



---

# AdaptWest

Western Adelaide Region

Climate Change Adaptation Plan

---



URPS in collaboration with SEED consulting and AECOM



# AdaptWest Climate Change Adaptation Plan

11 October 2016



<b>Lead consultant</b>	URPS
<b>In association with</b>	Seed Consulting Services AECOM
<b>Prepared for</b>	AdaptWest
<b>Consultant Project Manager</b>	Nicole Halsey, Director  Suite 12/154 Fullarton Road (cnr Alexandra Ave) Rose Park, SA 5067 Tel: (08) 8333 7999 Email: nicole@urps.com.au
<b>URPS Ref</b>	2014-045 R008

## **Document history and status**

Revision	Date	Reviewed	Approved	Details
1	24.06.2016	A Pannell	N Halsey	Draft report
2	08.09.2016	N Halsey	N Halsey	Final draft report following client feedback
3	11.10.2016	N Halsey	N Halsey	Regional Climate Change Adaptation Plan

© URPS

All rights reserved; these materials are copyright. No part may be reproduced or copied in any way, form or by any means without prior permission.

This report has been prepared for URPS' client. URPS and its associated consultants are not liable to any person or entity for any damage or loss that has occurred, or may occur, in relation to that person or entity taking or not taking action in respect of any representation, statement, opinion or advice referred to herein.

www.urps.com.au  
ABN 55 640 546 010

# Contents

<b>Acknowledgments</b> .....	
<b>Glossary</b> .....	
<b>Executive summary</b> .....	<b>i</b>
<b>1 Introduction</b> .....	<b>1</b>
1.1 Who does this Plan belong to? .....	1
1.2 Overview of the Western Adelaide Region .....	3
1.3 How has this Regional Adaptation Plan been developed?.....	5
1.4 Guide to reading this Regional Adaptation Plan .....	6
<b>2 How will climate change be experienced by the Western Adelaide Region?</b> .....	<b>8</b>
<b>3 Understanding vulnerability and areas for focussing adaptation action</b> .....	<b>10</b>
3.1 What is an IVA? .....	10
3.2 What did the IVA tell us?.....	11
3.3 Transitioning from the IVA to adaptation planning .....	12
3.4 Understanding adaptation pathways analysis .....	13
<b>4 Adaptation options for the Western Adelaide Region</b> .....	<b>14</b>
4.1 Interpreting the pathway maps .....	15
4.2 Business and industry.....	18
4.3 Community resilience.....	21
4.4 Estuarine waters.....	25
4.5 Natural landscapes – coastal.....	28
4.6 Open and green spaces .....	31
4.7 Public coastal built assets.....	34
4.8 Stormwater management infrastructure.....	37
4.9 Transport and essential services .....	40
4.10 Urban living .....	44
4.11 West Lakes .....	47
4.12 Summary of preferred adaption options .....	50
<b>5 Priorities for adaptation in the Western Adelaide Region</b> .....	<b>53</b>
5.1 Implementing the priority adaptation options for the Western Adelaide Region .....	62
<b>6 Enabling adaptation action</b> .....	<b>64</b>
<b>7 References</b> .....	<b>66</b>
<b>Appendix A</b> .....	<b>68</b>
Organisations and sectors that contributed to the preparation of the Regional Adaptation Plan .....	68
<b>Appendix B</b> .....	<b>69</b>
Western Adelaide Regional Adaptation Priorities Action Plan.....	69
<b>Appendix C</b> .....	<b>80</b>
Mapping of vulnerability to sea level rise and flooding .....	80
<b>Appendix D</b> .....	<b>98</b>
Mapping of key features and characteristics of the Western Adelaide Region .....	98

# Acknowledgments

The Western Adelaide Region Regional Adaptation Plan is the product of collaboration between the Cities of Charles Sturt, West Torrens, and Port Adelaide Enfield and the stakeholders who have a role or interest in the Western Adelaide Region.

The Regional Adaptation Plan was supported and co-funded by contributions from the Commonwealth Government through the Natural Disaster Resilience Program, South Australian Fire and Emergency Services Commission (SAFECOM) and the South Australian Department of Environment, Water, and Natural Resources (DEWNR).

Particular acknowledgment is made of the many individuals representing a diversity of organisations, sectors and interests from across the Western Adelaide Region who gave up their time to actively participate in workshop processes and directly influence the development of this Regional Adaptation Plan.

The preparation of the Regional Adaptation Plan was overseen by a project steering group comprising representation from the member Councils and the State Government.

The development of the Regional Adaptation Plan was undertaken by a consultant team led by URPS in association with Seed Consulting Services and Aecom.

# Glossary

Term	Explanation
Adaptation	Taking action to avoid, withstand or benefit from current and projected climate changes and impacts.
Adaptive capacity	<p>Adaptive capacity is the ability of a feature or function to adjust to climate change impacts (including climate variability and extremes), to moderate potential damages, take advantage of opportunities, or cope with consequences and maintain the valued characteristics of that feature or function.</p> <p>Consideration is given to what extent a feature or its function in its current form, with current management practices, resourcing or funding, is able to continue to function, cope or adjust to the expected climate conditions at a point in the future. For AdaptWest, predicted changes in the climate at 2070 were used.</p> <p>For example, water sensitive urban design (WSUD) can provide the ability for a streetscape to function in response to reduced rainfall, but if no WSUD measures are in place now, then the adaptive capacity would be considered to be less than if WSUD was currently in place.</p>
Adaptation Pathways	<p>An approach to adaptation planning which enables the consideration of a range of possible adaptation options, how they will be impacted by climate change through time, and whether any options have an “expiry date” (ie a point in time at which they are no longer viable). A key aspect of this approach is the identification of a preferred pathway which identifies those options to be progressed now and into the future based on currently available information, including stakeholder input/preferences at the time of preparing the Adaptation Plan.</p> <p>The preferred pathway does not preclude current actions that contribute to future adaptation from continuing and should be reviewed at least every 5 years, at which time new information may suggest that the preferred pathway should take a different course through potential options.</p>
Climate	Climate summarises the average, range and variability of weather elements, eg precipitation, wind speed, air temperature, humidity, and sunshine hours (solar radiation), observed over many years (typically > 30 years) at a location or across an area.
Climate change	Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.
Climate variable	Climate variables are the different climate factors such as rainfall and temperature that determine the climate. Changes in these are projected to occur as a result of climate change including declining rainfall, increasing rainfall intensity, increasing average temperature, increasing frequency and intensity of heatwaves and increasing bushfire risk.
Exposure	Exposure considers the likelihood of a feature or its function being subjected to change in a particular climate variable. For example low lying land is more exposed to inundation from flooding, the entire Region is exposed to heatwaves and locations along the coast are more exposed to sea level rise. For AdaptWest, exposure relates to predicted changes in the climate at 2070.
Green infrastructure	Green infrastructure is the strategically planned network of green spaces and environmental or water management features that deliver a wide range of environmental, economic and social benefits including provision of clean water and clean air, more attractive and greener cooler cities, mitigation of urban heat island effects and improved wildlife habitat and biodiversity. Green infrastructure features can operate and provide benefits at small scales such as living walls, roof gardens and pathways and larger scales such as parks and reserves, transport corridors, watercourses and wetlands.
Maladaptation	Maladaptation occurs when an attempt to adapt produces unintended negative consequences.
Mitigation	In the context of climate change, mitigation is taking action to reduce or prevent emission of greenhouse gases.
Resilience	The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress or environmental change.

Term	Explanation
Sensitivity	Sensitivity considers the degree to which a feature or its functions are affected by change to a particular climate variable. For example, older people are more sensitive to heatwaves, non-irrigated open space is sensitive to reduced rainfall, and coastal development is sensitive to sea level rise.
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability to the impacts of climate change is a function of exposure to climate conditions, sensitivity to those conditions, and the capacity to adapt to the changes.
Water sensitive urban design (WSUD)	Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the land use and development process. It includes consideration of available water sources including rainwater and stormwater, improving water quality and managing runoff to improve biodiversity and the liveability of urban environments.

## Abbreviations

Abbreviation	Full Name
AILA	Australian Institute of Landscape Architects
AMLR NRMB	Adelaide and Mount Lofty Ranges Natural Resources Management Board
CPB	Coast Protection Board
DCSI	Department of Communities and Social Inclusion
DEWNR	Department of Environment, Water and Natural Resources
DPTI	Department of Planning, Transport and Infrastructure
DSD	Department of State Development
HIA	Housing Industry Association
IVA	Integrated Vulnerability Assessment
LGA	Local Government Association
NRM	Natural Resources Management
MAR	Managed Aquifer Recharge
RDA	Regional Development Australia
SAFECOM	South Australian Fire and Emergency Services Commission
SES	State Emergency Service
SMA	Stormwater Management Authority
SMP	Stormwater Management Plan
UDIA	Urban Development Institute of Australia
WSUD	Water Sensitive Urban Design

# Executive summary

The Western Adelaide Region is already experiencing extreme and hazardous climatic events such as flooding from intense rainfall and storm surge as well as extreme temperatures and heatwaves. Recent storm events have resulted in interruptions to our electricity supply and key transport routes, damage to built infrastructure such as jetties and coastal paths and erosion of our beaches and dunes. Extreme temperatures and extended heatwaves have resulted in increased hospital admissions and heat related illnesses and deaths.

With continued changes in climate projected into the future, the intensity and frequency of extreme events will also increase. Without intervention, the Western Adelaide Region will not only continue to flood and experience extreme heat, but this will occur more often and the impacts will be more severe.

As a Region we must think, plan and act now to build the resilience of Western Adelaide, not only for ourselves but for the rest of the State which is reliant on us for a range of goods, services and experiences. If we do not take action, interruption, damage or destruction of critical infrastructure and services such as the Adelaide Airport, port and wharf facilities and beaches and dunes will occur, and the health and wellbeing of more than 271,850 people who live in the Region and the viability of more than 21,000 businesses and industry located there will be at risk.

AdaptWest is about making sure that the communities, environment and businesses and industries of the Western Adelaide Region remain productive, connected and strong and can respond positively to the challenges and opportunities presented by a changing climate.

We know that despite global action being taken to manage and reduce greenhouse gas emissions, we are already on a pathway which means that some degree of adaptation will be required. By being proactive and thinking and planning now for the impacts that are likely to occur as the climate changes, the Western Adelaide Region (the Region) can position itself to manage adverse impacts and take advantage of any opportunities.

By collaborating, our Region can deliver a coordinated response to climate change and by sharing information, resources, responsibilities and actions we can AdaptWest. This Regional Climate Change Adaptation Plan (Regional Adaptation Plan) provides the foundation for this coordinated and collaborative response to climate change and identifies priorities for adaptation across the Western Adelaide Region.

The Western Adelaide Region Climate Change Adaptation project is supported and co-funded by contributions from the Commonwealth Government through the Natural Disaster Resilience Program, South Australian Fire and Emergency Services Commission (SAFECOM), the South Australian Department of Environment, Water, and Natural Resources (DEWNR), and the Cities of Charles Sturt, West Torrens, and Port Adelaide Enfield.

The preparation of the Regional Adaptation Plan was undertaken over three key stages as follows:

- understanding the Western Adelaide Region in relation to a changing climate
- identifying and assessing the vulnerability of what we value in our Region, and
- identifying adaptation responses.

## Identifying options for adaptation

The Regional Adaptation Plan identifies adaptation options for the Western Adelaide Region to address key vulnerabilities or opportunities presented by a changing climate.

Climate projections prepared to inform this adaptation planning process (refer section 2) indicate that the Western Adelaide Region will face warmer and drier conditions, with increased risks being posed by extreme events such as heatwave, flooding and inundation associated with sea level rise and more frequent storm surge.

Using these climate projections, an Integrated Vulnerability Assessment (IVA) was undertaken to determine how aspects or features that are valued across the Western Adelaide Region may be impacted by climate change (refer section 3). A total of 51 indicators were assessed using the IVA, the analysis of which revealed those valued aspects or features of the Western Adelaide Region that have a higher vulnerability to climate change than others. The IVA showed that adaptation by the Western Adelaide Region will particularly be required in relation to impacts associated with sea level rise and extreme events such as flooding and heatwaves.

Based on the analysis of the IVA, areas of focus were derived for adaptation planning known as 'key decision areas'. For the Western Adelaide Region ten key decision areas were identified and adaptation pathways analysis was used to gather and assess a range of information in order to identify adaptation options for the Region (refer section 4). For each of the ten key decision areas pathway maps were generated with a range of adaptation options identified (refer section 4).

## Priorities for adaptation across the Western Adelaide Region

Further review and assessment of the adaptation options resulted in the identification of ten priority adaptation options for the Western Adelaide Region (refer section 5). Of these ten priorities a number of options are for immediate implementation - whether that be the acceleration of current activities, commencement of new responses or planning for future action, while others may be required at some point in the future as the climate changes.

These priority adaptation options are summarised by Table A and the infographic following.

Priority options denoted by a \* represent options that are the same or similar to adaptation priorities in other regional adaptation plans. They would therefore benefit from considering how they could be progressed in partnership with other region.



Table A: Priority adaptation options for the Western Adelaide Region

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>Develop alternative approaches to funding adaptation</b>	Natural landscapes - coastal Public coastal built assets Stormwater management infrastructure Urban living Business and industry Transport and essential services	Rising sea levels and increasing intensity of heavy rainfall events may require the construction of new or upgrade of existing infrastructure. This type of infrastructure will require significant resource input, particularly where stormwater infrastructure capacity upgrades or hard coast protection structures (eg sea walls) are required. It is recognised that 'traditional' approaches to funding may not be sufficient or appropriate and that new approaches may be required. Funding adaptation works may require the reallocation of existing resources and developing new cost-sharing models (including with private sector), particularly for adaptation options that are of regional benefit or relate to more than one Council area.	Now	State Government Western Adelaide Region Councils	Asset and infrastructure owners and operators Developers Local Government Association (LGA) Other Regions Commonwealth Government Regional Development Australia (RDA) and other infrastructure funding agencies
<b>* Increase urban greenness</b>	Open and Green Spaces Urban Living	Dark coloured roads and roofs absorb heat and store it, increasing the temperature of built-up urban areas. Trees and plants can reduce the urban heat island effect by shading and preventing heat from being absorbed and through evapotranspirative cooling. The existing canopy cover in Adelaide's western suburbs is the lowest of any region in metropolitan Adelaide. Increasing urban greenness through additional tree planting, vegetation and irrigating open space will assist in lowering the urban heat island effect as the climate warms and the frequency and intensity of extreme heat events increases.	Now	State Government Western Adelaide Region Councils	Adelaide and Mount Lofty Ranges Natural Resources Management Board (AMLR NRMB) Developers Universities and research institutions Private landowners Community (advocates)

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>* Plan and design climate resilient buildings, places and spaces</b>	<ul style="list-style-type: none"> <li>Business and industry</li> <li>Community resilience</li> <li>Estuarine waters</li> <li>Natural landscapes-coastal</li> <li>Open and green spaces</li> <li>Public coastal built assets</li> <li>Transport and essential services</li> <li>Urban living</li> </ul>	<p>Climate resilient buildings, spaces and places are those that are designed and constructed to take into account anticipated climate change and assist with mitigating climate change impacts such as extreme heat and flooding from stormwater, sea level rise and storm surge.</p> <p>Climate resilient buildings, spaces and places can play a significant role in creating an urban environment that is amenable and comfortable for residents and visitors and contribute to improving human health. They also contribute to creating safe urban areas and supporting the ongoing function of services, business and industry in the face of extreme events.</p>	Now	<p>State Government – in particular Department of Planning, Transport and Infrastructure (DPTI)</p> <p>Western Adelaide Region Councils</p>	<ul style="list-style-type: none"> <li>AMLR NRMB</li> <li>Australian Institute of Landscape Architects (AILA)</li> <li>Botanic Gardens</li> <li>Developers</li> <li>Housing Industry Association (HIA)</li> <li>LGA</li> <li>Other regions</li> <li>Property Council of Australia</li> <li>Universities and research institutions</li> <li>Urban Development Institute of Australia (UDIA)</li> <li>Water Sensitive SA</li> </ul>
<b>* Education and awareness raising</b>	<ul style="list-style-type: none"> <li>Business and industry</li> <li>Community resilience</li> <li>Estuarine waters</li> <li>Natural landscapes-coastal</li> <li>Open and green spaces</li> <li>Public coastal built assets</li> <li>Urban living</li> </ul>	<p>Increasing the awareness and understanding of how climate change may impact individuals, communities and organisations is critical to enabling the Region to adapt. Many people in the Region are aware of the impacts of climate change and climate hazards however many have not considered how these hazards may affect their homes, businesses or lifestyles. Education and awareness raising are the first steps to build capacity so that individuals are able to take responsibility and undertake their own adaptation.</p>	Now	<p>State Government including SA Health, Department of State Development (DSD), State Emergency Service, Department of Environment, Water and Natural Resources (DEWNR) (including Coast Protection Board (CPB), Climate Change Branch and Natural Resource Management).</p> <p>Western Adelaide Region Councils</p> <p>Insurance sector</p>	<ul style="list-style-type: none"> <li>Australian Red Cross</li> <li>Business and industry</li> <li>Other Regions</li> <li>Community service agencies</li> </ul>

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>* Build community connectedness</b>	Community resilience	Community connectedness supports individual physical and mental health, and strong networks increase the capacity of communities to withstand challenging circumstances. Access to formal and informal support is particularly important for members of the community with vulnerabilities who may otherwise be isolated. Climate projections indicate an increasing frequency of inundation (from stormwater and sea water) and increasing frequency and intensity of extreme heat events, meaning strong and connected communities will be even more important.	Now	Western Adelaide Region Councils Department of Communities and Social Inclusion (DCSI)	Community service agencies Not-for Profit Sector Other State Government agencies Commonwealth Government funding bodies Community groups
<b>Use risk assessment approaches to prioritise adaptation responses</b>	Business and industry Estuarine waters Open and green spaces Public coastal built assets Stormwater management infrastructure Transport and essential services Urban living	The high cost of some adaptation options (such as sea walls), funding and resource constraints, and the need for a staged approach to infrastructure development means the Region needs a comprehensive understanding of the priorities for adaptation and the timing over which these should occur. Risk assessment approaches applied to individual asset types (eg roads, beaches, jetties) or considering climate impacts (eg sea level rise) can ensure investment is targeted and prioritised appropriately.	Now	Western Adelaide Region Councils State Government including DPTI, Renewal SA, DSD, CPB	DEWNR Insurance sector
<b>* Manage urban runoff to mitigate flood risk and improve water quality and reuse</b>	Estuarine waters Natural landscapes-coastal Open and green spaces Stormwater management infrastructure	Increasing intensity of heavy rainfall events will require acceleration of existing initiatives as well as new approaches to managing the quality and quantity of urban runoff to mitigate flood risk and maintain and improve the quality of marine and estuarine receiving environments.	Now	Western Adelaide Region Councils Stormwater Management Authority (SMA) DPTI	AMLR NRMB DEWNR LGA Water Sensitive SA Universities and research institutions

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>* Embed climate considerations into asset management plans</b>	Natural landscapes-coastal Transport and essential services	Asset management planning is used to understand risk and manage assets and infrastructure, yet the majority do not consider climate impacts. This is a particular issue given that asset management plans often relate to infrastructure that has a long lifespan and therefore is likely to be impacted by changes in climate. Climate change considerations therefore should be embedded in asset management plans so that adaptation becomes part of everyday practice.	Now	Western Adelaide Region Councils CPB SMA DPTI Infrastructure owners and operators (eg Adelaide Airport, DPTI, SA Water, SA Power Networks, Flinders Ports, Australian Submarine Corporation)	LGA
<b>* Establish soft infrastructure protection measures along the coast</b>	Estuarine waters Natural landscapes-coastal Public coastal built assets	Sea level rise combined with storm surge will impact natural and built assets. Business, industry, port and wharf infrastructure, stormwater management infrastructure, housing and recreation facilities along the coast of Gulf St Vincent as well as inland around Port Adelaide and West Lakes will be impacted as changes in sea level occur. Sand dunes and beaches will continue to be eroded and for some, without intervention, disappear given their inability to retreat inland due to hard physical barriers created by urban development. Soft coastal protection measures such as dune revegetation, fencing and the establishment of living shorelines can protect and stabilise beaches and dunes which contribute to the protection of assets and infrastructure.	Now	Renewal SA DSD CPB DPTI Western Adelaide Region Councils	AMLR NRMB Developers Private landowners RDA and other infrastructure funding agencies

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>Establish hard infrastructure protection measures along the coast</b>	<ul style="list-style-type: none"> <li>Business and industry</li> <li>Estuarine waters</li> <li>Natural landscapes-coastal</li> <li>Public coastal built assets</li> <li>Stormwater management infrastructure</li> <li>Transport and essential services</li> </ul>	<p>Sea level rise combined with storm surge will impact natural and built assets. Business, industry, port and wharf infrastructure, stormwater management infrastructure, housing and recreation facilities along the coast of Gulf St Vincent as well as inland around Port Adelaide and West Lakes will be impacted as changes in sea level occur. Sand dunes and beaches will continue to be eroded and for some, without intervention, disappear given their inability to retreat inland due to hard physical barriers created by urban development. Hard infrastructure such as sea walls and barrages may be required to protect assets and infrastructure as the sea level rises.</p>	Later (5 years)	<ul style="list-style-type: none"> <li>Renewal SA</li> <li>DSD</li> <li>CPB</li> <li>DPTI Western Adelaide Region Councils</li> </ul>	<ul style="list-style-type: none"> <li>AMLR NRMB</li> <li>Developers</li> <li>Private landowners</li> <li>RDA and other infrastructure funding agencies</li> </ul>
<b>*Relocate assets and infrastructure away from high risk areas</b>	<ul style="list-style-type: none"> <li>Business and industry</li> <li>Open and green spaces</li> <li>Public coastal built assets</li> <li>Stormwater management infrastructure</li> <li>Urban living</li> <li>West Lakes</li> </ul>	<p>Relocating assets and infrastructure away from high risk areas will become an increasingly important consideration in locations exposed to flooding from sea level rise and storm surge and catchment run off following periods of intense rainfall. Although this was not identified as a priority option at a regional scale, it will remain a consideration into the future especially when decisions are being made to invest in protection measures along the coast. There are complex issues associated with this option, including the need to balance the community's desire to live near the coast or along watercourses while ensuring community members and their property are safe and not at risk from sea level rise and flooding.</p>	Later (20 years)	State government	<ul style="list-style-type: none"> <li>LGA</li> <li>Other regions</li> <li>Western Adelaide Region Councils</li> <li>Insurance sector</li> </ul>

### Progressing implementation of adaptation actions in the Western Adelaide Region

To assist with progressing adaptation across the Western Adelaide Region, the priority adaptation options identified by Table A have been brought together in the Western Adelaide Region Regional Adaptation Priorities Action Plan (refer Appendix B). These priority adaptation options are the focus of the Regional Adaptation Priorities Action Plan given their multi-sectoral relevance and opportunity to benefit multiple sectors or key decision areas. To support initial action, mapping has been prepared bringing together vulnerability 'hot spots' with regional adaptation priorities (refer Appendix B).

