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SOUTHERN METROPOLITAN
REGIONAL COUNCIL

Climate Change Climate Change Risk Management and Adaptation Action plan for the Southern Metropolitan Councils

September 2009



Australian Government
Department of Climate Change

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The information for the climate change risk assessment was provided by SMRC representatives.

The analysis, recommendations and summaries presented in this report are based on information provided by SMRC, *ABS, CSIRO, IPCC, the DCC and other similarly recognized Government bodies*. This information has not been independently verified and where assumptions are identified and recommendations made these need to be verified and tested as noted in the text of the report.

The data and process used as the basis for conducting the climate change risk assessment was adopted by SMRC and was based on the *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006) as per the requirements of LAPP.

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Executive Summary

Councils provide numerous services that are integral to local communities and therefore municipalities are ideally placed to provide a co-ordinated response to changes in the regional climate. The Australian Government recognises the importance for local government to address its preparedness for anticipated Climate Change impacts by assessing how it will affect the infrastructure and services for which it is responsible. The Australian Government Department of Climate Change developed the Local Adaptation Pathways Program (LAPP) to provide grants to Councils across Australia to conduct a risk assessment and develop an adaptation response.

The Southern Metropolitan Regional council (SMRC) has completed the first three phases of the LAPP including the context setting, risk assessment and adaptation option identification. This report provides a detailed summary of the context setting and risk assessment, as well as the results of the adaptation option identification phase.

The risk assessment and adaptation were conducted using the prescribed methodology for LAPP funding approval as defined in *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006), which is aligned with the Australian Standard for Risk Management (AS/NZS 4360:2004). The risk framework utilised was based on the consequence and likelihood criteria defined in the AGO documentation.

The climate variables considered included reduced rainfall, increased temperature and extreme weather events (flooding, bushfire, high winds), with the level of risk for each risk scenario being analysed for now (2008), 2030 (without any additional controls), 2070 (without any additional controls), and for 2030 with implementation of potential adaptation control options.

The assessment identified ten risks which were all analysed for Level of Risk. The risk level summary is given in Table 1, where two risks were rated as 'Extreme' for 2030 and two for 2070. For the current timeframe two risks were rated as 'High', four as 'Medium' and four as 'Low'. This increased to two 'Extreme', four 'High' and four 'Medium' for 2030, which further increased to two 'Extreme', seven 'High' and one 'Medium' for 2070. During the risk assessment and adaptation workshops potential controls and actions were identified for all of the risks. It was determined that with controls in place, there were no 'Extreme', five 'High' and five 'Medium' (residual¹) risks for 2030.

Table 1 Number of risks in each category

Risk Level	Now	2030	2070	Residual
Low	4	0	0	0
Medium	4	4	1	5
High	2	4	7	5
Extreme	0	2	2	0
Total	10	10	10	10

¹ Residual Risk is defined as the risk or danger of an action or an event, where residual means "the quantity left over at the end of the process; a remainder." It is therefore the remaining risk after all relevant controls have been taken into account.



It is important to note that SMRC carried through these risks to the adaptation stage due to their perceived relevance. While a number of risks have been carried through to the adaptation stage due to their perceived relevance to the individual councils they are not likely to represent all the climate change risks that may affect the region. The risks assessment and adaptation plan covered in this report are of a high level assessment and are based on the knowledge of the participants in the workshops, which may be imperfect. Furthermore, this study was reliant on the data available at the time, and it is quite possible that the qualitative evaluation may change as knowledge improves in this emerging area. Climate change is an emerging issue and the workshop team sought to qualitatively understand the effects and risks using reasonable assumptions. Further assessment of some of the identified impacts and controls should be undertaken prior to implementation.

Adaptation actions identified by SMRC to address climate change risks were largely focused on infrastructure design and retrofit, as well as community education and awareness of climate change and potential adaptation actions they can implement. Adaptation actions surrounding further research and monitoring of climate change factors were also high in number. In order to implement these particular controls it is recommended that a Communication Plan be developed to address community consultation, education and awareness programs. This plan may also include strategies for communications with State and Australian Government, other Councils, universities and agencies to enhance research and monitoring capabilities.

The ranking of adaptive actions reflect that the three criteria, “cost” and “Council establishment time” and “practicality” were the most heavily weighted selection criteria. There is likelihood that most of the top controls for each risk received a high ranking because they require little or no additional funding. They may as such be limiting adaptation action to seeking policy and regulatory change from State and Australian Government, and liaison with other Government agencies whose core business relates to particular risks (such as water provision). For the same reason they may also be largely based on controls already in place.

The majority of controls identified by the SMRC aimed to reduce the severity of the risk. Ideally the risk management approach should consist of a range of controls across the hierarchy, with a greater focus on elimination or prevention rather than mitigation. The fact that fewer of the controls focus on elimination or prevention is likely to reflect the ability of local government to actually do so, either through financial limitations (i.e. prevention/elimination options too expensive) or because they lack regulatory or jurisdictional control (i.e. controls fall within State or Australian Government jurisdiction). So SMRC can only lobby State or Australian Government to implement the control.

The majority of controls require short-term implementation. This may reflect that climate change risk and adaptation work is in an initiation phase. Eventually, as issue or risk specific strategies are signed off and enter into the action phase – there would be more medium and long-term actions and controls. However, the focus on short-term controls may also suggest a limited strategic (or long term) view of Council assets, operations and services.

The risk assessment and adaptation planning workshops were successful in bringing together a number of council staff from different parts of Council and the community to recognise that climate change has



impacts across all of Council's assets, operations and services.

It is recommended that SMRC members review their business and strategic plans in light of the identified climate change risks and integrate the implementation of adaptation actions into these plans, as well as begin to engage and inform the community on climate change and what it means for the councils. It is also important for the Council to optimise co-ordination with the State and Australian Governments, and other agencies such as the Department of Water and Water Corporation, the Department of Agriculture and Food and universities.

1. Introduction

1.1 Objectives

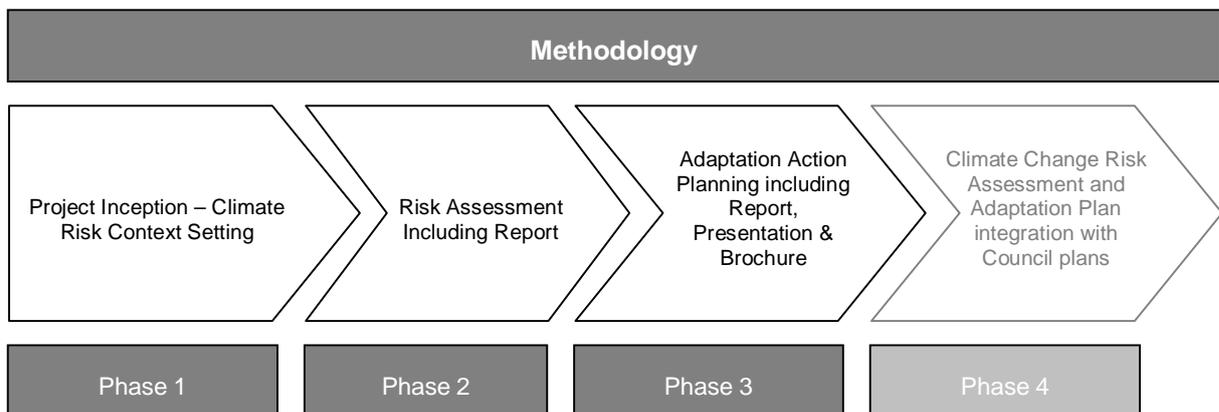
Western Australian Councils provide some 100 services that are integral to local communities; therefore municipalities are ideally placed to provide a co-ordinated local response to changes in the regional climate. The Australian Government recognises the importance for local government to address its preparedness for anticipated climate change impacts by assessing how it will affect the infrastructure and services for which it is responsible. The Australian Department of Climate Change (DCC, formally AGO) developed the Local Adaptation Pathways Program (LAPP) to provide grants to Councils across Australia to conduct a risk assessment and develop an adaptation response.

The objective of the Australian Government’s LAPP is to increase the adaptive capacity of local governments to deal with the impacts of climate change and more specifically to:

- » Identify and prioritise risks that climate change impacts pose to the operations and responsibilities of local governments;
- » Develop strategies for managing risks, adaptive actions and building resilience within communities; and
- » Identify where knowledge gaps may be and where further investigation is needed.

The four phases of the project methodology are summarised in Figure 1-1:

Figure 1-1 Project Phases



GHD requested a list of information from SMRC as background to the risk assessment process, and the outcome of that study, based on information available in the timeframe, is included in this document.



1.2 Risk Assessment

A one day risk assessment workshop, held on 18th November 2008, aimed to identify, analyse, evaluate and treat risks related to climate change. Risk is commonly referred to as a combination of the likelihood of an occurrence and the consequence of the occurrence. *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006) suggests that climate change is not expected to create new risks, but potentially change the frequency and intensity of existing risks. There are a range of uncertainties around global climate scenarios and modelling results in varying degrees of confidence. Refer to Appendix D for a detailed methodology.

The outcomes of the workshop and further analysis by the climate change risk assessment team have been used in this report to develop an Adaptation Action Plan.

1.3 Adaptation Planning

The SMRC adaptation workshop was conducted on the 19th March 2009 at the Council offices of the City of Canning. Refer to Appendix C for a list of the workshop participants.

The adaptation workshop was conducted based on the information obtained by the knowledge of the workshop group during the Risk Assessment phase and the climate change predictions as outlined in section 3 of this report.

The methodology used for the SMRC change adaptation workshop was consistent with that outlined in the DCC document *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006) as per the LAPP requirements. Refer to Appendix F for a detailed methodology.

1.4 Report Structure

This report documents the available information, the methodology followed and the outcomes of the adaptation planning in the following sections:

- » Section 3 provides the contextual information for the assessment;
- » Section 4 details the outcomes of the risk assessment;
- » Section 5 documents the outcomes of the adaptation planning process;
- » Section 6 discusses the outcomes of the process and how it relates to the Council; and
- » Section 7 provides recommended next steps for consideration by the Council.

2. Climate Change Risk Context Setting

2.1 Scope

The Southern Metropolitan Regional Councils (SMRC) is made up of five Cities and two Towns within the Perth Metropolitan area. All of the councils have tidal waterlines (estuarine or ocean) and are located south of the Swan and Canning Rivers (as depicted in Figure 2-1). The councils range between 10 and 35 kilometres from the Perth CBD. For the purposes of this report the City of Melville² was excluded. Therefore any further information relating to the SMRC in this report is taken to only involve the Canning, East Fremantle, Fremantle, Cockburn, Kwinana and Rockingham councils.



Figure 2-1 Geographic Area of the SMRC

2.2 Population

According to Census data (Australian Bureau of Statistics) the SMRC had a total population of 290,814 (excluding overseas visitors). Some of the councils are considered to be mature areas and are not expected to have a dramatic increase in population in the future. Other areas however, are still developing, with new residential property becoming available. The Town of Kwinana's population is expected to increase by 60-70% by 2013 and triple in the next 15 – 20 years. The City of Cockburn's population is expected to increase from 74,472 (2006) to in excess of 100,000 by 2010.

² City of Melville decided not to participate in the regional project

Table 2-1 Local Populations and Number of Private Dwellings (2006 Census Data)³

Locality	Population	Private Dwellings
Canning	77,305	31,259
Cockburn	74,472	29,609
East Fremantle	6,697	2,991
Fremantle	24,835	12,613
Kwinana	23,198	9,370
Rockingham	84,307	34,922

2.3 Services, Amenities and Infrastructure

The councils provide many services and amenities including those directly to their communities. These include numerous schools, libraries, nursing homes and aged carers, hospitals, emergency services (ambulance, fire etc.) and recreation facilities (pools, sports grounds etc.). The SMRC operates the alternative waste facility located in Canning Vale. There are two landfill sites in the region – Millar Road Landfill managed by the City of Rockingham and Henderson Road Landfill managed by the City of Cockburn.

Numerous kilometres of road exist within the SMRC, with the maintenance responsibility shared between the Council and State Governments. Major arteries include the Kwinana Freeway, Leach Highway, South Street, Tonkin Highway, Roe Highway, Canning Highway and Albany Highway. Thirteen train stations are also present within the SMRC servicing the Mandurah, Armadale/Thornlie and Fremantle lines, with more stations in the proposal stage. Numerous bus networks are also present within the councils which Transperth provides along with the train services.

Numerous utilities are provided to the council and the community including:

- » Electricity: provided by Synergy;
- » Gas: provided by Alinta; and
- » Water: provided with the Water Corporation.

2.3.1 Economic Base

Many major industrial areas are located within the SMRC, the most notable being the Kwinana Industrial Area. The local industries include alumina, nickel and oil refineries, chemical factories, power plants, a cement manufacturer and fertiliser plants. Other industrial areas within the SMRC include Cockburn Commercial Park, Yangebup Business Park and Jandakot Industrial Area.

Tourism makes up a large component of the SMRC business. The Town of East Fremantle and City of Fremantle have many businesses targeting tourists, including markets, restaurants and cafes, most of



Refinery located within the Kwinana Industrial Area.

³ Australian Bureau of Statistics



which are in close proximity to the coast. Other points of interest are the numerous wetlands throughout the council areas. Some of the tourist attractions include:

- » Fishing;
- » Whale Watching and Swim with the Dolphins;
- » Penguin Island;
- » Shoalwater Islands;
- » Museums;
- » Marapana Deer and Wildlife Park;
- » Pt Peron Lookout;
- » Churchhill Park;
- » Bell Park;
- » Art Gallery;
- » Community Theatre;
- » Naragebup Environment Centre;
- » Archery Park;
- » WA Water Ski Park;
- » Wineries;
- » Perth Motorplex;
- » Kwinana Beach;
- » Sloan's Cottage and Smirks Heritage Cottages and Museum;
- » The Spectacles Yargan Tours and Wetlands;
- » Entertainment such as films/movies and music;
- » Festivals such as the children's fiesta, street arts festival, heritage festival, Fremantle festival, village art festival and Wardarnji Aboriginal festival;
- » Fremantle prison;
- » Historic buildings;
- » Museums;
- » The shipwreck gallery;
- » Whalers tunnel;
- » Markets (Fremantle markets, Fremantle village markets, and E Shed markets);
- » Art galleries and centres;
- » Walking trails;
- » Restaurants and hotels including the Red Herring, the Left Bank and the Trade Wind Hotel;
- » Walking Trails;
- » Fishing on the Swan River;
- » Adventure World;
- » Cockburn Ice Arena;
- » Bungee West;
- » Azelia Ley Homestead Museum;
- » The Coogee Beach jetties;
- » Chain of five lakes running north to south through the heart of the City. Sixteen Aboriginal campsites have been identified throughout Cockburn, most of them on the fringes of two of the larger lakes, North Lake and Bibra Lake;
- » Castle Miniature Railway;
- » 29 heritage buildings and 6 sites on the state heritage register throughout Fremantle;
- » Whaleback golf course; and
- » Canning River Regional Park.



2.4 Current Climate

The area experiences a Mediterranean climate with hot, dry summers and cool, wet winters. According to the Bureau of Meteorology (BoM) the average maximum and minimum temperatures are 27.9 - 32.4°C and 8.1 - 10.6°C. Rainfall is 750 - 761 mm on average and the region experiences an average of 11-22 hot days (see Table 2-3 for further details).

Several tornadoes have occurred throughout the SMRC area, predominantly in the Rockingham area with tornadoes also recorded in Fremantle. Severe thunderstorms are common and include high winds, hail, lightning and flash floods.

2.5 Hydrology

2.5.1 Groundwater

Groundwater levels within the SMRC ranges from 1 - 25 m below ground level. A summary of the groundwater levels for each council is shown in Table 2-2. Groundwater use is currently tracked through licensing bores.

Table 2-2 Approximate Groundwater Levels (DoW Groundwater Atlas, 2008)

Council	Groundwater Level mbgl (2003)	Groundwater Level mbgl (Historical)
Canning	1 - 20	1 - 22
Cockburn	1 - 25	1 - 27
East Fremantle	1	1
Fremantle	1	1 - 2
Kwinana	1 - 24	1 - 25
Rockingham	1 - 10	Not available

2.5.2 Surface Water

Numerous wetlands and drains exist within the SMRC boundaries, including North Lake, South Lake, Bibra Lake, Thomsons Lake and Banganup Lake. These wetlands form a natural corridor through the centre of the City of Cockburn running north to south and are an important environmental feature. In recent years, Yangebup Lake is the only lake in this area that normally possesses water all year round. The other lakes become considerably dry during the summer months. Thomsons Lake is a class 'A' nature reserve and internationally recognised wetland, protected under the RAMSAR, JAMBA treaties. Some of these lakes are protected in the Region Park System while others are covered by various management plans. These wetlands provide a significant habitat for the numerous species of nomadic and migratory water birds. The wetlands are dependent on the groundwater level; currently there are measures to pump water directly into some wetlands to combat lower water levels which have resulted from decreasing winter rainfall.

2.5.3 Catchment Management

Manning Lake Reserve is one of City of Cockburn's local conservation reserves situated near the coast. The reserve encompasses Manning Lake and the limestone ridge to the west of the wetland.



In order to maintain the Manning Reserve, the impacts on the bushland need to be reduced. These include activities such as illegal vehicle access, rubbish dumping and taking of wildlife.

2.5.4 Floods

Kwinana, Fremantle, Cockburn and Rockingham councils' western boundaries are along the Indian Ocean. Given that sea levels are predicted to rise, the proximity of these councils to the ocean is expected to be a significant issue. Canning, East Fremantle and Fremantle councils border the Swan or Canning Rivers.

According to the DoW Perth Groundwater Database, certain areas of Baldivis are subject to inundation. Affordable housing is planned for development in the flood plains, hence there is a potential for flood water backup in the Rockingham flood plains from Mandurah Lake in conjunction with sea level rise.

2.6 Flora and Fauna

The EPBC Act Protected Matters Search Tool identified numerous "Vulnerable", 'Endangered', 'Listed', 'Migratory' and 'Cetacean' flora and fauna species within the SMRC. The 'Endangered' fauna species include:

- » Carnaby's Black-Cockatoo;
- » Red-tail Phascogale;
- » Amsterdam Albatross;
- » Southern Giant-Petrel; and
- » Loggerhead Turtle.

The 'Endangered' flora species include:

- » Slender Andersonia;
- » King Spider-orchid;
- » Glossy-leaved Hammer-orchid;
- » Wing-fruited Lasiopetalum;
- » Keighery's Macarthuria; and
- » Beaked Lepidosperma.

Of these, Carnaby's Black-Cockatoo has iconic status, as it ranges in conspicuous flocks for its non-breeding food supplies throughout the SMRC bush reserves, parks and suburban gardens.

There are also five Threatened Ecological Communities within the SMRC area protected under the EPBC Act.

All bush reserves and remnants are more or less impacted by exotic plants, some of which are declared weeds. Similarly, introduced animals contribute to existing threatening processes which are the subject of a variety of ongoing control and management programs through councils, community organisations and WA government agencies.

2.7 Heritage

There are numerous heritage sites within the SMRC, many of which are Heritage Registered. These include cottages, buildings and shipwrecks. Many are also tourist attractions including Fremantle Prison and the Roundhouse. Fremantle Prison is the only heritage site registered as a National Heritage Place



and as such is protected under the EPBC Act.

