, 2015, *International Infrastructure Management Manual*, IPWEA.

IPCC, 2014, *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Intergovernmental Panel on Climate Change, <https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf>.

IPCC 2021, The Physical Science Basis, *Regional fact sheet - Australasia*, Intergovernmental Panel on Climate Change.

NCCARF, 2016, *Guidance on undertaking a first-pass risk screening,* CoastAdapt, National Climate Change Adaptation Research Facility, Gold Coast.

National Water Account, 2017, *Adelaide: Geographic Information*, Australian Bureau of Meteorology, <http://www.bom.gov.au/water/nwa/2017/adelaide/regiondescription/geographicinformation.shtml>.

O'Neill, B., Kriegler, E., Ebi, K., Kemp-Benedict, E., Riahi, K., Rothman, D., van Ruijven, B., van Vuuren, D., Birkmann J., Kok, K., Levy M., & Solecki, W., January 2017*, The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century*, Global Environmental Change, vol 42, pp. 169-180.

Resilient South, 2023, *Southern Adelaide,* <https://www.resilientsouth.com/southern-Adelaide>.

Standards Australia, 30 October 2018, *Risk management – Guidelines AS ISO 31000:2018*, Council of Standards Australia.

Standards Australia, 5 June 2013, *Climate change adaptation for settlements and infrastructure – A risk based approach AS 5334:2013,* Council of Standards Australia.

TCFD, June 2017, *Recommendations of the Task Force on Climate-related Financial Disclosure*, Task Force on Climate-Related Financial Disclosures, Basel, Switzerland.