It is not intended that the Regional Adaptation Priorities Action Plan be considered the only adaptation actions that are required in the Western Adelaide Region, but rather a starting point to focus initial regional, cross-sectoral action. The remainder of the preferred options identified by the Regional Adaptation Plan are still considered critical to ensure the Region's businesses and industries, communities and environment remain productive, connected and strong.

### Creating enabling conditions that support the implementation of the Regional Adaptation Plan

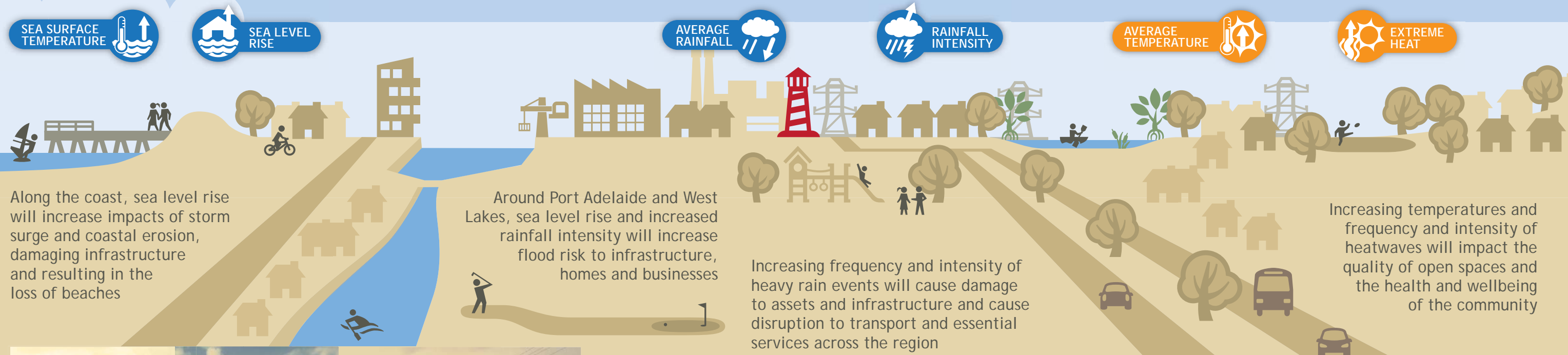
In developing this Regional Adaptation Plan, consideration was given to the conditions that sit 'outside' of the Plan and the broader decision making context that may impact on whether adaptation action occurs (refer section 6). Understanding this context and ensuring appropriate conditions are in place to enable adaptation action is considered as important as identifying the adaptation options themselves. Table C summarises the key enabling conditions identified as being critical to supporting the successful implementation of the Regional Adaptation Plan.

**Table C Summary of enabling conditions**

Enabling condition	Action to create enabling condition
Ratify regional commitment	Establish a new Climate Change Sector Agreement, building on initial regional agreement and partnerships to support the implementation of the Regional Adaptation Plan.
Effective governance arrangements	Develop a governance framework to support implementation of the Regional Adaptation Plan including designating a lead group/organisation, establishing a coordinator role, identifying roles, responsibilities and resources. Governance arrangement to include identification of other initiatives that will be required to support implementation including the development of a monitoring and review framework.
Leadership and ownership	Allocate resources to the implementation of identified adaptation actions. Identify new approaches to funding including opportunities to reallocate existing funds. Focus on the multiple benefits delivered by action (in addition to adaptation) to attract funding. Embed climate change considerations in key organisational strategies, plans, policies and processes (eg strategic management plans, asset management plans, procurement policies etc). (Note a number of the above actions are also identified as a regional adaptation priorities.)
Education and awareness raising	Build community awareness and understanding about the potential impacts of climate change and opportunities to adapt Share knowledge about opportunities to adapt, particularly where actions provide multiple benefits Promote success stories of 'adaptation in action' (note education and awareness raising is also identified as a regional adaptation priority)

# Building a Resilient Western Adelaide Region

The Western Adelaide Region experiences regular flooding, storms, coastal erosion and heatwaves. Climate change will increase the frequency and intensity of these extreme events. Through implementing the adaptation priorities identified by the Region we will build our resilience and be better prepared and able to respond and recover from these extreme events.



April 2009

Damage to Semaphore Jetty, as a result of king tide and storm



May 2016

King tide and storm surge led to 5-10m dune lost near Henley Beach



April 2009

Storm surge at Henley Beach tops seawall disrupting traffic



April 2009

King tide and storm surge at Port Adelaide affects Port operations



May 2016

The Birkenhead Bridge was closed to all traffic due to flooding



February 2016

Extreme flooding at Ethelton damages homes and contents



2009

Heatwave results in 16% increase in ambulance callouts



2009

Heat related illness hospital admission increase 14 fold

## To be resilient we need to...

Establish soft and hard infrastructure protection measures along the coast

Relocate assets and infrastructure away from high risk areas

Develop alternative approaches to funding adaptation

Use risk assessment approaches to prioritise adaptation responses

Increase understanding of risks associated with sea level rise, extreme heat and flooding

Manage urban runoff to mitigate flood risk and improve water quality and reuse

Embed climate considerations into asset management plans

Build community connectedness to strengthen support networks

Increase urban greenness

Plan and design climate resilient buildings, places and spaces





# 1 Introduction

AdaptWest is about making sure that the communities, environment and businesses and industries of the Western Adelaide Region remain productive, connected and strong and can respond positively to the challenges and opportunities presented by a changing climate.

We know that despite global action being taken to manage and reduce greenhouse gas emissions, we are already on a pathway which means that some degree of adaptation will be required. By being proactive and thinking and planning now for the impacts that are likely to occur as the climate changes, the Western Adelaide Region (the Region) can position itself to manage adverse impacts and take advantage of any opportunities.

By collaborating, our Region can deliver a coordinated response to climate change and by sharing information, resources, responsibilities and actions we can AdaptWest. This Regional Climate Change Adaptation Plan (Regional Adaptation Plan) provides the foundation for this coordinated and collaborative response to climate change and identifies priorities for adaptation across the Western Adelaide Region.

The Western Adelaide Region Climate Change Adaptation project is supported and co-funded by contributions from the Commonwealth Government through the Natural Disaster Resilience Program, South Australian Fire and Emergency Services Commission (SAFECOM), the South Australian Department of Environment, Water, and Natural Resources (DEWNR), and the Cities of Charles Sturt, West Torrens, and Port Adelaide Enfield.

## 1.1 Who does this Plan belong to?

This Regional Adaptation Plan is for the Western Adelaide Region which comprises the Cities of Charles Sturt, Port Adelaide Enfield and West Torrens (refer Figure 1). State Government administrative regions identify the Western Adelaide Region as comprising a portion of the City of Port Adelaide Enfield, however the entire City of Port Adelaide Enfield has been considered by the Regional Adaptation Plan. The term Western Adelaide Region has been used to refer to the entirety of the three Councils. Where required, the administrative region has been referred to as the Western Adelaide Planning Region.

The AdaptWest project is a partnership between the three Councils identified above, together with Commonwealth and State government support and the stakeholders and communities who have a role or interest in the Western Adelaide Region and is consistent with South Australia's Adaptation Framework<sup>1</sup>.

Adaptation to climate change is everyone's business and we can all play a role in taking action that builds our resilience and reduce or ameliorate the impacts of climate change. The Regional Adaptation Plan is therefore a plan for the Region and its implementation resides with individuals and organisations across the Western Adelaide Region including service providers, government agencies, not-for-profit organisations, Local Government, business and industry, infrastructure owners and managers and community groups.

---

<sup>1</sup> The South Australian Adaptation Framework, *Prospering in Changing Climate: A Climate Change Adaptation Framework for South Australia*, provides a foundation for guiding business, the community, non-government organisations, the research sector, local governments and state government agencies to develop well-informed and timely adaptation responses.

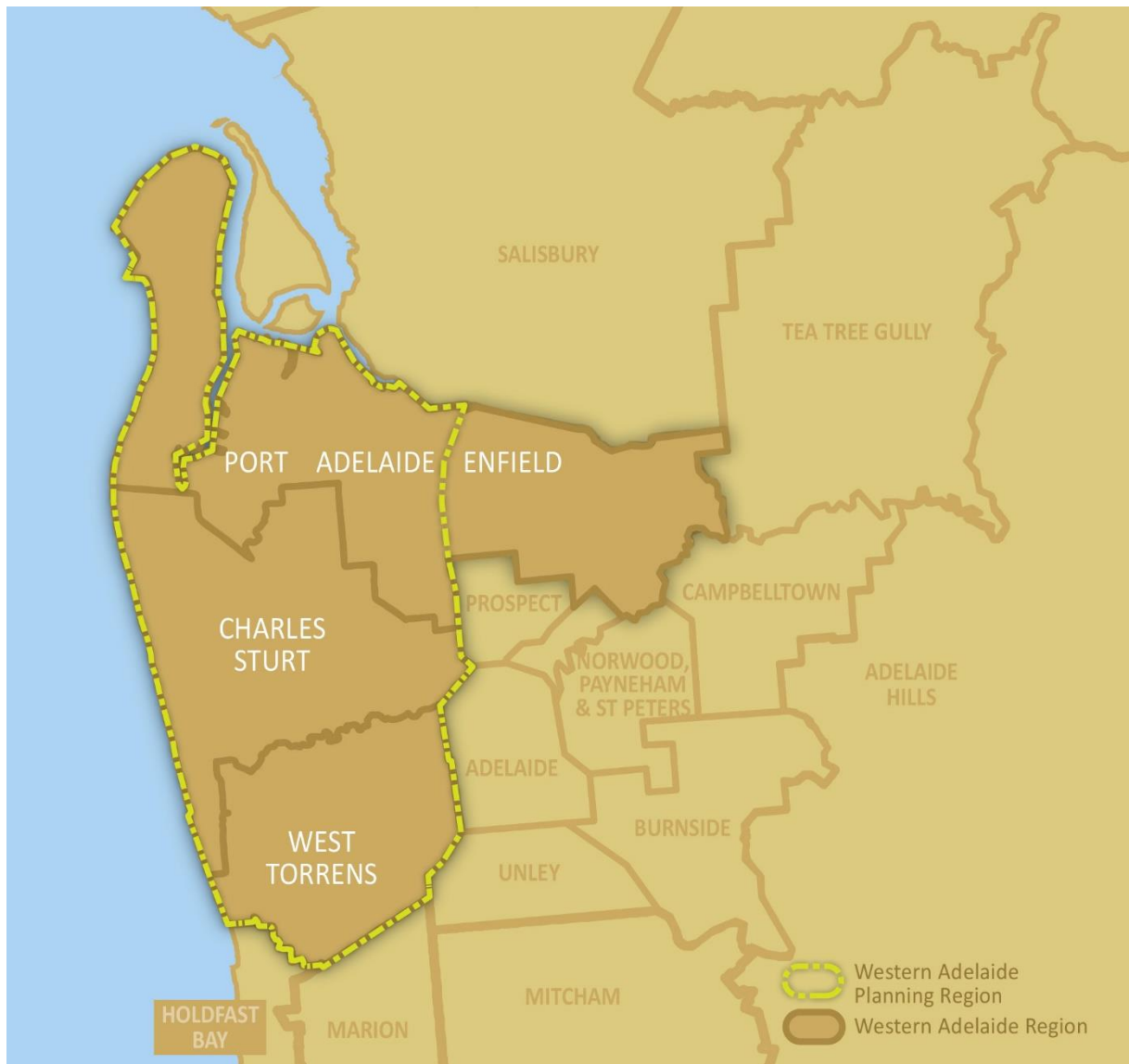


Figure 1 The Western Adelaide Region (showing the Western Adelaide Planning Region boundary)

## 1.2 Adaptation planning context

This Regional Adaptation Plan sits within the context of a number of other planning documents with similar, complementary or overlapping roles.

Each of the Council's strategic and community plans describe goals and strategies relating to climate change adaptation. These are also linked to the State Strategic Plan which includes a strategy to work collaboratively to plan for, and adapt to the impacts of a changing climate, and a number of related targets. South Australia's Climate Change Strategy 2015-2025 is also related and describes initiatives to create a resilient state including initiatives to build coastal resilience and developing a state wide whole of government Adaptation Action Plan. The City of West Torrens also has a council specific climate change action plan which describe council initiatives to reduce carbon emissions and prepare for climate change.

Preparing for climate change is one of the key 'pillars' of the South Australian Public Health Plan and subsequently each of the Councils' Public Health Plans include related strategies. The preparation of the Zone Emergency Management Plans included risk assessments and identified priority risk treatments for flooding and extreme weather (extreme heat and extreme storm). Although the risk assessments did not include consideration of how climate change may impact the likelihood of hazard events occurring, many of the risk treatments and control improvements contribute to adaptation.

These plans also plays an important role in supporting the Region's people, environment and economy to be prepared for and adapt to climate change.

## 1.3 Overview of the Western Adelaide Region

The Western Adelaide Region is a significant part of the Adelaide metropolitan area, with a total population estimated at 271,850 people, or 22% of the population of Greater Adelaide<sup>2</sup>. The Western Adelaide Region is predominantly residential with 59% or more than 10,000 hectares of land zoned for residential land uses. This is followed by industrial land which comprises 23% or 3,900 hectares of zoned industrial land<sup>3</sup>.

The Western Adelaide Planning Region generates \$16.9 million dollars in Gross Regional Product (GRP) in 2013/14, 17.5% of the Gross State Product<sup>4</sup>.

The Western Adelaide Region is home to 21,450 businesses comprising a mix of small and large firms, with key sectors being construction, manufacturing, wholesale, retail activities and transport. The Region is home to some of the State's key infrastructure such as Adelaide Airport, the port and wharf facilities, West Beach Waste Water treatment plant and the Torrens Island and Pelican Point power plants as well as significant industries such as Adelaide Brighton Cement, Shell Bitumen Plant and Adelaide Submarine Corporation.

The Western Adelaide Region has less open space (including parks, reserves and outdoor sporting areas) than other metropolitan Adelaide regions. Approximately 1,400 hectares or 8% of the Region comprises open space, compared to Resilient South (Southern Adelaide) with 14% open space and Resilient East,

---

<sup>2</sup> ABS Basic Community Profile 2011 for the Cities of Port Adelaide Enfield, Charles Sturt, West Torrens and Greater Adelaide

<sup>3</sup> Department of Planning, Transport and Infrastructure, Land use generalised, updated June 2012.

<sup>4</sup> Department of the Premier and Cabinet, Regional profile Western Adelaide, 2013/14.

with 15% open space<sup>5</sup>. Key environmental assets located in the Region include the beaches along Gulf St Vincent and dunes at Tennyson and Semaphore, as well as the River Torrens, Port River estuary and mangroves at Mutton Cove and the Barker Inlet. These open space and natural areas provide important habitat and biodiversity, contribute to the health and wellbeing of residents and visitors and contribute to the character and amenity of the Region.

The proportion of the population aged over 65 has been declining in the Western Adelaide Region, although it is still higher than the Greater Adelaide Region. The community is culturally diverse with higher proportions of residents born overseas and speaking a range of languages other than English than the Greater Adelaide Region. This is combined with lower levels of proficiency in English. The Region also has a slightly higher proportion of indigenous people than the Greater Adelaide Region<sup>6</sup>.

There is considerable diversity in incomes and qualification levels across the Region, with pockets of high income households in some places, and concentrations of income support recipients in others. The region has higher proportions of people receiving income support, particularly in the City of Port Adelaide Enfield.

The Western Adelaide Region has higher rates of self-assessed fair or poor health, higher rates of key health risk factors (eg smoking, harmful use of alcohol, physical inactivity or obesity) and above average proportions of people requiring assistance with core activities, rates of chronic disease and psychological distress<sup>7</sup>.

The Stage One report and research papers listed at section 1.3 provide comprehensive detail regarding the economic, social and environmental characteristics of the Western Adelaide Region.

---

<sup>5</sup> Department of Planning, Transport and Infrastructure, Land use generalised, updated June 2012.

<sup>6</sup> ABS Basic Community Profile 2011 for the Cities of Port Adelaide Enfield, Charles Sturt, West Torrens and Greater Adelaide

<sup>7</sup> 2007/08 National Health Survey via the 2011 Social Health Atlas of Local Governments

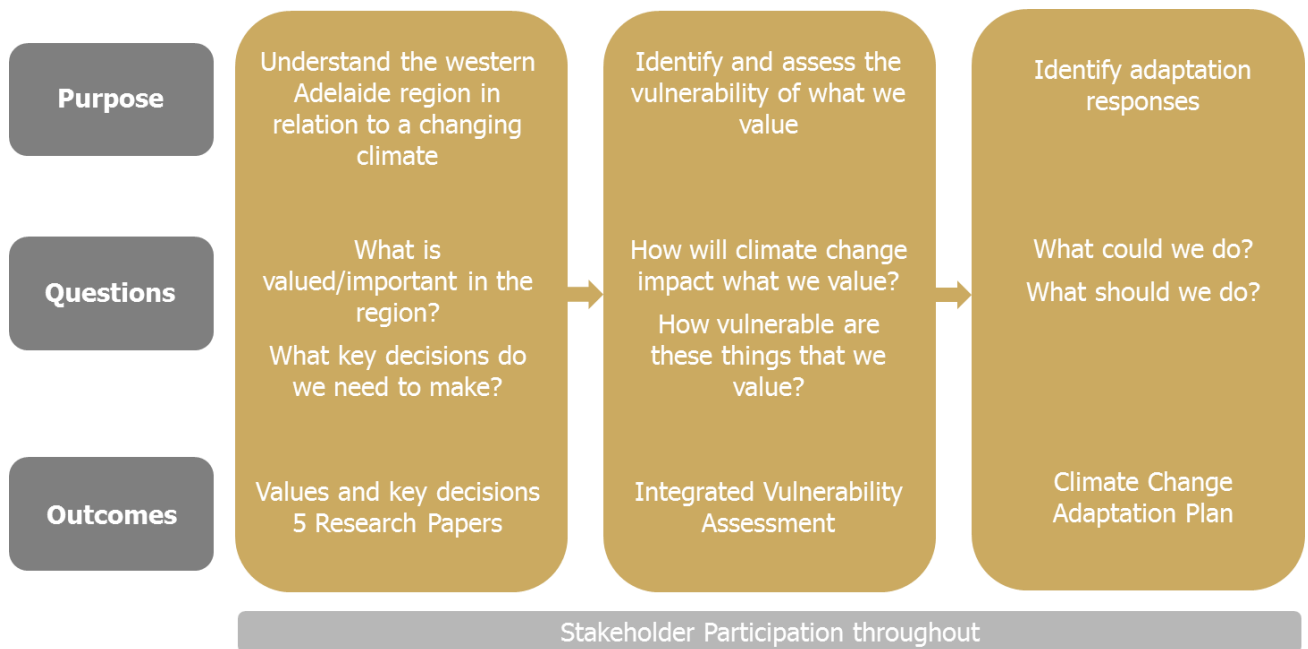
### 1.4 How has this Regional Adaptation Plan been developed?

In 2013, an initial stage of work was completed comprising the preparation of a social, economic and environmental profile of the Western Adelaide Region, and collation of historical climate observations and future climate projections<sup>8</sup>. AdaptWest builds on this work.

This Regional Adaptation Plan was developed over three key stages (refer Figure 2) involving the active participation of the Region’s key stakeholders, players and influencers in order to provide a strong foundation for ongoing coordination and collaboration to tackle the challenges of climate change into the future. The three project stages incorporated a series of workshops involving representatives of organisations that play a role in the Region’s:

- Assets, infrastructure and economy
- Coastal management
- Environment and open space
- Social and community resilience and health
- Urban planning and development

Appendix A lists those organisations and sectors that contributed to the preparation of the Regional Adaptation Plan.



**Figure 2 Overview of approach to preparing the Regional Adaptation Plan**

<sup>8</sup> SKM (2013) *Western Adelaide Region Climate Change Adaptation Plan – Stage 1*

Delivery of these three stages resulted in the preparation of the following key reports.

- Research papers relating to the following themes:
  - > Assets, infrastructure and economy
  - > Coastal management
  - > Environment and open space
  - > Social and community resilience and health
  - > Urban planning and development
- Identifying climate variables for use by the Integrated Vulnerability Assessment for the Western Adelaide Region Report-this report documents the approach to identifying the climate variables to be used by the Integrated Vulnerability Assessment.
- Integrated Vulnerability Assessment Report- this report documents the assessment of valued aspects and features to determine their vulnerability to the impacts of climate change.
- Regional Adaptation Plan - this report identifies adaptation options for the Region to build resilience and adapt to the impacts of climate change in relation to key areas of vulnerability and take advantage of any opportunities.

## 1.5 Guide to reading this Regional Adaptation Plan

Table 1 provides an overview of the content of each section of the Regional Adaptation Plan.

**Table 1 Guide to the Regional Adaptation Plan**

Section	Purpose
1 Introduction	Describes the AdaptWest project partners, who the Plan belongs to, what it hopes to achieve and how it has been prepared
2 How will climate change be experienced across the Western Adelaide Region?	Summarises the current and projected climate for the Western Adelaide Region. This information was used to understand risks and opportunities presented by climate change
3 Understanding vulnerability and identifying areas for focussing adaptation action	Provides an overview of how areas for focussing adaptation action were identified based on: <ul style="list-style-type: none"> <li>• Understanding what is valued in the region</li> <li>• Implementation and analysis of the Integrated Vulnerability Assessment</li> <li>• Identification of key decision areas for adaptation action</li> <li>• Identification and assessment of adaptation options utilising adaptation pathways analysis</li> </ul>
4 Adaptation options for the Western Adelaide Region	Provides further detail regarding adaptation pathways analysis Describes the pathway maps and how to interpret them Describes the adaptation options identified for each key decision area

Section		Purpose
5	Priorities for adaption in the Western Adelaide Region	Identifies 10 priority adaptation options for the Western Adelaide Region with reference to the Adaptation Priorities Action Plan
6	Enabling adaptation action	Identifies enabling conditions to support the implementation of the Regional Adaptation Plan
7	References	List of documents referred to in the Plan
	Appendix A	List of organisations/sectors that participated in the preparation of the Regional Adaptation Plan
	Appendix B	Regional Adaptation Priorities Action Plan which proposes cross-sectoral, regional actions for adaptation options for more immediate implementation as well as identification of leaders and partners for actions. Also includes maps that identify potential locations for initially targeting actions associated with regional adaptation responses
	Appendix C	Vulnerability mapping in relation to key climate variables (sea level rise and flooding)
	Appendix D	Mapping of key features and characteristics of the Western Adelaide Region

## 2 How will climate change be experienced by the Western Adelaide Region?

To assist with preparing the Regional Adaptation Plan, climate projections were prepared and documented in the 'Identifying climate variables for use by the Integrated Vulnerability Assessment for the Western Adelaide Region Report'<sup>9</sup>.

Climate projections differ depending on a range of factors including which climate model, concentration pathway (previously referred to as emissions scenario) and timeframe for the concentration pathway are selected.

The Project Steering Committee overseeing the preparation of the Regional Adaptation Plan considered the range of projections that could be used and chose to use data from the median model outputs to 2070 under a medium (emissions) concentration pathway (RCP4.5).

