

Climate Change Adaptation Plan



Statement from the Mayor

This plan starts with acknowledgment that climate change is happening and is highly likely to accelerate over the rest of the 21st century.

This has huge implications for an historic city like Fremantle whose fabulous built heritage remains vulnerable to rising sea levels, just as our enviable lifestyle and diverse infrastructure is vulnerable to the predicted higher temperatures, lower rainfall and more extreme storm events.

But as they say: in crisis is opportunity. The climate crisis gives the City of Fremantle the opportunity to focus on investing in more resilient and sustainable infrastructure over coming years. As one example; the plan demonstrates that we can still have a green city whilst using less water and using it more efficiently.

The City of Fremantle Climate Change Adaptation Plan sits alongside our ambitious Low Carbon City Plan 2011-2015, in which we seek to reduce both our local government and our community emissions radically over the next few decades.

This plan will ensure that Fremantle is prepared and ready to adapt to the climate change challenges that lie ahead. I hope you find the plan both useful and informative.

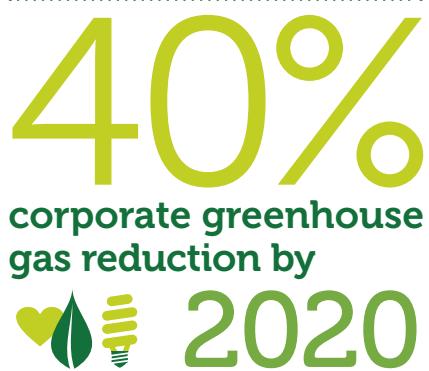
Dr Brad Pettitt
Mayor

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Background

The City of Fremantle has been a climate change mitigation leader for some time. We became the first carbon neutral local government in WA in 2009, the first locality outside the Perth CBD to establish a CAT bus and we recently introduced a small secondary dwelling scheme amendment which will encourage more resource efficient infill development in our suburbs – something that is notoriously difficult to achieve.



In 2011 the City adopted the Low Carbon City Plan. This plan sets out the steps that the City will take to progress towards its 40% corporate greenhouse gas reduction targets by 2020, as well as how the City will support the community to take action to reduce emissions.

The next stage of the climate change journey is to begin adapting to both the existing and inevitable climate changes. This document sets out the scientific basis behind the key climate change impacts, the scenarios that have been considered when choosing our actions and a prioritised list of actions that the City will take to adapt to each impact.

Like the Low Carbon City Plan, the Climate Change Adaptation Plan is broken up into key themes and the actions are further prioritised into:

Corporate actions

What the City will do with its own resources and assets

Community actions

What the City will do to influence and support its residents' behaviour

Advocacy and communication

An important action that is outside the City's jurisdiction to directly implement.



When deciding what the City should do, it also needs to understand what it can do. Parts of the storm water system, for example, are owned and operated by the Water Corporation, so the City only has minimal influence over it.

While the City of Fremantle acknowledges the need for further investigation and research, it also acknowledges the need to address promptly those risks which are known and which present immediate or pressing concern.

Thus this plan is not designed as a comprehensive risk assessment and action strategy, but as a live document which will evolve as new information becomes available and as new issues for the City and the community are identified.

The actions through this document have been prioritised as short, medium or long term. Short term is intended to be completed in the 2013/14 budget cycle. Medium term is intended to be completed by the end of the 2014/15 budget cycle and long term is beyond that but within a relevant timeframe. It should be noted that many of the short term actions proposed in this plan depend on the results of detailed sea level rise modelling that the City has commissioned as part of the Cockburn Sound Coastal Alliance. As such this document stands as a live document to be updated as more relevant data and modelling is applied through the completion of this process.



Sea level rise

18-59cm
increase in sea level
indicated by
 **2100**

Science and design scenarios

The latest Intergovernmental Panel on Climate Change (IPCC) modelling indicates the sea level will rise by 18-59 cm by 2100. Additionally sea level rise due to some types of ice flow / melt that have not yet been properly modelled can be expected to add to these projections.

The Australian government has released a 'bucket-fill' or 'bathtub' model, which shows how the shoreline would move if the sea level rose with no change to topography. This ignores accretion and erosion, which is likely to have a large impact on eventual shorelines. At this stage, in the absence of more rigorous data / research, the City has used this as an indicator of possible impacts. Further modelling is currently being conducted. The following images show selected changes to the City of Fremantle shoreline from this 'bucket-fill' model with a 1m projected sea level rise.



Publicly available source (with 1.2, 1.4 & 1.8m sea level rise scenarios):
www.ozcoasts.gov.au/climate/Map_images/Perth/mapLevel2_North.jsp

Until more detailed modelling is completed, these maps represent the best science currently available to the City, and therefore provide a notional basis for precautionary planning decisions.