2.8 Climate Change Initiatives

The councils which make up the SMRC have shown initiative in dealing with the issues surrounding climate change. All of the Councils are members of the Cities for Climate Protection (CCP) program which is an international campaign that helps local governments and their communities reduce greenhouse gas emissions and their impact on the environment. This program is facilitated by the International Councils for Local Environmental Initiatives (ICLEI). This international association of local governments, as well as national and regional local government organisations, have made a commitment to sustainable development. The ICLEI provides technical consulting, training and information services to build capacity, share knowledge and support local government in the implementation of sustainable development at the local level (ICLEI, 2008). The Town of Kwinana and the City of Rockingham are also part of this organisation.

2.8.1 City of Fremantle

In line with the Strategic Plan and to address climate change, an Environmental Action Plan has been developed to guide action to promote environmental sustainability internally and in the wider community. It employs a range of mechanisms including regulation, organisational initiatives, educational initiatives and incentives to promote change in the wider community.

As part of the Environmental Action Plan, the City of Fremantle will also be giving more consideration to how they report against sustainability objectives (KPI report, Council Items etc). This is to ensure that everything they do as an organisation is in line with what the Strategic and Environmental Action Plans set out to achieve and so that they can assess whether they are progressing in the right direction. As a local government authority, they are well placed to lead responsible environmental management being able to work closely with the local community on environmental programs.

The City has three major themes relating to environmental responsibility:

- » Using Council resources in a responsible, efficient and cost-effective way;
- » Taking responsibility for decisions, performance and achievements of agreed outcomes; and
- » Consideration of the environmental impact of all council actions to ensure responsible environmental management and minimal waste.

2.8.2 City of Cockburn

The City of Cockburn's website provides climate change information and links to relevant websites. It also provides a list of things that residents can do to assist in managing some of the health orientated impacts of Climate Change on a local level. These include:

- » Being aware of mosquito and rat breeding sites;
- » Pigeon, fly and dust control;
- » Cleaning of roofs and gutters;
- » Maintenance of stormwater soaks and wells; and
- » Installation of grey water systems.

The City adopted Policy SC37 Sustainability in June 2006. This policy provides a framework for the City to ensure its activities and operation consider sustainability issues. The City has adopted the following definition of 'Sustainability';



"Meeting the needs of current and future generations through integration of environmental protection, social advancement, and economic prosperity."

The City of Cockburn became a member of the CCP in 1999 and is actively addressing greenhouse gas management.

The City of Cockburn has also undertaken other climate change initiatives which include:

- » Arranged for the purchase of digital imagery;
- » Convened a workshop with representatives from the Department of Planning and Infrastructure and other agencies;
- » Requested information from the CSIRO regarding climate change, particularly regarding the region that the City lies in;
- » Initiated discussions with the Kwinana Industries Council and Cockburn Sound Management Council;
- » Undertaken a brief review of the Cockburn coastline to determine areas that may be at risk from climate change;
- » Commissioned a drainage engineer to look at the City's drainage capacity and capability;
- » Attended a number of seminars and workshops in relation to climate change;
- » Is in the process of developing an adaptation action plan; and
- » Are involved in the SMRC's Climate Wise initiative.

2.8.3 Town of East Fremantle

The Town of East Fremantle participates in the CCP to reduce greenhouse gas emissions. Council officers regularly attended regional CCP meetings to help develop a regional approach to cross border issues. A regional CCP committee assists the Town with Regional CCP initiatives. These issues include street lighting, energy consumption in the business sector, transportation (including alternative fuels), green purchasing policy and education/promotion. A summary of the Regional Community Greenhouse Gas Project follows:

- » Climate Actions Project;
- » Living Smart;
- » Energy Actions;
- » Alternative Fuel; and
- » Renewable Energy.

2.8.4 City of Canning

The City of Canning is part of the CCP program to help minimise the impact of climate change and has received the status of CCP Plus. Specific climate change risk/impact statements related with the council will be incorporated once the information is received.

2.8.5 City of Rockingham

The City of Rockingham participates in the CCP Plus program to reduce greenhouse gas emissions as well as a member of ICLEI. The city undertakes a number of activities to reduce greenhouse gas emissions, listed are a few of these activities:



- » Auditing and retrofitting buildings;
- » Downsizing the vehicle fleet, and introducing hybrid vehicles;
- » Methane extraction from the landfill; and
- » Undertaking a wind turbine feasibility study.

The community has been dealt with on a regional basis with other councils, as part of the ClimateWise program. This work involves the development and implementation of community education.

In May 2008, Council endorsed the development of a Climate Change Response Plan and provided funds to the development of this plan. This plan will deal with understanding the outcomes of climate change and what actions are needed to mitigate these impacts, or ensure that the City is capable of adapting to these impacts.

2.8.6 Town of Kwinana

The Town of Kwinana is a CCP Plus council as well as an ICLEI member and actively participates in a number of initiatives to reduce greenhouse gas emissions. This includes: a building retrofit program to make existing buildings more energy and water efficient; the sourcing of Green Power for use on our streetlights; and an on-going revegetation program which assists in abating greenhouse gases. In addition, any new council building is also designed to meet a high standard of energy and water efficiency.

The Council also participates in the SMRC led Regional Community Greenhouse Gas Abatement Project and Council officers within the region met regularly to develop a regional approach to climate change. Through the SMRC project, the following programs are provided within Kwinana:

- » Living Smart – An annual course, free of charge to Kwinana residents to learn how to improve the sustainability of their homes and their community;
- » Residential Targeted Energy Action – This program works with individual households on specific actions that can make big reductions in household energy use.
- » Local Centre's Combined Project – Some small to medium size local businesses and adjoining residents within Kwinana will be invited to participate in a new project aimed at reducing greenhouse gas emissions through energy and waste reduction.

2.9 Climate Change Scenarios

There is overwhelming and increasing scientific evidence that human activities are leading to adverse changes in global and regional climates as a result of the emission of carbon dioxide and other greenhouse gases from the burning of fossil fuels and other sources.

In WA, average temperatures have risen broadly in line with global trends. The CSIRO has used its global climate change models to project future climate conditions for Australia's regions under differing greenhouse gas emission scenarios for 2030 to 2070⁴. Prolonged instances of heat, wind and rainfall, and increased variations in these phenomena, can also lead to accelerated structural fatigue and greater demands on construction and draining needs. The modelling suggests increased extinction of native flora, with similar impacts on some agricultural crops, water supplies and disease conditions. Other impacts expected to occur as a result of climate change include more frequent and prolonged droughts, more frequent bushfires, increased susceptibility to pestilence, increased spread of vector borne

⁴ CSIRO (2007a) *Climate Change in Australia Technical Report 2007*. Available at: http://www.climatechangeinaustralia.gov.au/technical_report.php . Further information available at <http://www.climatechange.gov.au/impacts/regions/swa.html> (Australian Government Department of Climate Change)



diseases (such as Ross River virus), more frequent heat waves and increased potential for storm surge along coastal developments.

2.9.1 Climate Change Variables

Climate change may affect local council's infrastructure through changes in the mean climate and changes in the frequency and intensity of extreme events. Severe weather events, storm surges, changing patterns and intensity of cyclones, increased bushfire hazard, rising sea level and sustained heat waves may have significant impacts on infrastructure.

As agreed with the SMRC, the high priority climate change impacts from the global scenarios were evaluated (based on the high level predictions provided by IPCC) including:

- » Temperature increase (including an increase in the number of hot days);
- » Rainfall reduction;
- » Sea level increase in conjunction of storm events; and
- » Increase in the frequency and severity of storm events.

The chosen risk evaluation timescale is to take into account the level of risk now (2008), for 2030 and 2070 based on the forward planning arrangements of SMRC.

As more up to date data becomes available, it is recommended that SMRC review the risk assessment and identify any potential changes in risk level based on the revised climate change data and modelling/projections.

2.10 Sea Level Rise

Globally sea levels are predicted to continue to rise due to ocean thermal expansion and glacier / ice sheet melting. Figure 2-2 shows the projected global sea level rise up to 2100 based on CSIRO analysis using the Intergovernmental Panel on Climate Change (IPCC) 2001 and 2007 Assessment Reports. The central dark shading represents an average of models for the range of SRES greenhouse gas emission scenarios with the light shading representing all models and all SRES scenarios. Land-ice uncertainty is included by the outer lines. It is important to note that in all cases the sea-level is predicted to rise. By 2100, global projected sea level rise (by the IPCC) is 18-59 cm with a possible 10 - 20 cm additional increase from icesheets. Sea levels since 1990 are tracking near the upper bound (black line) with a rise of approximately 5.5 cm.

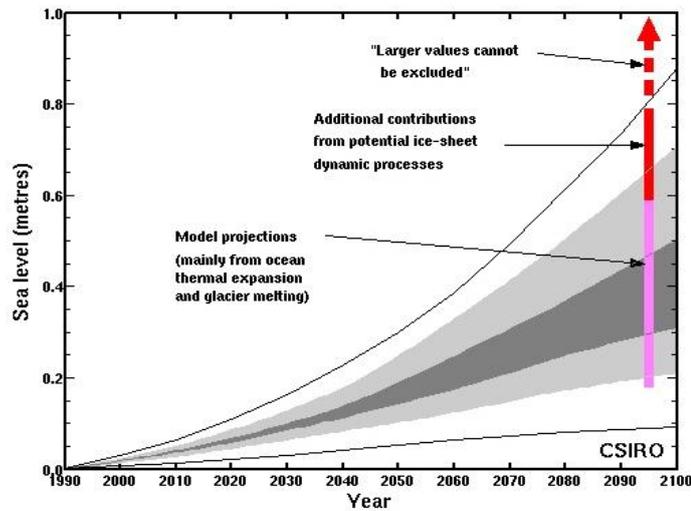


Figure 2-2 Predicted Global Average Sea-Level Rise⁵

A rise in sea-levels could cause encroachment of the ocean and severe beach erosion. This could cause damage/destruction to structures that rely on the delicate coastal dune systems for storm protection and support. Additional damage could also be caused to jetties, moorings, wharfs and bridges. There is also the potential for complete inundation of several beach areas.

It is however important to note that 14 of the 17 climate model simulations used in the IPCC report predict the ocean off the Kwinana, Cockburn and Rockingham councils to have a lower than average global-mean sea level rise (CSIRO, 2008; IPCC, 2007).

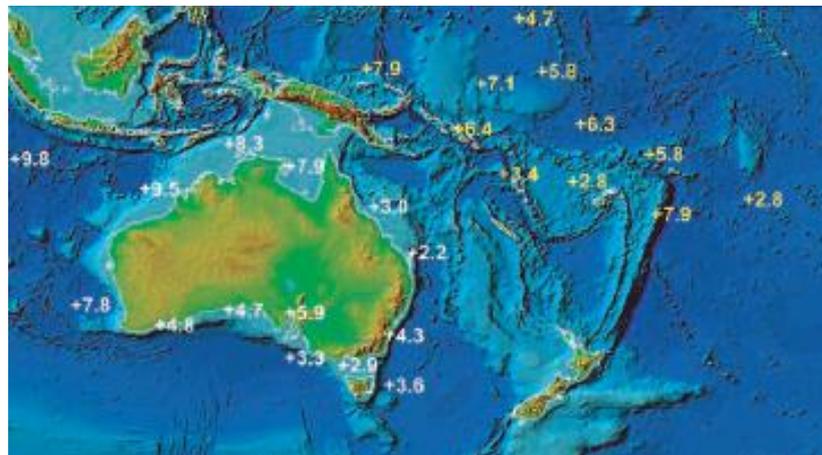


Figure 2-3 Average sea level rise from 1990's to 2007

Figure 2-3 shows observed rates of relative mean sea level rise (mm per year, with the vertical motion of the gauge with respect to the land excluded) from the early 1990s to June 2007 only.

⁵ Source: CSIRO Sea Level Rise http://www.cmar.csiro.au/sealevel/sl_proj_21st.html

2.11 Temperature Increase and Rainfall Reduction

The current climate averages and the predicted change for the SMRC region are shown in Table 2-3. According to the CSIRO (2007) the annual average temperature is predicted to increase by as much as 3°C by 2070, and the average annual rainfall will drop by 20 – 40%.

Table 2-3 Climate Averages for SMRC Region

Climate Variable		Current Average	Predicted Change			
			2030	2050	2070	
Temperature	Annual Average Temperature (°C)	Kwinana	Max: 29.3°C Min: 10.6 °C	0.6 to 1 °C	1.5 to 2 °C	2.5 to 3 °C
		Fremantle	Max: 27.9°C Min: 10.0°C			
		Canning	Max: 32.4°C Min: 8.1°C			
		East Fremantle ²	Max: 27.9°C Min: 10.0°C			
		Cockburn ³	Max: 29.3°C Min: 8.1°C			
		Rockingham ⁴	Max: 29.3°C Min: 10.6 °C			
		Extreme Temperature	Annual average number of hot days (over 35°C)			
		Fremantle	12.7			
		Canning	22.6			
		East Fremantle ²	12.7			
		Cockburn ³	11.3			
		Rockingham ⁴	11.3			
Rainfall	Annual average rainfall	Kwinana	760.1 mm	-5 to -10%	-10 to -20 %	-20 to -40 %
		Fremantle	766.7 mm			
		Canning	750.4 mm			
		East Fremantle ²	766.7 mm			
		Cockburn ³	760.1 mm			
		Rockingham ⁴	760.1 mm			
		Average summer rainfall				
Fremantle	29.1 mm					
Canning	34.5 mm					
East Fremantle ²	29.1 mm					
Cockburn ³	34.9 mm					
Rockingham ⁴	34.9 mm					

Climate Variable		Current Average	Predicted Change			
			2030	2050	2070	
Average winter rainfall	Kwinana	420.4 mm				
	Fremantle	439.4 mm				
	Canning	424.9 mm	-5 to -10 %	-10 to -20 %	-20 to -40 %	
	East Fremantle ²	439.4 mm				
	Cockburn ³	420.4 mm				
	Rockingham ⁴	420.4 mm				
Wind Speed	Average Wind Speed (km/h)	Kwinana ⁶	18.3 (9am) 22.7 (3pm)			
		Fremantle	18.3 (9am) 22.7 (3pm)			
		Canning	7.3 (9am)	-2 to 2 %	-2 to 2 %	-2 to 2 %
		East Fremantle ²	18.3 (9am) 22.7 (3pm)			
		Cockburn ³	18.3 (9am) 22.7 (3pm)			
		Rockingham ⁴	18.3 (9am) 22.7 (3pm)			
Evaporation	Annual Average	Kwinana				
		Fremantle				
		Canning	Data not available	-2 to 2 % ¹	-2 to 2 % ¹	-2 to 2 % ¹
		East Fremantle ²				
		Cockburn ³				
		Rockingham ⁴				
Relative Humidity	Annual Average (%)	Kwinana	63% (9am) 59% (3pm)			
		Fremantle	66% (9am) 61% (3pm)			
		Canning	71% (9am)	-0.5 to -1 %	-1 to -2 %	-1 to -2 %
		East Fremantle ²	66% (9am) 61% (3pm)			
		Cockburn ³	63% (9am) 59% (3pm)			
		Rockingham ⁴	63% (9am) 59% (3pm)			
Solar Radiation	Annual Average (MJ/m ²)	Kwinana	19.4			
		Fremantle	19.5			
		Canning	19.4	-1 to 1 %	-1 to 1 %	1 to 2 %
		East Fremantle ²	19.5			
		Cockburn ³	19.4			
		Rockingham ⁴	19.4			

» Current average data is the median data taken from the Bureau of Meteorology (2008). Kwinana data is from 1955 to current, Fremantle data is from 1852 to 1992 and Canning data is from 1971 to 1987. Canning data is taken from the Bentley weather station.
 » 1: Values are for Evapotranspiration.



- » 2: Values are based on Fremantle data as there are no weather stations within the Town of East Fremantle.
- » 3: Values are based on Kwinana data as there are no weather stations within the City of Cockburn.
- » 4: Values are based on Kwinana data as there are no weather stations within the City of Rockingham.
- » 5: Values are based on Fremantle data as there was no wind speed information for Kwinana.

2.12 Extreme Weather Events

» Several tornadoes have occurred throughout the SMRC area, predominantly in the Rockingham area with tornadoes also recorded in Fremantle. Severe thunderstorms are common and include high winds, hail, lightning and flash floods. The SMRC area, along with the rest of Perth and South West WA was also affected by cyclone Alby in the 1970's, which caused widespread damage.

2.12.1 Recorded Storm Events

Storm events for the last 10 years taken from the BoM (2008) Storm Summary include:

- » 9th June 2008 – An F1 tornado caused damage to over 270 houses from Shoalwater, Safety Bay and Coolongup. Twelve houses sustained severe roof damage. The destruction path was approximately 23-30m wide and 5 km long.
- » 31st May 2008 – Storm damage was reported in Rockingham.
- » 23rd July 2007 – An F1 tornado caused damage to approximately 70 houses from Rockingham to Waikiki. The path was approximately 50m wide and 2.5 km long.
- » Winter 2006 – Several thunderstorms and strong winds were encountered; however no significant damage was reported.
- » Winter 2005 – Several thunderstorms and strong winds were encountered, with minor damage reported on several occasions.
- » Winter 2003 – Several storms produced minor damage in the SMRC region.
- » 16th May 2003 – Fremantle recorded one of its highest tides ever (0.5 m above the highest astronomical tide) when a storm surge and high tide coincided.
- » 18th November 2002 – A livestock carrier swung from its berth in Fremantle harbour when its bowlines broke during strong winds caused by a front.
- » 24th July 2002 – A suspected tornado caused much localised damage to approximately 6 houses in Rockingham.
- » 13th June 2002 – A tornado caused damage to seven houses in Rockingham.
- » 23rd August 2001 – Thunderstorms caused damaging winds in Perth's southern suburbs.
- » 30th June 2000 – A tornado caused damage to several houses and flats in Fremantle.
- » 25th August 1999 – A tornado touched down in Fremantle at approximately 6 am and left a 50-100 m wide 8-9 km long trail of destruction including damage to houses and trees. The tornado finished in Ardross approximately 10 minutes after it began. One person was injured.
- » 13th July 1999 – Several tornadoes were reported in Rockingham. However little damage was reported.
- » 17th June 1999 – A tornado damaged 100 houses in Shoalwater, Safety Bay and Waikiki.
- » 23rd January 1999 – Lighting and flash flooding in Perth suburbs.
- » 14th December 1998 – Large hail and strong winds caused damage to Perth's southern suburbs and one person was killed by a lightning strike.

Due to the high number of industries located within the SMRC region, there is the potential for pollution



damage to be caused from storm activities. Facilities include fuel storage, processing plants, nickel refineries and fertiliser and chemical plants. If any of these facilities were to sustain severe storm damage, the consequence could be severe. As there are a large number of dwellings in the region, there is also the potential for widespread damage to houses and potential loss of life. Older houses such as weatherboard or fibro clad buildings will be more susceptible to storm and fire damage.