This data was used to identify climate variables which describe various aspects of the future climate such as:

- Average maximum and minimum temperatures
- Temperature at different times of the year eg summer versus winter
- Frequency and intensity of heatwaves
- Quantity and seasonality of rainfall
- Intensity of extreme rainfall events
- Sea level rise
- Water temperatures in the Gulf St Vincent
- Acidification of the waters of Gulf St Vincent










The changes in climate projected for the Western Adelaide Region are summarised by Table 2.

---

<sup>9</sup> AdaptWest (2014) *Identifying climate variables for use by the Integrated Vulnerability Assessment for the Western Adelaide Region* prepared as part of the AdaptWest consultancy led by URPS, for the Western Adelaide Region in association with the Government of South Australia and the Australian Government



Table 2 Summary of climate projections for the Western Adelaide Region

Climate Variable	Description (change by 2070)
 <b>AVERAGE TEMPERATURE</b> <i>Winter &gt; Spring</i>	An increase in average annual temperatures of up to 2°C (1-2.5°C) is projected in winter and 2°C (1-3°C) in spring across the Region by 2070
 <b>AVERAGE TEMPERATURE</b> <i>Summer &gt; Autumn</i>	An increase in average annual temperatures of up to 2°C (1-3°C) is projected in summer-autumn across the Region by 2070
 <b>AVERAGE RAINFALL</b> <i>Winter &gt; Spring</i>	Average winter rainfall predicted to decrease by up to 20% (5-20%) and spring rainfall by up to 20% (10-40%) below 1990 levels by 2070
 <b>AVERAGE RAINFALL</b> <i>Summer &gt; Autumn</i>	Average summer rainfall predicted to decrease by up to 10% (2 to 10%) and autumn by up to 5% (2 to 10%) below 1990 levels by 2070
 <b>EXTREME HEAT</b>	Sequences of three or more consecutive days with average temperatures of at least 32°C are projected to increase from 1 in 20 years under the baseline period to one in every 3-5 years under a low emissions scenario in 2070 and every year under a high emissions scenario by 2070
 <b>RAINFALL INTENSITY</b>	Climate models suggest that for each degree of global warming, extreme daily rainfall may increase by 7%
 <b>SEA LEVEL RISE</b>	Global mean sea level rise for 2046–2065 relative to 1986–2005 could be 0.26 m for more moderate emissions outlooks and up to 0.48 m by 2081–2100
 <b>SEA SURFACE TEMPERATURE</b>	By 2046–2065 warming of the ocean could result in a 1.4°C rise in global sea surface temperatures under a medium emissions outlook relative to 1986–2005 and a 1.8–2.2°C rise by 2081–2100
 <b>OCEAN ACIDITY</b>	Projections for decreasing pH range from 0.06 to 0.32 pH units by 2100, with a best estimate more likely to be in the order of a 0.2 pH unit decrease

## 3 Understanding vulnerability and areas for focussing adaptation action

The key objective of the Regional Adaptation Plan is to identify adaptation actions that reduce or address key vulnerabilities that are presented by climate change or build on areas of resilience and take advantage of opportunities.

The Integrated Vulnerability Assessment (IVA)<sup>10</sup> undertaken in stage two of the project assessed 51 indicators that related to aspects or features valued by the Western Adelaide Region to understand how they might be vulnerable to climate change. These indicators related to aspects or features of the Western Adelaide Region which were considered to contribute to the following values identified during stage one of the project:

- Amenity and quality of life
- A strong and connected community
- Biodiversity
- Coastal and riverine water quality
- Coastal environment
- Infrastructure and essential services
- Management and use of stormwater
- Regional productivity and economic contribution to the State.

### 3.1 What is an IVA?

The IVA is a tool that enables consideration of both the potential impact of climate change (exposure and sensitivity) and adaptive capacity (refer Table 3 for definitions). Once implemented, analysis of the IVA enables aspects or features of the Region that may be more vulnerable than others to the impacts of climate change to be determined. This then allows areas of focus to be identified for adaptation planning.

---

<sup>10</sup> AdaptWest (2015) *Integrated Vulnerability Assessment* prepared as part of the AdaptWest consultancy led by URPS, for the Western Adelaide Region in association with the Government of South Australia and the Australian Government

**Table 3 Definition of key terms**

Term	Definition
<b>Exposure</b>	Exposure considers the likelihood of a feature or its function being subjected to change in relation to a particular climate variable. For example low lying land is more exposed to inundation from flooding, the entire Region is exposed to heatwaves and locations along the coast are more exposed to sea level rise. For AdaptWest, exposure relates to predicted changes in the climate at 2070.
<b>Sensitivity</b>	Sensitivity considers the degree to which a feature or its functions are affected by change to a particular climate variable. For example, older people are more sensitive to heatwaves, non-irrigated open space is sensitive to reduced rainfall and coastal development is sensitive to sea level rise.
<b>Adaptive capacity (to cope with 2070 conditions)</b>	Adaptive capacity is the ability or potential of a feature or function to adjust to climate change impacts (including climate variability and extremes). It enables systems to moderate potential damages, take advantage of opportunities, or cope with consequences and maintain the valued characteristics of that feature or function. Consideration is given to what extent a feature or its function in its current form, with current management practices or funding, is able to continue to function, cope or adjust to the expected climate conditions at 2070. For example, water sensitive urban design (WSUD) can provide the ability for a streetscape to function in response to reduced rainfall, but if no WSUD measures are in place now, then the adaptive capacity would be considered to be less than if WSUD was currently in place.

### 3.2 What did the IVA tell us?

Table 4 summarises those valued aspects or features of the Western Adelaide Region that were identified via analysis of the IVA as having a higher vulnerability to climate change than others.

**Table 4 Indicators that were assessed by the IVA as having a higher vulnerability to climate change**

Indicators assessed as having higher vulnerability to climate change
Condition and extent of beaches and dunes
Condition and extent of native vegetation cover by vegetation type
Condition of benthic habitat (eg sea grass, pests)
Condition of built cultural heritage (eg heritage buildings, bridges, monuments, public art)
Contribution to Gross Regional Product (Western Adelaide)
Effective functioning of active recreation and sporting sites (indoor and outdoor)
Effective functioning of built assets and contents (houses)
Effective functioning of cycling and walking infrastructure (eg footpaths etc.)
Effective functioning of recreation facilities (eg Surf Life Saving Clubs, playgrounds)
Effective functioning of stormwater management infrastructure (drains, gutters, pipes)
Effective operation of built assets and contents (business and industry)
Effective operation of coastal assets
Effective operation of electricity supply
Effective operation of rail network
Effective operation of road network
Incidence of anti-social behaviour
Incidence of social behaviour-Neighbourly interactions
Members of the community living with mental health problems
Members of the community who require assistance for core activities

**Indicators assessed as having higher vulnerability to climate change**

Members of the community with poor self-assessed health  
 Older members of the community (aged >75)  
 Potential for future industrial development  
 Quality of water – coastal/estuaries  
 Quality of water - inland waters

### 3.3 Transitioning from the IVA to adaptation planning

Adaptation pathways analysis was used to prepare the Regional Adaptation Plan. An important step in undertaking this approach is to frame the areas of focus identified by the analysis of the IVA as ‘key areas of decision making’.

Key areas of decision making comprise questions that the Regional Adaptation Plan is looking to respond to and are made up of three elements:

- The objective of what the Western Adelaide Region is looking to achieve in relation to an aspect or feature that is valued. For example, to provide, protect and manage [the aspect or feature].
- The valued feature or aspect that the Region is focussed on. For example, the health, safety and wellbeing of members of the community with vulnerabilities.
- The reason why the Region needs to take action, ie in response to a particular climate impact such as increased frequency and intensity of heat waves.

For AdaptWest, ten key areas of decision making were developed as summarised in Table 5 and their development is directly linked back to the IVA analysis (refer Integrated Vulnerability Assessment Report).

**Table 5 AdaptWest key areas of decision making**

Theme	Key area of decision making
<b>Business and industry</b>	How do we enable business and industry to prosper as rainfall intensity increases and the sea level rises?
<b>Community resilience</b>	How do we build a strong and connected community and improve the health, safety and wellbeing of people with vulnerabilities as more frequent and intense heatwaves and flood events occur?
<b>Estuarine waters</b>	How do we maintain the amenity and function of estuarine waters as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?
<b>Natural landscapes-coastal</b>	How do we protect and enhance the condition of natural coastal landscapes as the sea level rises?
<b>Open and green spaces and recreation</b>	How do we provide, protect and manage open and green spaces as we experience warmer and drier conditions, more frequent and intense heatwaves and sea level rise?
<b>Public coastal built assets</b>	How do we provide, protect and manage public coastal assets as the sea level rises?
<b>Stormwater management infrastructure</b>	How do we design, construct and maintain stormwater management infrastructure as annual rainfall declines, rainfall intensity increases and the sea level rises?
<b>Transport and essential services</b>	How do we minimise disruption to transport and essential services as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?

Theme	Key area of decision making
Urban living	How do we create better amenity and liveability in our urban areas as our climate becomes warmer and drier, we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?
West Lakes <sup>11</sup>	How do we maintain the amenity and function of West Lakes as we experience increased rainfall intensity and sea level rise?

### 3.4 Understanding adaptation pathways analysis

As referred to above, adaptation pathways analysis has been used to prepare this Regional Adaptation Plan.

Adaptation pathways provides a way of considering and visualising adaptation options. Rather than being limited to identifying the best single set of adaptation options, it enables decision makers and communities to consider a range of possible actions, how they will be impacted by climate change through time, and whether any options have a ‘used by date’ (ie a point in time at which they are no longer viable or useful for addressing the impact being experienced). It also enables the exploration of what combination of options are most suitable for adapting to future climate change and how these could be sequenced over time (ie what should be done now, versus what can be delayed). This type of analysis can break down the disempowering sense that ‘everything’ will be affected by climate change, or that everything needs to be done at once. It can also assist with understanding where investment might be required over time.

---

<sup>11</sup> Note that this key area of decision making is an evolution of an initial theme related to ‘inland waters’. The focus on West Lakes provided the opportunity to pilot a new approach to utilising adaptation pathways in a location-specific context (refer section 4.11)

## 4 Adaptation options for the Western Adelaide Region

Adaptation options have been identified and assessed in relation to the ten key areas of decision making (refer sections 4.2 to 4.11).

To develop adaptation options for each of the key areas of decision making, a range of information generated by the project was drawn upon including the project reports described in Section 1.3.

For each key area of decision making the following aspects are discussed:

- why the area of focus is important to the Region,
- how projected climate change may impact that area of focus, and
- how the Region can respond through adaptation.

Critical to the identification and assessment of adaptation options for each key area of decision making was the consideration of the aspects summarised by Table 6. The majority of information documented in response to these aspects was generated by stakeholders from the Region at the adaptation options workshops.

**Table 6 Key considerations for identifying and assessing adaptation options**

Consideration	Questions we asked our Region	Why is it important to consider this?
Current practice	What are we currently doing in relation to the key area of decision making?	By understanding what we are doing now, we can think about what else we might need to do in the future as the climate changes
Thresholds for changing our approach	What are our levels of tolerance, or thresholds, for changing what we are doing as we experience changes in climate?	By understanding thresholds, we can identify when we might need to change our approaches so we can adapt to changes in climate
When what we are doing will no longer be enough to cope	Given what we understand about projected climate change, when might what we are doing no longer be enough to cope with changes in climate?	By understanding what we are doing now and how the climate might change, we can consider when our current approaches may not be enough to cope
Identifying adaptation options	What options are there to respond to the challenge posed by the key decision area?	By identifying options we can take action to adapt
Now or later	What adaptation options should be progressed now or later?	By understanding when options might be needed we can consider how to sequence actions over time as we don't need to do everything all at once
Identifying the preferred combination of options	What is the preferred combination of adaptation of options to be implemented to address the key area of decision making?	By understanding a preferred combination of options, we can plan and implement actions. This recognises that there is often no one adaptation response but multiple ways to address a particular climate impact

## 4.1 Interpreting the pathway maps

In addition to the descriptive text provided for each key area of decision making, a pathway map is also provided. The pathway maps set out the range of adaptation options considered for each key decision area and the preferred adaptation pathway, made up of the preferred combination of options identified by the Region's stakeholders for implementation. The timing for each option and the relationship with other preferred options are also shown on each pathway.

Each pathway should be read in conjunction with the description of the relevant key decision area. Figure 3 describes the symbology used.

The horizontal axis of the pathway shows both a timescale, and expected changes to the climate that are particularly relevant to the key decision area (as identified by the IVA).

The range of adaptation options identified for the key decision area are listed on the left side of the pathway map.

Against each option is a combination of dots and lines that indicate:

- The contribution of the option to the relevant key decision – whether it fully or partly addresses the decision area
- The favourability of the option
- The time period over which the option may be effective
- The time period before an option is implemented during which preparatory work is required
- Decision points where decision makers need to choose between options
- The preferred pathway through all of the options listed.

Each circle on the pathway map represents a decision point, a point in time where decision makers will need to determine whether an option should start being implemented, continue or stop. Vertical lines that are dark green in colour and that connect more than one decision point indicate that at that time, decision makers need to choose whether to start, continue or stop implementing more than one option. Where a vertical line correlates with the x-axis indicates the timing of a decision. Vertical lines can also be light green in colour and not intersect with decision points. This indicates that there will be times when decision makers need to determine whether to continue or commence the planning or lead time for one or more options.

### 4.1.1 Understanding the preferred pathway

The preferred pathway (yellow line/s) identifies which options should be progressed now and into the future based on currently available information and preferences for implementation, including information provided by stakeholders at the adaptation workshops.









The preferred pathway does not preclude current actions that contribute to future adaptation from continuing but rather indicates actions over and above current practice that are required to enable adaptation to climate change impacts. The pathways should be reviewed at least every 5 years, at which time new information may suggest that the preferred pathway should take a different course through potential options.

For some preferred pathways, an end point is identified. End points occur for two main reasons:

- a point in time when the action is no longer considered to be effective in helping to achieve the key area of decision making under the projected climatic conditions. In this instance the action can be said to have reached its 'used-by date'
- the action has been completed. For example, the action involves an initial burst of work or involves a once off process (eg mandate targets for WSUD), after which the focus is on implementation, review and maintenance.

It should be noted that although there was significant stakeholder involvement in the preparation of the pathways, further assessment of options by relevant individual sectors may still be required.

**Figure 3 Pathway map symbology**

	A solid, dark green line indicates the time period over which an option could usefully address the relevant key area of decision making
	A lighter green line indicates time before an option is implemented during which preparatory work is required
	A dashed, thick dark green line indicates that the option contributes to the adaptation solution but only in part
	A solid dark grey line indicates an option that is not favoured
	A lighter grey line indicates an option that is not preferred but that requires time during which preparatory work would be required if such an option was to be pursued
	Circles indicate a decision point, such as when decision makers may need to choose between different options
	A yellow line indicates the preferred pathway through the options (as identified by stakeholders)
	A yellow line with an end point indicates a preferred pathway that has reached a used-by-date, that is, the point at which the option no longer usefully addresses the key area of decision making, or an action has been completed



### 4.1.2 Monitoring and review

This Regional Adaptation Plan presents adaptation options based on information available at the time of its preparation and local knowledge and preferences of those stakeholders who were involved in its development.

It is recommended that the Regional Adaptation Plan be periodically reviewed, and that this review process be consistent with an adaptive management approach. This will enable new information to be considered, including changes in climatic conditions or as adaptive capacity of sectors grows as adaptation responses are implemented.

To support this review process, the establishment of a monitoring and evaluation framework is recommended. This framework should include indicators that seek to understand what success looks like in the context of adaptation responses, as well indicators that seek to monitor thresholds and therefore when changes in adaptation action might need to occur (refer section 4 for potential thresholds).

The development and implementation of the monitoring and review framework associated with this Regional Adaptation Plan should be embedded in the governance structure, and could be one of the aspects that is identified specifically in the Climate Change Sector Agreement (refer section 6).

## 4.2 Business and industry

### Why are business and industry important to the Region?

Business and industry in the Western Adelaide Region are valued for their contribution to the economy of not only the Region, but more broadly the State. Significant commercial and industrial areas are located in the Region, with more than 21,000 small and large businesses providing employment opportunities and contributing to household income. The Western Adelaide Planning Region generated \$16,969 million in Gross Regional Product in 2013/14 (17.5% of the Gross State Product), with key sectors being construction, manufacturing, wholesale and retail trade and transport<sup>12</sup>.

### How will climate change impact business and industry?

The IVA found that the combined effects of sea level rise, storm surge and high volumes of stormwater runoff following high intensity rainfall events could lead to significant inundation of land, transport routes and commercial and industrial buildings. This has implications for the ongoing operation and viability of current business and industrial areas as well as those planned for potential future industrial development, particularly areas surrounding the Port River Estuary. Small businesses were identified as being more vulnerable as they may be less aware of the hazards that may challenge their business, have lower capacity to alter their operation or practice and have lower levels of insurance.

### How do we enable business and industry to prosper as rainfall intensity increases and the sea level rises?

A number of investigations have been undertaken to better understand the impact of increases in rainfall intensity and sea level rise on the Port River Estuary. The Port Adelaide/LeFevre Peninsula Port Adelaide River Seawall Study<sup>13</sup> estimated the potential damages from the combined impacts of sea level rise and land subsidence and recommended seawall infrastructure upgrades. While many buildings in the Port River Estuary may be at risk of inundation in the future, some facilities such as the Australian Submarine Corporation have been constructed considering future sea levels. Despite these efforts and the presence of some existing protection works, the Region's stakeholders determined that these measures will be insufficient on their own to help business and industry prosper as rainfall intensity increases and sea levels rise.

Priorities for adaptation in relation to business and industry are described in Figure 4. There are three adaptation options considered as an immediate priority. **Education and awareness to support business and industry** to understand the risks associated with climate change will contribute to building adaptive capacity. While government agencies will be able to contribute to this task by providing information and supporting awareness raising activities, the sector will need to progress this option by working collaboratively across business groups such as the Western Business Leaders, Adelaide Business Hub and Business SA. Awareness raising will need to consider the threats posed by rainfall induced flooding and storm surge events that will be exacerbated in the future by rising sea levels. It may also be desirable to

<sup>12</sup> Department of the Premier and Cabinet, Regional profile Western Adelaide, 2013/14.

<sup>13</sup> Tonkin (2013) *Port Adelaide/Le Fevre Peninsula/Port Adelaide River Seawall Study*

work with the insurance sector to provide opportunities to increase business and asset owners' understanding of the implications of climate change on insurance risk and their premiums.

Following on from education and awareness raising will be **continuity planning by asset owners and businesses**. This will require business owners to consider how their operations can respond to and recover from unexpected events or disasters including climate-related events such as flooding. Some support to undertake business continuity planning is already available, with the Department of State Development providing a range of resources however there is opportunity to enhance information by providing information relating to the likelihood of disasters occurring and the areas that may be affected (eg through existing flood mapping).

Also required now and into the future is **modelling and mapping to identify assets at risk**. The resulting information can be used to inform private and public sector management responses. In the future, modelling will need to account for revised sea level and rainfall projections as well actual observations of sea level rise and impacts from storm surge events.

With available and new information from modelling and mapping, adaptation for business and industry needs to focus on **using planning policy and design techniques to manage new development in areas at risk**, such as low lying sites in close proximity to Port Adelaide's Inner Harbour. Such planning will reduce the risk to business and industry as sea level rises in the future and rainfall intensity increases.

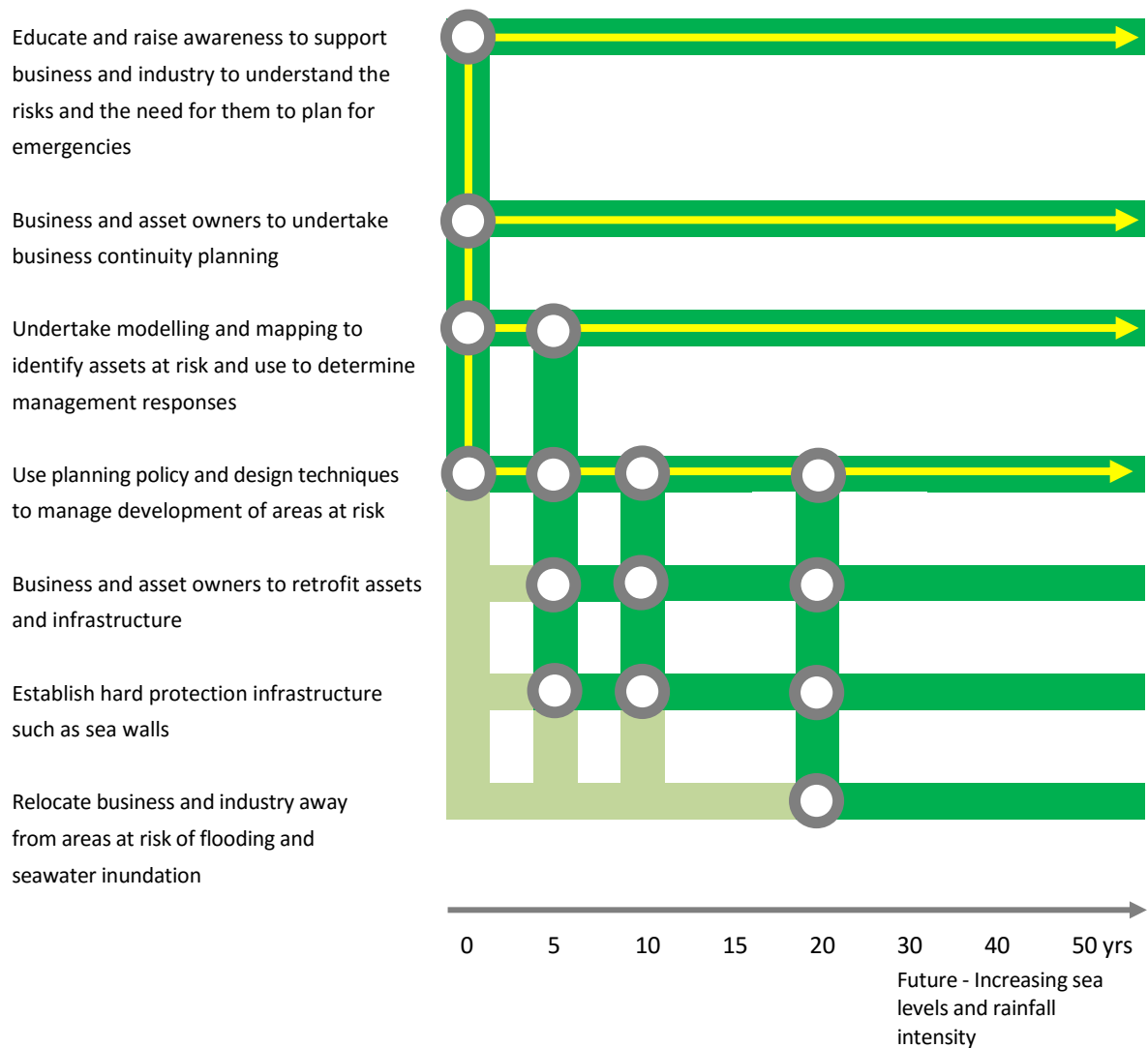
Planning and design for the **sea wall** associated with the Northern Connector has already started and construction is likely to commence within 5 years. Other **major hard infrastructure** like barrages and sea walls around Port Adelaide may also be required in the future and planning for these has also commenced in some locations.