More information:
www.realclimate.org/index.php/archives/2007/03/the-ipcc-sea-level-numbers/

Consequences of sea level rise

01	02	03	04
Primary impacts	Secondary impacts	Tertiary impacts	Quaternary impacts
Sea level rise Globally sea levels could rise 0.59m by 2100 on average. The degree of sea level rise is subjective to the geographic location. (This does not include the volume of water from the melting of the ice sheet) (IPCC 2007, p. 45)	Modification of coastal ecosystems (IPCC 2007, p. 48). Salt-water inundation in low-lying regions (IPCC 2007, p. 48, 53). Coastal erosion and inundation in low-lying regions (IPCC 2007, p. 48).	Impact on the livelihood of coastal fisheries and productivity of marine ecosystems (IPCC 2007, p. 54). Decline in natural biodiversity (Prato 2009, p. 923; IPCC 2007, p. 48) Threat to the water supply of low-lying areas (IPCC 2007, p. 53). Impacts on tourism and recreation activities along the coast (SMEC 2009, p. 10).	Economic loss (IPCC 2007, pp. 48, 53). Impacts on tourism and recreation activities along the coast (SMEC 2009, p. 10). Encourage competition with exotic species (Wilby and Perry 2006, p. 76). Water shortages for irrigation and drinking purposes (IPCC 2007, p. 48). Modifications in ecosystems and threat to biodiversity (Prato 2009, p. 923; IPCC 2007, p. 48). Economic loss (IPCC 2007, pp. 48, 53). Impacts on tourism and recreation activities along the coast (SMEC 2009, p. 10). Pressures on health and emergency services (IPCC 2007, p. 48). Beach closures, eg. Due to E.coli levels after storms (SMEC 2009 p. 10).

Table 1: Synthesis of climate change impacts resulting from sea level rise.

Sea level rise

Action to date

The City has commenced a detailed modelling exercise of sea level rise. This is being done through the Cockburn Sound Coastal Alliance which comprises of the local governments of Fremantle, Cockburn, Rockingham, Kwinana as well as the Department of Defence and the Cockburn Sound Management Council. The study aims to conduct detailed weather and sea level modelling to quantify the impact on the shorelines. It will also conduct a risk assessment and begin detailed adaptation planning. This is expected to be completed by mid-2013, which neatly aligns with the City's budget cycle and will allow further work to be completed by the City in 2013/14.

Prioritised actions to adapt to sea level rise

As with any risk-based problem, the response to sea level rise will depend on the severity of the potential consequence.

The 'bucket-fill' mapping identifies that a sea level rise of 1m will result in localised flooding in North Fremantle along Johannah St and some inundation through Fishing Boat Harbour. The more rigorous modelling that is currently being undertaken by the Cockburn Sound Coastal Alliance may highlight more or less severe consequences, which would likewise affect the City's response. Until this is confirmed, actions will remain at a strategic level.

CORPORATE ACTIONS

Action	Directorate	Priority
Develop a planning policy dealing with sea level rise for existing development (ie where roads and infrastructure are already in place). This will need to consider conflicting priorities, such as streetscape impacts and heritage requirements. Prepare a town planning scheme amendment and/or a local law depending on the most appropriate means to implement this policy.	Planning	Short term
Develop a planning policy which ensures that proposed new development considers and mitigates the risks from projected sea level rise.	Planning	Short term
Review level of risk to existing coastal infrastructure and prioritise protection/upgrades/relocation.	Technical Services	Short term
Review and implement options to address both sea water incursion and rising ground water salinity levels in the West End heritage precinct and the damage that is being done to these buildings.	Planning	Short term
Review and amend standards to provide future protection of coastal infrastructure where appropriate.	Technical Services	Long term
Source funding including external opportunities to implement prioritised works and measures.	Technical Services	As appropriate

ADVOCACY AND COMMUNICATION ACTIONS

Action	Directorate	Priority
Work with relevant state agencies to model impacts on marine environments and subsequent impacts on marine and tourist industries.	Economic Development and Marketing	Long term