2.13 Risk Issues of Special Concern

Climate change is likely to have many significant impacts on the global economy, social well being and environmental conditions. SMRC has particular assets and responsibilities which can be considered vulnerable to climate change because:

- » Some of the councils forecast an increase in elderly population who may be more vulnerable to climate change events;
- » Numerous surface water bodies exist throughout the council areas, which rely on groundwater levels which in turn rely on rainfall recharge to maintain water levels and supply;
- » All councils border the ocean and/or the Swan or Canning Rivers along which high value housing and commercial infrastructure is concentrated ; and
- » Affordable housing is planned for development on flood plains.
- » All councils predict a rise in population (some as high as a 300% increase in the next 15-20 years);

It should be noted that not only does a risk occur due to the potential impact on things for which the Councils are directly responsible (i.e. infrastructure elements, wetlands etc) but there is a significant third party risk to Councils from planning decisions that they make, and developments or buildings they approve. Should Council approve a development building or structure, under local planning procedures, where the potential effects of climate change have not been specifically assessed, and addressed, and there is shown to be subsequent impact/s or damage from climate change, then the Council could be liable under law. Therefore SMRC need to consider (possibly through seeking legal advice) both the risks to their own direct operation and assets, but also the risks incurred by their planning decisions.



3. Risk Assessment Results

3.1 Attendees

A one day risk assessment workshop, held on 18th November 2008, aimed to identify, analyse, evaluate and treat risks related to climate change. Risk is commonly referred to as a combination of the likelihood of an occurrence and the consequence of the occurrence. *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006) suggests that climate change is not expected to create new risks, but potentially change the frequency and intensity of existing risks. There are a range of uncertainties around global climate scenarios and modelling results in varying degrees of confidence. Refer to Appendix D for a detailed methodology.

The outcomes of the workshop and further analysis by the GHD climate change risk assessment team have been used in this report to develop an Adaptation Action Plan.

3.2 Risks Identified

Taking each key element and each climate change variable in turn, risks associated with climate change and potential impacts on the Council were brainstormed for scenarios for the current timeframe, then the years 2030 and 2070. Ten potential climate change impacts were identified for the council over these time periods (see Table 3-1) by the attendees of risk assessment workshop. Although the climate change variables of changes in rainfall patterns, increased temperature and extreme weather events were addressed separately, there were many incidences where the potential impacts were determined to be a result of a combination of the variables. For example, a combination of sea level rise and increased storm events could result in the inundation of infrastructure in low lying areas resulting in a higher replacement cost for the local economy.

For each of the risks and potential impacts identified, any existing controls were noted and then, taking these controls into account, the existing level of consequence and likelihood were agreed by the workshop participants. Then, taking into account the projected changes in climatic variables for 2030 and 2070, the level of consequence and likelihood for each risk impact were reassessed and adopted by the participants. Potential controls to be introduced to mitigate these risks were also discussed and the residual risk at 2030, assuming the controls were in place, was then documented. The risk register, which details each of these elements, is contained in Appendix E.



Table 3-1 Identified climate change risks for the SMRC

Potential Impacts	Specific Consequence / Vulnerability	Current Risk level	2030 Risk Level
Reduced Rainfall			
Reduced water availability for watering park areas affecting the community and lifestyle.	<ul style="list-style-type: none"> » Lack of vegetation/turf resulting in closure of sports fields. » Impact on community lifestyle. » Complaints from community regarding field quality. 	High	Extreme
Reduced water available for natural wetlands affecting the environment and sustainability.	<ul style="list-style-type: none"> » Loss of biodiversity (thousands of species within area) » Possible loss of wildlife corridor. » Some pest species will be reduced (e.g. midges). » Community complaints. » Detrimental effect on other plant species (e.g. Banksias). 	High	Extreme
Temperature Change			
Increased potential for bush fires impacting public safety.	<ul style="list-style-type: none"> » Home evacuations to a recovery centre. » Access blockage of major arterial roads/trains. » Some people unable to evacuate (e.g. elderly). 	Medium	High
Increased potential for bush fires impacting environment and sustainability	<ul style="list-style-type: none"> » Major loss of ecosystems. » Regeneration cycle. » Increase in weed invasion. » Water quality impacts. 	Medium	Medium



Potential Impacts	Specific Consequence / Vulnerability	Current Risk level	2030 Risk Level
Increased potential for bush fires impacting Public Administration	<ul style="list-style-type: none"> » Council facilities. » Community facilities. » Potential damage to bridges. » Property damage. » Stock damage. » Street lighting. » Loss of power (cut off power to operating centre). 	Medium	Medium
Impacts on public health	<ul style="list-style-type: none"> » Increase in food poisoning cases. » Increase in mosquito borne diseases. » Increase in nuisance species (e.g. midges). » Heat stress (increasing in deaths). » Increase resource requirements on health sector. 	Low	High
Increase sea level and conjunction of storm events			
Inundation of infrastructure in low lying areas affecting local economy and growth.	<ul style="list-style-type: none"> » Loss of beaches. » Devaluation of land, property and utilities (including industrial areas). » Potential litigation. » Increase community concern. » Decrease in economic development and growth. » Detrimental effect to sewerage systems. 	Low	Medium



Potential Impacts	Specific Consequence / Vulnerability	Current Risk level	2030 Risk Level
	<ul style="list-style-type: none"> » Loss of reputation of local area. » Negative impacts and damage to boats/ships. » Salinity damage to foundations and infrastructure. 		
Inundation of infrastructure in low lying areas affecting environment and sustainability	<ul style="list-style-type: none"> » Loss of foreshore areas (dune habitat). » Disrupt breeding patterns of some species. » Loss of vegetation. » Salt water intrusion. » Erosion. » Pollution accumulation from industrial areas and sewerage systems inundated with water. 	Medium	High
Increased frequency and severity of storm events			
Damage to infrastructure and environment due to increased wind speed, flooding, hail etc on public safety.	<ul style="list-style-type: none"> » Damage to vegetation (e.g. tree branches impacting roadways etc). » Damage to buildings. » Increased cleanup costs. » Disruption of & damage to critical services (power, water, sewerage systems, public health facilities). » Potential human injury. 	Low	High
Damage to infrastructure and environment due to increased wind speed, flooding, hail etc on local economy and growth	<ul style="list-style-type: none"> » Damage to vegetation (e.g. tree branches impacting roadways etc). » Damage to buildings. » Increased cleanup costs. 	Low	Medium



Potential Impacts	Specific Consequence / Vulnerability	Current Risk level	2030 Risk Level
	<ul style="list-style-type: none">» Disruption of & damage to critical services (power, water, sewerage systems, public health facilities).» Potential human injury.» Road closure.» Disruption to business.» Rebuild costs.» Flow on financial implications.		



3.3 Risk Prioritisation

In total there were ten risks identified and analysed to determine level of risk and priority (in the sense of importance). A summary of the risks are contained in Figure 3-1. Each of the risks considered had a residual risk rating after the identification and application of potential controls.

As demonstrated in Figure 3-1, it is anticipated that there will be a general increase in the level of risk associated with each of the risks. This is expected, as without adaptation planning (i.e. business operates as usual) the current controls may not be able to adequately manage the impacts of the changed climate.

With the implementation of the potential adaptation control strategies, the potential residual risk level of the main scenarios is estimated to be 5 high and 5 medium. It must be noted however that the initial estimate of residual risk was based on the professional opinions of the workshop attendees, and many were revised with subsequent adequacy assessment in the adaptation process. The residual risk represented an initial guidance about risk reduction potential given the nature of each scenario and likely ability to manage it based on current knowledge, without budget limitations or a formal planning process assessment.

3.4 Current Controls

The controls identified during the risk assessment workshop may be categorised into planning documentation and governing management plans and policies; community involvement and awareness programs; state or national governed controls; and engineering or physical controls. A summary of the controls used by the council is demonstrated in Table 3-2.

The detail of and commitment to these controls is vital to ensuring the level of risk associated with climate change is reduced to as low as reasonably practicable. An indication of the adequacy of the current controls is shown in the level of risk, where the majority of risks are currently rated as low or medium. Another indication of control adequacy is demonstrated by the number of incidents occurring.

Climate change risks are unique in terms of their control strategies, as when looking into the future, the level of risk will increase for climate change when controls are not modified. This is because in most cases the controls are aimed at managing the current level of risk and in the future climate, they may not be suitable for controlling the level of risk posed by the altered climate.

Figure 3-1 Summary of trends across scenarios

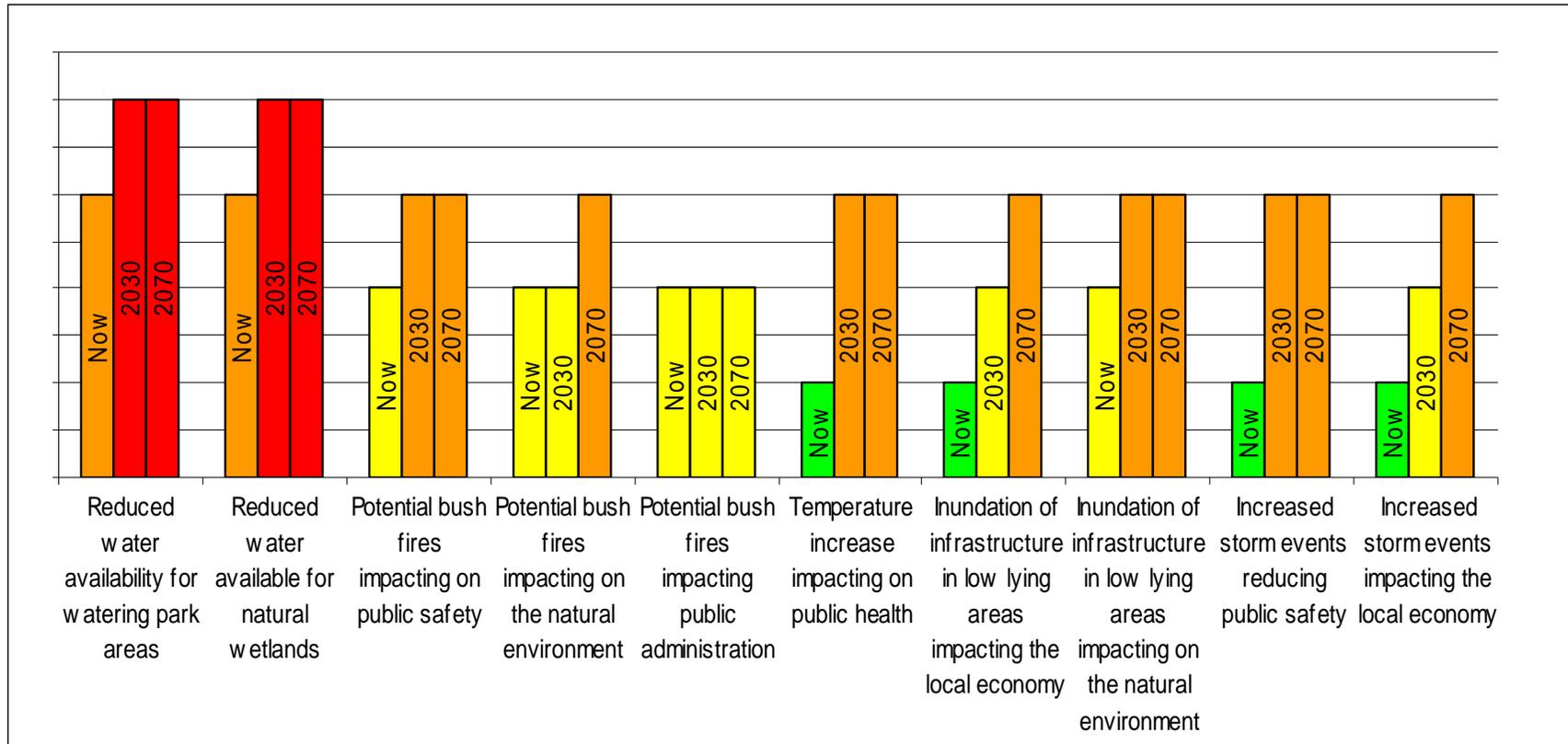




Table 3-2 Current controls

Management Plans & Policies	Community Services And Awareness Programs	State or National Governed Controls	Engineering / Physical Controls
Council water management plans	Vegetation condition mapping	Groundwater licenses for extraction	Monitoring of pest species
Turf management programs	Fire hazard reduction strategies	Dept of sport and recreation communication and engagement	Ad Hoc monitoring of water aquifer levels
Catchment and stormwater management	Education on effects of climate change	Re enforce fire breaks	Occasional spray for pests
Bush fire and emergency management plans.	Shading of public areas	Bush Fire Brigades	Fuel reduction burns
Grass and weed control	Tree pruning	Access to water for fire fighting purposes	Vector control for pest species.
Heat stress management in schools		Health inspectors	Building and engineering codes
Industry and resource planning		State Government zoning and planning	Storm water systems
Energy authority management practices and back up capability		CSIRO and Australian Government monitoring or sea level rise	Underground power systems
Emergency management plans		BoM monitoring and warning systems	Weather monitoring and warning systems
		Legislation to facilitate emergency response planning	
		Emergency Management Act 2005	
		Disaster recovery funding	

4. Adaptation Planning

4.1 Methodology Summary

As detailed in section 1 the adaptation workshop was conducted on the risks and controls identified in the risk assessment phase and the climate change predictions (known to date) as outlined in Section 4 of this report. A detailed methodology for this process can be found in Appendix F and the resultant climate change adaptation assessment register is provided in Appendix G. The methodology is consistent with 'Climate Change Impacts and Risk Management: A Guide for Business and Government (AGO, 2006)', as per the LAPP requirements.

During this process the risks and associated adaptation actions identified during the previous workshop were refined, with one risk split into two similar risks one regarding public safety, the other relating to public infrastructure damage during extreme weather events.

4.1.1 Prioritisation and Categorisation of Controls

In order to further qualify and analyse the adaptation actions in the workshop, a Multi Criteria Analysis (MCA) approach was employed to score the potential controls in relation to the screening criteria. The screening criteria used were:

- » Cost of implementing the control;
- » Council staff establishment time;
- » Operating cost of the control;
- » Dependability;
- » Practicality;
- » Political feasibility;
- » Community acceptance; and
- » Flexibility of implementing the control.

For each risk scenario examined in the adaptation workshop, the potential controls were categorised based on the following:

- » Control type – Policy, Research, Engineering, Engagement, etc;
- » Control hierarchy – Elimination, Prevention, Reduction, Mitigation;
- » Could control be implemented via existing frameworks; and
- » Benefits of implementing control (additional benefits or concerns that may arise from the control).

Controls were also qualified based on:

- » Applicability to all risks;
- » Concurrent effects;
- » State / Australian Government/ other external support required;
- » Timeframe to implement;



- » When to consider / action (date);
- » Initiation point (what will have happen necessitating actioning of this control); and
- » Functional area of Council responsible.

Further information regarding this process can be found in Appendix F.

These criteria and categories have been used to qualify the adaptation actions because they may enable Council to transition from a high-level climate change strategy to actually identify how and when to implement the adaptation actions, thereby developing an (adaptation) action plan.

4.2 Adaptation Results

The focus for the adaptation workshop was on the priority risks identified from the risk assessment phase. These priority risks included those that were rated 'high' or above, as well as a number of those rated 'medium' during the risk workshop. The potential controls associated with the risk scenarios analysed during the adaptation workshop are shown in Table 4-1.

As the workshop only covered the potential controls for the priority risks, it is recommended that the Council continue the adaptation phase by completing the assessment for the remaining potential controls associated with the lower priority risks.

It must be noted that all control analysis is based on the potential controls analysed during the adaptation workshop associated with the priority risks.

All potential controls are in effect action items for the SMRC to facilitate integration into the Business and other relevant plans (such as Emergency Response Plans) of their member councils.

During the MCA process, the screening criteria were weighted to reflect the perceived importance of each criterion with regards to the influence of the viability of the potential adaptation actions and controls. The weightings assigned by the PRG reflect that cost, where council time and practicality were the most heavily weighted selection criteria. There is a risk that the potential controls that rank highly reflect the current status of available funding. Absence of this funding may be limiting adaptation action to seeking policy and regulatory changes from State and Australian Government (see Appendix H for Government's response to climate change), and liaising with other government agencies whose core business relates to particular risks. For the same reason the top three ranked controls may also be largely based on controls currently in place.



Table 4-1 Potential Adaptation Actions and Controls Analysed

Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Reduction in rainfall leading to a reduction in the availability of water for park areas and ovals.						
Alternative surfaces may be used.	Yes	Already passed (water price increases already flagged).	Parks and gardens	4	Extreme	Medium
Increased water storage capacity (e.g. stormwater and rainwater catchment and storage in rainwater tanks)	Yes	Water availability, licence number/ allocation and/or costs reach threshold where they become prohibitive.	Planning and engineering and works	5		
Reduce the surface to be irrigated	No	Already passed	Parks and gardens and community services	3		
Current best practise water strategies for new urban designs	Yes	Already passed	Planning and engineering and works	2		
Alternative species of grass/ plants/ trees for new parks/ovals and old parks/ovals requiring upgrading/ replacing.	No	Already passed	Parks and gardens	1		



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Reduction in rainfall leading to the reduction in availability of water for natural wetlands, other natural features and water courses.						
Council liaison with DoW and Water Corp to encourage alternative water supply technologies such as waste water treatment plants and more aquifer recharge by allowing sewerage/process water pumped in close proximity to wetlands (Increase diversion of waste water from Waste water treatment plants to specifically considering allocation for wetlands).	Yes	Already passed	Environment	4	Extreme	High
Groundwater management programs (limit groundwater abstraction around sensitive areas).	Yes	Already passed	Planning	6		
Engagement with universities to improve research (targeted monitoring program, Vulnerability study to identify trigger points) and knowledge (formalise and grow)	No	Already passed	Environment	1		
Preservation strategy (e.g. collecting seeds).	Yes	When sufficient number of significant species reach endangered levels	Environment and parks and gardens	5		
Implement water sensitive urban design policies within Council operations (ongoing retrofit to existing operations (during maintenance and natural refurbishment cycle) and include in all new operations).	Yes	Already passed	Engineering and works	2		



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Require/encourage water sensitive urban design policies as part of planning approval	No	Already passed	Planning and community services	3		
Engineer the ecosystems to be more climate change adaptive	Yes	When other practical measures have failed and facing significant loss of ecosystem.	Environment	8		
Increase maintenance of ecosystems to increase resilience	Yes	Already passed	Environment	7		
Temperature increase (including number of hot days and drought conditions) increasing the potential of bush fires, thereby impacting public safety.						
Review / improve emergency response plans to consider increased frequency/severity of bushfires.	No	Already passed (Victorian experience)	Emergency Response	2	High	Medium
Encourage state to review / expand current legislation (Emergency management act) to include effects due to climate change variables	Yes	Already passed (Victorian experience)	Emergency Response	5		
Improved fuel load management (controlled burning, mowing)	Yes	Already passed (Victorian experience)	Emergency Response	11		
Build on research of fuel load of vegetation (in particular Swan Coastal Plain with the urban context) through alliances with universities or consultation with DEC.	Yes	Already passed (Victorian experience)	Environment	1		