Although not identified as a priority adaptation option now (ie not on the preferred pathway), within 20 years it is anticipated that increasing flood risk will result in the need for some business and industry to relocate to alternate sites in the region. While the implementation of this option may be still some decades away, initial planning for this may be required in the shorter term.

Implementation of future adaptation options will be triggered when certain thresholds are met, with respect to the economy, community, environment or climate. Important thresholds for business and industry are likely to include when:

- Flood risk from storm surge and increasing rainfall intensity can impact business continuity, resulting in declines in the profitability of local business and industry, such as by impacting access to freight routes or through the closure of main street shops and businesses; or
- Operating costs for business and industry increase above viable levels.

In addition to these adaptation options, there may be opportunities for business and industry to benefit through the export of their adaptation knowledge, skills, research or products.



**Figure 4 Adaptation pathways map showing options to enable business and industry to prosper as rainfall intensity increases and sea levels rise**

### 4.3 Community resilience

#### **Why is a strong and connected community and improving the health, safety and wellbeing of people with vulnerabilities important to the Region?**

Maintaining and enhancing the health, safety, wellbeing and connectedness of the Western Adelaide Region's community and in particular people with vulnerabilities, is valued for its contribution to building community resilience to both climate change and other challenging circumstances. Caring for people with vulnerabilities is a particularly important part of building a strong and connected community, and achieving a quality of life for all.

In addition there is significant evidence from around the world that strong and connected communities respond and recover from disasters more effectively<sup>14</sup>. This is reiterated in the *National Strategy for Disaster Resilience*<sup>15</sup> and means that improving community resilience can be a key adaptation response to a changing climate as well as delivering other broader societal benefits relating to the general health and wellbeing of the community.

#### **How will climate change impact upon vulnerable members of the community and community connectedness?**

The IVA found that climate change will adversely impact the health, safety and wellbeing of vulnerable members of the community. Vulnerable members of the community are likely to be more sensitive to climate hazards than the broader population due to factors such as limited mobility, limited capacity, social isolation, and a lack of financial resources. Vulnerable members of the community may also rely heavily on services that are under pressure during extreme heat, heatwaves, and periods of intense rainfall and/or coastal inundation, for example GP and hospital services, community buses, community centres and libraries, and in-home support.

The IVA also found that participation in events, celebrations and organised activities that provide opportunities for social interaction and build community connection will be impacted by climate change due to increasing rainfall intensity and more frequent and intense heatwaves. These changes will impact the ability of spaces and places such as parks and open spaces, community buildings, streets and plazas to hold events, celebrations and activities as well as people's desire and ability to participate. Events may be cancelled more often, rescheduling can be difficult and there are a limited number of indoor or covered venues suitable for larger events.

#### **How do we build a strong and connected community and improve the health, safety and wellbeing of people with vulnerabilities as more frequent and intense heatwaves and flood events occur?**

Significant work is already occurring in the Region to improve the health, safety and wellbeing of vulnerable members of the community, much of which contributes to building adaptive capacity. Public warnings and communication programs aim to build awareness of the risk of extreme heat and flood and the need for preparation. The Region's stakeholders identified that current warnings systems and approaches are not adequate and more targeted action to raise awareness is required. The Red Cross

---

<sup>14</sup> Deloitte Access Economics (2013) *The economic cost of the social impact of natural disasters*.

<sup>15</sup> Australia-New Zealand Emergency Management Committee (ANZEMC) (2011) *National Strategy for Disaster Resilience: Building our nation's resilience to disasters*, <https://www.coag.gov.au/node/81>

Telecross REDI phone service provide calls during heat waves, however, the Region's stakeholders identified that there is a heavy reliance on this service and it is already stretched in its ability to extend its reach.

In addition, programs to build community connectedness include regular activities and special events such as live music and exhibitions, recreation and sporting events at Council open spaces and the beach, library activities and ongoing programs at community centres. Community buses enable those with restricted mobility to access opportunities for socialising and building networks. Despite such initiatives, the Region's stakeholders identified that these actions alone will be insufficient to build a strong and connected community and improve the health, safety and wellbeing of people with vulnerabilities as more frequent and intense heatwaves and flood events occur.

The first three immediate priorities identified for adaptation to build community connectedness and improve the health, safety and wellbeing of people with vulnerabilities include a continuation and improvement of current practices (refer Figure 5). **Communication and education to raise awareness about climate risks and promote appropriate responses** is required with a particular focus on engaging with vulnerable members of the community. This is especially relevant to extreme heat events, which have a major impact on community health and wellbeing. Awareness raising should focus on how to prepare for and cope during extreme heat, where to go for emergency treatment and suggestions for recovering from extreme heat. There are a number of existing publications that should guide this priority including SA Health's *Extreme Heat: Guide to coping and staying healthy in the heat*<sup>16</sup>.

The increased frequency of climate hazard events will required the Region to **increase the capacity of the emergency services sector**. This will require action to increase the "people power" of the sector (both operations and volunteers), improve systems and processes, and increase and enhance communication approaches to preparedness and response (including the use of digital technologies). Council and hazard leaders (including the SES and DEWNR) would be key partners to progress this.

Although already existing, a stronger emphasis needs to be placed on **further developing and enhancing community connectedness programs**. This will require a focus on those activities that build individual as well as overall community resilience such as programs that aim to connect neighbours, organised local events and activities and encouraging people to check on family, friends and neighbours during extreme heat or storm events (eg formalised 'buddy program').

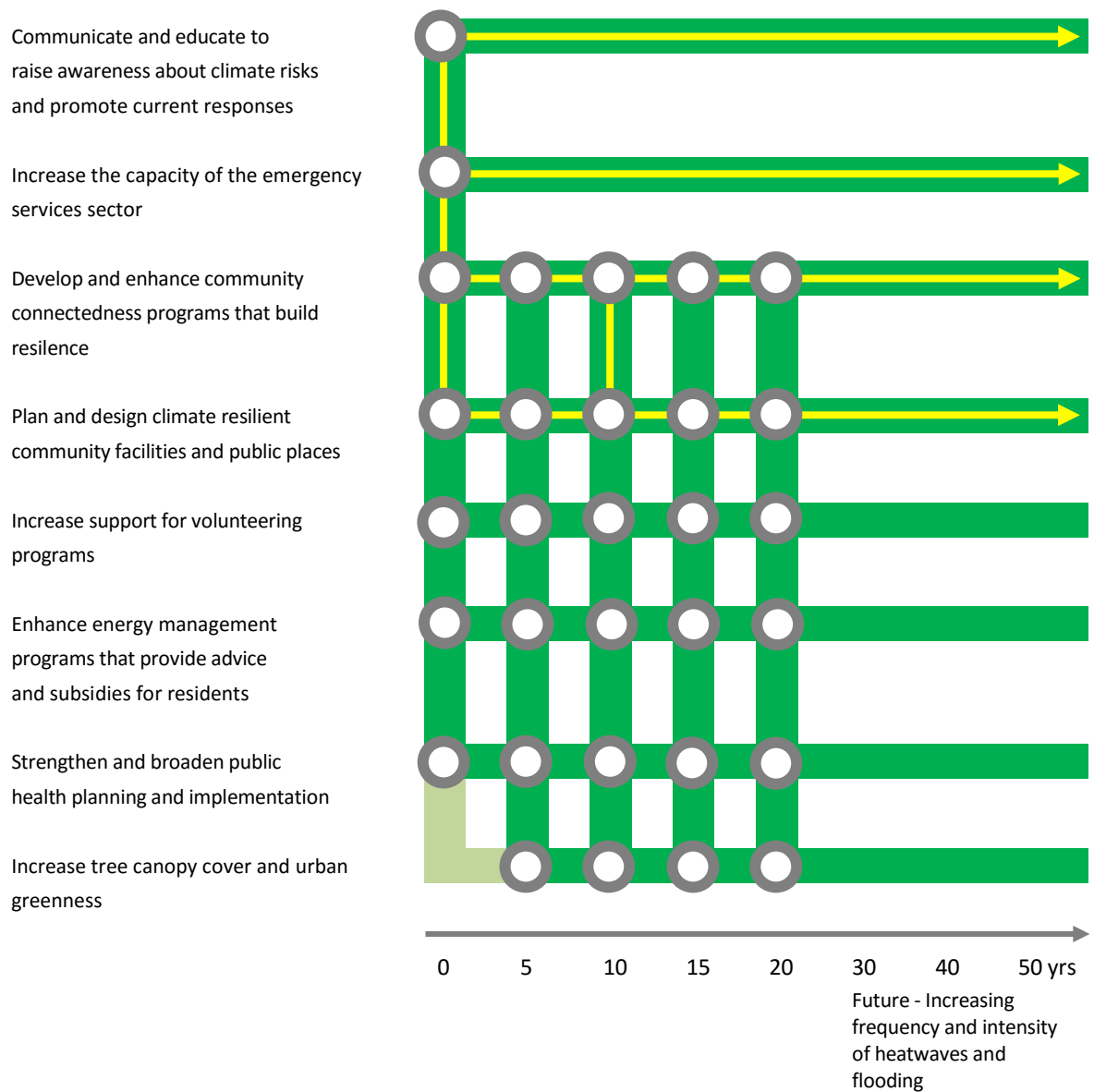
Another important option for immediate implementation is to **plan and design climate resilient community facilities and public places**. This includes developing guidelines for landscaping and building material selection that can withstand different future climate conditions (eg more frequent heatwaves) and avoiding construction of buildings and infrastructure in high risk areas (eg low lying sites close to the coast). Such facilities should also aim to provide a place for people to seek respite from extreme events like heat waves. If facilities are to be used for heat respite, guidance from the SES (as extreme heat hazard leader) should be sought.

---

<sup>16</sup> Government of South Australia (2014) *Extreme Heat: Guide to coping and staying healthy in the heat*

A large number of thresholds were identified that could influence when adaptation options that build community resilience are implemented. These include increased:

- Deaths or hospital admissions as result of extreme events
- Insurance premiums, to the point where insurance is no longer affordable compared with pensions and household income or when event based insurance is so high that activities become cost prohibitive
- Frequency of home floor level inundation (eg occurs more than twice a year)
- Cost of repair from flood or storm damage
- Request for emergency services responding to extreme events
- Number of events cancelled as result of extreme events (eg 2 major events or > 3-4 minor events)
- Frequency of days over 35°C to the point that operating hours of services and facilities need to change
- Flooding of community facilities.



**Figure 5 Adaptation pathways map showing options to build a strong and connected community and improve the health, safety and wellbeing of people with vulnerabilities to cope better with extreme events such as more frequent and intense heatwaves and flooding**



## 4.4 Estuarine waters

### Why are estuarine waters important to the Region?

Estuarine waters in the Western Adelaide Region such as the Port River Estuary and Barker Inlet are highly valued for their contribution to the coastal environment and water quality, amenity and quality of life, biodiversity (supporting mangroves and as fish nursery areas) and to tourism.

### How will climate change impact upon estuarine waters?

The IVA found that climate change will impact estuarine waters by increasing the risk of poor water quality, especially due to algal (cyanobacterial) blooms which will be encouraged by warmer conditions and input of nutrients from stormwater runoff from urban areas as a consequence of more intense rainfall events. Changes in nutrient cycling and primary productivity of estuarine waters are expected as water temperature rises. In addition, changes in water quality are likely to have secondary impacts on valued biodiversity.

### How do we maintain the amenity and function of estuarine waters as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?

Current measures to maintain the amenity and function of estuarine waters are focused on managing stormwater inflows and restricting impacts on existing biodiversity through designated protected areas including the Adelaide Dolphin Sanctuary, the Barker Inlet-St Kilda Aquatic Reserve, Mutton Cove Conservation Reserve and Torrens Island Conservation Park. The Magazine Creek, Range and Barker Inlet wetlands have been designed to improve the quality of stormwater prior to discharge to Barker Inlet. Gross pollutant traps have been installed at the inlets to these wetlands. Stormwater management plans (SMP) including the Torrens Road Catchment SMP recommend a number of water quality improvement measures however the Region's stakeholders identified more work is required to improve stormwater quality. Monitoring programs collect data on water quality, birds, mangrove condition and marine mammals to inform management responses.

Despite current measures to maintain the amenity and function of estuarine waters, the Region's stakeholders agreed that these will be insufficient as we experience more frequent and intense heatwaves, increasing rainfall intensity and sea level rise. The immediate priorities for adaptation are to implement the following options (Figure 6):

- **Continue baseline studies and ongoing monitoring to inform other adaptation actions.** These studies should focus on the quality of water in the Port River Estuary and associated and consequential impacts on estuarine biodiversity. Establishing triggers for monitoring programs will help to inform when new adaptation actions need to be implemented
- **Develop policies to encourage greater adoption of water sensitive urban design.** Significant work is already occurring across local government to develop policies to encourage greater adoption of water sensitive urban design (WSUD), which is resulting these features being installed in new residential and public realm developments. This option is also being supported by the work of Water Sensitive SA, which aims to build the capacity of practitioners in WSUD

- **Build community stewardship of the estuarine environment.** By building community stewardship there will be more people willing to assist with protection and remediation works, and greater community propensity to avoid activities that have a negative impact on the estuarine environment. Building stewardship requires engagement with local residents and people from within the business community so these groups understand the value of the estuarine environment and the ecosystem services provided
- **Improve upstream catchment management.** Many of the water quality impacts on the Port River Estuary are from runoff from upstream urban catchments in the Region. Reducing stormwater pollutant loads and managing stormwater flows through initiatives like Water Proofing the West are required.

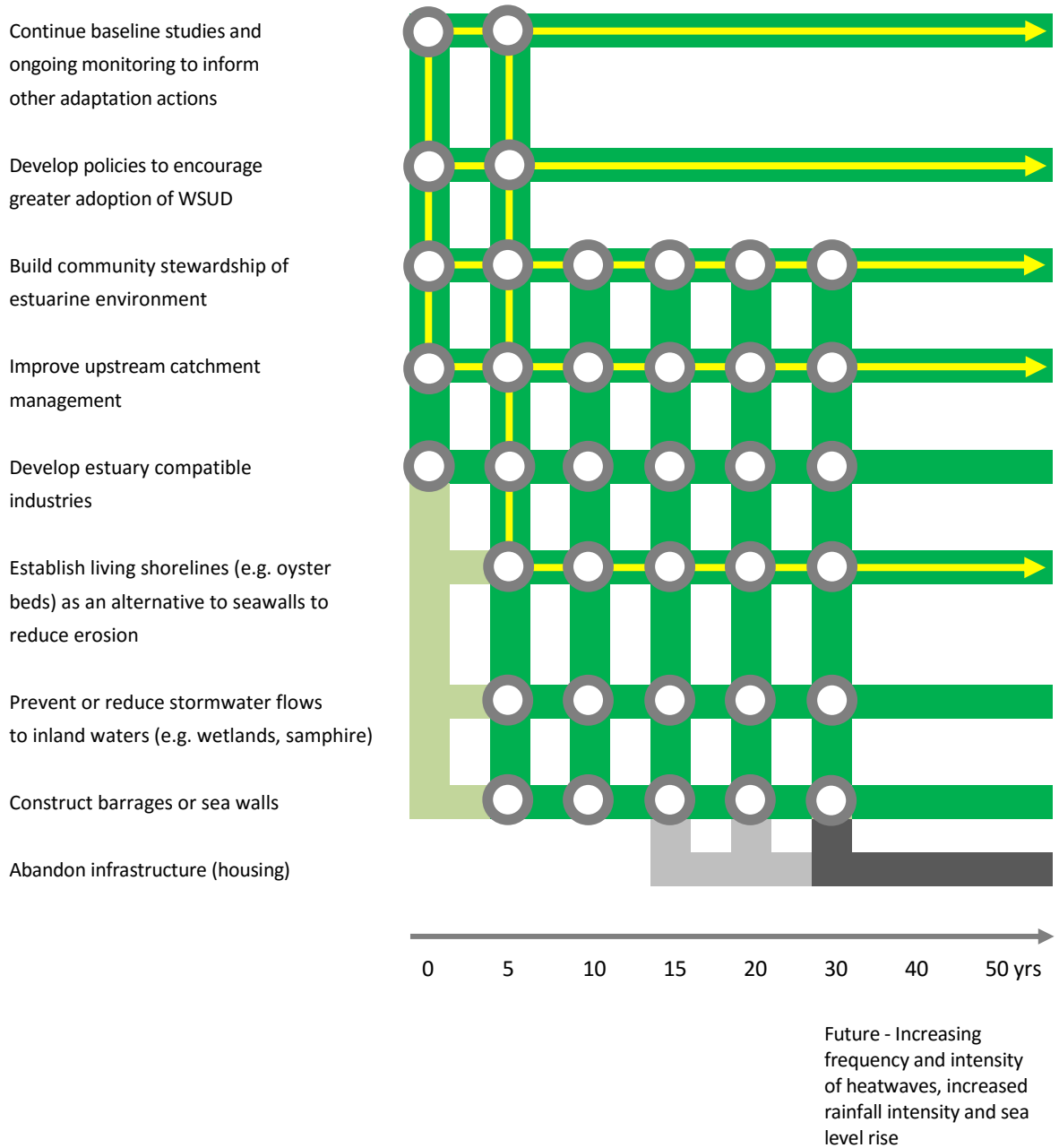
Continuing baseline studies and monitoring and developing policies to encourage greater adoption of water sensitive urban design will require ongoing implementation. In contrast, investment in building community stewardship and improving upstream catchment management will require periodic review to determine the extent to which additional investment is required as rainfall intensity and sea levels rise.

While not required immediately, within 5 years work should commence on **establishing living shorelines**. These systems use natural bank stabilisation techniques and organic materials, such as plants, oyster reefs, logs, sand fill, and stone to provide shoreline protection and maintain habitat. They present an alternative to seawalls as a way to reduce erosion. The next five years present an opportunity to commence field trials of natural shoreline systems. Options for living shorelines are being discussed by the community and Councils however implementation may depend on outcomes of the next iteration of the CPB's Living Beaches Strategy.

Planning and design for the sea wall associated with the Northern Connector has already commenced and construction is likely to commence within 5 years. Other major hard infrastructure like barrages and sea walls around Port Adelaide may also be required in the future and planning for these has commenced.

Within 30 years more significant decisions will need to be made that affect the amenity and function of estuarine waters, such as whether to abandon selected infrastructure (which is not a favoured option at present).

The timing of adaptation options for estuarine waters will be influenced by when certain thresholds are met or exceeded. These are likely to relate to water quality triggers being met or when changes in the environment lead to the loss of mangroves, samphire shrublands or fish nursery areas.



**Figure 6 Adaptation pathways map showing options to maintain the amenity and function of estuarine waters as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise**

## 4.5 Natural landscapes – coastal

### Why are natural coastal landscapes important to the Region?

The coast is a valued environmental, community and economic asset to the Western Adelaide Region and wider community contributing to its amenity and character. Vegetation on the coastal dunes at Tennyson and Semaphore Park provides habitat for birds and animals, stabilises the sandy dunes and provide natural protection for the built assets behind. The coast is also valued for providing opportunities for recreation and community events, as well as being a popular tourist and visitor destination.

### How will climate change impact upon natural landscapes – coastal?

The IVA found that climate change will adversely impact the condition of natural coastal landscapes, especially beaches and dunes, which will erode as sea levels rise. The impact will vary depending on the presence of backshore vegetated dunes, which will provide some degree of adaptive capacity as beaches recede. The beaches south of Bower Road were identified as being particularly vulnerable as they have limited backshore dunes. Natural sand drift north up the coast as a result of wave action is expected to be exacerbated with sea level rise.

### How do we protect and enhance the condition of natural coastal landscapes as the sea level rises?

The Adelaide Living Beaches strategy is a major part of the current action to protect and enhance natural coastal landscapes. Beach replenishment and construction of coastal structures to slow sand drift are key components of the strategy. Sand is transferred from northern beaches by pipeline (for example from the Torrens Outlet to West Beach dunes) or by truck (eg from Semaphore South to Henley south).

On-ground works are supported by the councils and the Adelaide and Mount Lofty Ranges Natural Resources Management Board, including pest plant and animal control, fencing to manage beach access and revegetation. Coastal bushland condition monitoring at several points along the coast is also undertaken regularly. Despite these works programs, the Region's stakeholders determined that these actions alone will be insufficient to protect and enhance the condition of natural coastal landscapes as sea levels rise.

The majority of priority adaptation options are for immediate implementation. Some require completion within the coming decades while others need ongoing delivery (refer Figure 7). A key action to commence immediately is to **review and update the Adelaide Living Beaches Strategy** and reach agreement on **continuing support and funding for implementing the Adelaide Living Beaches Strategy** (including the sand replenishment program). There is no funding commitment beyond the life of the existing strategy (2025). Confirming future funding to implement the next iteration of the Living Beaches Strategy is considered essential for maintaining high value beaches, especially in the southern part of the Region (refer Figure 9). Sand replenishment is important for protecting public coastal assets because beaches provide a soft structural barrier to the impacts of storm surge events.