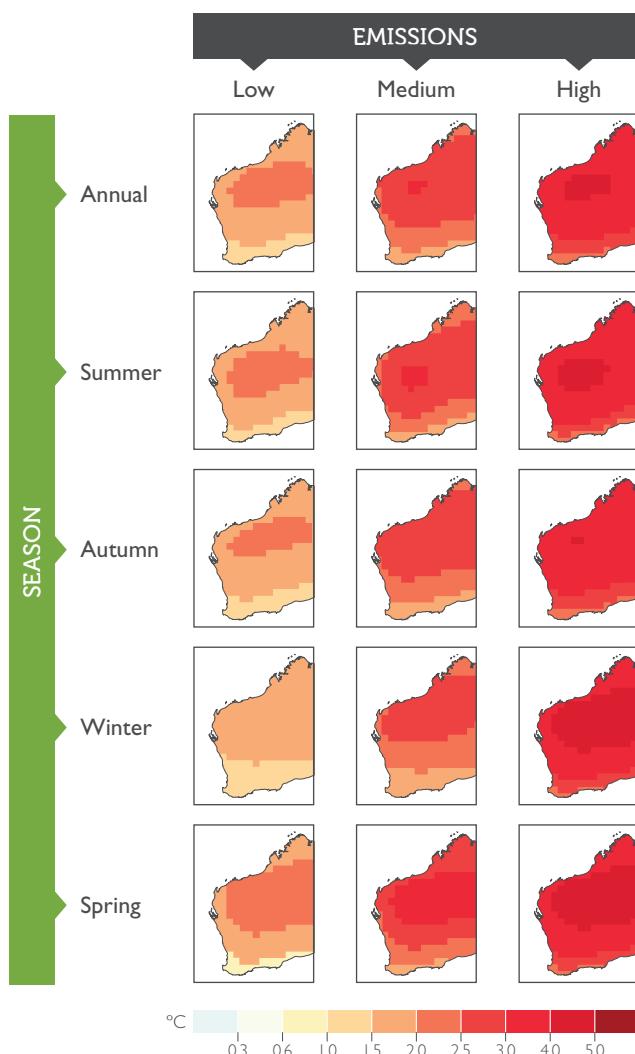
Increased temperatures

1-6.5%
increase in south west
WA temperature by
 **2070**

Science and design scenarios

The IPCC AR4 is the latest source of information regarding temperature changes. As the figure below for expected temperature changes in 2070 shows, all emissions scenarios indicate that Perth will become a hotter place. The drying trend applies to all seasons, but more so the Spring and Summer months.

Depending on the emissions scenario applied, South West WA is likely to experience temperature increases of between 1 and 6.5°C by 2070.



Source: <http://climatechangeinaustralia.com.au/watemp23.php>

Consequences of higher temperatures

01 Primary impacts	02 Secondary impacts	03 Tertiary impacts	04 Quaternary impacts
Temperature increase Global temperature is liable to increase by as much as 6.4°C by 2099 (Likely range between 2.4°C – 6.4°C) (IPCC 2007, p. 45).	Rise in the number of heatwaves (IPCC 2007, p. 46). Bushfires will be become more frequent and more intense (IPCC 2007, p. 48).	88% of species risk extinction (Garnaut 2008, p. 102). Decline in natural biodiversity (Prato 2009, p. 923; IPCC 2007, p. 48)	Pressures on health and emergency services (IPCC 2007, p. 48).
	Increase in geographical range and seasonality of vector-borne diseases and the possibility for an expansion of receptive zones (IPCC 2007, p. 48). Increasing incidence of food and water-borne diseases (IPCC 2007, pp. 48, 53).	Threat to the water supply of low-lying areas (IPCC 2007, p. 53). Impacts on tourism and recreation activities along the coast (SMEC 2009, p. 10).	Economic loss (IPCC 2007, pp. 48, 53). Risks to public safety and tourism and longer term impacts on regional economies (SMEC 2009, p. 11; IPCC 2007, p. 53).
	Higher evaporation rates (IPCC 2007, p. 49). Contribute to the Urban Heat Island Effect (Trenberth 2007, p. 244).	Damage to coastal infrastructure (specifically recreational infrastructure) (SMEC 2009, p. 10). Loss of existing public space in coastal areas (SMEC 2009, p. 10). Loss of beach width (SMEC 2009, p. 11).	Water shortages (IPCC 2007, pp. 48-50). Exacerbate health problems such as asthma (IPCC 2007, p. 48). Reduced ecosystem resilience to stress (IPCC 2007, p. 48).
	Decline in natural biodiversity (Prato 2009, p. 923). 88% of species risk extinction (Garnaut 2008, p. 102).	Spread of water-borne disease (IPCC 2007, pp. 48, 53).	Further threat of the intensity of bushfires (IPCC 2007, p. 48). Impact on the livelihood of coastal fisheries and productivity of marine ecosystems (IPCC 2007, pp. 48, 54).

Table 2: Synthesis of climate change impacts resulting from temperature increase.

Increased temperatures

Action to date

The following steps have been taken to adapt to increasing temperatures:

- Dramatically increased the City's tree planting program so that 1000 new trees are planted each year.
- Installed several drinking fountains in public places, with a focus near bike parking.
- Including solar passive design principles in the local planning policy 2.2: Split Density Codes and Energy Efficiency, which allows increase density in some areas as a bonus for sustainability outcomes.
- Support for green wall research and a demonstration green wall installed on the City's administration building.

Prioritised actions to adapt to increased temperatures

CORPORATE ACTIONS

Action	Directorate	Priority
Provide more outdoor drinking facilities.	Technical Services	Medium term
Address the urban heat island effect by trialling the use of lighter and more heat reflective bitumen on roads and use permeable / vegetated surfaces where possible. Measure and report on the impact of this trial.	Technical Services	Short term
Identify planning measures (possibly amendment to local planning scheme, or local planning policy) to limit heat absorption and energy consumption associated with new development including outdoor areas.	Planning	Short term

COMMUNITY ACTIONS

Action	Directorate	Priority
Increase the availability of relevant City services to assist people to deal with increased temperatures. Consider discounting leisure centre access for vulnerable groups and extending opening hours of facilities such as the library and Hilton community centre.	Community Development	Long term