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Improvements in future town planning to improve safety (with mandated setback requirements for life and property or alternative safety systems in place)	Yes	Already passed (Victorian experience)	Planning	10		
Require appropriate bush fire prevention and response in relation to new developments (planning policy).	Yes	Already passed (Victorian experience)	Planning	8		
Fire mapping through GIS technology.	Yes	Already passed (Victorian experience)	Environment	4		
Enhance regular public education program.	Yes	Already passed (Victorian experience)	Community Services	3		
Liaise with State Government to incorporate new building design requirements to incorporate bush fire management.	Yes	Already passed (Victorian experience)	Engineering and works and building services	9		
The local govt in consultation with FESA develop/update guidelines for the protection of life and property.	Yes	Already passed (Victorian experience)	Emergency Response	7		
Develop and implement bush fire management plan	Yes	Already passed (Victorian experience)	Environment, Emergency Response, Community services and Parks and gardens.	6		



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Temperature increase (including number of hot days) increasing the potential of bush fires, thereby impacting the environment						
Review / improve emergency/recovery plans.	No	Already passed (Victorian experience)	Emergency response	2		
Encourage state to review / expand current legislation (Emergency management act) to include effects due to climate change variables	Yes	Already passed (Victorian experience)	Emergency Response	3		
Improved fuel load management (Controlled burning, mowing, weed control)	Yes	Already passed (Victorian experience)	Emergency response	8		
Improvements in future town planning (reserved bushland areas/condition are of sufficient to be resilient to bush fires in terms of recuperating).	Yes	Next review of town planning scheme (at least consider) and/or when support is received from the state monitoring determining a significant decrease in bushland.	Planning	7	High	Medium
Fire mapping through GIS technology.	Yes	Already passed (Victorian experience)	Environment	6		
Enhance public education program.	No	Already passed (Victorian experience)	Community services	1		
New building design approval processes to incorporate bush fire management.	Yes	Already passed (Victorian experience)	Engineering and works	5		
Develop and implement bush land management plan integrated with fire management plan.	No	Already passed (Victorian experience)	Planning	4		



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Temperature increase (including number of hot days) impacting on public health and safety.						
Shade policies (e.g. street scaping, shade over playgrounds, parks and beaches) along with increase vegetation. Focus priority on public used areas and routes.	No	Already reached as part of other considerations	Parks and gardens	7	High	Medium
Liaise with the Australian Building Codes Board regarding Australian building codes to include potential climate change impacts.	Yes	Already passed	Engineering and works	8		
Monitor advances of technology in the future of early warning systems (e.g. Motion monitors for elderly which alert Silver Chain to falls / no movements, remote censoring for house temperature).	Yes (Department of Health)	Certain number of hot days	Environmental health	2		
Improved health warnings (such as advertising in conjunction with other councils).	Yes	Certain number of hot days	Environmental health	4		
Research coping mechanisms of places living in these temperatures today.	No	Already passed	Environmental health	5		
Improved planning for emergency situations.	No	Already passed , see Victorian experience	Emergency response	3		
Investigate potential pest migration to identify vector carrying pests that may potentially be introduced into the area.	Yes (Department of Health)	Already passed (for baseline monitoring)	Environmental health	1		



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Increase access to water facilities in public areas e.g. drink fountains parks and reserves	No	Certain number of hot days	Engineering and works	9		
Utilise existing council facilities to monitor at risk members of the community e.g. Meals on Wheels	No (From existing networks)	Already passed	Community services	6		
Increased frequency and severity of storm events impacting public safety through damage to infrastructure and environmental damage as a result of increased wind speed, flooding, hail etc.						
Potential to retrofit Council buildings with updated codes.	Yes	Increased number and/or severity of storm events resulting in decrease in public safety	Engineering and works	7	High	Medium
Review stormwater retention design basis - change storage requirement to 1 in 100 year storm. Review design and implement stormwater drainage systems to be capable of handling greater flows (including retention basins) for new and existing drainage systems.	Yes	Increased flooding (severity and frequency), storm events and community complaints	Engineering and works	8		
Improved public education regarding storm events.	Yes	Trigger threshold level of number of storm related injuries	Community services	5		
Increased regularity of maintenance of stormwater systems.	Yes	Threshold of number of storm events exceeded when drainage falls	Engineering and works	6		



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Conduct research regarding likely location of more vulnerable areas to storm and direction and route of storms.	Yes	Already passed	Engineering and works and Environment	2		
Arboreal assessment and management of trees in high risk areas (e.g. high value infrastructure)	No	Increase in cost due to damage to trees	Field services	4		
Budget for potential increase of public liability insurance premiums.	No	Once a substantial increase in insurance premiums (as a result of climate change) is noticed	Finance	2		
Review building codes in relation to climate change impacts (may require further research on Council's behalf).	Yes (From Australian Building Codes)	Already passed	Building services	1		
Increased frequency and severity of storm events impacting local economy and growth through infrastructure and environmental damage as a result of increased wind speed, flooding, hail etc. (Not linked to sea level rise and not including public safety)						
Assess feasibility of developing a readily accessible emergency management funds in order to have provision for cleanup and rebuild costs due to extreme weather events (potential rate increases)	No	Threshold of number of storm events with significant damage (with corresponding financial impact) exceeded	Finance	3	Medium	Medium



Potential Adaptation Actions and Controls	External Support Required	Trigger Point	Functional Area of Council	MCA ranking (high=best)	Business as usual risk (2030)	Residual Risk (2030)
Increased regularity of maintenance of stormwater systems.	Yes	Threshold of number of storm events exceeded where drainage falls	Field services	7		
Conduct research regarding likely location of more vulnerable areas to storm and direction and route of storms.	Yes	Already passed	Environment	4		
Arboreal assessment and management of trees in high risk areas (e.g. high value infrastructure)	No	Increase in cost due to damage caused by trees	Field services	6		
Revisit existing high risk infrastructure and develop and implement priority/ strategic mitigation strategies	Yes	Already passed	Planning and Engineering and works	8		
Research and monitor storm/rainfall frequency and severity within the SMRC (using data readily available from BoM, engage with universities for research capability)	Yes (University support)	Threshold of number of storm events with significant damage (with corresponding financial impact) exceeded	Engineering and works	2		
Assess, review and alter Councils' engineering standards to allow for change in severity/ frequency of storm events.	Yes	Already passed	Engineering and works	5		
Potential to retrofit Council buildings with updated codes.	Yes	Increased number and/or severity of storm events resulting in clear decrease in public safety	Engineering and works	1		

4.2.1 Control Categorisation

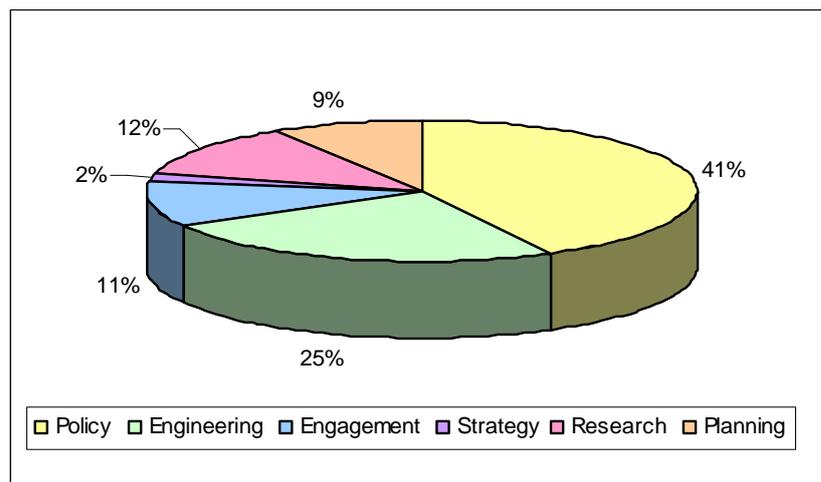
The controls identified were classified into treatment types and control hierarchy as a way of understanding the adequacy of the variety or range of controls.

Treatment types used elsewhere for adaptation planning have generally been:

- » To spread or displace the risk (though insurance, risk sharing and diversification);
- » Implement engineering solutions;
- » Policy (including planning) or regulatory changes;
- » Research to improve understanding on climate change, its local impacts or solutions;
- » Engagement, education and information provision; and
- » Internal procedures which include provisioning and contingency and disaster planning etc.

Figure 4-1 below shows the spread of treatment types (and combinations thereof).

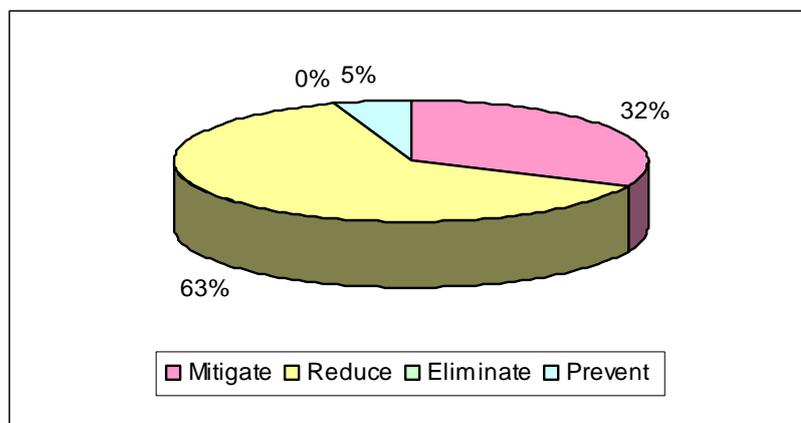
Figure 4-1 Number of controls per control type



The distribution across these categories shows that the majority of control types were based on policy (41%), engineering (25%) and research (12%). This demonstrates the reliance on council policies, investment into research and engineering practices, as well as the uncertainty of the extent of the impacts the council may experience due to climate change.

Figure 4-2 demonstrates the control hierarchy of the risks, that is, how the control will treat the risk, whether by elimination, prevention, reduction or mitigation. The majority of treatment types identified by the council are mainly aimed at reducing the effects caused by the priority risks.

Figure 4-2 Potential control hierarchy distribution



Examples of three potential controls for risk reduction were:

- » Increasing the maintenance of the ecosystems to increase their resilience to the reduction in rainfall which may lead to the reduction in availability of water for natural wetlands, other natural features and water courses;
- » Monitoring of advances within technology in the future of early warning systems (e.g. motion monitors for elderly which alert silver chain to falls/ no movements, remote sensors for house temperatures) for detecting increased temperatures or number of hot days as this may impact public health and safety;
- » Assessing, reviewing and altering Council's engineering standards to allow for change in severity/frequency of storm events in the case of increased frequency and severity of storm events impacting local economy and growth through infrastructure and environmental damage. Increased frequency or severity of storm events could cause damage through increased wind speed, flooding, hail etc.

The control hierarchy gives an indication as to the management strategy of the risks identified. Ideally the management approach should consist of a range of controls from across the hierarchy, with a greater focus on prevention/ reduction rather than mitigation. It is important to note that the quality of controls for elimination and prevention is important versus the quantity of controls overall. The above graph may show many reduction and mitigation controls but this is not a reflection of lack of quality of controls overall. This is dealt with in the control ratings section.

4.2.2 Ranking of controls

The potential controls identified were ranked in accordance with the methodology provided in Appendix F. The initial step involved the allocation of a weighting to each of the criteria. The SMRC Project Reference Group was asked how important they consider the listed criteria and then to allocate a value from the described weightings as illustrated in the table below. The weightings were defined on a continuum.

The criteria used and the weighting for each criterion are provided in the table below.

Table 4-2 Criteria Weightings

Criteria	Weighting
Cost of implementing the control	12
Council staff establishment time	10
Operating cost of control	6
Dependability	8.5
Practicality	8.5
Political feasibility	6
Community acceptance	6
Flexibility of implementing the control	3

The Project Reference Group were then required to rate how well they thought the potential controls would perform against the specified criteria. Again, a continuum scale was used for this rating, as provided in the following table.

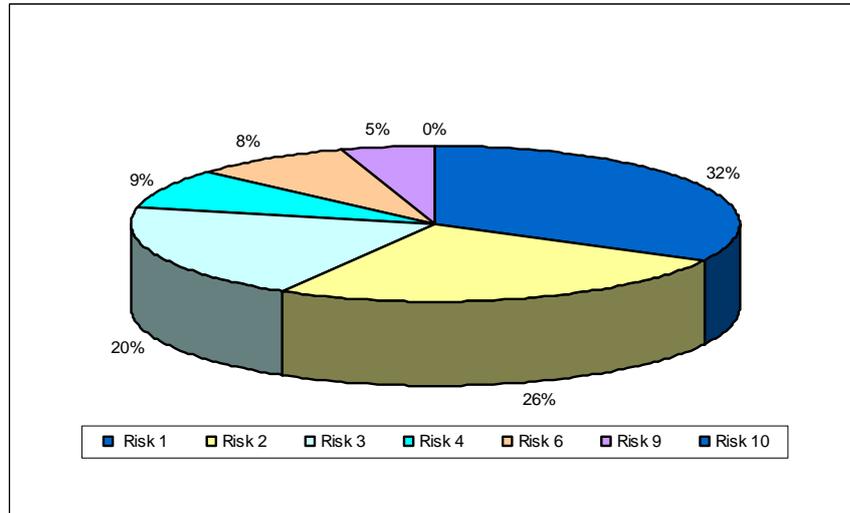
Table 4-3 Option Rating Continuum

0	1	2	3	4	5	6	7	8	9	10
Very poor		Poor		Satisfactory		Good		Very good		Excellent

Based on the combination of both the criteria weighting and opinion rating a percentage value was assigned to each potential control from each risk assessed in the adaptation exercise. A comparison of the percentage value determined the rank of each control. The control with the better percentage value was ranked higher than the others.

The highest weighting was given to criterion of capital cost required for implementing the control. This criterion therefore had the largest influence towards the ranking achieved by the controls analysed. Figure 4-3 illustrates the sensitivity of rankings within each of the identified risks if cost is not taken into account.

Figure 4-3 Changes in ranking without considering costs



Risk 10 (increased frequency and severity of storm events impacting local economy and growth through infrastructure and environmental damage as a result of increased wind speed, flooding, hail etc.) had controls most sensitive to cost. Without the cost factor, the rankings would change by about 32% of their original values. Risk 1 (reduction in rainfall leading to the reduction in availability of water for natural wetlands, other natural features and water courses) had the potential controls least affected by cost. There was no change in the rankings even after the cost factor was taken out.

Although cost may have been a major contributing factor towards the rankings, the analysis illustrated that even without taking the cost factor into consideration; the top 5 ranked control in each risk did not change much. The order of ranking may have changed in some cases but the actual controls within that category did not change.

Figure 4-4 Number of Controls dropping out of the Top % after taking cost out of consideration

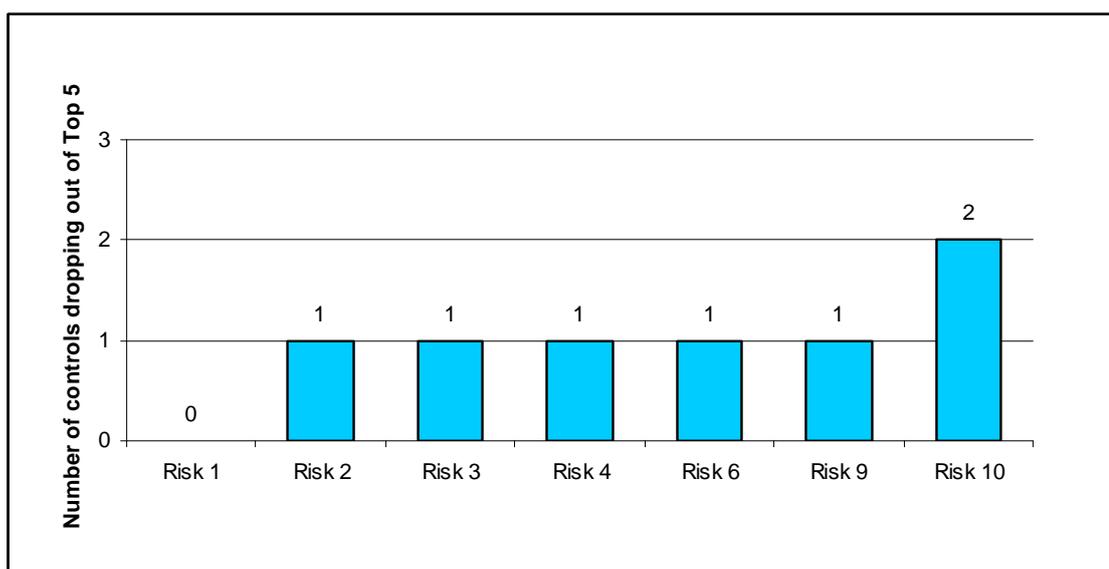


Figure 4-4 illustrates that there was no change to the Top 5 controls within Risk 1 (reduction in rainfall leading to the reduction in availability of water for natural wetlands, other natural features and water courses) but two of the Top 5 controls dropped out of the list in Risk 10 (increased frequency and

severity of storm events impacting local economy and growth through infrastructure and environmental damage as a result of increased wind speed, flooding, hail etc.) as a result of not considering the cost criterion.

This demonstrates that the ranking process in the workshop was not biased towards only cost but also considered the other criterion fairly and with an open mind.

4.2.3 Residual Risk

Taking into consideration the combined effect of the adaptation controls, the risk level was re-evaluated for each of the risk scenarios in order to estimate the impact of the controls on the 2030 risk level. Figure 4-5 shows that the risk level for a majority of the risks was decreased. The reduction in severity of the residual risk level was based on the assumption that the control types were successfully implemented.

Figure 4-5 Risk Level

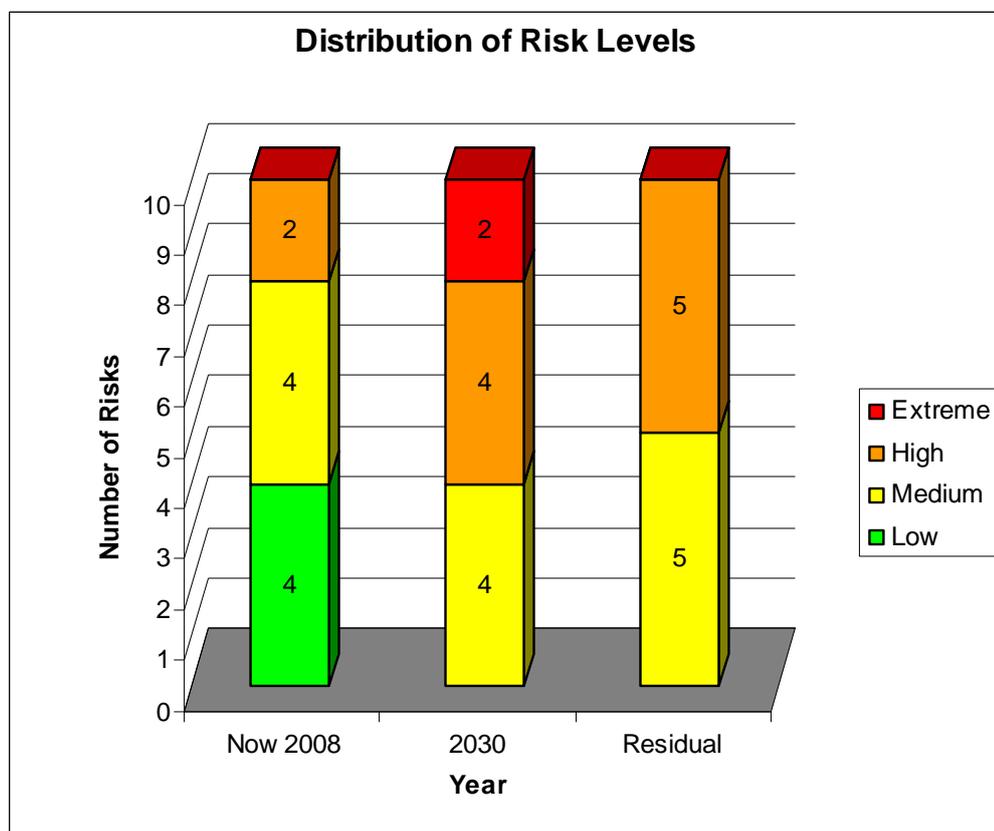


Figure 4-5 demonstrates the number of risks for each risk level for the period of “Now” to 2030 and the Residual Risk. In 2030 there is an increase in the number of “Extreme” risks compared to that of now and “High” risks compared to that of “Now.” The number of residual “High” risks however increases from 4 to 5 as a result of better controls for the “Extreme” risks. This is a direct result of the intended treatment types by council. A noteworthy point is that residually there are no risks rated as “Extreme” from 2030, these risks are reduced to “High” and “Medium”.