To be completed within the coming 15 years is **further research and trials into alternative dune stabilisation** vegetation species. Identifying alternative vegetation species that can stabilise dunes without having an adverse impact on native biodiversity could enable 'soft' coastal protection measures to be effective longer, thus delaying the need for hard infrastructure options. Also to occur within 15

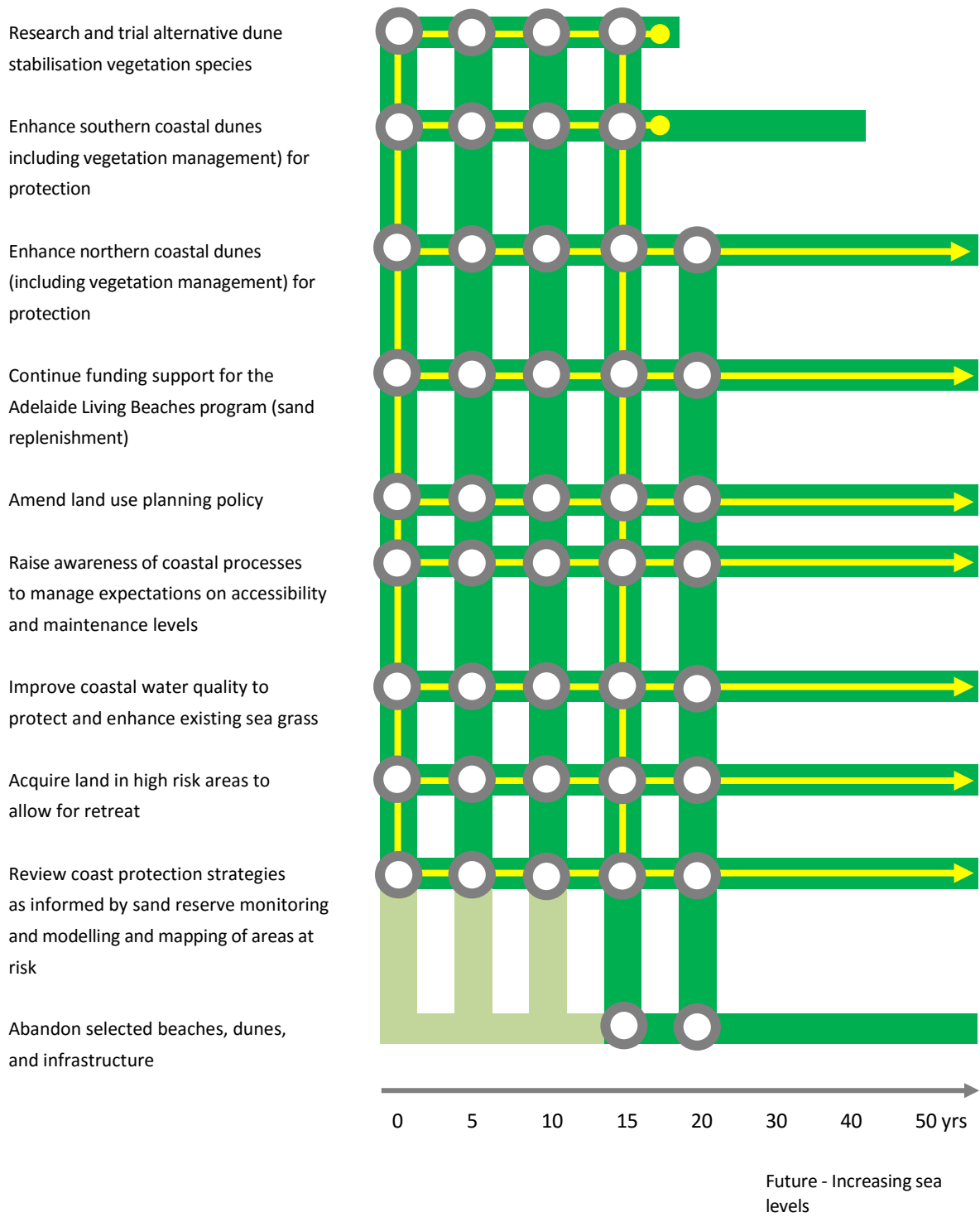
years is **enhancing the southern coastal dunes** (including vegetation management) for protection. While this would ideally be a priority option for the coming 50 years, it is expected that within 15 years the erosion pressure from rising sea levels along this part of the Region's coast (ie south of Bower Road) will mean that this option is no longer viable.

Other adaptation options that require immediate implementation and ongoing delivery are:

- **Enhancing northern coastal dunes (ie north of Bower Road) including through revegetation.** The focus of these works is on protecting the beach and infrastructure located behind the beach, including Lady Gowrie Drive.
- **Amend land use planning policy.** Major infrastructure projects and land division associated with projects including the Northern Connector and saltfields residential development, should consider how to protect local coastal assets and tidal wetlands that will be part of the Adelaide International Bird Sanctuary.
- **Raising awareness of coastal processes to manage expectations on accessibility and maintenance levels.** It is anticipated that this will improve the community's understanding of how sea level rise and associated erosive impacts will influence beach condition and access and the extent to which these can be effectively maintained, especially for southern beaches in the Region.
- **Improving coastal water quality to protect and enhance sea grass.** Sea grass communities in the near-shore marine environment provide significant protection in moderating the impacts of storm surge events and are also important in moderating sand movement in the Region. Improving coastal water quality requires management of inflows (stormwater quality and quantity) and marine activities (including shipping, boating and recreational activities).
- **Acquiring land in high risk areas to allow for retreat.** The natural movement of beaches and dunes as the sea level rises would be to migrate inland. Barriers to natural migration such as roads and other built infrastructure means migration cannot occur and beaches may be lost. Along some parts of the Region's coast, acquiring land in high risk areas will enable retreat, meaning that beaches and dunes can be maintained for longer periods. This will also reduce the investment required in hard structural barriers.
- **Review coast protection strategies.** A review of the Adelaide Living Beaches Strategy should be completed within 10 years, and be informed by monitoring sand reserves and modelling and mapping high risk areas. This review will be able to better inform the ability to protect and enhance the condition of beaches and dunes in the Region, especially those south of Bower Road.

While not a preferred option, within 15 years regional decision makers may need to consider whether to abandon selected beaches, dunes and infrastructure as the impacts of storm surge events mount.

The decision to proceed with adaptation options in coastal natural landscapes will be influenced by a range of environmental and community based thresholds. Environmental thresholds will likely include when large storm surge events result in the major loss of sandy beach, dune vegetation or species of conservation significance. Community thresholds will more likely relate to when restrictions to beach access occur, or when beaches are no longer sufficiently wide for recreational use. Linked to this latter threshold will be the time at which sand replenishment works are no longer sufficient to maintain beaches.



**Figure 7 Adaptation pathway map showing options to protect and enhance the condition of natural coastal landscapes as the sea level rises**

## 4.6 Open and green spaces

### Why are open and green spaces important to the Region?

Open and green spaces in the Western Adelaide Region are highly valued and play an important role in supporting strong and connected communities, and contribute to amenity, quality of life, health and wellbeing and biodiversity. In addition to the aesthetic values and health benefits of green and open spaces, these environments provide locations for active sport, recreation, and entertainment and tourism activities. Street trees and landscaped public realm areas also assist in reducing the urban heat island effect.

### How will climate change impact upon open and green spaces?

The IVA found that the condition of open and green spaces will be adversely impacted by climate change as a result of warmer and drier conditions. The condition of trees, landscaped areas and turf are likely to reduce as soils dry and evapotranspiration increases. Maintenance and replacement requirements of outdoor recreation and playground facilities are likely to increase as extreme heat events become more frequent and intense. Both the condition and usability of open and green spaces along the coast will be increasingly impacted as the sea level rises, with storm surge events leading to more frequent inundation and salt water impacts to turfed areas. Extreme heat events in recent years have resulted in limb drop in mature trees across the Western Region. Increasing frequency and intensity of heatwaves may reduce tree condition with associated risks to public safety as well as amenity.

Open space is often designed to provide stormwater retention, detention or treatment (through swales or wetlands). Increasing rainfall intensity and flooding frequency may impact the function of stormwater management features and this is considered in more detail in section 4.8.

### How do we provide, protect and manage open and green spaces as we experience warmer and drier conditions, more frequent and intense heatwaves and sea level rise?

A number of existing plans, strategies and management actions to manage open and green spaces contribute to their current adaptive capacity including open space strategies, open space provisions, asset management plans and irrigation management. In some areas, open space has been reviewed to prioritise areas for irrigation and irrigation water for some areas is sourced from recycled stormwater through Managed Aquifer Recharge (MAR) systems. Landscaping guidelines are increasing the use of indigenous plants with lower water demands, and shade structures have been installed at many playgrounds.

Despite the development of these plans and strategies and the resulting on-ground works, the Region's stakeholders determined that these actions alone will be insufficient to provide, protect and manage open and green spaces as we experience warmer and drier conditions, more frequent and intense heatwaves and sea level rise.

An immediate priority for the adaptation of open space and recreation facilities (eg sporting fields) is to **implement efficient irrigation practices** to maximise greening of urban space (refer Figure 8). This requires ongoing delivery in the coming decades and will need open space managers to keep abreast of developments in water use efficiency technologies.

Over the coming five years **modelling and mapping for risk management and planning** needs to be completed. While potentially an ongoing action, the five year time frame is required to inform major investment that is likely to be required in the near future, particularly in relation to potential protection works. Complementing this technical work is the need to continue to **increase community awareness and inform expectations regarding management of open space**, identifying areas of open space that may not be able to be maintained given projected coastal inundation. Informing community expectations will also need to identify and explain the plants species that will be used in green spaces given that warmer and drier conditions may require a change in species selection.

Whilst increasing irrigation is one response to hotter and drier conditions, the Region's stakeholders identified that the increasing cost of potable water is likely to limit the ability of Councils to increase irrigation using mains water. The final adaptation option for immediate implementation but ongoing delivery is therefore to **reduce reliance on potable water to irrigate public open space and increase alternative water sources**, including stormwater capture and re-use.

While not required immediately, within 5 years adaptation will need to focus on:

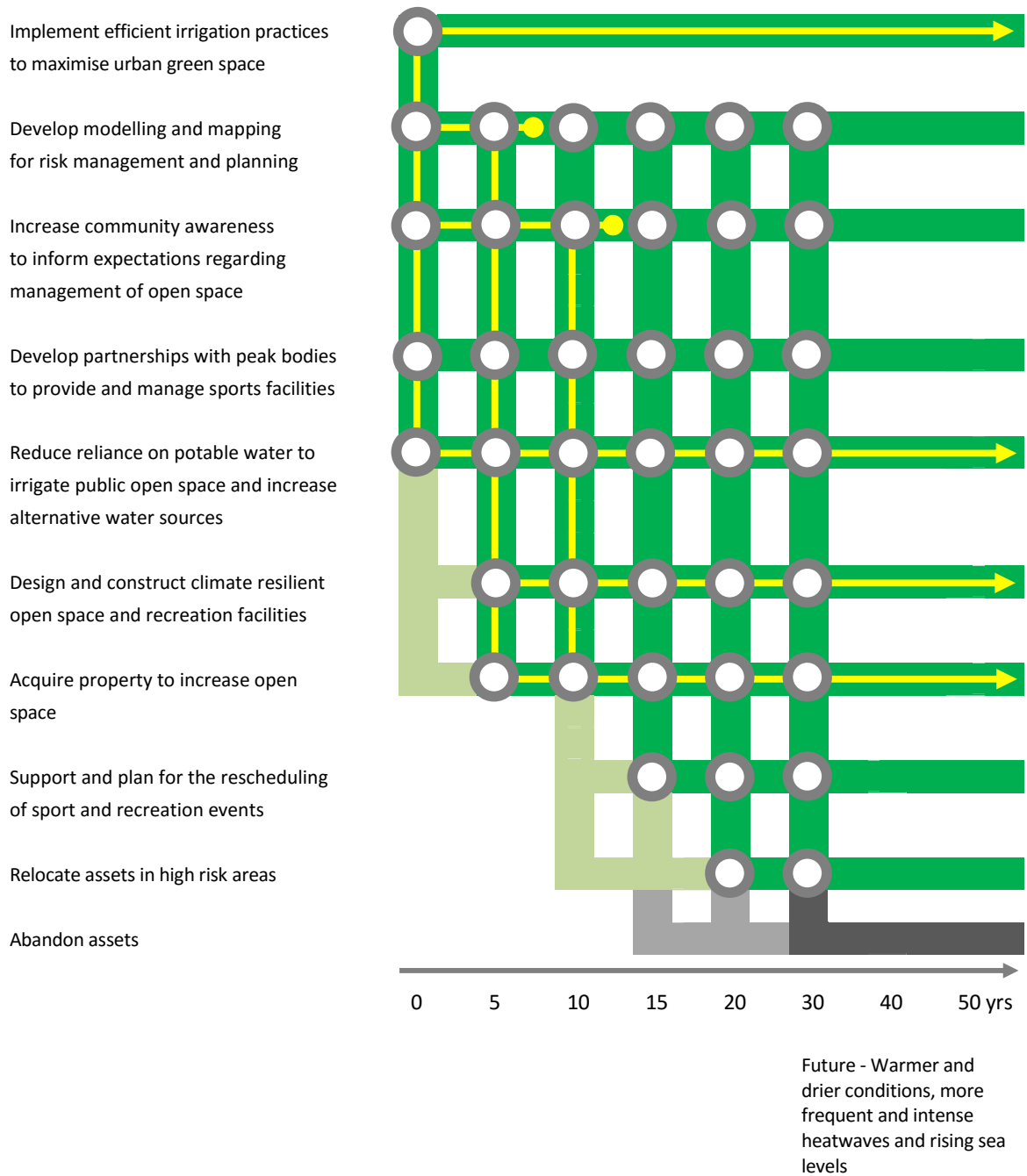
- **Designing and constructing climate resilient open space and recreation facilities.** This will require the use of a range of climate-resilient designs and materials to ensure that investment in new open space and recreation facilities or upgrades takes into account different future climatic conditions. Changes to landscaping practices may also be required, for example reduced areas of turf and more 'urban forest'.
- **Acquiring property to increase open space.** Strategic acquisitions of land will aim to provide additional areas for recreation but will also need to consider how best to maximise urban greenness, reducing the impact of the urban heat island effect.

Although not considered a priority at this stage, there is recognition that relocating some assets in high risk areas, such as low lying areas close to the coast may be required in the decades ahead.

Many of the thresholds regarding adaptation options for the management of open and green spaces relate to impacts on members of the public due to a decrease in functionality. A variety of thresholds were identified and include:

- Increasing extreme weather events such as heatwaves or intense rainfall events impacting on players and the quality of turf leading to the cancellation of events (particularly as the capacity to reschedule events is limited)
- Groundwater requirements to maintain open space exceeding allocated volumes
- Reduced functionality of playgrounds
- Community and elected member expectations not being met by open space and recreation facilities
- Storm damage leading to reduced effectiveness of recreation facilities, particularly coastal assets like jetties, walkways and beach access.





**Figure 8 Adaptation pathway map showing options to provide, protect and manage open and green spaces as we experience warmer and drier conditions, more frequent and intense heatwaves and sea level rise**

## 4.7 Public coastal built assets

### Why are public coastal built assets important to the Region?

Public coastal built assets play a vital role in enabling the use and enjoyment of coastal areas in the Western Adelaide Region and are valued for their contribution to the health and wellbeing and quality of life of residents and visitors. These assets include jetties, beach access paths, boat ramps and Surf Life Saving Clubs, existing sea walls, foreshore open space and cycling and walking pathways.

### How will climate change impact upon public coastal built assets?

Assets in coastal areas are impacted by storms, high tides, salt spray and adjacent development. The erosive nature of beaches and dunes means many of these assets are already at risk, particularly south of Bower Road where limited backshore dunes remain. The IVA found that climate change will impact public coastal built assets as a consequence of inundation caused by the combined effects of sea level rise and storm surge. Periodic or permanent flooding will result in reduced amenity, useability and quality of some assets and consequently less opportunities for people to be active. Physical damage to assets may lead to increased maintenance, repair and replacement costs. Some assets such as beach access paths and older sea walls are not sufficiently robust to withstand damage in current storm events and are likely to be at even greater risk of damage as sea levels rise.

### How do we provide, protect and manage public coastal assets as the sea level rises?

Ongoing management and maintenance of public coastal assets contributes to their current adaptive capacity, however it is recognised that Councils and the Coast Protection Board may be unable to continue to resource maintenance and renewal works. Sand replenishment undertaken as part of the Adelaide Living Beaches strategy is a major component of the current action to protect and enhance beaches however in 10-20 years, this approach may no longer be effective. Stormwater management, in particular management of coastal outflows and drain outlets, has been undertaken across much of the Region but more work is required to prevent erosion and damage to coastal assets. Sea walls have been installed at several locations however less robust, older installations are regularly damaged in storm events.

Despite work to maintain beaches and upgrade or install sea walls, the Region's stakeholders determined that these actions alone will be insufficient to protect and manage public coastal assets as the sea level rises.

A key action to commence immediately is to **review and update the Adelaide Living Beaches Strategy** and reach agreement on **continuing support and funding for implementing the Adelaide Living Beaches Strategy** (including the sand replenishment program). There is no funding commitment beyond the life of the existing strategy (2025). Confirming future funding to implement the next iteration of the Living Beaches Strategy is considered essential for maintaining high value beaches, especially in the southern part of the Region (refer Figure 9). Sand replenishment is important for protecting public coastal assets because beaches provide a soft structural barrier to the impacts of storm surge events.

Also for immediate implementation but ongoing delivery is to use **modelling and mapping for risk management and planning to identify assets at risk**. This will help to confirm and prioritise where

additional capital intensive protection works will be required in the next 5-10 years and into the future. In the future, modelling will need to account for revised sea level projections as well actual observations of sea level rise and impacts from storm surge events. Modelling and mapping outputs can also be used to **raise awareness about coastal processes** such as beach erosion and dune recession and to inform the community about impacts and response options.

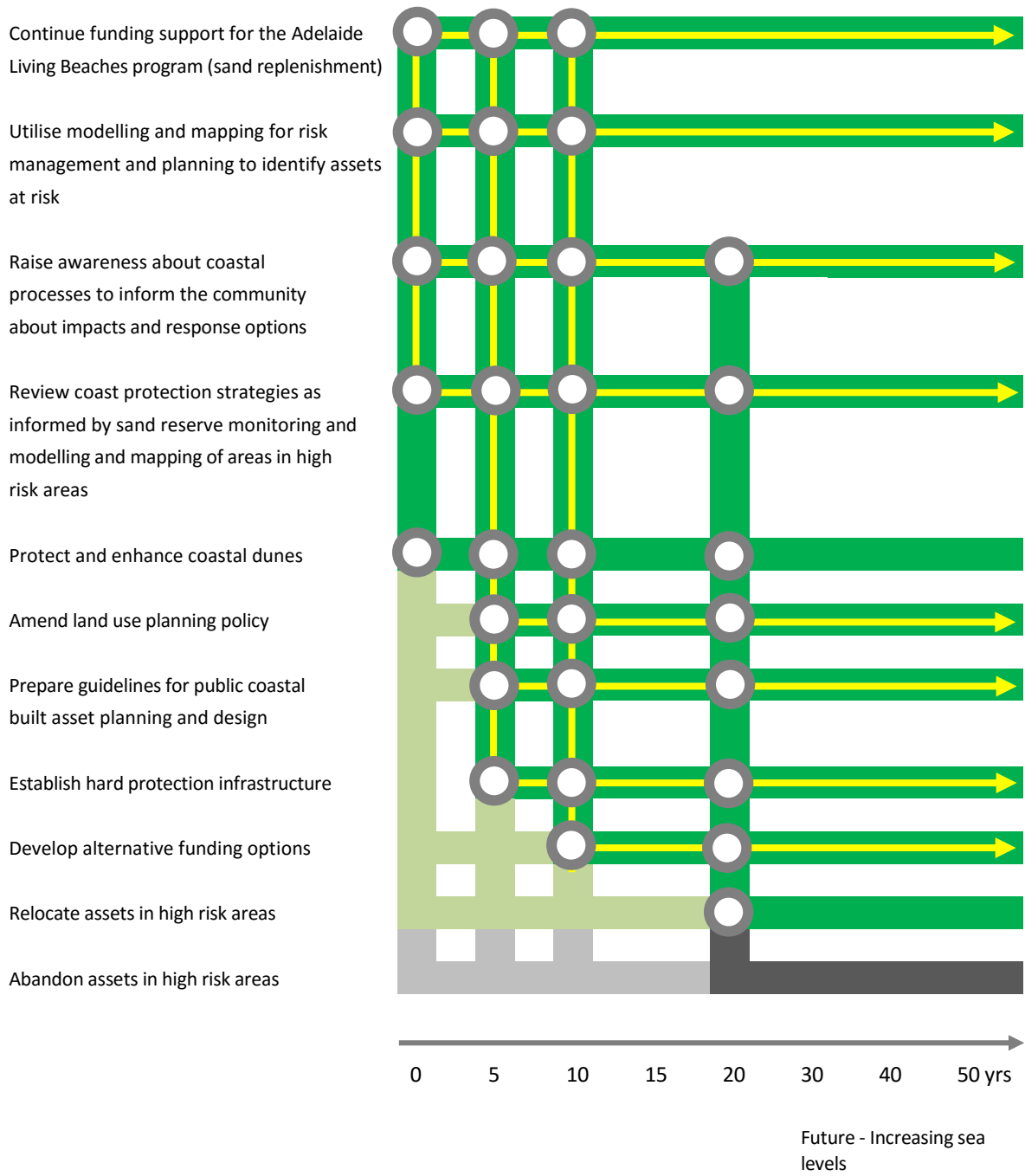
Within five years, **amendments to land use planning policy** will be required, with the aim of ensuring that public coastal assets are not built in areas at high risk from sea water inundation. This will help avoid major costs in the future to relocate or protect such assets. Complementing these policy changes will be the **preparation of planning and design guidelines for public coastal built assets**. This will help to ensure that buildings in areas that may be at higher risk of impact from seawater inundation have appropriate floor heights and structures/assets are designed and constructed using appropriate materials.

Within 10 years, there will be a requirement to **develop alternative funding options** to provide the capital necessary to protect and manage public coastal assets as the sea level rises. This will need to consider funding options from across multiple tiers of government, exploring mechanisms already in place in Australia and overseas. One of the reasons for developing alternative funding options will be to provide the investment needed to construct new **hard protection infrastructure**. While some of this infrastructure already exists in the Region, within 10 years much of it will need to be upgraded and additional structures are likely to be required.

At this stage, abandoning public coastal assets that are impacted by sea level rise is not supported.

A range of thresholds are relevant to triggering decisions to implement adaptation options that will provide, protect and manage public coastal assets as sea levels rise. These include:

- Flood impacts that damage built assets, cause over-floor flooding and disruptions to transportation from road closures.
- Increasing maintenance costs and frequency of repairs to assets. An important trigger for action will be when these costs become unviable for Councils, particularly regarding the management of beach sand erosion.
- Damage to public assets such as levee banks and built structures due to sea level rise or storm surge.
- Reduced public access to facilities like surf lifesaving clubs leading to community services not functioning effectively.



**Figure 9 Adaptation pathway map showing options to provide, protect and manage public coastal assets as the sea level rises**

## 4.8 Stormwater management infrastructure

### Why is stormwater management infrastructure important to the region?

The management and use of stormwater is valued by the Western Adelaide Region as it contributes to the protection of housing and other development from flooding and can be collected and harvested for irrigation thereby contributing to the greenness and amenity of the Region. Stormwater management infrastructure is vital to improve the quality and quantity of discharges to receiving waters. Water quality in coastal waters, West Lakes and the Port River and Barker Inlet affects aquatic biodiversity in these receiving environments, as well as impacting recreational use and amenity.

### How will climate change impact upon stormwater management infrastructure?

The IVA found that stormwater management infrastructure will be impacted in a variety of ways. The capacity of pipes and drains and areas of open space designed to provide stormwater detention are likely to be limited in their capacity to manage (detain and drain) increasing rainfall intensity and flooding. The operation of stormwater wetlands may be reduced as water regimes change and longer dry spells occur and the operation of stormwater outlets and pump stations will be periodically affected by the combined effects of sea level rise and storm surge. The Region's stakeholders noted in particular that above ground stormwater infrastructure such as gutters and drains, are designed for low rainfall events and a slight increase in rainfall intensity may have a marked impact on infrastructure condition and function.

Maintaining stormwater infrastructure is essential because it can also contribute to the adaptive capacity for other important features of the Region such as open vegetated space, estuarine waters and natural coastal landscapes as well as built assets such as homes, business and industry.

### How do we design, construct and maintain stormwater management infrastructure as annual rainfall declines, rainfall intensity increases and the sea level rises?

Local and State government agencies and developers have invested in a number of plans, policies and on-ground works that improve the management of stormwater and mitigate flood risks. Existing stormwater infrastructure includes the gutter, drain, pipe and pump networks, gross pollutant traps, wetlands, rain gardens and detention and retention basins. Stormwater management plans (SMP) have been prepared for much of the Region, and many recommend additional water quality improvement measures. Waterproofing the West is a major initiative of the City of Charles Sturt and has resulted in the construction of diversion systems that allow additional stormwater to be directed to wetlands for treatment and aquifer storage. Although these actions contribute to the adaptive capacity of the Region's stormwater infrastructure, the Region's stakeholders identified that more work is required to improve stormwater quality and flood mitigation as the climate changes in the future.