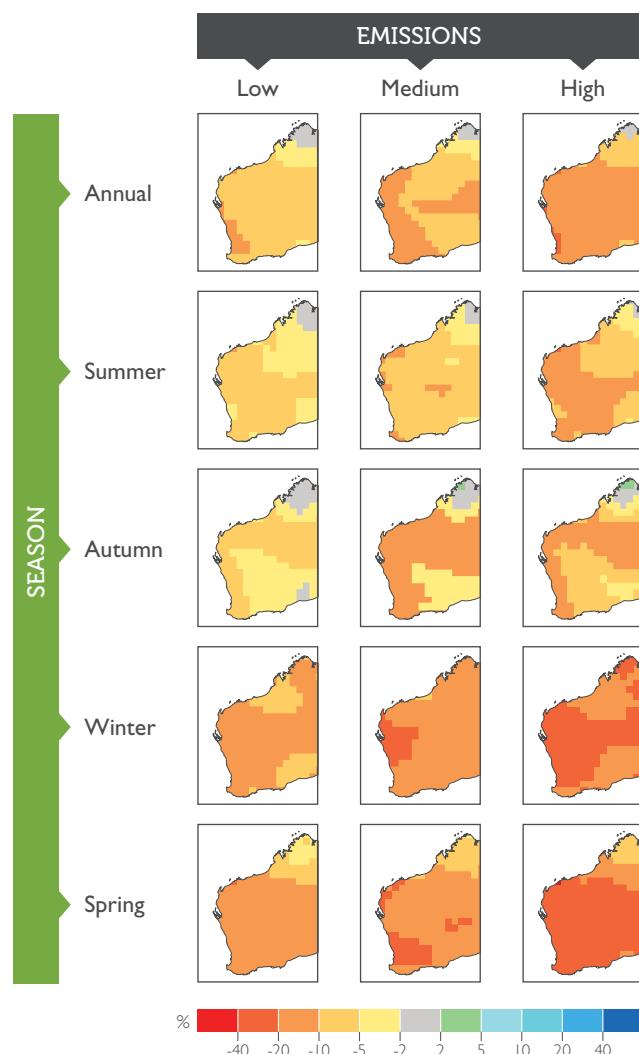


Decreased rainfall

5-60%
decrease in south west
WA rainfall by
- **2070**

Science and design scenarios

The IPCC AR4 indicates that rainfall in the Southwest of WA will decrease dramatically. Depending on the emissions scenario applied, South West WA likely to experience rainfall decreasing by between 5 and 60% by 2070.



This shows that the greatest relative decrease is in Winter and Spring, which is when most of Perth's rain falls. As such ground and surface sources of water are expected to become even scarcer.

Consequences of reduced rainfall

01 Primary impacts	02 Secondary impacts	03 Tertiary impacts	04 Quaternary impacts
Changes in precipitation Precipitation levels will increase at high-latitude and decrease in subtropical areas by as much as 20% by 2100 (IPCC 2007, p. 30).	Increase the intensity of rainfall events (IPCC 2007, pp. 48-49). Changes to ground water recharge and flow Loáiciga 2003).	Increase extreme and flash flooding events (IPCC 2007, pp. 48-50). Impacts of water supply for irrigated agriculture (IPCC 2007, pp. 48-50). More frequent and severe droughts (IPCC 2009, pp. 48-49).	Exceedence of existing flood defences (SMEC 2009, p. 10). Exceedence in drainage capacity (SMEC 2009, p. 10). Transporting contaminants into waterways (SMEC 2009, p. 11). Changes in flood plains (SMEC 2009, p. 12). Further changes in ecosystems and threat to biodiversity (Prato 2009, p. 923; IPCC 2007, p. 48). Food shortages (IPCC 2007, pp. 48, 50). Reduced water quality and quantity resulting in less watering and irrigation of open space and sports grounds and closure of ovals (SMEC 2009, p. 10). Limited water for swimming pools, etc (SMEC 2009, p. 10). Risks to public safety and tourism and longer term impacts on regional economies (SMEC 2009, p. 11; IPCC 2007, p. 53). Food shortages (IPCC 2007, pp. 48, 50).

Table 3: Synthesis of climate change impacts resulting from changes in precipitation

Decreased rainfall

Action to date

The following steps have already been taken to adapt to decreasing rainfall:

- Participating in the ICLEI Water Campaign and committing to an ambitious Water Conservation Plan. The Water Conservation Plan lists many actions, including establishing targets on ground water extraction, hydrozoning and reviewing alternative water supplies.
- Funding a project to hydrozone Fremantle Park, will be modelled to illustrate reduction in water demand.
- Installing low flow shower heads at the leisure centre, which use 45% less water.
- Retrofitting The Meeting Place as a sustainable demonstration home, including a rain water tank and low flow plumbing fittings.
- Subsidising native plants for all residents and schools each year, as well as providing additional incentives to install native verges.
- Created a school garden at Winterfold Primary School, which stores storm water for use as reticulation.
- Increased the use of permeable surfaces around street trees to allow more rain water to be captured by these trees.
- Including Water Sensitive Urban Design considerations at structure planning stages – for example the Lefroy Road Quarry site.