The “Extreme” risks identified for 2030 are:

- » Reduced rainfall leading to a reduction in water availability for parks and areas thereby affecting the

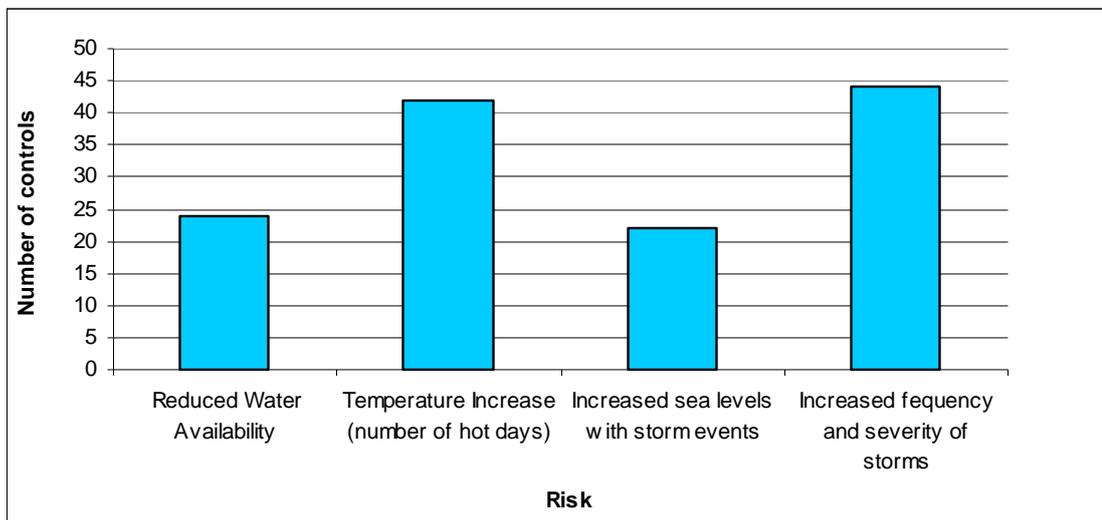
community and lifestyle; and

- » Reduced rainfall leading to a reduction in water availability for natural wetlands other natural features and water courses.

4.2.4 Controls are highly interlinked

During the workshop, participants assessed the potential controls applicability to other risks. Figure 4-6 shows the frequency at which the controls affect the risks of Reduced Water Availability, Temperature Increase (number of hot days), increased sea levels with storm events and increased frequency and severity of storms. The majority of the potential controls have an effect on Temperature Increase (number of hot days) and increased frequency and severity of storms, while fewer have an effect on Reduced Water Availability and increased sea levels with storm events.

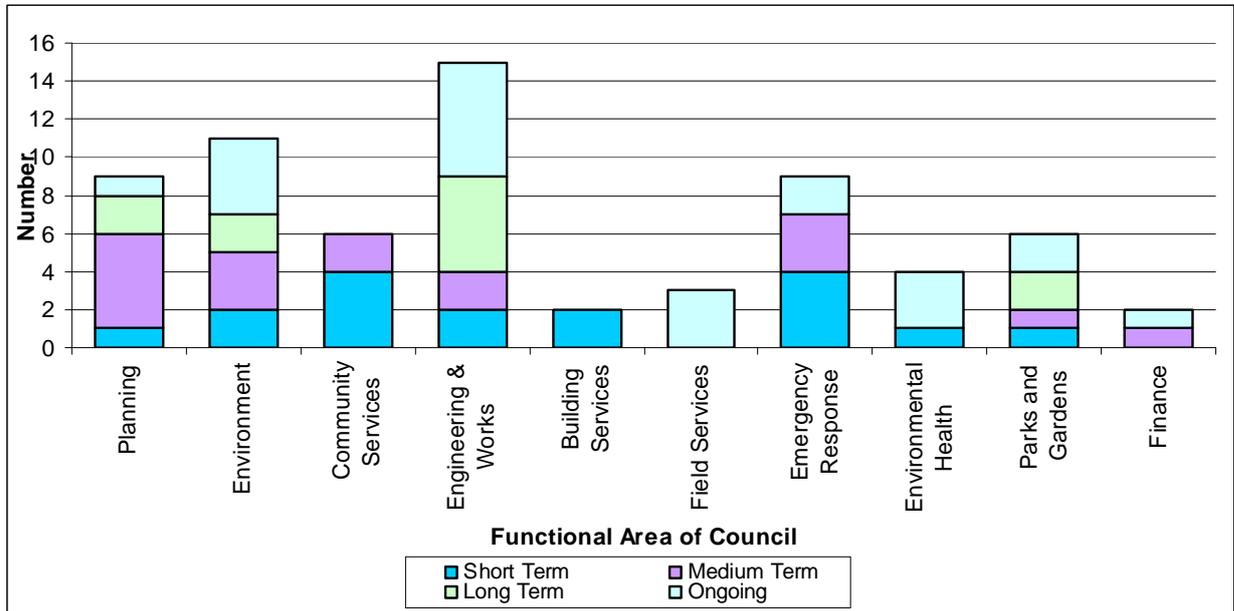
Figure 4-6 Applicability to other risks



4.2.5 Control Implementation

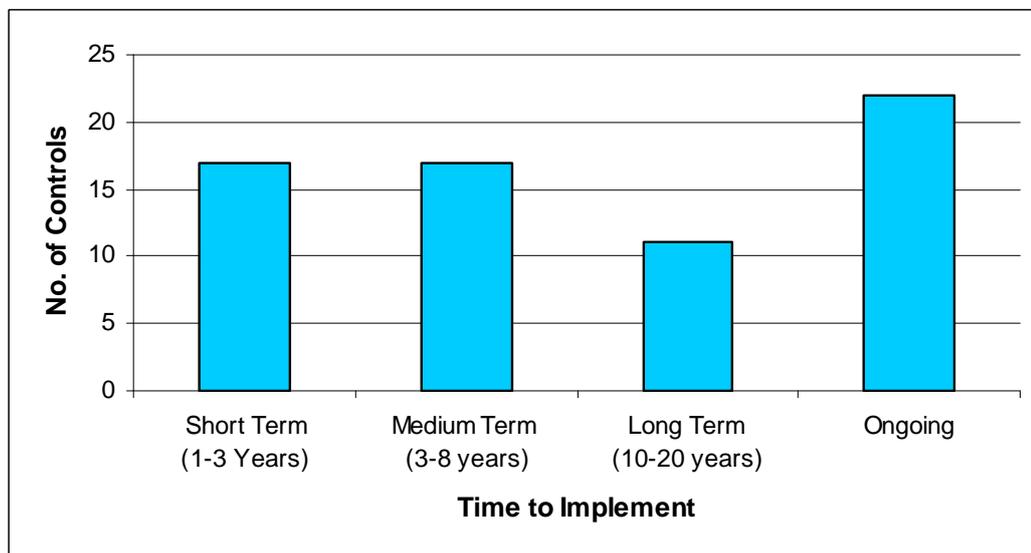
The graph above shows the relationship between the number of controls per functional area of council and the timeframe in which to implement them. The Engineering and Works section has the largest number of controls to implement, most of which require action in the short or medium term. Five controls were determined to require implementation in the long term. The assessment also identified that majority of the sections currently have ongoing systems which can be used as controls against future trends.

Figure 4-7 Distribution of Timeframe to implement Controls per Functional Area



A summary of the distribution of the timeframe to implement the controls is shown in Figure 4-8.

Figure 4-8 Summary of timeframe to implement controls



The above graph indicates that climate change risk and adaptation work is in initiation phase, i.e. there are a large number of ongoing and short-term controls. Eventually, as issue or risk specific strategies are signed off and enter into the action phase – there would be more medium and long-term actions and controls. However the focus on short-term and on-going (or existing) controls may also suggest a limited strategic or long term view held by SMRC and member Councils of their assets, operations and services.

5. Discussion

The approaches that have been considered by SMRC and member Councils to address the climate change risk scenarios included:

- » Heighten existing controls;
- » Policy and regulation;
- » Community engagement, information provision and incentives;
- » Engagement with State and Australian Government agencies;
- » Increase knowledge and understanding through research and monitoring programs;
- » Engineering/infrastructure; and
- » Internal planning.

5.1 Heighten existing controls

The climate change risk assessment and adaptation workshops identified risk scenarios and the control strategies in place to manage these risks. It is understood that climate change may increase the frequency and intensity of these risks and an initial approach is to build on the existing controls in place. As such, the risk assessment and adaptation approach act in part as an audit of the existing controls and then identification of additional control measures. In this way, it is possible for the councils to utilise the momentum they currently have in the management of risks and continuous improvement of control measures. For example, a number of potential controls identified during this project for the management of the impacts associated with water scarcity are currently underway and this project can act as further impetus to enhance these action items and improve the adaptive response.

5.2 Costing and Resources

Numerous potential adaptation controls were identified and it will take time and resources to implement these actions. In order to assist in the development of the adaptation plan and implementation of the actions, it is suggested that a resource and cost plan be developed in order to assist council in determining what they can effectively manage to implement over a given timeframe.

5.3 State and Australian Government Frameworks, Policies and Support

A number of potential adaptation actions require support from the State and Australian Governments (see Appendix H for Government's response to climate change), other surrounding Councils or universities. Where this support is required, it is recommended that Council develop a plan for communication, or enhancing existing communications and focussing a part of their communications effort on climate change risk and adaptation, between Council and these organisations in order to drive implementation of the required actions.

A coordinated approach from all tiers of Government, and strong leadership with conviction about managing climate change is required for effective change management of this issue. The approach will need to be dynamic and flexible because it will need to adapt as new climate change information comes to hand.

While work required for developing policy or regulatory changes can commence immediately (or is



already underway), implementation and actual change driven by policy may not be realised or functioning until the next 10-15 years. Taking severe storm events as an example, although new guidelines may be put into place to reduce the likely impact of severe storm events for new buildings, the existing buildings will not have the same design considerations and therefore will be at a higher risk as compared to newer buildings. This provides opportunities to complement changes in policy or planning regulations, such as retrofitting to be applied to existing buildings where possible.

5.4 Engagement Approaches

It is recognised that adaptation to climate change will involve people changing the way they live and interact with their environment.

Climate change risks may present greater challenges than other types of risk because the causes are systemic. Government at all levels will grapple with facilitating changes to societies' values required for adaptation. For example, with people living in areas where climate change risks are likely and have significant consequences.

Local Government already plays a key role in education for their communities about what climate change means for them and what communities need to do to adapt. This includes issues such as; making visible local monitoring of environmental conditions for bushfire, and local water consumption. These approaches should be enhanced because having to monitor and report on relevant indicators means the Council will need to develop a cause and effect logic about the indicators and therefore an enhanced ability to manage the outcomes.

5.5 Internal Planning

Two significant instances of feedback were provided by Council staff at the end of the adaptation workshop. These were:

- » This was the first time some of the Council staff from various areas had together, considered the issues of climate change and how they apply across Council operations together; and
- » The realisation that climate change adaptation measures should be implemented sooner rather than later.

In view of this, Council need to develop a position on Climate Change in order to provide direction for future planning.

5.5.1 Core Council Approach and Official Position

To adapt successfully to climate change risks, it is vital for the SMRC and its member Councils to develop an agreed position regarding climate change and communicate this position throughout council and the community. This will:

- » Allow Council to align adaptation actions with the long-term vision and strategy for SMRC and member Councils;
- » Provide an opportunity for the community to engage with adaptation planning;
- » Provide a basis for seeking Government support through policy and regulatory changes, grants and education/information programs; and
- » Provide an opportunity to liaise with other Government agencies including the Department of water, as well as external agencies such as universities.



The stakeholder engagement process should incorporate education seminars both internally and externally to assist in the understanding of the agreed climate change position and what it means for individuals and the community.

A suggested approach to the development of an agreed position on climate change is to develop an overarching sustainability strategy for SMRC and member councils and allowing climate change to become a subset of the sustainability strategy.

Based on the agreed position of council, it is then necessary to develop an integrated approach to climate change with the surrounding regions and associated service providers such as the Department of Water and or Water Corporation.

The integrated approach will assist as a support mechanism for the council both in terms of resources and funding. Additionally, a number of issues were raised which are outside of the control of SMRC and member councils, therefore these relationships and integrated approaches will assist SMRC and member councils in the management of climate change risks and vice versa, they may be able to assist others in their approach to the management of climate change risks.

5.5.2 Business Plan

As the SMRC member council business plans currently stand, there is no explicit allowance for climate change conditions and the risk scenarios identified during the climate change risk assessment and adaptation project. It is recommended that the Business Plans, and other relevant plans such as the Emergency Response Plans, be reviewed and upgraded to:

- » Consider all items in light of climate change;
- » Integrate identified and prioritised adaptation actions into the (Business) Plan;
- » Conduct a gap analysis, i.e. what aspects of the (Business) Plan will have climate change impacts that have not been addressed by the adaptation actions; and
- » Make recommendations for how these items are to be managed through allocation of resources and budget.

An additional factor to consider when developing the climate change adaptation plan is the population dynamics of the local area. The population must be considered when developing strategies such as evacuation plans and when considering design options for building air conditions etc.

The business plan should be reviewed regularly in order to incorporate any further advances in knowledge and technology that relates to climate change risks.

5.6 Issues

5.6.1 Costs and Resources

Numerous potential adaptation controls were identified and it will take time and resources to implement these actions. In order to assist in the development of the adaptation plan and implementation of the actions, it is suggested that a resource and cost plan be developed in order to assist council determine what they can effectively manage to implement over a given timeframe. It will also assist in determining where additional funds are required from Australian or State Government, and assist in applying for those funds.

A number of potential controls showed a reliance on State and Australian Government support for policy,



as well as funding to meet higher budget requirements. The majority of controls require short and medium-term implementation. This is likely to pose significant resourcing and budgeting challenges for Council. It is therefore important to optimise co-ordination with State, Australian Government and other agencies such as water authorities and universities.

5.6.2 Adequacy/Effectiveness Assessment

In order to get an in depth understanding of the effectiveness of the controls used for managing climate change risks, consideration should be given to conducting a detailed adequacy assessment of the current control strategies. This may also be applied to the potential adaptation controls in order to develop performance standards for the controls. During the adequacy assessment, investigations should be made in regards to the controls dependability and practicality when used in a number of circumstances.

From the work conducted during the risk assessment and adaptation workshops and subsequent reports, the next phase of this project is for council to integrate the potential adaptation controls into council business planning processes.

6. Recommendations

The intent of the adaptation assessment is to develop strategies for managing risks, adaptive actions and building resilience within communities to address climate change impacts and the risks they pose to the operations and responsibilities of the Southern Metropolitan Regional Councils

6.1 Recommendations

6.1.1 Identification of risks requiring detailed investigation or research

This report is based on a high level assessment of climate change related risks and possible adaptation actions and possible controls. However, due to the resource constraints, it was not possible to complete the investigation to the level of detail required for a number of the risks. The control measures for other risks identified the need for additional investigation or research.

The following table shows risks that were identified during the assessment as requiring further more detailed investigation or research. It is recommended that the council undertakes this investigation and research on a prioritised basis as shown in Table 6-1.

Table 6-1: Identification of risks requiring further research and/or investigation

Risk - Impact	Adaptation Actions	Action Priority High/Medium/ Low	Timeframe Immediate/Years/ Review etc
	Investigate key roads, buildings and other facilities and infrastructure that will potentially be significantly affected by climate change	High	1-3 years
Higher temperature and rainfall affecting infrastructure, building and other related services (road, recreational facilities, buildings etc)	Undertake an investigation of the key infrastructure that should be upgraded with new engineering specifications to ensure least disruption of services in case of extreme events (e.g. ensuring that in the case of road flooding, key roads remain passable to enable ingress and egress from population centres)	High	1-3 years
	Investigate incorporating higher design standards to withstand higher heating / cooling loads on buildings	High	1-3 years
	Investigate how to incorporate the handling of climate change scenarios into Council's policy and decision making processes	High	Immediate
Temperature increase (including number of hot days and drought conditions) increasing the potential of bush fires, thereby impacting public	Investigate how to improve emergency response plans considering increased frequency/severity of bushfires	High	Immediate
	Investigate improving fuel load management process (Controlled burning, mowing)	High	Immediate



Risk - Impact	Adaptation Actions	Action Priority High/Medium/ Low	Timeframe Immediate/Years/ Review etc
	Research appropriate bush fire prevention and response system in relation to new developments (planning policy)	High	1 – 3 years
	Investigate new building design approval processes to incorporate bush fire management	High	Immediate
	Investigate potential pest migration to identify vector carrying pests that may potentially be introduced into the local area	Medium	Review
Increased frequency and severity of storm events impacting public safety and local economy through infrastructure and environmental damage as a result of increased wind speed, flooding, hail etc	Investigate updating building codes in relation to climate change impacts (may require further research on Council's behalf)	Medium	2 – 5 years
	Research stormwater retention design basis – e.g. change storage requirement to 1 in 100 year storm	High	1 – 3 years
	Investigate stormwater drainage systems that are capable of handling greater flows (including retention basins) for new and existing drainage system	High	1 – 3 years
	Conduct research regarding likely location of more vulnerable areas to storm and direction and route of storms	Medium	Review
	Research feasibility of developing a readily accessible emergency management funds in order to have provision for cleanup and rebuild costs due to extreme weather events (potential rate increases)	Medium	2 – 5 years
	Research and monitor storm/rainfall frequency and severity within the SMRC (using data readily available from BoM, engage with universities for research capability)	High	Immediate
Reduction in rainfall leading to a reduction in the availability of water for park areas and ovals	Research best practice water strategies for new urban designs	Medium	Review
	Investigate implementation of more water efficient irrigation systems / techniques	Medium	1-3 years
	Investigate increasing the water storage capacity (e.g. storm water and rainwater catchment and storage in rainwater tanks)	High	1 – 3 years
	Research and invest into more efficient water retention and preservation techniques	Medium	1 – 3 years
	Investigate the use of alternative surfaces for selected park areas and ovals	Medium	1-3 years



Risk - Impact	Adaptation Actions	Action Priority High/Medium/ Low	Timeframe Immediate/Years/ Review etc
	Investigate the use of alternative species of grass, plants, and trees requiring less water for the new parks and ovals as well as old parks / ovals requiring upgrading / replacing	Medium	Review
Reduction in rainfall leading to the reduction in availability of water for natural wetlands, other natural features and water courses	Investigate with DoW and Water Corp to encourage the adoption of alternative water supply technologies such as waste water treatment plants and more aquifer recharge by allowing sewerage/process water pumped in close proximity to wetlands (e.g. Increase in diversion of waste)	High	1 – 3 years
	Investigate other groundwater management programs such as limiting groundwater abstraction around sensitive areas	High	Immediate
	Investigate Council's engagement with the universities to improve knowledge sharing (targeted monitoring program, vulnerability study to identify trigger points)	Medium	Immediate
	Investigate methods to implement water sensitive urban design policies within Council operations (ongoing retrofit to existing operations (during maintenance and natural refurbishment cycle) and include in all new operations)	High	1 – 3 years
	Investigate implementation of water sensitive urban design policies as part of planning approval	High	1 – 3 years
Risk from climate change impact on developments and structures given planning approval by Councils	Undertake investigation of best method for including appropriate consideration of climate change impact assessment and adaptation response in all planning approvals sought from Council.	High	Immediate

6.1.2 Additional actions related to lower ranked risks

It is recommended that the Council continue the climate change risk adaptation action by completing the assessment for the remaining potential controls associated with the lower priority risks;

- » Conduct an in-depth assessment, such as a cost benefit analysis and or a detailed adequacy assessment of existing controls identified during this process, for relevant adaptation actions;
- » Use a systems approach on key adaptation areas;
- » Alternative approaches and potential controls should be considered in order to develop a diverse adaptation approach (such as revisiting the relative lack of prevention compared to mitigation measures);



- » Further develop the collection and evaluation of climate change forecasts, for purposes of strategic planning;
- » Develop a monitoring program of local environmental variables sensitive to climate change; and
- » Identify environmental, social and economic thresholds and therefore associated initiation points for associated adaptation controls.