An immediate priority adaptation option for completion within the coming 5 years is to **amend land use planning policy regarding finished floor levels** (refer Figure 10). This will ensure that new buildings constructed in areas at risk from flooding caused by more intense rainfall events as well as storm surge exacerbated sea level rise, will have ground floor levels at elevations that reduce inundation risk. In particular this should consider how access to buildings or facilities occupied or visited by people with vulnerabilities may be impacted by flooding of adjacent roads. Other adaptation options for immediate implementation but ongoing delivery are to:

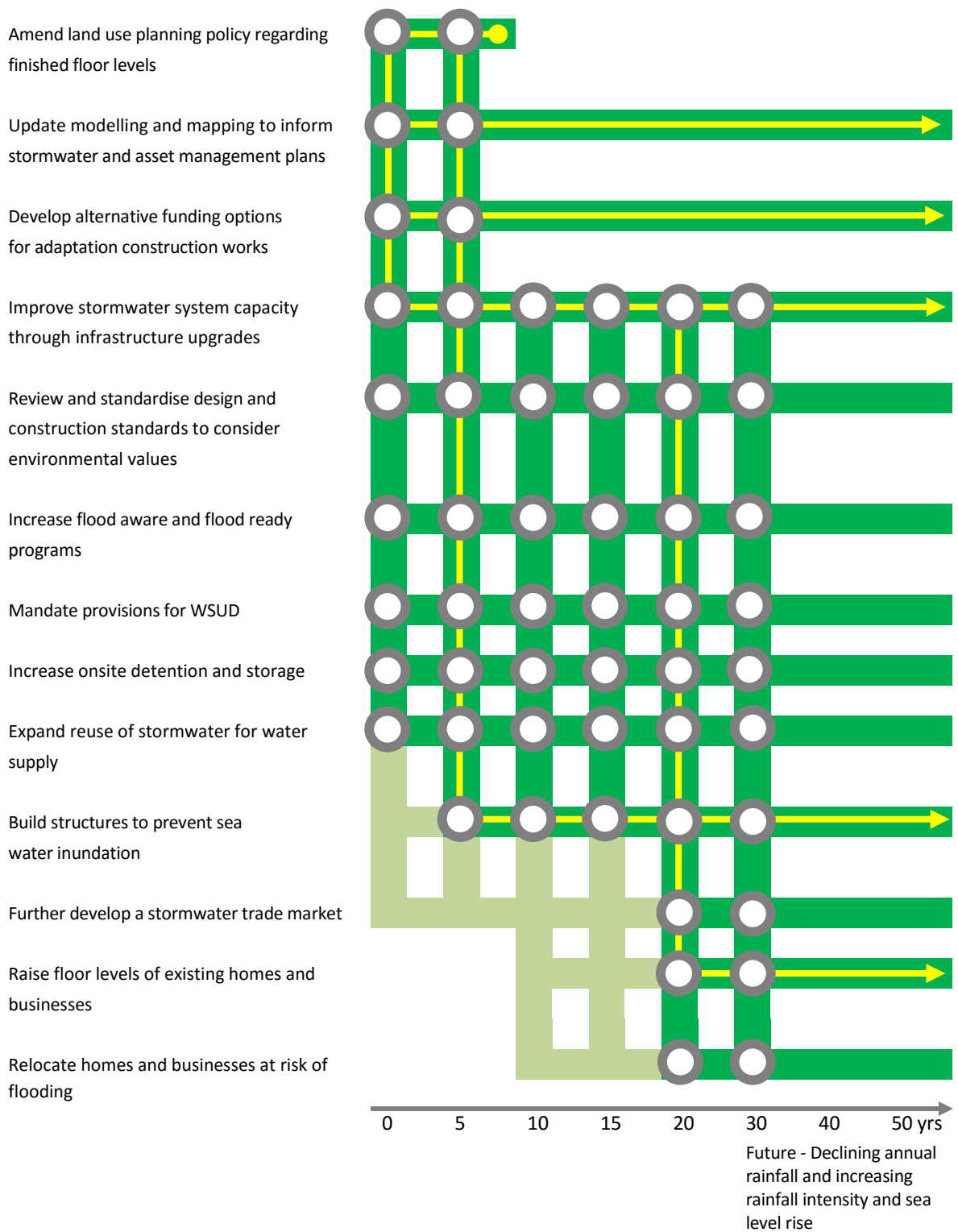
- **Update modelling and mapping to inform stormwater and asset management plans.** This will assist to identify what locations in the Region are most exposed to the combined effects of more intense rainfall events and storm surge exacerbated sea level rise.
- **Develop alternative funding options for adaptation construction works.** This option recognises that upgrades to stormwater infrastructure will be required in the future and that current funding mechanisms may prove insufficient, especially where large scale replacement rather than upgrade programs are required.
- **Improve stormwater system capacity through infrastructure upgrades.** This will increase the ability for the stormwater system to drain runoff from heavy rainfall events and will also need to consider where additional detention and retention is required to mitigate flood risk.

Planning and design for the **sea wall** associated with the Northern Connector has already started and construction is likely to commence within 5 years. Other major hard infrastructure like barrages and sea walls around Port Adelaide may also be required in the future and planning for these has also commenced in some locations.

An alternate to investing in defence mechanisms will be to **raise the floor levels of existing homes and businesses**. While not a preferred option at this stage, relocating homes and businesses at risk from flooding will also be a potential management response in 20 years.

Various thresholds exist that are likely to trigger a change in the management of stormwater infrastructure in the region. Overall the stormwater system is currently not considered adequate to protect the community so the increasing risks from climate change are particularly significant for this area. A key threshold will be increasing insurance premiums, which is likely to prompt more action by Local Government, home owners and businesses. Other thresholds with the potential to alter management responses for stormwater management infrastructure include:

- Number of un-insurable homes increases, with the trigger for action being the need to relocate or abandon homes
- Deaths occurring as a result of extreme events
- Increased frequency of houses experiencing over floor level inundation.



**Figure 10 Adaptation pathways map showing options to design, construct and maintain stormwater management infrastructure as annual rainfall declines, rainfall intensity increases and the sea level rises**

## 4.9 Transport and essential services

### Why are transport and essential services important to the Region?

The Western Adelaide Region contains transport and essential services (energy, water and waste) that are vital for the local and State economy. Transport facilities and infrastructure including maritime (Flinders Ports infrastructure at Port of Adelaide and Inner and Outer Harbor), rail, road and aviation (Adelaide Airport) are fundamental to the facilitation of commerce, import of liquid fuel (petrol) and the provision of services. The Outer Harbor fuel import facility operated by Flinders Ports is the only liquid fuel import facility in South Australia. Transport services (trains and buses) enable residents and visitors to access places of employment, shopping centres and recreation facilities. Energy infrastructure including transmission lines is essential for the Region to function and thrive.

### How will climate change impact upon transport and essential services?

The IVA found that road and rail infrastructure and associated transport services are likely to be impacted by more frequent and intense heatwaves. More rapid deterioration of transport infrastructure (road surfaces in particular), disruption caused by power outages and traffic light dysfunction, and changes to public transport scheduling are likely to result. Increased rainfall intensity, sea level rise and storm surge can also combine to reduce the effective operation of transport infrastructure (road and rail) and energy distribution networks, increasing the risk of multiple and interconnected system failures.

### How do we minimise disruption to transport and essential services as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?

Some of the Western Region's transport infrastructure is well prepared for the projected impacts of climate change. For example, Adelaide Airport's runway surface is designed to be highly resistant to high temperatures and the airport drainage systems are designed to cope with heavy rainfall. In recent years significant investment has been made in rail track upgrades in the Region including concrete sleepers and drainage improvements. Tracks that are more vulnerable to buckling in extreme heat have been identified and mitigation plans developed. The adaptive capacity of other transport infrastructure is lower. The Region's stakeholders identified that whilst Council managed roads are managed according to asset management plans, many do not consider projected climate impacts or alternative surface options.

Many of the services and facilities in the Region are reliant on electricity for public safety and response (eg hospitals and major intersections) have backup power supplies. Other adaptive capacity measures relating to electricity supply includes SA Power Networks' load shedding and the installation of roof top domestic solar photovoltaic power systems.

Rainfall intensity and flood impacts are addressed in current stormwater management plans however the Region's stakeholders identified the need to mitigate flooding impacts on transport infrastructure around Port Adelaide and Inner and Outer Harbours.

An immediate priority for adaptation to be completed within the coming 5 years is for all asset owners to **review and update design standards and asset management plans** to consider and address climate change considerations. This will need to pay particular attention to the flood risk posed to electricity, stormwater, potable water and telecommunications infrastructure and roads in low lying areas



surrounding Port Adelaide's Inner and Outer Harbours. Another important consideration will be the impact that extreme heat may have on the functioning of transport and essential services infrastructure and its use by the community, businesses and industry.

Adaptation options that are immediate priorities but that require ongoing implementation are (refer Figure 11):

- **Developing and updating modelling and mapping to assist with risk management.** This will be essential for better understanding which assets are at risk and what response options should be considered and prioritised
- **Assessing and planning for the impact of climate change on essential services assets.** Informed by modelling and mapping and risk/vulnerability assessments, this option will allow public and private sector providers of transport and essential services to further target adaptation strategies
- **Encouraging growth in decentralised energy generation and storage.** This is part of an existing trend, which is resulting in a large number of homes and businesses investing in rooftop solar photo-voltaic systems. This change is likely to be hastened by falling prices of battery back-up systems. Overall, greater investment in decentralised energy generation will result in lower (long-term) investment being required to upgrade and maintain the current electricity distribution networks
- **Improving comfort at public transport stops.** Public transport is important for the community as a low-carbon transport option and for providing a mode of transport for people without access to a motor vehicle. Improving comfort at public transport stops will require increased provision of shade shelters and/or planting of trees.

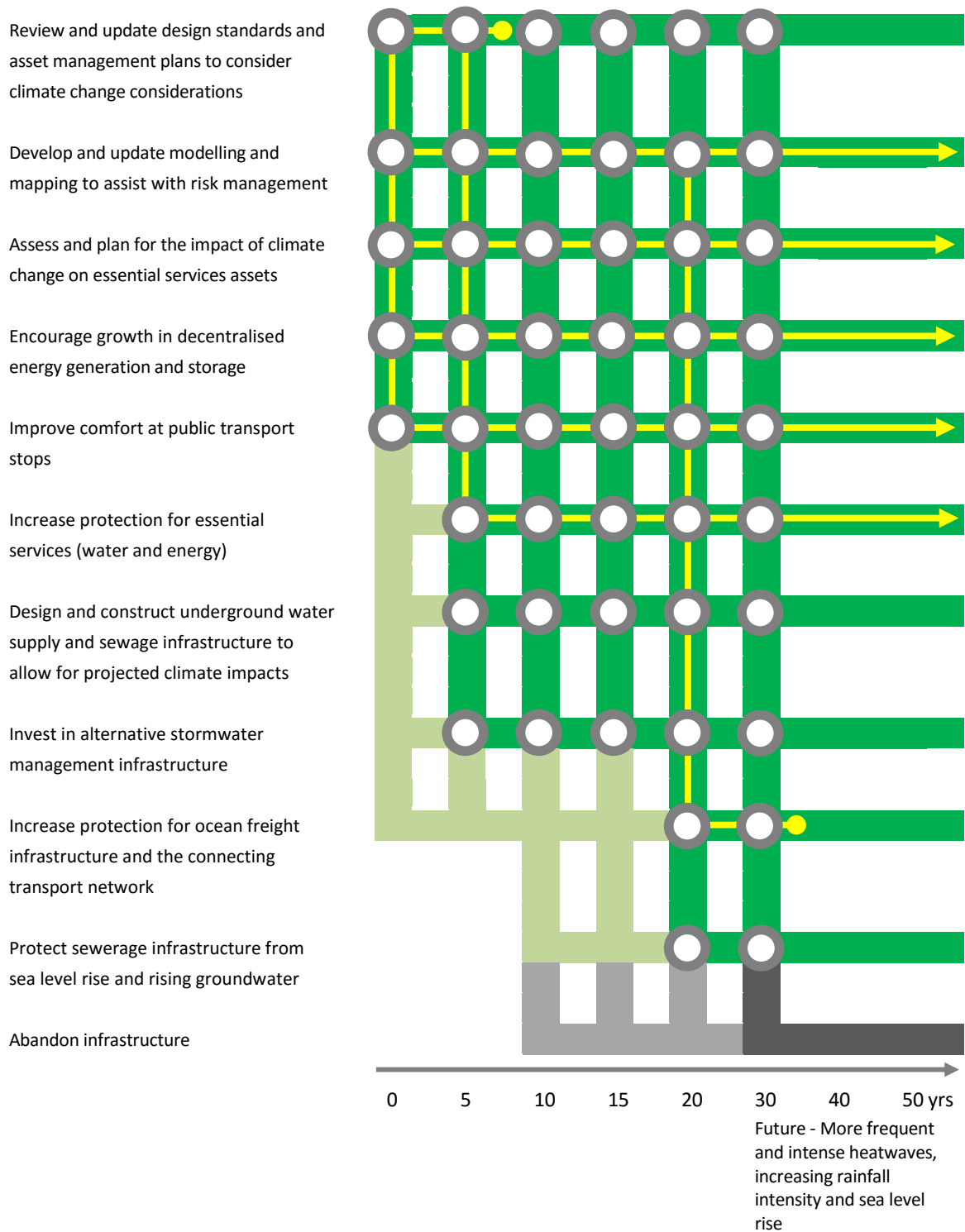
Within 5 years, work will need to commence on **increasing the protection of water and energy infrastructure**. The coming five years should focus on planning where protection works will be needed. It is likely that the initial focus will be on building adaptive capacity to extreme heat (eg to reduce disruption caused by electricity outages) followed by addressing the increasing risk of sea level rise.

In 20 years, major investment will be required to **increase protection for ocean freight infrastructure and the connecting transport network**. Given the role of the Port Adelaide Inner and Outer Harbours in moving freight into and out of the State, this is a strategic adaptation priority relevant to the State's community and economy. Planning work should commence immediately for this option to determine the optimal mix of defend and retreat strategies. This will also provide sufficient time to determine the necessary financing mechanisms. This option is listed as having a 10 year delivery timeframe, suggesting that it is a transformational change to the operation of the Harbours rather than a series of incremental and ongoing changes through time.

Various thresholds exist that are likely to trigger a change in the management of transport and essential services in the region as the climate changes. These include:

- Flooding impacts resulting in the closure of both local roads and major transport routes impacting the provision of emergency services. This will be especially important for hospital access and evacuation routes

- Increasing frequency and extent of flooding causing track slumping and damaging the rail network
- Reduced utilisation of public transport because of reduced access and/or unsuitable conditions (eg too hot to wait at the bus stop)
- Increasing hospital admissions as a result of extreme events
- The closure of main street shops and businesses
- Increasing insurance premiums.



**Figure 11 Adaptation pathways map showing options to minimise disruption to transport and essential services as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rises**

## 4.10 Urban living

### Why is urban living important to the Region?

Much of the Western Adelaide Region is highly urbanised, with the predominant land use being residential. Urban density will increase in coming years as the Region is earmarked for further urban development (the majority of which will be infill) and population growth. The design of urban areas ranging from individual dwellings to the public realm will in turn impact the health and wellbeing of people living in the Region and on values including a strong and connected community and amenity and quality of life. The extent of street trees and landscaped public realm assists in reducing the urban heat island effect however increasing urban density and a greater proportion of buildings and hard surfaces across the Region is limiting opportunities for green spaces and exacerbating the urban heat island effect.

### How will climate change impact upon urban living?

The IVA found that climate change will influence the amenity and liveability of urban areas. The condition of older houses may decline as reduced rainfall increases the risk of soil heavage and lower floor levels may be inundated by flood or sea water/storm surge. Increasing frequency of salt water inundation may impact soil stability and underground infrastructure with subsequent impacts on building and vegetation condition. An increase in the frequency and intensity of heatwaves may impact on tree condition in private gardens and public realm. Many households rely on air-conditioning to maintain in-house thermal comfort however increasing electricity costs, increasing need for air-conditioning and power outages during extreme heat events may impact households' capacity to maintain thermal comfort.

### How do we create better amenity and liveability in our urban areas as our climate becomes warmer and drier, we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?

A range of current measures are already being implemented that will contribute to creating better amenity and liveability of urban areas in the Western Adelaide Region. Stormwater management including harvest and reuse and the Waterproofing the West project are increasing the volume of water available for irrigation of public spaces. Household energy and water efficiency programs are raising community awareness about how households can reduce consumption while maintaining comfort and amenity. Despite existing programs, the Region's stakeholders agreed that more action is required to create better amenity and liveability in our urban areas as the climate becomes warmer and drier, and we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise.

Within the coming five years, reform of **standards, regulations and land use planning policy** to promote and encourage development, urban design and public realm that is climate resilient is required (Figure 12). This should then be used to direct future development and potentially limiting or preventing development in areas at risk of coastal or flood inundation and will require engagement with the building and development industry as well as the broader community.

Over the coming 10 years work will be required to **raise awareness about insurance industry reforms**. The insurance sector is already changing its underwriting policies in response to projected climate risks. However, the resulting reforms to the insurance industry are not always well understood and hence awareness raising is required across the community and business sectors.

The coming 20 years will require major investment to **increase green urban spaces and increase tree canopy cover** in the public and private realm. This is of heightened importance given that the existing canopy cover in Adelaide's Western suburbs is the lowest of any Region in metropolitan Adelaide<sup>17</sup>. The timeframe of 20 years is designed to ensure that trees can mature and provide the benefits of addressing the urban heat island effect before the middle of the century. After this time maintenance and replenishment of tree stock will be an ongoing requirement.

An immediate adaptation priority requiring ongoing implementation is to **communicate, educate and raise awareness about climate hazards**. This includes communicating the risk of extreme heat to residents, which will occur on an increasingly frequent basis in the future, and the periodic threat posed by storm surge events. As demonstrated by the May 2016 king tide and storm surge event, this will need to consider flood risk on the coast and land surrounding the Port Adelaide Inner Harbour. To help residents as well as builders and developers construct appropriate dwellings, **modelling and mapping** will be required to support risk management and planning. This information will also be important for awareness raising activities.

Although not identified as a preferred option, the Region's stakeholders also noted that relocating some homes, businesses and infrastructure in high risk areas may need to be considered within 20 years.

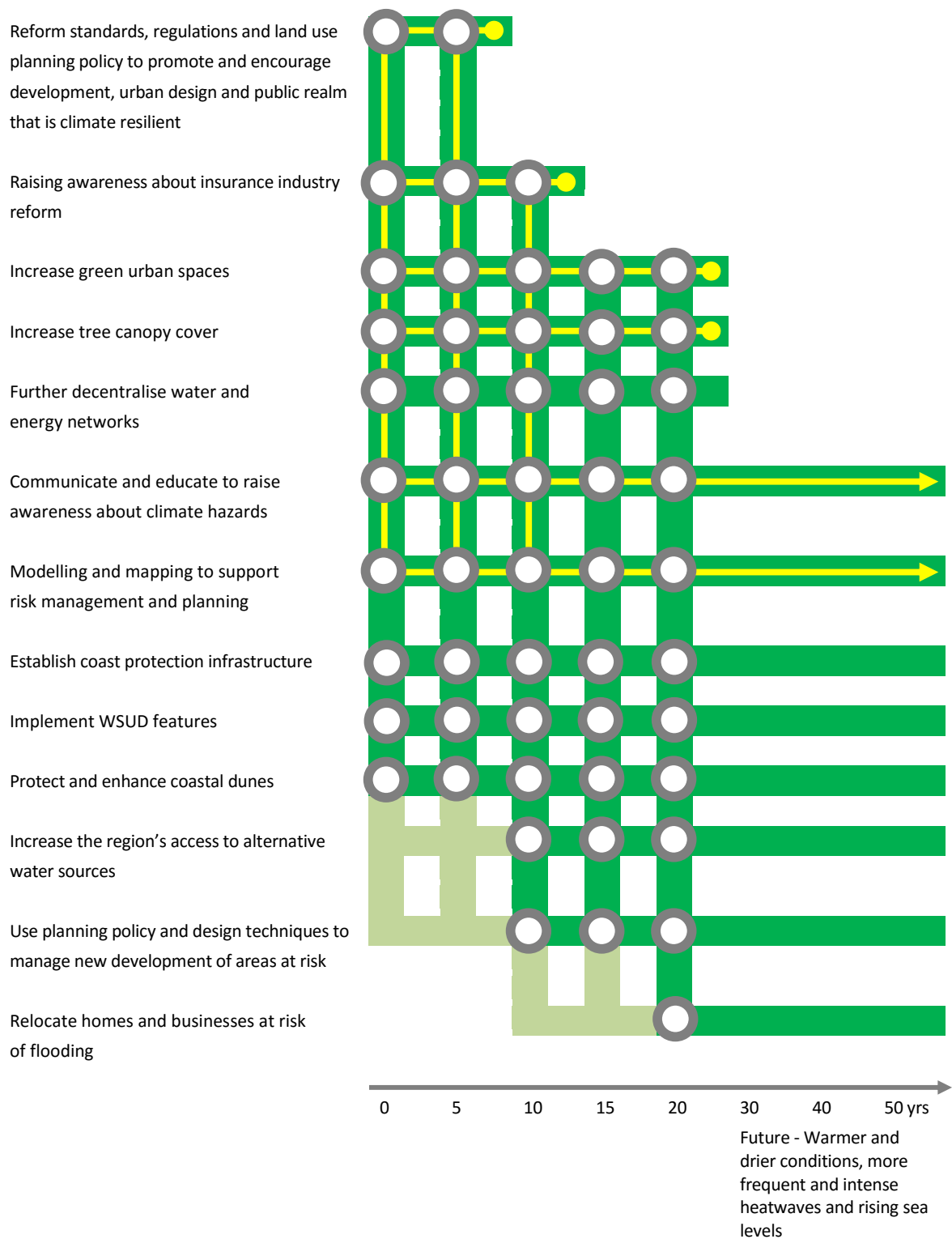
Decisions to change the combination of adaptation options or transition to new options will be influenced by thresholds being exceeded relevant to the amenity and liveability of urban areas. A key threshold will be mortality resulting from extreme events particularly as a consequence of heat stress due to air-conditioners not operating during power blackouts. An increased frequency of above floor level inundation is also considered a key threshold, with a trigger for action identified by the Region's stakeholders to be if such events were to occur more than once every 8 years.

Other thresholds that will influence the timing of implementation for adaptation options include:

- Grass and vegetation mortality that may be exacerbated by the urban heat island effect
- Increasing irrigation demand (eg demand for groundwater above allocated volumes)
- Increasing hospital admissions as result of extreme events
- Increasing cost of living (eg as electricity demand increases) and repair from flood damage
- Inability to access homes during flooding.