Prioritised actions to adapt to decreased rainfall

CORPORATE ACTIONS

Action	Directorate	Priority
Plant trees based on future climate – e.g. drought tolerant indigenous species	Technical Services	Short term
Develop an action plan to divert storm water from the ocean to freshwater aquifer recharge. Consider bioretention swales and other passive means of achieving this within the limits of the City's jurisdiction.	Technical Services	Short term
Implement the above plan to divert storm water from the oceans to freshwater aquifer recharge.	Technical Services	Medium – long term
Reuse water from outdoor / public showers at beaches for grass reticulation (starting with pilot at Leighton Beach)	Technical Services	Short term

ADVOCACY AND COMMUNICATION

Action	Directorate	Priority
Partner with the Water Corp and Department of Water for aquifer recharge and alternative supply technologies	Technical Services	Long term
Consider forming ground water management programs with other councils, such as through the South West Group	Technical Services	Long term

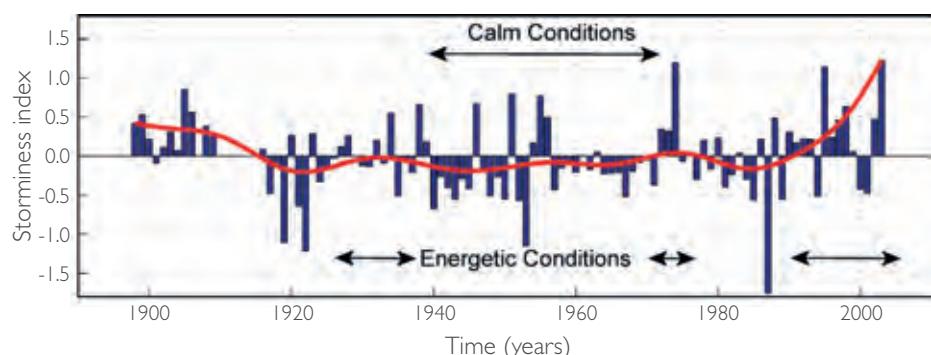


Increased storm intensity

18-59cm
increase in sea level
indicated by
 **2100**

Science and design scenarios

The science regarding how climate change will impact on storm intensity is less well understood than other climate variables included in this report. When allowing for long term tidal effects however storminess in Fremantle has increased rapidly in the last 10-15 years.



The red line shows the interannual variability in the record obtained by running a 19 year Hanning window to remove the long-term tidal effects. Source: Technical Advisory Panel 2007.¹

¹ Swan River Trust Technical Advisory Panel, above no. 5, pg 25

Consequences of increased storm intensity

01	02	03	04
Primary impacts	Secondary impacts	Tertiary impacts	Quaternary impacts
<p>Extreme weather events Extreme weather events (including typhoons, cyclones and hurricanes) will become more frequent (IPCC 2007, p. 30).</p> <p>High likelihood of a gradual pole-ward progression of tropical storms (p. 46).</p>	<p>Increase in extreme winds, flooding and erosion (IPCC 2007, pp. 48-50).</p>	<p>Disrupt electricity services with more frequent and severe blackouts (CSIRO 2006, p. 22).</p> <p>Increased pressure on dune systems (SMEC 2009, p. 11).</p> <p>Damage to development and infrastructure (IPCC 2007, p. 48; SMEC 2009, pp. 11-13).</p> <p>Encourage outbreaks of water-borne disease, especially in low-lying regions susceptible to coastal inundation (IPCC 2007, pp. 48, 53).</p> <p>Increase the risk of bushfires from lightning strikes (SMEC 2009, p. 8).</p>	<p>Risks to public safety and tourism and longer term impacts on regional economies (SMEC 2009, p. 11; IPCC 2007, p. 53).</p> <p>Modifications in insurance policies and costs (IPCC 2007, p. 53).</p> <p>Increased costs associated with operation and maintenance costs of public amenities recreational sites due to storm damage (SMEC 2009, p. 10).</p> <p>Pressures on health and emergency services (IPCC 2007, p. 48).</p>

Table 4: Synthesis of climate change impacts resulting from increase in extreme weather events.

Action to date

The following steps have been taken to adapt to increasing storm intensity:

- Conducted a drainage review and continuing to install gross pollutant traps where necessary.
- Increased the use of permeable surfaces around street trees to allow faster dispersal of storm water.
- Upgrading the storm water system to comply with Department of Water best practice storm water management whenever changes are made. More information on best practice stormwater management can be found here:

<http://www.publish.csiro.au/pid/2190.htm> and here:

<http://www.water.wa.gov.au/Managing+water/Urban+water/Stormwater/Stormwater+management+manual/default.aspx>

Increased storm intensity

Prioritised actions to adapt to decreased rainfall

CORPORATE ACTIONS

Action	Directorate	Priority
Review and where necessary update emergency response plans and infrastructure to deal with severe storm events	Corporate Services	Short term
Investigate whether the costs associated with disaster recovery can and should be insured against	Corporate Services	Short term
Ensure the City's insurance policies adequately treat climate change risks	Corporate Services	Short term
Review the storm water system for adequacy. Consider ways to maximise storm water diversion to the water table, or to directly productive uses such as irrigation or swimming pool top up	Technical Services	Short term
Assess and manage trees in high storm risk areas	Technical Services	Medium term