6.1.3 Monitoring and Review

- » Review of the Council's business plan and strategic plan in light of the identified climate change risks and implementation of Adaptations actions;
- » Develop a long-term position for Councils on climate change, beyond the 4 year term;
- » Integrate potential controls (actions) into business plan; and
- » Develop a plan that explicitly addresses the implementation of the controls including resources, external agencies (such as other Government agencies and universities) and funding required.

6.1.4 Community consultation and engagement

- » Engage and educate the community on climate change and what it means for the Councils within SMRC;
- » Communicate Council's position on climate change throughout local government and the community;
- » Further develop community engagement approach that maximises community knowledge, decision-making, risk identification, mitigation/solution selection and risk acceptance; and
- » Communicate with State & Australian Government to ensure funding for research on local climate change impacts.

6.1.5 Liaison with Governments and their agencies

- » Identify opportunities to complement policy and regulatory changes such as retrofitting buildings to reduce greenhouse emissions through to reducing the impact of a bushfire.
- » Utilise outputs from LAPP climate change exercise and coordinate with the State and local authorities.
- » Further develop and enhance relationships with regional service providers such as the water authority to ensure a co-ordinated response.

See Appendix H for the current Australian State and Australian Government responses to climate change for more information.

6.2 Other Potential Controls to Consider

There are a range of controls for climate change risks that have been identified in similar work across Australia, some of which could be considered for the Councils within the Southern Metropolitan Region into the future. Some of these are used by member councils now but may not have been explicitly reviewed at the workshop due to time limitations. Some of these are also in the guidelines for managing climate change.



6.2.1 General

Alliance	With universities/CSIRO etc to assist with ecological research
Monitoring	Monitoring of local climate change sensitive
Plan	Media management plan
Plan	Improved contingency and disaster planning
Plan	Enhanced communication plans
Research	Improve knowledge of the probability of frequency and magnitude of changes to extreme climate events and other climate variables under climate change
Research	Improve modelling of regionally based climate change impacts
Stakeholders	Targeted awareness campaign (specify groups and issues)
Strategy	Factor climate change into criteria for designation of species or ecosystems requiring increased protection

6.2.2 Temperature increase and rainfall patterns

Design	Amend building design standards
Management	Firebreaks and management program
Policy	Harvest ban over 35°C
Planning	Implementation of Drought Management Plan

6.2.3 Increased stress on local flora and fauna

Strategy	Factor climate change into criteria for designation of species or ecosystems requiring increased protection
Design	Measures to retain water in landscape e.g. detention basins, recharge areas, water sensitive urban design

6.2.4 Extreme Weather – economic hardship, and health of individuals

Grants	Australian Tourism Development Program (ATDP)
Grants	Caring for our Country
Grants	Eco Living grants program
Monitoring	Community audit
Plan	Encourage: review plans of adjoining Councils
Plan	Current Council core value/objectives for area, vision for region



Appendix A

Abbreviations



ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
ACC	Avon Catchment Council
AGO	Australian Greenhouse Office
AS	Australian Standard
BOM	Bureau of Meteorology
CSIRO	Australian Commonwealth Scientific and Industrial Research Organisation
DCC	Australian Department of Climate Change (Formerly AGO)
DAF	Western Australian Department of Agriculture and Food
DEC	Western Australian Department of Environment and Conservation
DHW	Western Australian Department of Housing and Works
EPA	Environmental Protection Authority (WA)
FESA	Fire and Emergency Services Authority of Western Australia
GM	Genetically Modified
IPCC	Intergovernmental Panel on Climate Change
KVA	Kilo Volt Amperes
LAPP	Local Adaptation Pathways Program
LPG	Liquefied petroleum gas
MCA	Multiple Criteria Analysis
NZS	New Zealand Standard
PRG	Project Reference Group
SWIS	South West Interconnected System



Appendix B

References



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Appendix C

Workshop Participants



SMRC Climate Change Risk Assessment Workshop

18 November 2008

Name	Organization	Position / Role
Paddy Strano	City of Rockingham	Coordinator for environment and sustainability
Paul Garbett	City of Fremantle	Manager of Planning projects and policies
David Herrington	City of Canning	Manager of patrol and safety services
Shelley Cocks	Town of East Fremantle	Principal environmental health officer
Clare Bush	City of Canning	Environmental health officer
Steve Atwell	City of Canning	Manager of Parks
Tony Carusi	City of Canning	Finance Officer
Peter McKenzie	Town of Kwinana	Manager environmental health services
Karen Loader	City of Canning	Planning officer
Alan Mihala	City of Canning	Senior environmental health officer
Ryan Munro	Town of Kwinana	Environmental coordinator
Hana Jestríkova	City of Cockburn	Sustainability officer
Nick Jones	City of Cockburn	Manager environmental health
Chris Beaton	City of Cockburn	Environmental manager
Chris Lynch	Town of Kwinana	Senior planning officer
Rebecca L Freeman	GHD	Workshop scribe
Meheroop Chopra	GHD	Workshop scribe
Amy Elkington	GHD	Workshop scribe
Mike Erskine	GHD	Workshop facilitator



Appendix D

Risk Assessment Methodology



D Risk Assessment Framework and Methodology

D.1 Risk Assessment Framework

The risk assessment framework used for SMRC Climate Change Risk Assessment is based on the AGO Climate Change Risk Management Framework. This framework is consistent with the Australian and New Zealand Standard for Risk Management, AS/NZS 4360:2004.

The framework defines the method for risk assessment by clarifying the objectives and success criteria for the Council, and establishing scales for measuring consequences, likelihoods and risk priorities.

D.2 Definitions

The definitions of the risk management terminology are provided below:

- » **Risk** – The chance of something happening that will have an impact upon objectives. It is measured in terms of consequence and likelihood;
- » **Consequence** – The outcome or impact of an event expressed qualitatively or quantitatively, ranging from positive to negative;
- » **Likelihood** – Used as a general description of probability or frequency. It can be expressed qualitatively or quantitatively;
- » **Risk Management** – The culture, process and structures that are directed towards effective management of potential opportunities and adverse effects.

The types of risks to be considered in the Climate Change Risk Assessment include:

- » **Strategic Risk** – e.g. risks arising from policy decisions or major decision affecting organizational priorities; risks arising from senior level decisions on priorities;
- » **Financial Risk** – e.g. risks arising from spending on capital projects or fraud or impropriety; risks from failed resource bids and insufficient resources;
- » **Operational Risk** – e.g. risks associated with the delivery of public services; risks associated with recruitment difficulties or diversion of staff to other duties; risks surrounding IT systems;
- » **Environmental** – e.g. risks arising from sustainability or pollution; risks associated with EPA compliance and climate change such as storms, floods, heavy rain, reduced rainfall, longer hot days;
- » **Community** – e.g. risks arising from public health and safety, public relations and Council reputation.

D.3 Objectives, success criteria and consequence scales

Success criteria are measures of an organization's ability to meet its objectives. The success criteria and consequence scales used for the SMRC assessment were those suggested for local government authorities in the *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006). These success criteria included:

- » Maintenance of public safety;
- » Protection and enhancement of the local economy;
- » Protection of existing community structures and the lifestyle enjoyed by the people of the region;
- » Sustain and enhancement of the physical and natural environment; and
- » Ensure sound public administration and governance.



Five consequence ratings (from insignificant to catastrophic) for each success criteria were used to create the consequence scale matrix as depicted in Table D-1 below:



Table D-1 Consequence scales

Success Criteria	Public Safety	Local Economy & Growth	Community & Lifestyle	Environment & Sustainability	Public Administration
Rating					
Catastrophic	Large numbers of serious injuries or loss of lives	Regional decline leading to widespread business failure, loss of employment and hardship	The region would be seen as very unattractive, moribund and unable to support its community	Major widespread loss of environmental amenity and progressive irrecoverable environmental damage	Public administration would fall into decay and cease to be effective
Major	Isolated instances of serious injuries or loss of lives	Regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth	Severe and widespread decline in services and quality of life within the community	Severe loss of environmental amenity and danger of continuing environmental damage	Public administration would struggle to remain effective and would be seen to be in danger of failing completely
Moderate	Small number of injuries	Significant general reduction in economic performance relative to current forecasts	General appreciable decline in services	Isolated but significant instances of environmental damage that might be reversed with intensive efforts	Public administration would be under severe pressure on several fronts
Minor	Serious near misses or minor injuries	Individually significant but isolated areas of reduction in economic performance relative to current forecasts	Isolated noticeable examples of decline in services	Minor instances of environmental damage that could be reversed	Isolated instances of public administration being under severe pressure
Insignificant	Appearance of threat but no actual harm	Minor shortfall relative to current forecasts	There would be minor areas in which the region was unable to maintain its current services	No environmental damage	There would be minor instances of public administration being under more than usual stress but it could be managed



D.4 Likelihood scales

Likelihood scales are used to predict the probability of a risk, based on the assumption that the climate change scenario occurs. The likelihood scales used are those suggested in the *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006). These can be used to assess both single event and recurrent risks as provided below in Table D-2.

Table D-2 Likelihood (given that the climate scenario arises)

Rating	Recurrent Risks	Single Events
Almost Certain	Could occur several times per year	More likely than not - Probability greater than 50%
Likely	May arise about once per year	As likely as not - 50/50 chance
Possible	May arise once in ten years	Less likely than not but still appreciable - Probability less than 50% but still quite high
Unlikely	May arise once in 10 years to 25 years	Unlikely but not negligible - Probability low but noticeably greater than zero
Rare	Unlikely to occur during the next 25 years	Negligible - Probability very small, close to zero

D.5 Risk Priority Levels

The likelihood and consequence scales are combined in a matrix to determine the priority of the risk. The priority may be classed as low, medium, high or extreme depending on the combination. The AGO matrix is provided below in Table D-3.

Table D-3 AGO Risk Priority Matrix

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost Certain	Medium	Medium	High	Extreme	Extreme
	Likely	Low	Medium	High	High	Extreme
	Possible	Low	Medium	Medium	High	High
	Unlikely	Low	Low	Medium	Medium	Medium
	Rare	Low	Low	Low	Low	Medium

The risk priority level then informs the urgency and suggested treatment of the risk by the organisation. A summary of suggested priority level treatments is provided below in Table D-4.

Table D-4 Risk Priority Level Descriptors⁶

Extreme	Risks demand urgent attention at the most senior level and cannot be simply accepted as part of routine operations without executive sanction.
High	Risks are the most severe that can be accepted as part of routine operations without executive sanction but they will be the responsibility of the most senior operational management and reported upon at the executive level.
Medium	Risks can be expected to form part of routine operations but they will be explicitly assigned to relevant managers for action, maintained under review and reported upon at senior management level.
Low	Risks will be maintained under review but it is expected that existing controls will be sufficient and no further action will be required to treat them unless they become more severe.

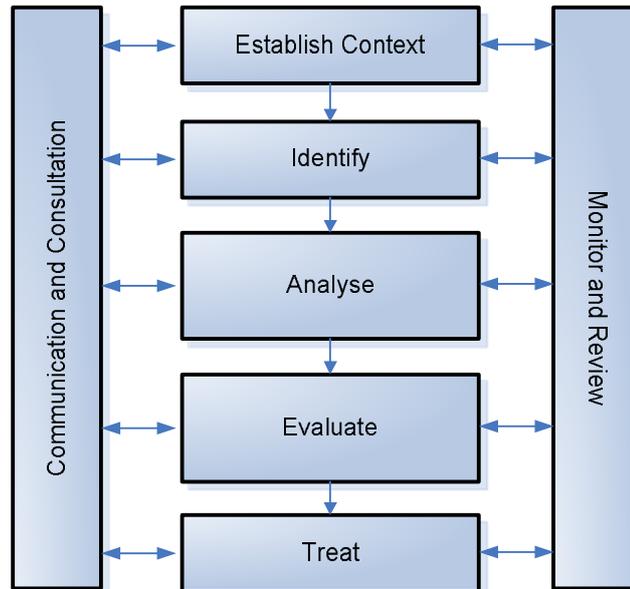
D.6 Risk Assessment Methodology

The risk assessment methodology recommended by the *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO, 2006) is adapted from AS 4360: 2004, the

⁶ Source: AGO (2006), *Climate Change Impacts & Risk Management - A guide for Business and Government*

Australian Standard for Risk Management. A simplified summary of the methodology is represented in Figure D-1.

Figure D-1 Risk Assessment Methodology



The main elements are described in the following subsections.

D.6.1 Establish Context

In order to maximise the efficiency of the risk assessment workshop, a context setting document was prepared prior to the workshop and sent to all relevant parties. The purpose of this document was to:

- » Establish the agenda for the workshop;
- » Introduce global and local climate change projections, trends and effects to the workshop participants;
- » Introduce the Risk Assessment methodology to the workshop participants;
- » Provide copies of the Risk Matrices to the workshop participants for familiarisation; and
- » Provide background information relevant to the climate change scenarios that were to be discussed in the workshop;

D.6.2 Identify

During the risk assessment workshop, the hazards and risks associated with climate change relating to the operations of the Council were identified. This was done by taking each climate change variable in turn and discussing associated risks until the main issues were felt to have been examined sufficiently.



D.6.3 Analyse

Once the risks and their causes were identified, the likelihood of the risks manifesting themselves and their consequence were measured. The assessment tables in Section D.1 were used to determine the likelihood and consequence levels.

For each risk:

- » Existing controls already in place to mitigate the risk were identified;
- » Consequences arising from the risks were identified and controls for each of the scenarios under consideration were determined using the adopted consequence scale;
- » The likelihood of the consequence given the controls for each of the scenarios under consideration was determined using the adopted likelihood scale; and
- » An initial priority was assigned to each scenario based on the likelihood and consequence of the risk. The adopted risk matrix was used to achieve this.

D.6.4 Evaluate

After all relevant climate change variables had been considered; all the risks were assembled into a single set and reviewed as a whole.

Any risks found to have been over or under-rated were manually altered to illustrate the workshop agreed priority. The outcome was a list of risks with all the information recorded in the identification and analysis stage.

D.6.5 Treat

Based upon the findings of the workshop, a planning exercise known as the Adaptation Approach will be carried out as a second workshop to identify methods or controls to mitigate risks that were deemed as high in the first workshop.

This plan will establish the method by which these new controls or methods can be implemented and integrated into the design and existing systems within the Council.

D.6.6 Monitor and Review

Ongoing review is essential to ensure that the management plan remains relevant. As the project progresses, drawings and project documentation will be verified at regular intervals to make sure that control measures and special requirements are constructed and documented as required.