---

<sup>17</sup> Jacobs, B., Mikhailovich, N., and Delaney, C. (2014) Benchmarking Australia's Urban Tree Canopy: An i-Tree Assessment, prepared for Horticulture Australia Limited by the Institute for Sustainable Futures, University of Technology Sydney



**Figure 12 Adaptation pathway map showing options to create better amenity and liveability in our urban areas as our climate becomes warmer and drier, we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise**

## 4.11 West Lakes

Unlike other key areas of decision making addressed in this Regional Adaptation Plan, the pathways map for West Lakes outlines the sequencing of implementation against the height of sea levels as opposed to time (Figure 13). This key area of decision making is an evolution of an initial theme related to 'inland waters' identified for the Region. The focus on West Lakes provided the opportunity to pilot a new approach to utilising adaptation pathways in a location specific context.

The pathway map for West Lakes has been informed by the Department of Planning, Transport and Infrastructure's (DPTI) (the system operator) understanding about the relationship between the height of water levels in West Lakes, flushing capacity and tide height. The advantage of presenting the pathways map with sea level rise on the horizontal axis is that this variable can be directly monitored and used to inform the timing of future adaptation options.

### Why is West Lakes important to the Region?

Inland waters and in particular West Lakes, are highly valued by the Western Region for their contribution to strong and connected communities through the provision of recreational opportunities, amenity and quality of life. West Lakes is a constructed water body that is flushed daily using changing tide levels to draw water from an offshore intake in Gulf St Vincent to an outlet at the southern end of the lake, with release of water through a barrage gate at the northern end at Bower Road to the Port River.

### How will climate change impact upon West Lakes?

The IVA found that climate change will impact water quality in West Lakes by increasing the risk of poor water quality, especially due to algal (cyanobacterial) blooms which will be encouraged by warmer conditions and input of nutrients from stormwater runoff as a consequence of more intense rainfall events. In addition, rising sea levels are likely to reduce the rate and amount of flushing the current gravity-driven system can facilitate, with subsequent adverse impacts on water quality. As water quality declines, public health and safety requirements will require more frequent closure of West Lakes to recreational activity. As sea levels continue to rise, a point will be reached where sufficient flushing is no longer possible with the current system configuration.

### How do we maintain the amenity and function of West Lakes as we experience increased rainfall intensity and sea level rise?

Maintaining the amenity and function of West Lakes will require adaptation options to be implemented that address both stormwater and sea level rise impacts. Immediate priorities for adaptation are:

- **Modelling and mapping to support risk management and planning.** This should focus on understanding which homes and infrastructure will be at risk under different combinations of lake height, tide height and incoming flows from the surrounding urban catchment
- **Upgrading stormwater management infrastructure to increase the peak flow mitigation capacity.** This will reduce the amount of stormwater entering West Lakes during any given storm event, therefore reducing localised flood risk and adverse impacts on water quality. This option will complement the adaptation options identified for stormwater management infrastructure in Section 4.8

- **Reforming land use planning policy to ensure that development does not occur in high risk areas.** Even where development occurs in lower risk areas, consideration should be given to raised floor heights
- **Modify operational design parameters.** This can be implemented over the coming 10 years and will focus on how operation of the inlet and outlet structures could be modified to maintain flushing rates without requiring major investment in capital works.

Once sea levels have risen by about 20 cm<sup>18</sup> work will be required to **upgrade the Bower Road barrier** to reduce the risk of localised flooding caused by water from the northern side of the road (ie Port Adelaide Inner Harbour) into West Lakes. This will require major infrastructure works for which planning should commence in the coming 5 years.

When sea levels in Gulf St Vincent reach 50 cm above baseline conditions<sup>19</sup> a number of additional adaptation options will be required. The first will be to **install a new pump** to manage water levels and enable additional flushing of the Lake if the tidal movement proves insufficient to flush the Lake. A second adaptation response will be to **raise the height of the intake structure** to increase the height differential between the Lake and Gulf, enabling greater movement of water into the system on a high tide.

Although not considered a priority option at this stage, system operators may also need to consider acquiring and relocating infrastructure and housing once sea levels in the Gulf reach 50 cm above baseline conditions. West Lakes is an important provider of recreational and sporting activities at a regional and State level. If it is no longer available for regular use as a result of health and safety concerns, alternative locations for water activities including rowing, canoeing and kayaking may need to be identified.

In order to operationalise management according to this pathway, system operators will need to determine what gauge sea level rise is being measured against and what years should be for the baseline or reference period.

Triggers that will influence when adaptation options need to be implemented have been identified for West Lakes in relation to 10 cm increments of sea level rise. However, other thresholds will likely be relevant, such as:

- Declining levels of public access to West Lakes as recurring water quality problems occur
- Repeated flooding of low lying homes or businesses
- Flooding of Bower Road at the northern end of West Lakes leading to frequent traffic disruptions
- Costs of upgrading West Lakes being deemed to large compared with the benefits derived.

---

<sup>18</sup> Projected to occur by mid-century under an intermediate emissions scenario (RCP 4.5) (CSIRO and BoM 2015)

<sup>19</sup> Projected to occur toward the end of the century under an intermediate emissions scenario (RCP4.5) (CSIRO and BoM 2015)



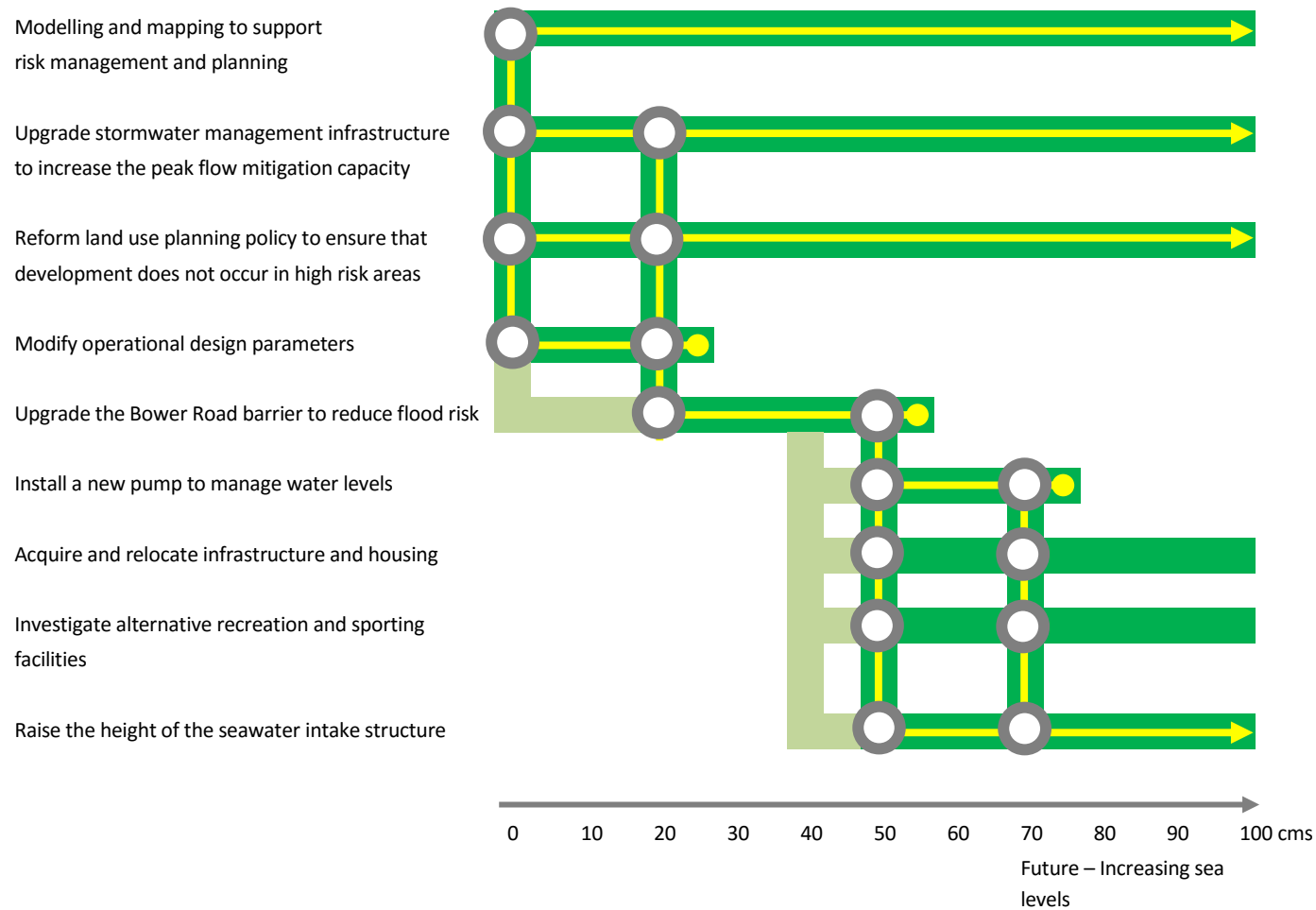


Figure 13 Adaptation pathways map showing options to maintain the amenity and function of West Lakes as we experience increased rainfall intensity and sea level rise

## 4.12 Summary of preferred adaption options

Sections 4.1.2 to 4.11 identify preferred adaptation options in relation to the ten key areas of decision making for the Western Adelaide Region to build resilience and adapt to the impacts of climate change. These preferred adaptation options are summarised by Table 7 and comprise the preferred combination of options that the Region's stakeholders considered will support adaptation in relation to the 10 key areas of decision making. The preferred options for each key area of decision making were further reviewed to identify regional adaptation priorities (see section 5).

**Table 7 Summary of preferred adaptation options for the Western Adelaide Region**

Key decision area	Timing	Preferred adaptation options
<b>Business and industry</b> How do we enable business and industry to prosper as rainfall intensity increases and the sea level rises?	Now	Education and awareness to support business and industry to understand the risks of climate change and the need for them to plan for emergencies
	Now	Continuity planning undertaken by asset owners and businesses
	Now	Undertake modelling and mapping to identify assets at risk and use to determine management responses
	Now	Use planning policy and design techniques to manage new development of areas at risk
<b>Community resilience</b> How do we build a strong and connected community and improve the health, safety and wellbeing of people with vulnerabilities to cope better with extreme events such as more frequent and intense heatwaves and flooding?	Now	Communicate and educate to raise awareness about climate risks and promote current responses
	Now	Develop and enhance community connectedness programs that build resilience
	Now	Plan and design climate resilient community facilities and public spaces
	Now	Increase the capacity of the emergency services sector
<b>Estuarine waters</b> How do we maintain the amenity and function of estuarine waters as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?	Now	Continue baseline studies and ongoing monitoring to inform other adaptation options
	Now	Develop policies to encourage greater adoption of WSUD
	Now	Build community stewardship of estuarine environment
	Now	Improve upstream catchment management
	Later	Establish living shorelines (eg oyster beds) as an alternative to seawalls to reduce erosion
<b>Natural landscapes-coastal</b> How do we protect and enhance the condition of natural coastal landscapes as the sea level rises?	Now	Continue funding support for the Adelaide Living Beaches program
	Now	Research and trial alternative dune stabilisation vegetation species
	Now	Enhance southern (south of Bower Road) coastal dunes (including vegetation management) for protection
	Now	Enhance northern (north of Bower Road) coastal dunes (including vegetation management) for protection
	Now	Amend land use planning policy

Key decision area	Timing	Preferred adaptation options
	Now	Raise awareness of coastal processes to manage expectations on accessibility and maintenance levels
	Now	Improve coastal water quality to protect and enhance sea grass
	Now	Acquire land in high risk areas to allow for retreat
	Now	Review coast protection strategies as informed by sand reserves monitoring and modelling and mapping of areas at risk
<b>Open and green spaces</b> How do we provide, protect and manage open and green spaces as we experience warmer and drier conditions, more frequent and intense heatwaves and sea level rise?	Now	Implement efficient irrigation practices to maximise urban green space
	Now	Develop modelling and mapping for risk management and planning
	Now	Increase community awareness to inform expectations regarding management of open space
	Now	Reduce reliance on potable water to irrigate public open space and increase alternative water sources
	Now	Design and construct climate resilient open space and recreation facilities
	Later	Acquire property to increase open space
<b>Public coastal built assets</b> How do we provide, protect and manage public coastal assets as the sea level rises?	Now	Continue funding support for the Adelaide Living Beaches program
	Now	Utilise modelling and mapping for risk management and planning to identify assets at risk
	Now	Raise awareness about coastal processes to inform the community about impacts and response options
	Now	Review coast protection strategies as informed by sand reserve monitoring and modelling and mapping of areas in high risk areas
	Later	Amend land use planning policy
	Later	Prepare guidelines for public coastal built asset planning and design
	Later	Develop alternative funding options
	Later	Establish hard protection infrastructure
<b>Stormwater management infrastructure</b> How do we design, construct and maintain stormwater management infrastructure as annual rainfall declines, rainfall intensity increases and the sea level rises?	Now	Amend land use planning policy regarding finished floor levels
	Now	Update modelling and mapping to inform stormwater and asset management plans
	Now	Develop alternative funding options for adaptation construction works
	Now	Improve stormwater system capacity through infrastructure upgrades
	Later	Build structures to prevent sea water inundation
	Later	Raise floor levels of existing homes and businesses

Key decision area	Timing	Preferred adaptation options
<b>Transport and essential services</b> How do we minimise disruption to transport and essential services as we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?	Now	Review and update design standards and asset management plans to consider climate change considerations
	Now	Develop and update modelling and mapping to assist with risk management
	Now	Assess and plan for the impact of climate change on essential services and assets
	Now	Encourage growth in decentralised energy generation and storage
	Now	Improve comfort at public transport stops
	Later	Increase protection for essential services (water and energy infrastructure)
	Later	Increase protection for ocean freight infrastructure and the connecting transport network
<b>Urban living</b> How do we create better amenity and liveability in our urban areas as our climate becomes warmer and drier, we experience more frequent and intense heatwaves, increased rainfall intensity and sea level rise?	Now	Reform standards, regulations and land use planning policy to promote and encourage development, urban design and public realm that is climate resilient
	Now	Raise awareness about insurance industry reforms.
	Now	Increase green urban spaces
	Now	Increase tree canopy cover
	Now	Communicate and educate to raise awareness about climate hazards
	Now	Modelling and mapping to support risk management and planning
<b>West Lakes</b> How do we maintain the amenity and function of West Lakes as we experience increased rainfall intensity and sea level rise?	Now	Modelling and mapping to support risk management and planning
	Now	Upgrade stormwater management infrastructure to increase the peak flow mitigation capacity
	Now	Reform land use planning policy to ensure that development does not occur in high risk areas.
	Now	Modify operational design parameters
	Later	Upgrade the Bower Road barriers to reduce flood risk, considering potential impacts on the Port River system
	Later	Install a new pump to manage water levels
	Later	Raise the height of the seawater intake structure

## 5 Priorities for adaptation in the Western Adelaide Region

The adaptation pathways presented in section 4 of this Regional Adaptation Plan identify a range of options relevant to the ten different key areas of decision making.

To sharpen the focus of the Regional Adaptation Plan and assist with identifying adaptation priorities for regional implementation, the preferred adaptation options were further reviewed to determine those that are:

- of regional scale or relevance
- common to more than one key decision area (ie are cross-sectoral)
- will deliver multiple benefits, and
- would benefit from a coordinated, regional response across key regional stakeholders.

This review process resulted in the identification of ten adaptation priorities for the Western Adelaide Region (refer Figure 14, the infographic following and Table 8).

A number of these priority adaptation options accelerate current practice and are recommended for immediate implementation. Options for delivery over a longer timeframe (eg in 20 years' time) have a greater focus on strategies that will protect people, assets and services.

It is not intended that these options be considered the only adaptation actions required in the Western Adelaide Region, but rather provide a starting point to focus initial regional, cross-sectoral action. The remainder of the preferred options identified by the Regional Adaptation Plan are still considered critical to ensuring the Region remains strong, productive and vibrant and can respond to the challenges of climate change.

Priority options denoted by a \* represent options that are the same or similar to adaptation priorities in other regional adaptation plans. They would therefore benefit from considering how they could be progressed in partnership with other region.

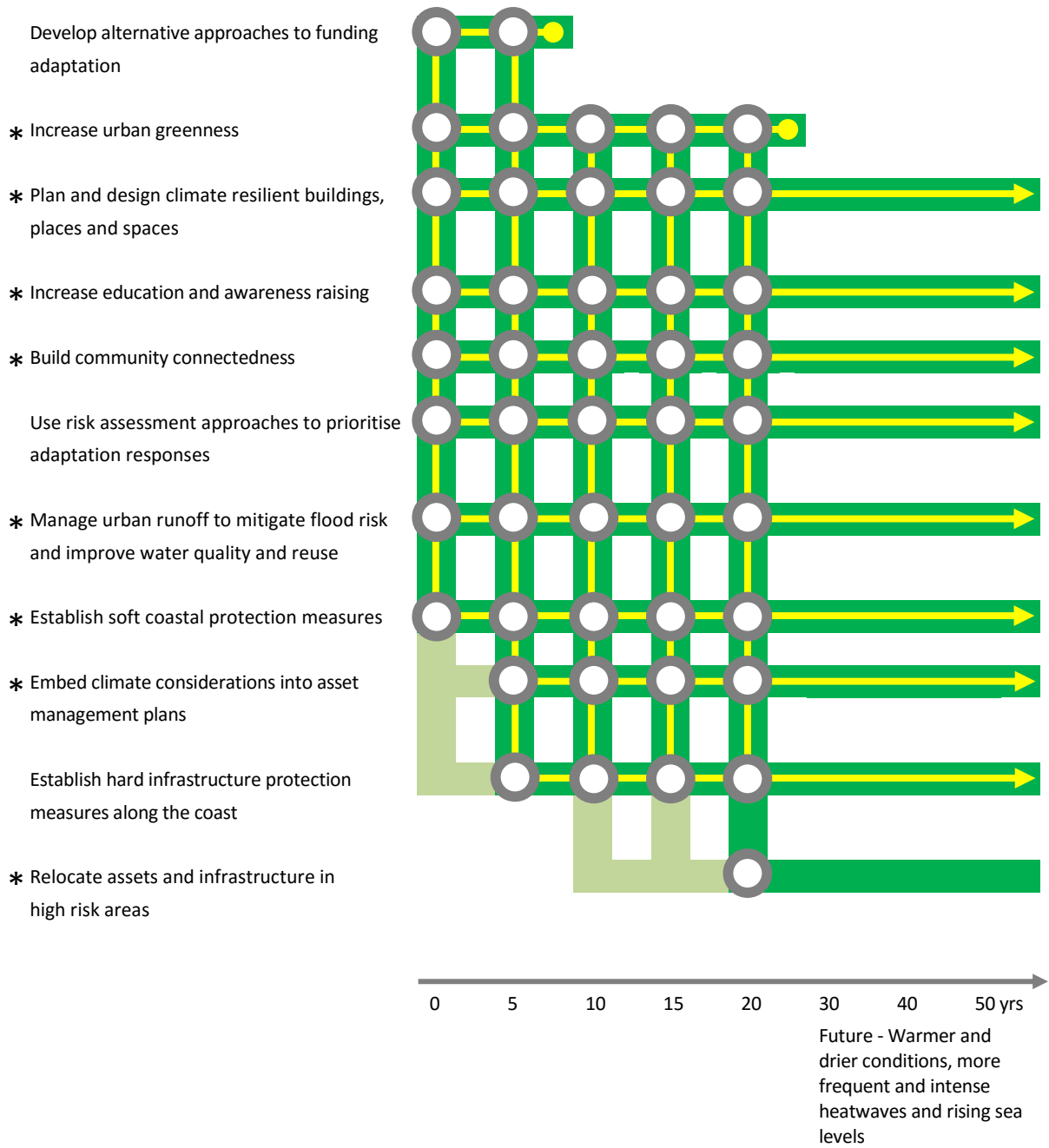


Figure 14 Adaptation pathway map showing priority adaptation options for the Western Adelaide Region

# AdaptWest

## Regional Priorities for the Western Adelaide Region

Increase understanding of risks associated with sea level rise, extreme heat and flooding

Relocate assets and infrastructure away from high risk areas

Build community connectedness to strengthen support networks

Embed climate considerations into asset management plans

Develop alternative approaches to funding adaptation

Use risk assessment approaches to prioritise adaptation responses

Increase urban greenness

Build community connectedness to strengthen support networks

Establish soft and hard infrastructure protection measures along the coast

How climate will change across the Region



Manage urban runoff to mitigate flood risk and improve water quality and reuse

Plan and design climate resilient buildings, places and spaces

Plan and design climate resilient buildings, places and spaces

**Table 8 Priority adaptation options**

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>Develop alternative approaches to funding adaptation</b>	Natural landscapes - coastal Public coastal built assets Stormwater management infrastructure Urban living Business and industry Transport and essential services	Rising sea levels and increasing intensity of heavy rainfall events may require the construction of new or upgrade of existing infrastructure. This type of infrastructure will require significant resource input, particularly where stormwater infrastructure capacity upgrades or hard coast protection structures (eg sea walls) are required. It is recognised that ‘traditional’ approaches to funding may not be sufficient or appropriate and that new approaches may be required. Funding adaptation works may require the reallocation of existing resources and developing new cost-sharing models (including with private sector), particularly for adaptation options that are of regional benefit or relate to more than one Council area.	Now	State Government Western Adelaide Region Councils	Asset and infrastructure owners and operators Developers Local Government Association (LGA) Other Regions Commonwealth Government Regional Development Australia (RDA) and other infrastructure funding agencies
<b>*Increase urban greenness</b>	Open and Green Spaces Urban Living	Dark coloured roads and roofs absorb heat and store it, increasing the temperature of built-up urban areas. Trees and plants can reduce the urban heat island effect by shading and preventing heat from being absorbed and through evapotranspirative cooling. The existing canopy cover in Adelaide’s western suburbs is the lowest of any region in metropolitan Adelaide. Increasing urban greenness through additional tree planting, vegetation and irrigating open space will assist in lowering the urban heat island effect as the climate warms and the frequency and intensity of extreme heat events increases.	Now	State Government Western Adelaide Region Councils	Adelaide and Mount Lofty Ranges Natural Resources Management Board (AMLR NRMB) Developers Universities and research institutions Private landowners Community (advocates)



Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>* Plan and design climate resilient buildings, places and spaces</b>	<ul style="list-style-type: none"> <li>Business and industry</li> <li>Community resilience</li> <li>Estuarine waters</li> <li>Natural landscapes-coastal</li> <li>Open and green spaces</li> <li>Public coastal built assets</li> <li>Transport and essential services</li> <li>Urban living</li> </ul>	<p>Climate resilient buildings, spaces and places are those that are designed and constructed to take into account anticipated climate change and assist with mitigating climate change impacts such as extreme heat and flooding from stormwater, sea level rise and storm surge.</p> <p>Climate resilient buildings, spaces and places can play a significant role in creating an urban environment that is amenable and comfortable for residents and visitors and contribute to improving human health. They also contribute to creating safe urban areas and supporting the ongoing function of services, business and industry in the face of extreme events.</p>	Now	<p>State Government – in particular Department of Planning, Transport and Infrastructure (DPTI)</p> <p>Western Adelaide Region Councils</p>	<ul style="list-style-type: none"> <li>AMLR NRMB</li> <li>Australian Institute of Landscape Architects (AILA)</li> <li>Botanic Gardens</li> <li>Developers</li> <li>Housing Industry Association (HIA)</li> <li>LGA</li> <li>Other Regions</li> <li>Property Council of Australia</li> <li>Universities and research institutions</li> <li>Urban Development Institute of Australia (UDIA)</li> <li>Water Sensitive SA</li> </ul>