ADVOCACY AND COMMUNICATION

Action	Directorate	Priority
Request that building codes be updated to accommodate high risk storms and flooding zones	Planning	Long term
Research modelling that identifies impacts of severe storms through Fremantle.	Technical Services	Long term

Education

The City will use its unique position to inform local residents about climate change adaptation issues. In particular the City is the planning regulator; so is involved in the building and renovation of buildings throughout Fremantle. It is also informed every time that a house is sold. The City will prepare information suitable for prospective builders or renovators as well as new residents and provide this information to each of these groups. This information may be provided as fact sheets, policy or planning recommendations. This is a medium term action.

References

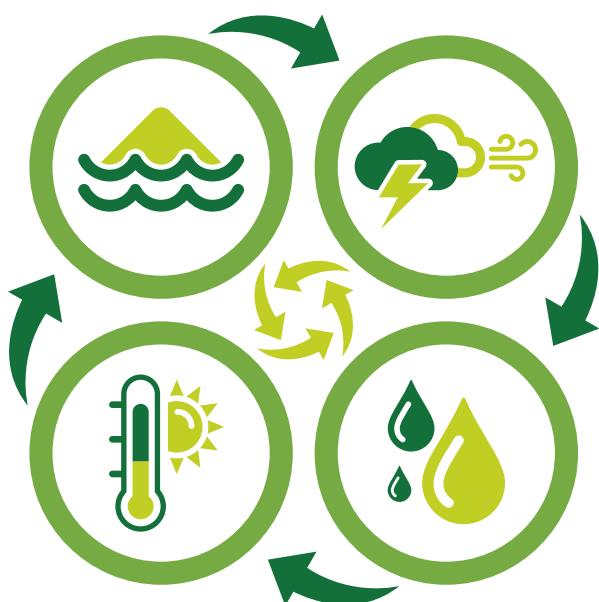
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Acknowledgements

It is acknowledged that this report has relied heavily on work by others. A broad literature review of both the science and potential adaptation options was conducted by one of Mayor Brad Pettitt's Murdoch University Honours students – Lauren Mackaway. Jessica Lisle also adapted her Master's thesis to present the cascade of impacts from each climate change theme. The City also acknowledges the work of other local governments which is informing the broader discussion about how to adapt to Climate Change – in particular the City of Mandurah and the Town of Cottesloe, who have been leaders in WA local government adaptation research, planning and action.

2019 Updates

Endorsed by Council - July 2020



Addendum - City of Fremantle Climate Change Adaption Plan – 2019 Update

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
Topic 1: Sea Level Rise					
Corporate actions					
Develop a planning policy dealing with sea level rise for existing development i.e. where roads and infrastructure are already in place. This will need to consider conflicting priorities, such as streetscape impacts and heritage requirements. Prepare a town planning scheme amendment and/or a local law depending on the most appropriate means to implement this policy	Strategic Planning and Projects	Medium	Partially complete. Informed by modelling of coastal impact via Cockburn Sound Vulnerability and Flexible Adaption Pathways (CSCV&FAPP 2016) and Port, Leighton and Mosman Beaches Coastal Hazard and Risk Management and Adaption Plan (CHRMAP 2017). Identified as priority item in Local Planning Scheme Review Report 2019.	Short term	Develop planning response as part of proposed scheme review process (pending WAPC approval of Scheme Review Report): Potential Legal costs to confirm approach \$
Develop a planning policy which ensures that proposed new development considers and mitigates the risks from projected sea level rise	Strategic Planning and Projects	Medium	As above	Short term	Develop planning response as part of proposed local planning scheme review process and through advocating for WAPC-led work on reviewing Metropolitan Region Scheme reserves and zonings in vicinity of Port and Leighton beaches. Legal costs (for advice on local scheme) \$

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
Review level of risk to existing coastal infrastructure and prioritise protection/upgrades/relocation	Infrastructure	High	<p>Partially complete: modelling and basic risk profile established through:</p> <ul style="list-style-type: none"> • Cockburn Sound Vulnerability and Flexible Adaption Pathways (CSCV&FAPP 2016) • Port, Leighton and Mosman Beaches Coastal Hazard and Risk Management and Adaption Plan (CHRMAP 2017). • Swan River Trust modelling 	<p>Short term</p> <p>Ongoing</p>	<p>Extreme risk actions prioritised: Protection/relocation costs high. \$\$\$\$</p> <p>On-going monitoring required: moderate cost \$\$.</p>
Review and implement options to address both sea water incursion and rising ground water salinity levels in the West End heritage precinct and the damage that is being done to these buildings.	Strategic Planning and Projects	Medium	<p>Partially complete. Informed by modelling of coastal impact via Cockburn Sound Vulnerability and Flexible Adaption Pathways (CSCV&FAPP 2016)).</p> <p>Identified as priority item in Local Planning Scheme Review Report 2019.</p> <p>Interim measures included in draft West End Heritage Area Policy 2020.</p>	Medium term	<p>Develop more comprehensive planning response as part of proposed scheme review process (pending WAPC approval of Scheme Review Report): Engineering and legal costs. \$</p>