Appendix E

Risk Assessment Register



No	Scenario	Climate Change Scenario	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk						Potential Controls	Residual Risk			Comments			
							Now			2030				2070				Consequence	Likelihood	Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level		Consequence	Likelihood	Risk Level				
1	High	Reduced Rainfall	Reduced water availability for watering park areas	Community & Lifestyle	Groundwater licenses for extraction. Council water management plans (monitoring of irrigation, leachate collection & measurement). Landscape guidelines provided to developers (e.g. species selection). Turf management programs. Dept of sport & recreation communication & engagement.	Lack of vegetation resulting in closure of sports fields. Impact on community lifestyle. Complaints from community regarding field quality.	Major	Possible	High	Catastrophic	Likely	Extreme	Catastrophic	Likely	Extreme	Plan for water irrigation in capital budgets. Alternative surfaces may be used. Reduce the surface to be irrigated. Increased water storage capacity. Alternative species. Change in sporting locations and times of usage.	Moderate	Possible	Medium	Number of dry land parks in Kwinana that are not watered.
2	High	Reduced Rainfall	Reduced water available for natural wetlands	Environment & Sustainability	Catchment and stormwater management. Vegetation condition mapping. Ad hoc monitoring of water aquifer levels. Monitoring of pest species (e.g. mosquitoes). Occasional spray for pests.	Loss of biodiversity (thousands of species within area) Possible loss of wildlife corridor. Some pest species will be reduced (e.g. midges). Community complaints. Detrimental effect on other plant species (e.g. Banksias)	Major	Likely	High	Major	Almost Certain	Extreme	Major	Almost Certain	Extreme	Sewerage/process water pumped in close proximity to wetlands (recharge scheme) Groundwater management programs (limit groundwater abstraction around sensitive areas). Desalination plants Targeted monitoring program Vulnerability study to identify trigger points. Engagement with universities (formalise and grow). Engagement with state government. Waste water treatment plants specific allocation for wetlands. Strengthen/enhanced stormwater program. Preservation strategy (e.g. collecting seeds)	Major	Possible	High	Possibly expensive resources tested at adaptation cycle.
3	High	Temperature increase (including number of hot days)	Potential for bush fires	Public Safety	Fire hazard reduction strategies Reinforce fire breaks Bush Fire and Emergency Management plans Bush Fire brigades Education Access to water for fire fighting purposes (stand pipes and fire water access) Grass and weed control Fuel reduction burns Inspection and enforcement	Home evacuations to a recovery centre Access blockage of major arterial roads/trains Some people unable to evacuate (e.g. elderly)	Major	Unlikely	Medium	Major	Possible	High	Major	Possible	High	Review / improve emergency plans Review / expand current legislation Mandate water reserves in bush fire prone areas More controlled burns Improve research of fuel load of vegetation Bush land management plan Improvements in future town planning to improve safety Improve access to bush properties (possible legislation) Fire mapping through GIS technology Enhance public education program Building designs need to be reviewed for bush management	Major	Possible	High	Seasons timing change limiting the opportunity to perform control burning.
4	High	Temperature increase (including number of hot days)	Potential for bush fires	Environment & Sustainability	Fire hazard reduction strategies Reinforce fire breaks Bush Fire and Emergency Management plans Bush Fire brigades Education Access to water for fire fighting purposes (stand pipes and fire water access) Grass and weed control Fuel reduction burns Inspection and enforcement	Major loss of ecosystems Regeneration cycle Increase in weed invasion Water quality impacts	Moderate	Unlikely	Medium	Moderate	Possible	Medium	Moderate	Likely	High	Review / improve emergency plans Review / expand current legislation Mandate water reserves in bush fire prone areas More controlled burns Improve research of fuel load of vegetation Bush land management plan Improvements in future town planning to improve safety Improve access to bush properties (possible legislation) Fire mapping through GIS technology Enhance public education program Building designs need to be reviewed for bush management	Moderate	Possible	Medium	Seasons timing change limiting the opportunity to perform control burning.
5	High	Temperature increase (including number of hot days)	Potential for bush fires	Public Administration	Fire hazard reduction strategies including grass and weed control, fuel reduction burns etc). Reinforce fire breaks for properties of specific size. Bush Fire and Emergency Management plans. Bush Fire brigades. Public education. Access to water for fire fighting purposes (stand pipes and dams) Inspection and enforcement by council.	Council facilities Community facilities Potential damage to bridges Property damage Stock damage Street lighting Loss of power (cut off power to operating centre)	Minor	Possible	Medium	Minor	Possible	Medium	Minor	Possible	Medium	Conduct assessment on bush properties in future with regards to fire potential. Adjust frequency of control burn. Larger fire breaks. Increase public education regarding risk issues. Fire management and technology of the future? Advanced fire fighting technology? TBA	Minor	Possible	Medium	Quite likely flora species will adapt to climate



No	Scenario	Climate Change Scenario	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk						Residual Risk			Comments				
							Now			2030			2070				Potential Controls	Consequence	Likelihood	Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
6	High	Temperature increase (including number of hot days)	Impact on public health	Public Safety	Health inspectors Vector control for pest species (can access state budget if out break) Heat stress management in schools Shading of public areas Public education	Increase in food poisoning cases Increase in mosquito borne diseases Increase in nuisance species (e.g. midges) Heat stress (increasing in deaths) Increase resource requirements on health sector	Major	Rare	Low	Major	Possible	High	Major	Possible	High	Shade policies (e.g. street scaping) Revised building codes Technology in the future? Improved health warnings Learn from places living in these temperatures today. Improved planning for emergency situations. Improved health facilities. Investigate potential pest migration to identify pests that may potentially be introduced into the area. Implement new health impact assessment legislation.	Major	Unlikely	Medium	There are hot places now where people do manage
7	High	Increase sea level and conjunction of storm events	Inundation of infrastructure in low lying areas.	Local Economy & Growth	State government zoning and planning CSIRO and federal government monitoring sea level rise BoM monitoring and warning systems Industry and resource planning	Loss of beaches Devaluation of land, property and utilities (including industrial areas) Potential litigation Increase community concern Decrease in economic development and growth Detrimental effect to sewerage systems Loss of reputation of local area. Negative impacts and damage to boats/ships Salinity damage to foundations and infrastructure	Insignificant	Unlikely	Low	Major	Unlikely	Medium	Catastrophic	Possible	High	Monitoring of sea levels Research the local impact of sea level rise (scenario mapping) Building control seawall(s) Move infrastructure to higher areas over time Revise control of development subject to scenario mapping and other knowledge Consistent state and federal guidance. Revise insurance policy Land resumption programs Relocation incentive scheme (legislative)	Major	Possible	High	Possibly effect the Kwinana Industrial Area specifically. Upstream areas should be looked at as a take away point.
8	High	Increase sea level in conjunction with storm events	Inundation of infrastructure in low lying areas.	Environment & Sustainability	CSIRO and federal government monitoring sea level rise	Loss of foreshore areas (dune habitat) Disrupt breeding patterns of some species. Loss of vegetation Salt water intrusion Erosion Pollution accumulation from industrial areas and sewerage systems inundated with water	Minor	Possible	Medium	Moderate	Likely	High	Major	Likely	High	Monitoring of sea levels Research the local impact of sea level rise (scenario mapping) Building control seawall(s) Consistent state and federal guidance. Construct groynes Strategic planting of vegetation and new locations. Seed preservation.	Major	Possible	High	Obtain a better understanding of PASS, salinity and change in groundwater
9	High	Increased frequency and severity of storm events	Damage to infrastructure and environment due to increased wind speed, flooding, hail etc	Public Safety	Building and Engineering codes. Stormwater systems. Tree pruning program. Underground power systems. Energy authority emergency management practices and backup capability. Legislation to facilitate emergency management planning. Emergency Management Act 2005. Emergency management plans. Weather monitoring and warning systems. Stormwater retained on each site - capacity based on 1 in 10 year storm	Damage to vegetation (e.g. tree branches impacting roadways etc). Damage to buildings. Increased cleanup costs. Disruption of & damage to critical services (power, water, sewerage systems, public health facilities). Potential human injury.	Major	Rare	Low	Major	Possible	High	Major	Likely	High	Implementation of revised building code (review of building code currently underway). Potential to retrofit buildings with updated codes. Negotiations with state government. Review stormwater retention design basis - change storage requirement to 1 in 100 year. Review design of stormwater drainage systems to be capable of handling greater flows. Improved public education regarding storm events. Increased regularity of maintenance of stormwater systems. Conduct research regarding likely location of more vulnerable areas to storms and direction and route of storms. Potential increased input of building design on insurance premiums. International communication regarding design codes.	Major	Possible	High	Difficult to change the impact on existing infrastructure due to adherence to current design codes, whereas change out of infrastructure to future codes will improve ability to reduce risk. Potential technological advances will reduce the risk. Number of buildings with asbestos which may be disturbed due to building damage.



No	Scenario	Climate Change Scenario	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk									Potential Controls	Residual Risk			Comments
							Now			2030			2070				Consequence	Likelihood	Risk Level	
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
10	High	Increased frequency and severity of storm events	Damage to infrastructure and environment due to increased wind speed, flooding, hail etc	Local Economy & Growth	Building and Engineering codes. Stormwater systems. Tree pruning program. Underground power systems. Energy authority emergency management practices and backup capability. Legislation to facilitate emergency management planning. Emergency Management Act 2005. Emergency management plans. Weather monitoring and warning systems. Stormwater retained on each site - capacity based on 1 in 10 year storm. Disaster recovery funding.	Damage to vegetation (e.g. tree branches impacting roadways etc). Damage to buildings. Increased cleanup costs. Disruption of & damage to critical services (power, water, sewerage systems, public health facilities). Potential human injury. Road closure. Disruption to business. Rebuild costs. Flow on financial implications.	Moderate	Rare	Low	Moderate	Possible	Medium	Moderate	Likely	High	Potential rate increase. Develop emergency management trust reserve account in order to have provision for cleanup and rebuild costs due to extreme weather events. Increase frequency of cleanup services (roadside collection services). Implementation of revised building code (review of building code currently underway). Potential to retrofit buildings with updated codes.	Moderate	Possible	Medium	Solid waste disposal services shared by all councils - if damaged, all waste will need to be redirected.



Appendix F

Adaptation Methodology



F Methodology

The methodology adopted for SMRC Climate Change Adaptation workshop was consistent with the requirements for Local Adaptation Pathways Program (LAPP).

In order to focus on the priority risks associated with climate change for SMRC and member councils, the adaptation workshop focused on the risks identified as 'high' and a number of identified as 'medium' during the risk assessment phase, as defined by the AGO's risk management framework.

F.1 Control Categorisation

For each risk scenario examined in the adaptation workshop, the potential controls were categorised based on the following:

- » Control type – Policy, Research, Engineering and Engagement.
- » Control hierarchy – Elimination, Prevention, Reduction and Mitigation.
- » Could control be implemented via existing frameworks.
- » Benefits of implementing control (additional benefits or concerns that may arise from the control).

F.2 Control Ratings (Multi Criteria Assessment)

The methodology adopted for the workshop used elements from Multiple Criteria Decision Analysis (MCDA) and the Delphi Technique of prioritisation (Cline, 2000). By combining relevant elements of these techniques, a sound, robust and repeatable methodology was constructed to ensure that all participants were able to provide input into, and have ownership of the outcome.

Criteria Identification

In order to develop an understanding of the issues that may impact the performance of the potential controls, a criteria identification exercise was completed. This process enabled the identification of key issues that were considered to be of importance to the continued functionality of the controls. The following table defines the screening criteria.

Table F-1 Criteria

Criterion	Description
Cost of implementing control	Capital costs associated with the implementation of any control. Council has limited budgets but can seek grants which may not be guaranteed.
Council staff establishment time	Takes into consideration the time commitment of council staff measured as a cost.
Operating cost of control	This reflects ongoing maintenance and operating costs. This includes time commitment and resources.
Dependability	Reliability of the control over a long period of time.
Practicality	How practical each control is in both implementation and operation, and how well it will perform under normal circumstances. Is it an industry-accepted approach?



Criterion	Description
Political Feasibility	Council assessed the feasibility of each control in terms of the alignment with Council's core focus and directions to ensure that it did not conflict with existing policies and priorities.
Community Acceptance	Community acceptance of the control. Council understands the importance of the support of the community. The potential control must not jeopardize the rights of residents and businesses.
Flexibility of Implementing control	The control should have the ability to adapt to new climate change knowledge, and allow for add ons and changes to be made in the future as well as the ability of it to be implemented in a number of ways.

Following the identification of the critical elements, a weighting and rating exercise was completed based on the MCDA technique.

Multiple Criteria Decision Analysis

The principle aim of MCDA is to help decision makers learn about the problem situation, about their own and others' values and judgements, and through organisation, synthesis and appropriate presentation of information, guide them in identifying a preferred course of action.

Adopted Value Analysis Methodology

To facilitate the decision making process for the adaptation control selection, a simplified version of MCDA was used to aid in providing a value analysis of the proposed options.

Prioritisation

The prioritisation process to identify relative importance was completed in a workshop format of open discussions. Following are the general steps towards prioritisation, implemented during this workshop:

- » An overview of each potential control was provided;
- » Ratings were provided for each of the potential controls against the criteria;
- » The potential control rankings were weighted and results assessed, and informed opinion was received for each;
- » Weighted scores were normalised and comparisons made;
- » Results were tested for robustness; and
- » Adjustments were made as necessary.

Weightings and Ratings

The initial step involved the allocation of a weighting to each of the criteria. The SMRC Project Reference Group was asked how important they consider the listed criteria and to allocate a value from the described weightings as illustrated in the table below. The weightings were defined on continuum.



Table F-2 Criterion Weighting Continuum

0	1	2	3	4	5	6	7	8	9	10
Trivial		Of minor importance		Important		Moderately important		Very important		Extremely important

The weightings of the criteria used in the adaptation workshop are provided in the table below.

Table F-3 Criteria Weightings

Criteria	Weighting
Cost of implementing the control	12
Council staff establishment time	10
Operating cost of control	6
Dependability	8.5
Practicality	8.5
Political feasibility	6
Community acceptance	6
Flexibility of implementing the control	3

The Project Reference Group were then required to rate how well they think the potential controls would perform against the specified criteria. Again, a continuum scale was used for this rating, as provided in the following table.

Table F-4 Option Rating Continuum

0	1	2	3	4	5	6	7	8	9	10
Very poor		Poor		Satisfactory		Good		Very good		Excellent

F.3 Residual Risk

Taking into consideration the combined effect of the adaptation controls, the risk level was re-evaluated for each of the risk scenarios in order to estimate the impact of the controls on the 2030 risk level. The residual risk level was estimated using the AGO risk management framework, as described in Appendix D.

F.4 Control Implications

The impacts of the potential controls were identified in regards to whether the control would be applicable to other risks identified in the risk assessment workshop including:

- » Reduced water availability;



- » Bushfire;
- » Flooding; and
- » Extreme weather (temperature, wind etc.).

Any additional effects that may occur due to the implementation of the potential controls were also identified. Support requirements from other bodies such as State or Australian Government, water authorities etc. were also identified.

F.5 Control Implementation

In order to determine the timing requirements for the potential controls, a number of factors were considered including:

- » The timeframe required to implement the control (short, medium or long term implementation regimes);
- » When to implement the control (i.e. date);
- » Initiation point (what is required to occur in order to have the potential control implemented);
- » The functional area of council that will be in control of the implementation; and
- » Business case requirements and any additional follow on actions required to implement the potential control.



Appendix G

Adaptation Register

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of Implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60	Risk	Risk			
		17%	15%	15%	12%	12%	8%	17%	5%	100%					

Reduction in rainfall leading to a reduction in the availability of water for park areas and ovals.

<p>Lack of vegetation resulting in the closure of sports fields.</p> <p>Impact on community lifestyle.</p> <p>Complaints from community regarding field quality.</p>	Alternative surfaces may be used.	1	6	9	8	6	9	6	4	60%	Extreme	Medium	Long Term	Now	Already passed (water price increases already flagged).
	Increased water storage capacity (e.g. stormwater and rainwater catchment and storage in rainwater tanks).	1	2	7	4	5	9	8	6	50%			Long Term	Near future	Water availability, licence number/allocation and/or costs reach threshold where they become prohibitive.
	Reduce the surface to be irrigated.	8	7	9	7	9	9	7	7	79%			Short Term	Now	Already passed
	Current best practice water strategies for new urban designs	10	8	10	7	9	9	7	7	85%			Ongoing	Now	Already passed
	Alternative species of grass / plants / trees for new parks/ovals and old parks/ovals requiring upgrading/replacing.	10	10	10	7	9	10	8	7	91%			Ongoing	Now	Already passed

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60	Risk	Risk			
		17%	15%	15%	12%	12%	8%	17%	5%	100%					

Reduction in rainfall leading to the reduction in availability of water for natural wetlands, other natural features and water courses.

<p>Loss of biodiversity. Possible loss of wildlife corridor. Some pest/ weed species will be reduced (e.g. midges) while others may increase Community complaints. Detrimental effect on other plant species (e.g. Banksias). Loss of amenity and tourism.</p>	Council liaison with DoW and Water Corp to encourage alternative water supply technologies such as waste water treatment plants and more aquifer recharge by allowing sewerage/process water pumped in close proximity to wetlands (Increase diversion of waste	10	8	9	2	9	5	4	9	70%	Extreme	High	Medium Term	Now	Passed Trigger point
	Groundwater management programs (limit groundwater abstraction around sensitive areas).	8	5	7	4	8	8	4	7	62%			Short Term	Now	Passed Trigger point
	Engagement with universities to improve research (targeted monitoring program, Vulnerability study to identify trigger points) and knowledge (formalise and grow).	10	9	9	8	9	10	10	10	94%			Ongoing	Now	Trigger point already passed
	Preservation strategy (e.g. collecting seeds).	8	1	5	8	6	9	9	8	65%			Long Term	Near future	When sufficient number of significant species reach endangered level
	Implement water sensitive urban design policies within Council operations (ongoing retrofit to existing operations (during maintenance and natural refurbishment cycle) and include in all new operations).	9	9	9	4	9	9	9	9	84%			Ongoing	Now	Trigger point already passed
	Require/encourage water sensitive urban design policies as part of planning approval	9	7	9	4	9	9	8	8	79%			Medium Term	Now	Trigger point already passed
	Engineer the ecosystem to be more climate change adaptive.	1	1	2	2	1	8	5	5	27%			Long Term	Future	When other practical measures have failed and facing significant loss of ecosystem
	Increase maintenance of ecosystems to increase resilience	5	1	1	6	8	10	10	9	57%			Ongoing	Now	Trigger point already passed

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60	Risk	Risk			
		17%	15%	15%	12%	12%	8%	17%	5%	100%					
Temperature increase (including number of hot days and drought conditions) increasing the potential of bush fires, thereby impacting public safety.															
<p>Home evacuations to a recovery centre (stress on accomodation facilities).</p> <p>Access blockage of major arterial and local roads/trains.</p> <p>Some people unable to evacuate (e.g. elderly)</p> <p>Death and injury (burns, house collapse, falling trees)</p> <p>Increased stress</p>	Review / improve emergency response plans to consider increased frequency/severity of bushfires.	9	9	9	8	9	9	9	9	89%	High	Medium	Short Term	Now	Already passed/see Victorian experience
	Encourage state to review / expand current legislation (Emergency management act) to include effects due to climate change variables	10	8	9	6	9	7	8	8	83%			Medium Term	Now	Already passed/see Victorian experience
	Improved fuel load management (Controlled burning, mowing)	3	3	1	4	8	7	7	8	47%			Ongoing	Now	Already passed/see Victorian experience
	Build on research of fuel load of vegetation (in particular Swan Coastal Plain with the urban context) through alliances with universities or consultation with DEC.	10	9	9	7	9	10	10	10	92%			Medium Term	Now	Already passed/see Victorian experience
	Improvements in future town planning to improve safety (with mandated setback requirements for life and property or alternative safety systems in place)	10	6	9	6	9	7	3	4	70%			Medium Term	Now	Already passed/see Victorian experience
	Require appropriate bush fire prevention and response in relation to new developments (planning policy).	9	7	9	6	9	8	7	8	79%			Medium Term	Now	Already passed/see Victorian experience
	Fire mapping through GIS technology.	10	8	7	7	8	10	9	8	84%			Short Term	Now	Already passed/see Victorian experience
	Enhance regular public education program.	10	9	9	6	9	9	8	9	87%			Short Term	Now	Already passed/see Victorian experience
	Liaise with State Government to incorporate New building design to incorporate bush fire management.	10	8	9	2	9	5	4	9	70%			Short Term	Now	Already passed/see Victorian experience
	The local govt in consultation with FESA develop/update guidelines for the protection of life and property.	10	8	9	6	9	8	6	9	81%			Short Term	Now	Already passed/see Victorian experience
Develop and implement bush fire management plan	7	8	9	7	8	9	9	9	82%	Medium Term	Now	Already passed/see Victorian experience			

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60	Risk	Risk			
		17%	15%	15%	12%	12%	8%	17%	5%	100%					

Temperature increase (including number of hot days) increasing the potential of bush fires, thereby impacting the environment

<p>Major loss of ecosystems. Regeneration cycle. Increase in weed invasion. Water quality impacts.</p>	Review / improve emergency/recovery plans.	8	9	9	8	9	9	9	9	87%	High	Medium	Short Term	Now	Already passed/see Victorian experience
	Encourage state to review / expand current legislation (Emergency management act) to include effects due to climate change variables	10	8	9	6	9	7	8	8	83%			Medium Term	Now	Already passed/see Victorian experience
	Improved fuel load management (Controlled burning, mowing, weed control)	8	3	1	4	8	7	7	8	55%			Ongoing	Now	Already passed/see Victorian experience
	Improvements in future town planning (reserved bushland areas/condition are of sufficient to be resilient to bush fires in terms of recuperating).	10	3	9	9	8	2	6	7	70%			Medium Term	Near Future	Next review of Town Planning Scheme (at least consider) and/or when support is received from State Monitoring determining a significant decrease in bushland.
	Fire mapping through GIS technology.	5	8	7	7	8	10	9	8	76%			Short Term	Now	Already passed/see Victorian experience
	Enhance public education program.	10	9	9	8	9	9	8	9	89%			Short Term	Now	Already passed/see Victorian experience
	New building design approval processes to incorporate bush fire management.	9	7	9	7	9	8	7	8	80%			Short Term	Now	Already passed/see Victorian experience

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of Implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60	Risk	Risk			
		17%	15%	15%	12%	12%	8%	17%	5%	100%					
	Develop and implement bush land management plan integrated with fire management plan.	7	8	9	7	8	9	9	9	82%			Medium Term	Near future	Already passed/see Victorian experience

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60	Risk	Risk			
		17%	15%	15%	12%	12%	8%	17%	5%	100%					
Temperature increase (including number of hot days) impacting on public health and safety.															
<p>Increase in food poisoning cases.</p> <p>Increase in vector borne (mosquito) and other diseases.</p> <p>Increase in nuisance species (e.g. midges).</p> <p>Heat stress (increasing number of deaths).</p> <p>Increase resource requirements on health sector.</p> <p>Increase in violence (as</p>	Shade policies (e.g. street scaping, shade over playgrounds, parks and beaches) along with increase vegetation. Focus priority on public used areas and routes.	9	7	5	7	10	10	10	10	83%	High	Medium	Ongoing	Now	Already reached as part of other considerations
	Liaise with the Australian Building Codes Board regarding Australian building codes to include potential climate change impacts.	10	7	9	6	9	7	8	8	81%			Medium Term	Now	Already passed
	Monitor advances of technology in the future of early warning systems (e.g. Motion monitors for elderly which alert Silver Chain to falls / no movements, remote censoring for house temperature).	10	9	9	5	8	9	10	10	88%			Ongoing	Near future	Certain number of hot days
	Improved health warnings (such as advertising in conjunction with other councils).	9	9	8	7	9	9	9	10	87%			Ongoing	Near future	Certain number of hot days
	Research coping mechanisms of places living in these temperatures today.	8	7	10	7	9	9	9	10	85%			Short Term	Now	Already passed
	Improved planning for emergency situations.	8	9	9	8	9	9	9	9	87%			Short Term	Now	Already passed see Victorian experience
	Investigate potential pest migration to identify vector carrying pests that may potentially be introduced into the area.	10	9	9	7	8	10	10	10	91%			Ongoing	Now	Already passed (for baseline monitoring)
	Increase access to water facilities in public areas e.g. drink fountains parks and reserves	9	7	5	7	9	9	10	10	81%			Ongoing	Now	Certain number of hot days
	Utilise existing council facilities to monitor at risk members of the community e.g. Meals on Wheels	9	8	9	9	9	9	7	8	85%			Short Term	Now	Already passed

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60					
		17%	15%	15%	12%	12%	8%	17%	5%	100%	Risk	Risk			
Increased frequency and severity of storm events impacting public safety through infrastructure and environmental damage as a result of increased wind speed, flooding, hail etc.															
<p>Damage to vegetation (e.g. tree branches impacting roadways etc).</p> <p>Damage to buildings.</p> <p>Increased cleanup costs.</p> <p>Disruption of & damage to critical services (power, water, sewerage systems, public health facilities).</p> <p>Potential human injury.</p>	Potential to retrofit Council buildings with updated codes.	1	1	8	6	7	8	8	7	54%	High	Medium	Long Term	Near Future	Increase number and/or severity of storm events resulting in clear decrease in public safety.
	Review stormwater retention design basis change storage requirement to 1 in 100 year storm. Review design and implement stormwater drainage systems to be capable of handling greater flows (including retention basins) for new and existing drainage system	1	1	1	9	9	9	7	1	45%			Long Term	Future	Increase flooding (severity and frequency), storm events and community complaints
	Improved public education regarding storm events.	8	5	7	6	8	10	10	10	78%			Medium Term	Near Future	Trigger threshold level of number of storm related injuries.
	Increased regularity of maintenance of stormwater systems.	9	9	3	6	9	9	8	9	76%			Ongoing	Near future	Threshold of number of storm events exceeded where drainage fails.
	Conduct research regarding likely location of more vulnerable areas to storm and direction and route of storms.	9	8	9	7	8	9	8	10	84%			Ongoing	Now	Already passed
	Arboreal assessment and management of trees in high risk areas (e.g. high value infrastructure)	9	9	6	4	8	9	9	9	79%			Ongoing	Near future	Increase in cost due to damage due to trees.
	Budget for potential increase of public liability insurance premiums.	10	9	7	7	9	8	8	9	84%			Medium Term	Near Future	Once a substantial increase in insurance premiums (as a result of climate change) is noticed.
	Review building codes in relation to climate change impacts (may require further research on Council's behalf).	10	10	10	3	7	7	10	10	86%			Short Term	Now	Already passed

Consequence	Adaptation Action / Potential Control	Criteria rating: 1=poor, 10=excellent									Business as usual risk (2030)	Residual risk	Timeframe to implement Short = 1-3 yrs Medium = 3-8 yrs Long = 10-20 yrs Ongoing	When to consider / action (date)	Trigger point
		Cost of implementing control	Council staff establishment time	Operating cost of control	Dependability	Practicality	Political Feasibility	Community Acceptance	Flexibility of Implementing Control	Ranking High = best					
		10	9	9	7	7	5	10	3	60	Risk	Risk			
		17%	15%	15%	12%	12%	8%	17%	5%	100%					
Increased frequency and severity of storm events impacting local economy and growth through infrastructure and environmental damage as a result of increased wind speed, flooding, hail etc.															
<p>Damage to vegetation (e.g. tree branches impacting roadways etc.).</p> <p>Damage to buildings (including those containing asbestos).</p> <p>Increased maintenance, clean up and disposal costs.</p> <p>Disruption of damage to critical services (power, water, sewerage systems)</p>	Assess feasibility of developing a readily accessible emergency management funds in order to have provision for cleanup and rebuild costs due to extreme weather events (potential rate increases)	10	10	10	6	9	8	8	9	89%	Medium	Medium	Ongoing	Near future	Threshold of number of storm events with significant damaged (with corresponding financial impact) exceeded
	Increased regularity of maintenance of stormwater systems.	9	9	3	6	9	9	8	9	76%			Ongoing	Near future	Threshold of number of storm events exceeded where drainage fails.
	Conduct research regarding likely location of more vulnerable areas to storm and direction and route of storms.	9	8	9	7	8	9	8	10	84%			Ongoing	Now	Already passed
	Arboreal assessment and management of trees in high risk areas (e.g. high value infrastructure)	9	9	6	4	8	9	9	9	79%			Ongoing	Near future	Increase in cost due to damage due to trees.
	Revisit existing high risk infrastructure and develop and implement priority/ strategic mitigation strategies	1	1	1	7	1	5	4	2	26%			Long Term	Now	Past
	Research and monitor storm/rainfall frequency and severity within the SMRC (using data readily available from BoM, engage with universities for research capability)	10	9	9	8	9	10	10	10	94%			Ongoing	Now	Threshold of number of storm events with significant damaged (with corresponding financial impact) exceeded
	Assess, review and alter Councils' engineering standards to allow for change in severity/ frequency of storm events.	10	8	10	6	7	9	8	8	84%			Medium Term	Now	Already passed
	Potential to retrofit Council buildings with updated codes.	1	1	8	6	7	8	8	7	5.38			Long Term	Near Future	Increase number and/or severity of storm events resulting in clear decrease in public safety.



Appendix H

Australian State and Australian Government Responses to Climate Change



Government Responses to Climate Change

Government Agency (State or Australian Government)	Responses	Source
Office of Climate Change (WA)	<p>Current Government made an election commitment to:</p> <ul style="list-style-type: none"> » Work with industry, scientists, local government and conservation groups to develop a Climate Change Adaptation Strategy covering each major sector of Western Australian industry as well as urban planning agencies and state water and energy utilities. » The strategy will assess the likely impacts and risks of climate change to various sectors of the economy and to communities and make recommendations of mitigation and adaptation actions. <p>Stage 3 of the Indian Ocean Climate Initiative (IOCI) in partnership with WA Government, CSIRO and Bureau of Meteorology</p> <ul style="list-style-type: none"> » 4 year work program (2008 – 2012) » Downscaling climate change projections for South West and North West of WA to assist with impact and risk assessments and development of adaptation strategies. » Research into the drivers of climate for South-West and North-West of WA. <p>IOCI reports and documents will be available from: www.ioci.org.au/</p> <p>Climate Change Adaptation Toolkit for Local Government</p> <ul style="list-style-type: none"> » Partnership with Office of Climate Change (OCC) and WALGA. » Producing a web based Climate Change Adaptation Toolkit which will provide tools and templates to be used by local government officers and elected members to assist them in their decision making processes; and » Produce an analysis and assessment of the options for incorporating climate change issues into local government decision making frameworks, and recommendations for the most appropriate approach. » Scheduled to be completed by July/August 2009. <p>Margaret River Tourism Region project</p> <ul style="list-style-type: none"> » Study commissioned by the Office of Climate Change and the Sustainable Tourism Cooperative Research Centre and being undertaken by Curtin University to examine the impact of climate change on the iconic Margaret River tourism region. » The project will quantify the economic and non economic costs of these impacts, and identify the potential options available to reduce current risks and 	<p>Personal communication with Adaptation & Policy Officer, OCC</p> <p>More information on IOCI available from their website⁷</p>

⁷ <http://www.ioci.org.au>



Government Agency (State or Australian Government)	Responses	Source
	<p>minimize or avoid future risks.</p> <ul style="list-style-type: none"> » Report scheduled to be delivered in second half of 2009. <p>Project on “Risks from Climate Change to Indigenous Communities in the Tropical North of Australia”</p> <ul style="list-style-type: none"> » Project with OCC (WA) and Commonwealth Department of Climate Change. » Project will identify the impact of climate change on indigenous communities in northern Australia, and propose on ground priorities and future work required. » Report scheduled to be delivered by the end of 2009. <p>Climate Change Program Partnership with Conservation Council of Western Australia</p> <ul style="list-style-type: none"> » The Office of Climate Change provided a grant to the Conservation Council of Western Australia to develop and communicate information to the community on the impacts of climate change, adaptive strategies, and measures to reduce greenhouse gas emissions at the household and community scale. <p>Longitudinal Behaviour Change Study</p> <ul style="list-style-type: none"> » Office of Climate Change provided a grant to Edith Cowan University to undertake a project that would develop a longitudinal study into Western Australians’ attitudes and behaviours with respect to climate change science and existing and potential climate change mitigation and adaptation policies and programs. » Aim of the project is to gather information to identify opportunities for, and barriers to, successful implementation of climate change policy tools. » The data will be used to measure the success of current or foreshadowed policy measures and to explore attitudes and behaviours of Western Australians in relation to climate change science, existing and potential climate change mitigation and adaptation policies and programs. <p>OCC assistance to local government</p> <ul style="list-style-type: none"> » OCC currently provides assistance for local government agencies in preparing proposals for the Local Adaptations Pathways Program (Commonwealth Department of Climate Change). Funding is available for local government through this program to undertake climate change risk assessments and develop action plans. 	
Department of Planning and Infrastructure (WA)	<p>Policy dealing with climate change on the coast</p> <p><i>2003 State Planning policy No. 2.6 State Coastal Planning Policy</i></p> <p>State Planning Policy No. 2.6: State Coastal Planning Policy (2003) (SPP 2.6) is the primary policy mechanism for the consideration of potential climate change</p>	Personal communication with Coastal Planning Officer, DPI



Government Agency (State or Australian Government)	Responses	Source
	<p>impacts for new land developments in coastal regions. The key objective of the policy is to ensure that the location of coastal facilities and development takes into account coastal processes including erosion, accretion, storm surge, tides, wave conditions, sea level change and biophysical criteria. To achieve this objective, SPP 2.6 relies on the use of:</p> <ul style="list-style-type: none"> » measures to guide regional and local coastal planning; » encouragement of development of strategic coastal plans prior to development of an area; and » Development setback guidelines. <p>Schedule One of the policy includes guidance on coastal setback requirements in relation to the potential impacts of climate change, sea level rise and the dynamic nature of coastal processes, including the calculation of:</p> <ul style="list-style-type: none"> » S1: distance for absorbing extreme storm sequences; » S2: distance to allow for historic trends; and » S3: distance to allow for sea level change. <p>Coasts and climate change initiatives</p> <p>DPI's current initiatives in this regard include:</p> <ul style="list-style-type: none"> » Review of SPP2.6 Schedule One: <p>The WAPC policy on coastal development (see section above on SPP2.6) provides guidance on coastal setback requirements in relation to the potential impacts of climate change, sea level rise and the dynamic nature of coastal processes, including the calculation of S1: distance for absorbing extreme storm sequences; S2: distance to allow for historic trends (100 x annual rate); and S3: distance to allow for sea level change (currently calculated at 38m).</p> <p>The policy is currently being reviewed to provide a defensible sea level rise figure, conversion from vertical to horizontal distance and planning horizon timeframe, and guidance on developed (infill) areas vs. new (greenfield) development areas.</p> <ul style="list-style-type: none"> » National Coastal Vulnerability Assessment 1st pass Pilbara Case Study – DPI is involved in this Commonwealth Government initiative through membership on the Steering Committee and provision of data. » Provision of LiDAR / Airborne Laser Bathymetric Survey of the WA Coast from Two Rocks to Cape Naturaliste – DPI is currently seeking a consultant to undertake this project in 2009. The information derived from this study will be used to support decision making on the coast, taking in account the effects of 	



Government Agency (State or Australian Government)	Responses	Source
	<p>climate change, including storm surge and sea level rise. The baseline modelling will ensure areas of risk from coastal inundation and/or flooding, and the combined effects of storm surge and high winds will be better managed.</p> <ul style="list-style-type: none"> » LGA Coastal Vulnerability Assessments - Coastal areas are at risk of sea level rise and inundation, storm surge events and erosion. Other areas are at risk of being isolated through flooding and storm events. Understanding the implications of locating development in particular areas is critical to managing and mitigating the impacts of climate change. DPI is currently undertaking or assisting in priority areas such as Cottesloe, Mandurah, Lancelin, Exmouth, Geraldton, Dongara to Cape Burney, Albany, and Busselton. <p>Other ongoing activities:</p> <ul style="list-style-type: none"> » DPI operations division Coastal Protection Policy » Coastal Planning Program – CMPAP & Regional Coastal Strategies » SPP2.6 Statutory Planning Advice, Guidelines and Case Studies » 5 year program of Coastal Vulnerability Assessment State-wide 	
Department of Environment and Conservation (WA)	<p>DEC has provided several publications and has a focus on climate change and impacts on biodiversity in WA.</p> <p>Along with factsheets on climate change, the following publication is also available:</p> <p>Assessment of Greenhouse Gas Abatement Potential and Cost in Key Sectors of the Western Australian Economy (December 2008)</p>	Dept of Environment and Conservation website ⁸
Department of Agriculture & Food (WA)	<p>Climate Risks and Opportunities Project (CROP)</p> <p>Conducts research and development in key areas of climate variability, climate change, crop yield forecasting, climate forecasting, weather monitoring and decision support systems to improve the adoption of profitable and sustainable farming systems to manage climate risks.</p> <p>Climate Change and Adaptation in South West Western Australia: Community, industry and Government views on past and future climate change for South West Western Australia (November 2006)</p>	<p>Dept of Agriculture & Food website CROP⁹</p> <p>Report¹⁰</p>
WA Health	<p>Health impacts of climate change: Adaptation strategies for Western Australia (2007)</p> <p>WA Health in partnership with the World Health Organisation Collaborating Centre</p>	WA Health website ¹¹

⁸ <http://www.dec.wa.gov.au/our-environment/climate-change/reports-and-publications.html>

⁹ http://www.agric.wa.gov.au/content/LWE/CLI/climate_index.htm

¹⁰ http://www.agric.wa.gov.au/content/lwe/cli/bulletin2006_climatechange_lmorgan.pdf

Government Agency (State or Australian Government)	Responses	Source
	of Environmental Health Impact Assessment at Curtin University applied the Health Impact Assessment process to consider the potential health impacts that may arise in Western Australia from Climate Change.	
Department of Sport & Recreation (WA)	<p>Report: “How climate change could affect sport and recreation now and in the future” (December 2007)</p> <p>Climate change was recognised as a significant challenge in ‘Strategic Directions 4 — for the Western Australian Sport and Recreation Industry (2006–2010)’. This framework outlines the implications of climate change and provides a process to adapt to the provision of sport and recreation in WA.</p>	Dept of Sport & Recreation website ¹²
Department of Climate Change (Commonwealth)	<p>Climate Change Potential Impacts & Costs Report (for all states)</p> <p>Climate Change Adaptation Actions for Local Government</p> <p>Identify climate change adaptation actions that are applicable to Australia’s climatic conditions and climate impact risks as currently predicted (using CSIRO 2001 scenarios) and that can be implemented by Australian local governments.</p> <p>Local Adaptations Pathways Program (LAPP)</p> <p>Through the Local Adaptation Pathways Program, the Australian Government is providing funding to help councils undertake climate change risk assessments and develop action plans to prepare for the likely local impacts of climate change.</p> <p>Climate Change Impacts & Risk Management – A guide for business and Government</p> <p>A guide to integrating climate change impacts into risk management and other strategic planning activities in Australian public and private sector organisations.</p>	<p>WA factsheet¹³</p> <p>DCC website - Report¹⁴</p> <p>DCC website - LAPP¹⁵</p> <p>DCC website¹⁶</p>
Other		
ICLEI Oceania	<p>Cities for Climate Protection Initiative</p> <p>Cities for Climate Protection Australia Program helps local governments address climate change. This is done through a strategic milestone framework that empowers councils to make an inventory of their greenhouse gas emissions, set reduction goals, plan and implement actions, and monitor their progress.</p> <p>Local Government Climate Change Adaptation Toolkit</p>	ICLEI website CCP ¹⁷ Toolkit ¹⁸

¹¹ http://www.public.health.wa.gov.au/2/705/2/climate_change.pm

¹² <http://www.dsr.wa.gov.au/index.php?id=659>

¹³ <http://www.climatechange.gov.au/impacts/publications/fs-wa.html>

¹⁴ <http://www.climatechange.gov.au/impacts/publications/local-government.html>

¹⁵ <http://www.climatechange.gov.au/impacts/localgovernment/index.html>

¹⁶ <http://www.climatechange.gov.au/impacts/publications/risk-management.html>



Government Agency (State or Australian Government)	Responses	Source
	This toolkit is intended to build councils' capacity to make decisions using, rather than to generate, scientific data/projections or climate change impact models. Councils using the Toolkit are advised to access scientific data/projections and climate change impact models that are relevant to their municipality through other initiatives.	
Emergency Management Australia (Commonwealth)	Provided funding to Town of Cottesloe to assess their climate change vulnerability for the Cottesloe foreshore.	Town of Cottesloe website ¹⁹

¹⁷ <http://www.iclei.org/index.php?id=about>

¹⁸ <http://www.iclei.org/index.php?id=adaptation-toolkit#c34433>

¹⁹ <http://www.cottesloe.wa.gov.au/?p=942>



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