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
Review and amend standards to provide future protection of coastal infrastructure	Infrastructure	Medium	<p>Complete: Construction standards established through state and federal agencies and enforced through state planning policy.</p> <p>Local assessment effectively complete: Addressed in Cockburn Sound Vulnerability and Flexible Adaption Pathways (CSCV&FAPP 2016), Port, Leighton and Mosman Beaches Coastal Hazard and Risk Management and Adaption Plan (CHRMAP 2017), Swan River Trust modelling & associated State Planning Policies.</p>	Ongoing	<p>On-going coastal monitoring required: moderate cost \$\$.</p> <p>Opportunity for ongoing advocacy regarding the need for standards to be maintained.</p>
Source funding including external opportunities to implement prioritised works and measures	Infrastructure	High	<p>On-going. Informed by Cockburn Sound Vulnerability and Flexible Adaption Pathways (CSCV&FAPP 2016) and Port, Leighton and Mosman Beaches Coastal Hazard and Risk Management and Adaption Plan (CHRMAP 2017).</p> <p>State Coastal Adaption Plan grants and partnerships with Fremantle Ports and Department of Transport utilised (inc. \$200G for</p>	As appropriate	On-going.

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
			interim wall at Port Beach 2019/20).		
Advocacy and communication actions					
Work with relevant state agencies to model impacts on marine environments and subsequent impacts on marine and tourist industries.	City Business	Medium	<p>Partially in train: partnerships with state agencies and adjoining local governments established to address modelling.</p> <p>Analysis of and advocacy in relation to marine and tourist impacts outstanding: primarily a state and federal responsibility.</p> <p>Advocacy on climate change in train and ongoing.</p>	Long term	On-going advocacy.
Topic 2: Higher Temperatures					
Corporate actions					
Provide more outdoor drinking facilities.	Infrastructure	Low	<p>Partially complete: Water fountains provided as per attached.</p> <p>ProAcqua machine installed at Esplanade.</p> <p>To be further addressed in Recreation Plan and associated policy.</p>	Medium term	Further address in Recreation Plan/policy and associated implementation budgeting. Installation & maintenance costs: \$\$

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
Address the urban heat island effect by trialling the use of lighter and more heat reflective bitumen on roads and use permeable / vegetated surfaces where possible. Measure and report on the impact of this trial.	Infrastructure	Medium	Various trials in train elsewhere e.g. City of Sydney. Plantings incorporated into road upgrades, verges and roundabouts where possible.	Short term Ongoing	Review and report outcomes from existing cool road pilot projects to determine potential local application. Continue to integrate street trees, plantings and WUSD in road projects. Installation & maintenance costs: \$\$
Identify planning measures (possibly amendment to local planning scheme, or local planning policy) to limit heat absorption and energy consumption associated with new development including outdoor areas.	Strategic Planning and Projects	Medium	Partially complete: Amendment 22 refused by Minister for Planning, Freo Alternative (Amendment 63) subsequently approved. State Planning Policy 7.2 and updates to the Building Code increase energy efficiency requirements. Updates to City Local Planning Policies complete 2019. Further opportunities may exist	Medium term	On-going advocacy for more climate response design and construction standards.

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
<i>Cross-reference to Urban Forest Plan action: Increase tree canopy to help reduce effects of urban heat island.</i>	Strategic Planning and Projects & Infrastructure	High	<i>Urban Forest Plan 2017 identifies necessary actions.</i>	On-going Medium term	<i>On-going tree planting on public land as per Urban Forest Plan (subject to budget): Installation & maintenance costs: \$\$ Consider additional planting requirements for new development – may be addressed by release of updated R-Codes for medium density development – expected by end of 2020)</i>
Community actions					
Increase the availability of relevant City services to assist people to deal with increased temperatures. Consider discounting leisure centre access for vulnerable groups and extending opening hours of facilities such as the library and Hilton community centre.	Community Development	Medium	The City provides discounted entry fees to people who have the appropriate concession cards i.e. Pensioner Card / Seniors Card / Health Care Card / Students / Veterans Affairs. The library hours were extended to include Sunday afternoons from November 2014 and Hilton Community Centre operating hours is 7am to 10.30pm Monday to Sunday (depending on activities).	On-going	On-going.
Topic 3: Decreased Rainfall					
Corporate actions					

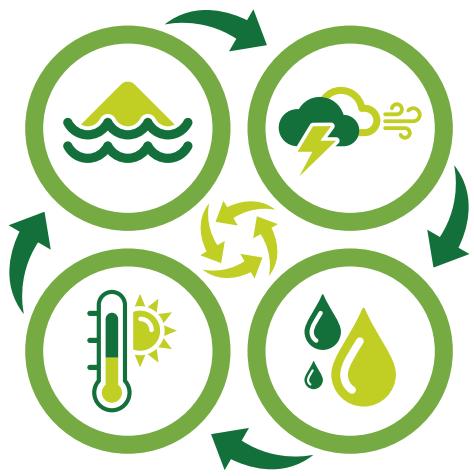
Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
Plant trees based on future climate – e.g. water tolerant local/WA species.	Infrastructure	High	Partially complete: Urban Forest Plan 2017. Implementation on-going.	On-going	On-going:
Develop an action plan to divert storm water from the ocean to the fresh water table. Consider bio retention swales and other passive means of achieving this within the limits of the City's jurisdiction.	Infrastructure	Medium	Partially complete: Water Conservation Strategy 2013 and updates to state planning policy. Stormwater harvesting incorporated into road upgrades where possible (e.g. Jenkin Street) Staged catchment reviews planned.	Medium term	Progress catchment modelling and reviews (subject to budget): study costs \$\$
Implement the above plan to divert storm water from the oceans to the fresh water table.	Infrastructure	Medium	As above.	Medium – long term	Implementation subject to modelling outcomes and provision of budget. Costs: \$\$\$
Reuse water from outdoor / public showers at beaches for grass reticulation starting with pilot at Leighton Beach.	Infrastructure	High	Complete: Detailed assessment completed in 2016: demonstrated that proposal not financially or environmentally feasible.	Short term	N/A - complete
<i>Cross-reference to Water Conservation Strategy action: Continue to upgrade irrigation systems to reduce water use</i>	Infrastructure	Medium-long term	<i>Some upgrades complete. Subject to budget availability.</i>	Medium-long term	<i>Program of upgrades – implementation subject to budget. Costs: \$\$\$</i>
Irrigation upgrade					
Advocacy and communication					

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
Partner with the Water Corp and Water Department for aquifer recharge and alternative supply technologies.	Infrastructure	Long term	<p>Water Corp conducting aquifer recharge trials through treated waste water: absence of waste water treatment plants in CoF reduces local application.</p> <p>CRC Kalamunda POS trial illustrates challenges and high cost (if not subsidised).</p> <p>Alternative supply technologies partially reviewed through CRC and other research.</p>	Long term	<p>Ongoing advocacy opportunity.</p> <p>Continued application of WUSD practices in upgrades where possible.</p>
Consider forming ground water management programs with other councils, such as through the South West Group.	Infrastructure	Long term		Medium term	Discuss option with Dept of Water and South West Group and investigate resource implications
Topic 4: Increased Storm Intensity					
Corporate actions					
Review and where necessary update emergency response plans and infrastructure to deal with severe storm events.	City Business	Medium	Complete: The City's Local Emergency Management Plan have been updated to include storm events	Short term	On-going maintenance of Emergency Management Plan.
Investigate whether the costs associated with disaster recovery can and should be insured against.	City Business	High	Complete: Insurers have confirmed that disaster recovery associated with storms and climate change risks is covered	Short term	On-going maintenance of insurance.

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
Ensure the City's insurance policies adequately treat climate change risks.	City Business	High	Complete: Insurers have confirmed that disaster recovery associated with storms and climate change risks is covered.	Short term	On-going maintenance of insurance.
Review the storm water system for adequacy. Consider ways to maximise storm water diversion to the water table, or to directly productive uses such as irrigation or swimming pool top up.	Infrastructure	Medium	<p>As per above.</p> <p>Options for diversion (e.g. rain gardens) pursued where possible on individual projects.</p> <p>Utilisation for public swimming pools unfeasible.</p>	Medium term	Drainage catchment studies subject to budget. Study costs: \$
Assess and manage trees in high storm risk areas.	Infrastructure	Medium	<p>On-going.</p> <p>Urban forest plan assumes 2% loss each year (through age and damage)</p>	Ongoing	On-going management.
Advocacy and communication					
Request that building codes be updated to accommodate high risk storms and flooding zones	Strategic Planning and Projects	Medium	<p>BCA contains requirements for development in Flood Hazard Areas. Construction standards reviewed every 3 years.</p> <p>On-going advocacy opportunities.</p>	Medium term	<p>Designate flood risk areas in planning scheme.</p> <p>On-going advocacy</p>
Research modelling that identifies likely paths and impacts of severe storms through Fremantle.	Infrastructure	Low	Coastal and Swan River storm impacts modelling complete. Advance modelling on	Long term	None identified at this time

Action	Responsibility	Priority	Status	Sequencing & Stages	Next Steps & Resourcing
			pathways unlikely to be LG specific		

NOTE: Actions listed will be assessed against other strategic priorities of the City through the corporate planning and budgeting process. Inclusion of an action on this list does not commit the City to delivering it: however it identifies it as desirable and allows it to be scoped and fed into the corporate prioritization process.



City of
Fremantle

City of Fremantle
PO Box 807
Fremantle WA 6959

T 1300 MY FREO (693 736)
F 08 9430 4634
TTY 08 9432 9777
www.fremantle.wa.gov.au

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