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>* Education and awareness raising</b>	<p>Business and industry</p> <p>Community resilience</p> <p>Estuarine waters</p> <p>Natural landscapes-coastal</p> <p>Open and green spaces</p> <p>Public coastal built assets</p> <p>Urban living</p>	<p>Increasing the awareness and understanding of how climate change may impact individuals, communities and organisations is critical to enabling the Region to adapt. Many people in the Region are aware of the impacts of climate change and climate hazards however many have not considered how these hazards may affect their homes, businesses or lifestyles. Education and awareness raising are the first steps to build capacity so that individuals are able to take responsibility and undertake their own adaptation.</p>	Now	<p>State Government including SA Health, Department of State Development (DSD), State Emergency Service, Department of Environment, Water and Natural Resources (DEWNR) (including Coast Protection Board (CPB), Climate Change Branch and Natural Resource Management).</p> <p>Western Adelaide Region Councils</p> <p>Insurance sector</p>	<p>Australian Red Cross</p> <p>Business and industry</p> <p>Other Regions</p> <p>Community service agencies</p>
<b>* Build community connectedness</b>	<p>Community resilience</p>	<p>Community connectedness supports individual physical and mental health, and strong networks increase the capacity of communities to withstand challenging circumstances. Access to formal and informal support is particularly important for members of the community with vulnerabilities who may otherwise be isolated. Climate projections indicate an increasing frequency of inundation (from stormwater and sea water) and increasing frequency and intensity of extreme heat events, meaning strong and connected communities will be even more important.</p>	Now	<p>Western Adelaide Region Councils</p> <p>Department of Communities and Social Inclusion (DCSI)</p>	<p>Community service agencies</p> <p>Not-for Profit Sector</p> <p>Other State Government agencies</p> <p>Commonwealth Government funding bodies</p> <p>Community groups</p>

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>Use risk assessment approaches to prioritise adaptation responses</b>	Business and industry Estuarine waters Open and green spaces Public coastal built assets Stormwater management infrastructure Transport and essential services Urban living	The high cost of some adaptation options (such as sea walls), funding and resource constraints, and the need for a staged approach to infrastructure development means the Region needs a comprehensive understanding of the priorities for adaptation and the timing over which these should occur. Risk assessment approaches applied to individual asset types (eg roads, beaches, jetties etc) or considering climate impacts (eg sea level rise) can ensure investment is targeted and prioritised appropriately.	Now	Western Adelaide Region Councils State Government including DPTI, Renewal SA, DSD, CPB	DEWNR Insurance sector
<b>*Manage urban runoff to mitigate flood risk and improve water quality and reuse</b>	Estuarine waters Natural landscapes-coastal Open and green spaces Stormwater management infrastructure	Increasing intensity of heavy rainfall events will require acceleration of existing initiatives as well as new approaches to managing the quality and quantity of urban runoff to mitigate flood risk and maintain and improve the quality of marine and estuarine receiving environments.	Now	Western Adelaide Region Councils Stormwater Management Authority (SMA) DPTI	AMLR NRMB DEWNR LGA Water Sensitive SA Universities and research institutions
<b>*Embed climate considerations into asset management plans</b>	Natural landscapes-coastal Transport and essential services	Asset management planning is used to understand risk and manage assets and infrastructure, yet the majority do not consider climate impacts. This is a particular issue given that asset management plans often relate to infrastructure that has a long lifespan and therefore is likely to be impacted by changes in climate. Climate change considerations therefore should be embedded in asset management plans so that adaptation becomes part of everyday practice.	Now	Western Adelaide Region Councils CPB SMA DPTI Infrastructure owners and operators (eg Adelaide Airport, DPTI, SA Water, SA Power Networks, Flinders Ports, Australian Submarine Corporation etc)	LGA

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
<b>* Establish soft infrastructure protection measures along the coast</b>	<p>Estuarine waters</p> <p>Natural landscapes-coastal</p> <p>Public coastal built assets</p>	<p>Sea level rise combined with storm surge will impact natural and built assets. Business, industry, port and wharf infrastructure, stormwater management infrastructure, housing and recreation facilities along the coast of Gulf St Vincent as well as inland around Port Adelaide and West Lakes will be impacted as changes in sea level occur. Sand dunes and beaches will continue to be eroded and for some, without intervention, disappear given their inability to retreat inland due to hard physical barriers created by urban development. Soft coastal protection measures such as dune revegetation, fencing and the establishment of living shorelines can protect and stabilise beaches and dunes which contribute to the protection of assets and infrastructure.</p>	Now	<p>Renewal SA</p> <p>DSD</p> <p>CPB</p> <p>DPTI Western Adelaide Region Councils</p>	<p>AMLR NRMB</p> <p>Developers</p> <p>Private landowners</p> <p>RDA and other infrastructure funding agencies</p>
<b>Establish hard infrastructure protection measures along the coast</b>	<p>Business and industry</p> <p>Estuarine waters</p> <p>Natural landscapes-coastal</p> <p>Public coastal built assets</p> <p>Stormwater management infrastructure</p> <p>Transport and essential services</p>	<p>Sea level rise combined with storm surge will impact natural and built assets. Business, industry, port and wharf infrastructure, stormwater management infrastructure, housing and recreation facilities along the coast of Gulf St Vincent as well as inland around Port Adelaide and West Lakes will be impacted as changes in sea level occur. Sand dunes and beaches will continue to be eroded and for some, without intervention, disappear given their inability to retreat inland due to hard physical barriers created by urban development. Hard infrastructure such as sea walls and barrages may be required to protect assets and infrastructure as the sea level rises.</p>	Later (5 years)	<p>Renewal SA</p> <p>DSD</p> <p>CPB</p> <p>DPTI Western Adelaide Region Councils</p>	<p>AMLR NRMB</p> <p>Developers</p> <p>Private landowners</p> <p>RDA and other infrastructure funding agencies</p>
<b>* Relocate assets and infrastructure away from high risk areas</b>	<p>Business and industry</p> <p>Open and green spaces</p> <p>Public coastal built assets</p>	<p>Relocating assets and infrastructure away from high risk areas will become an increasingly important consideration in locations exposed to flooding from sea level rise and storm surge and catchment run off following periods of intense rainfall. Although this</p>	Later (20 years)	State government	<p>LGA</p> <p>Other regions</p> <p>Western Adelaide Region Councils</p>

Priority adaptation option	Relevant key areas of decision making	Rationale	Timing	Lead	Key partners
	Stormwater management infrastructure Urban living West Lakes	was not identified as a priority option at a regional scale, it will remain a consideration into the future especially when decisions are being made to invest in protection measures along the coast. There are complex issues associated with this option, including the need to balance the community's desire to live near the coast or along watercourses while ensuring community members and their property are safe and not at risk from sea level rise and flooding.			Insurance sector

## 5.1 Implementing the priority adaptation options for the Western Adelaide Region

To assist with progressing the implementation of the priority adaptation options across the Region, the Western Adelaide Regional Adaptation Priorities Action Plan has been prepared (refer Appendix B).

For each priority adaptation option, the Regional Adaptation Priorities Action Plan summarises:

- potential actions to progress implementation of the option (including preparatory work required for future options)
- timing for implementation (ie now versus later)
- identification of lead responsibility for initiating and/or driving implementation of the option, and
- identification of others to be involved in implementation.

Involvement in actions could include one or more of the following:

- initiation of the action
- coordination with partners
- implementation
- funding or in kind support
- advocacy, and
- monitoring, evaluation and reporting.

It is intended that the Regional Adaptation Priorities Action Plan be used by organisations and individuals across the Western Adelaide Region to guide regional adaptation action, and where required be further developed and refined as new information becomes available, as monitoring and review occurs or as climatic conditions change.

It is not intended that the Regional Adaptation Priorities Action Plan includes the only adaptation actions that are required in the Western Adelaide Region, but rather it provides a starting point to focus initial regional, cross-sectoral action. The remainder of the preferred options summarised in Table 7 are still considered critical to ensure the Region remains strong, productive and vibrant and can respond to the challenges of climate change.

### 5.1.1 Mapping to assist the targeting of action

To support the implementation of regional adaptation priorities, mapping has been prepared identifying locations for targeting initial action (refer Appendix B).

Using spatial datasets, the relative vulnerability of key features and aspects of the Western Adelaide Region<sup>20</sup> to spatially variable climate variables (ie sea level rise and flood inundation) was modelled to develop maps that could enable identification of ‘hot-spots’ of vulnerability (refer Appendix C). These hot spots have been considered in relation to the regional adaptation priorities identified by Table 8 with the view to identifying initial locations for targeting adaptation responses across the Region. Appendix D provides a series of maps relating to key features and characteristics of the Region that can be used when considering adaptation responses.

---

<sup>20</sup> For example, open space, assets and infrastructure, demographics such as age, cultural diversity, health indicators etc

## 6 Enabling adaptation action

All decision making processes sit within a broader context. Understanding this context and ensuring appropriate conditions are in place to enable adaptation action is as important as identifying the adaptation options themselves.

New thinking is emerging from work by the CSIRO Adaptation Flagship<sup>21</sup> which suggests that there are three factors that influence whether a decision (to take action and implement an adaptation response) is made. These factors are values, knowledge and rules and it is considered that where there is overlap or alignment between all three of these factors, adaptation responses are more likely to occur.

At the final adaptation workshop, stakeholders from the Western Adelaide Region were asked to reflect on these three factors and consider what enabling conditions are needed to facilitate implementation of the Regional Adaptation Plan. Table 9 shows the enabling conditions identified as being critical to the successful implementation of this Regional Adaptation Plan. Actions to progress the creation of these conditions have been incorporated into the Western Adelaide Regional Adaptation Priorities Action Plan (refer Appendix B).

**Table 9 Summary of actions to create enabling conditions to support implementation of the Regional Adaptation Plan**

Enabling condition	Rationale	Action to create enabling condition
Ratify regional commitment	<p>It was identified that successful implementation will be dependent on the level of commitment demonstrated by all of the AdaptWest member Councils, the lead agencies and key private sector players identified in the Plan and the ability to take a long term view.</p> <p>One avenue to ratify this commitment is through the review and establishment of a new Climate Change Sector Agreement, to become the platform for a multi-party Committee to oversee the implementation and review of the AdaptWest Plan. The Regional Adaptation Plan can provide the foundation for agreement and working together to implement regional priorities for adaptation</p>	Establish a new Climate Change Sector Agreement and Committee, building on initial regional Agreement and partnerships
Effective governance arrangements	<p>It was identified that successful implementation of the Regional Adaptation Plan will be dependent on the effectiveness of the governance framework that is put in place to support implementation. This governance framework should:</p> <ul style="list-style-type: none"> <li>- designate a lead organisation/group charged with driving implementation</li> <li>- establish a regional coordinator role</li> <li>- facilitate coordination and collaboration between all levels of government and stakeholders</li> <li>- identify clear roles and responsibilities for adaptation actions</li> <li>- establish resources</li> <li>- provide the basis for shared accountability for implementation               <ul style="list-style-type: none"> <li>- identify other initiatives that will be required to support implementation including the development of a monitoring and review framework</li> </ul> </li> </ul>	Develop a governance framework to support implementation of the Regional Adaptation Plan including designating a lead group/organisation, establishing a coordinator role, identifying roles and responsibilities and resources

<sup>21</sup> The “VRK” framework has been developed primarily by Dr Russell Gorddard and Dr Russell Wise from the CSIRO Adaptation Flagship. It is described in more detail in Gorddard et al (2016) Values, rules and knowledge: Adaptation as change in the decision context. Environmental Science & Policy, vol 57, 60-69.



Enabling condition	Rationale	Action to create enabling condition
Leadership and ownership	<p>The need for leadership to be demonstrated by all levels of government, including the AdaptWest partner Councils, was considered critical to the successful implementation of the Regional Adaptation Plan. This leadership needs to be longer term and 'own' the importance of taking adaptation action in the Western Adelaide Region so that it can continue to thrive and prosper.</p> <p>This leadership and ownership can be demonstrated through actions such as the allocation of resources to adaptation actions and thinking differently about funding. This may require identifying new funding sources or reallocation of existing resources<sup>22</sup> and developing new cost-sharing models, particularly for adaptation options that are of regional or State benefit or relate to more than one Council area. To assist with acquiring new funding or reallocation of existing funding, business cases may need to be developed to identify the cost of not taking action to adapt. Focussing on the multi-benefits of adaptation projects that also deliver other benefits, in particular economic benefit, can also assist in attracting broad funding opportunities.</p> <p>Leadership and ownership can also be demonstrated by ensuring climate change considerations are integrated into decision making processes so that adaptation becomes 'business as usual' and part of everyday practices of the Region's Councils, State agencies, non-government organisations, businesses and the community.</p> <p>Opportunities for this integration include linking the Regional Adaptation Plan with other key plans and strategies which influence decision making and action such as Emergency Management Plans, Strategic Management Plans, Development Plans, asset management plans, procurement policies and the Regional Natural Resources Management Plan - and ensuring changes to relevant legislation and policy levers such as the Planning, Development and Infrastructure Act and Building Code of Australia.</p>	<p>Allocate resources to the implementation of identified adaptation actions</p> <p>Identify new approaches to funding including opportunities to reallocate existing funds</p> <p>Focus on the multiple benefits delivered by action (in addition to adaptation) to attract funding</p> <p>Embed climate change considerations in key organisational strategies, plans, policies and processes (eg strategic management plans, asset management plans, procurement policies etc)</p> <p>(note the above enabling actions are also identified as regional adaptation priorities)</p>
Education and awareness raising	<p>It was identified that gaining support from the broader community will be critical to the successful implementation of the Regional Adaptation Plan, particularly where the allocation of resources needs to be accounted for. This will require education and awareness raising to support attitudinal and behaviour change. This education and awareness raising not only needs to focus on the impacts of climate change and the opportunities to adapt but also the multiple benefits delivered by adaptation action. The sharing of knowledge and success stories will also assist with reinforcing positive messaging and conveying that adaptation to climate change is 'doable' and that we can all play a role in taking action whether it is at an individual or household scale or as a business or organisation.</p>	<p>Build community awareness and understanding about the potential impacts of climate change and opportunities to adapt</p> <p>Share knowledge about opportunities to adapt, particularly where actions provide multiple benefits</p> <p>Promote success stories of 'adaptation in action'</p> <p>(note education and awareness raising is also identified as a regional adaptation priority)</p>

<sup>22</sup> An example of reallocation of existing money that has occurred in relation to adaptation action is on the Eyre Peninsula where the Eyre Peninsula Natural Resources Management Board has reallocated \$200,000 of its NRM levy and matched dollar for dollar whereby an applicant can demonstrate that what is being proposed directly links with implementing an adaptation option identified in the Region's Adaptation Plan.

## 7 References

Australian Bureau of Statistics (ABS) (2011) Basic Community Profile 2011 for the Cities of Port Adelaide Enfield, Charles Sturt, West Torrens and Greater Adelaide

AdaptWest (2014) Assets, Infrastructure and Economy Research Paper

AdaptWest (2014) Coastal Management Research Paper

AdaptWest (2014) Environment and Open Space Research Paper

AdaptWest (2014) Social and Community Resilience and Health Research Paper

AdaptWest (2014) Urban Planning and Development Research Paper

AdaptWest (2014) Identifying climate variables for use by the Integrated Vulnerability Assessment for the Western Adelaide Region prepared as part of the AdaptWest consultancy led by URPS, for the Western Adelaide Region in association with the Government of South Australia and the Australian Government

AdaptWest (2015) Integrated Vulnerability Assessment prepared as part of the AdaptWest consultancy led by URPS, for the Western Adelaide Region in association with the Government of South Australia and the Australian Government

Australia-New Zealand Emergency Management Committee (ANZEMC) (2011) National Strategy for Disaster Resilience: Building our nation's resilience to disasters, <https://www.coag.gov.au/node/81>

Coastal Flooding Visualisation Tool, Department of the Environment <http://www.vistool.com.au>

Deloitte Access Economics (2013) The economic cost of the social impact of natural disasters, Australian Business Roundtable for Disaster Resilience & Safer Communities, <http://australianbusinessroundtable.com.au/assets/documents/Report%20-%20Social%20costs/Report%20-%20The%20economic%20cost%20of%20the%20social%20impact%20of%20natural%20disasters.pdf>

Department of Planning, Transport and Infrastructure (DPTI) (2011), Land use generalised spatial dataset, updated June 2012

Department of the Premier and Cabinet (2016) Regional profile Western Adelaide, 2013/14 <https://data.sa.gov.au/data/dataset/8b48d402-899c-46fc-8b2e-6628a3f0dad4/resource/95b230e0-e30e-49ec-8e21-f8f45c067d47/download/regional-profile-western-adelaide-2013-14.xlsx>

Gorddard, R., Wise, R.M., Ware, D., and Dunlop, M. (2016) Values, rules and knowledge: Adaptation as change in the decision context. Environmental Science & Policy, vol 57, 60-69. <http://www.sciencedirect.com/science/article/pii/S1462901115301210>

Government of South Australia (2012) Prospering in a Changing Climate: A Climate Change Adaptation Framework for South Australia <https://www.environment.sa.gov.au/files/sharedassets/public/climate-change/prospering-in-a-changing-climate-adaptation-framework-sa.pdf>

Government of South Australia (2014) Extreme Heat: Guide to coping and staying healthy in the heat <http://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/resources/extreme+heat+guide+-+guide+to+coping+and+staying+healthy+in+the+heat?contentIDR=bfee2c80431be000b42bff5dfb58e26&useDefaultText=1&useDefaultDesc=1>

Jacobs, B., Mikhailovich, N., and Delaney, C. (2014) Benchmarking Australia's Urban Tree Canopy: An i-Tree Assessment, prepared for Horticulture Australia Limited by the Institute for Sustainable Futures, University of Technology Sydney

[http://202020vision.com.au/media/7141/benchmarking\\_australias\\_urban\\_tree\\_canopy.pdf](http://202020vision.com.au/media/7141/benchmarking_australias_urban_tree_canopy.pdf)

Local Government Association of South Australia (2014) Climate Adaptation Planning Guidelines

<https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKewiPpMLSIPzOAhVDrJQKHTCZBfMQFggiMAA&url=https%3A%2F%2Fwww.lga.sa.gov.au%2Fwebdata%2Fresources%2Ffiles%2FLGA%2520CAPG%2520Final%2520Print%2520Version.pdf&usg=AFQjCNEhHuJqhm-9pLIFtpYP22T5RXWyQ>

National Health Survey (2007/08) via the 2011 Social Health Atlas of Local Governments

Tonkin (2013) Port Adelaide/Le Fevre Peninsula/Port Adelaide River Seawall Study

Tonkin (2015) Coastal and Inundation Modelling – Phase 1 Report

SKM (2013) Western Adelaide Region Climate Change Adaptation Plan – Stage 1

# Appendix A

## Organisations and sectors that contributed to the preparation of the Regional Adaptation Plan

Adelaide Airport

Adelaide Shores

Australian Submarine Corporation

Birdlife SA

Bureau of Meteorology

City of Charles Sturt

City of Port Adelaide Enfield

Department of Environment, Water and Natural Resources (Climate Change Unit, Coast Protection Board, Natural Resources Management)

Department of Communities and Social Inclusion

Department of Health

Department of Planning, Transport and Infrastructure

D Squared

Environment Protection Authority

Flinders University

Local Government Association

Port Adelaide Residents Environment Protection Group

Renewal SA

Ripe Near Me

SAFECOM

SA Water

Surf Life Saving SA

Trees for Life

Water Utilities Group

West Beach Surf Life Saving Club

Western Adelaide Coastal Residents Association

WestNet

West Torrens Council

# Appendix B

## Western Adelaide Regional Adaptation Priorities Action Plan

Ref	Priority adaptation option	Timing	Potential actions to progress implementation of priority adaptation options including preparatory work that may be required to commence now for longer term options	Lead This role could include one or more of the following:  - Initiation of the action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring, evaluation and reporting	Partners This role could include one or more of the following:  - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring, evaluation and reporting
A1	Develop alternative approaches to funding adaptation	Now	<p>To assist with acquiring new funding or reallocation of existing funding, business cases may need to be developed to identify the cost of not taking action to adapt. Reallocation of existing resources could follow the option implemented on Eyre Peninsula where the Eyre Peninsula Natural Resources Management Board has reallocated \$200,000 of its NRM levy and matched dollar for dollar whereby an applicant can demonstrate that what is being proposed directly links with implementing an adaptation option identified in the Region's Adaptation Plan.</p> <p>To progress this adaptation option a 'Regional Funding Forum' could be convened with stakeholders from across the Western Adelaide Region and State and Federal Government to explore new and innovative approaches to funding. This discussion could commence with understanding how funding is currently allocated and investigating opportunities for reallocation in relation to adaptation responses.</p>	State Government Western Adelaide Region Councils	Asset and infrastructure owners and operators Developers Local Government Association (LGA) Other Regions Commonwealth Government Regional Development Australia (RDA) and other infrastructure funding agencies
A2	*Increase urban greenness	Now	<p>An initial step could involve undertaking a "greenness" audit of the Region. This could include:</p> <ul style="list-style-type: none"> <li>- undertaking urban heat island mapping to determine priority areas for planting</li> <li>- identifying areas that experience high visitation (eg activity centres), provide connections between existing open space, are higher density, promote active travel (eg Torrens Linear Park) are planned urban growth areas, and assessing the extent of plantings</li> <li>- reviewing tree management strategies and open space plans/strategies to determine gaps in provision or requirements to renew/maintain existing plantings</li> </ul> <p>The mapping provided in Figure B1 can assist with identifying locations to commence greening action before the regional audit is complete.</p> <p>To increase planting across the Region more generally and not only in priority locations, this direction should be embedded into key plans, strategies and policies. Increasing canopy cover also requires development policies and guidelines to ensure space is available in higher density street designs.</p> <p>Undertaking water resource management is required as part of this option, recognising the important role water plays in the Region to irrigate open space and maintain greenness of the public and private realm. Reducing reliance on potable water and utilising more efficient irrigation practices will be key to maximising urban greenness across the Region.</p> <p>The preparation of the 'Climate Resilient Guidelines' identified at A3 can support the implementation of this action, in terms of species selection and opportunities to integrate water sensitive urban design with urban greening as well as actions associated with A7 relating to stormwater capture and reuse for irrigating parks and gardens across the private and public realm.</p>	State Government Western Adelaide Region Councils	Adelaide and Mount Lofty Ranges Natural Resources Management Board (AMLR NRMB) Developers Universities and research institutions Private landowners Community (advocates)
A3	*Plan and design climate resilient buildings, places and spaces	Now	<p>Climate resilience can be increased through:</p> <ul style="list-style-type: none"> <li>- Greening of urban areas through tree planting and open space and provision of green infrastructure including water sensitive urban design (refer A2). State development policies may also need to be reviewed to identify constraints to implementation of this action.</li> <li>- Building and infrastructure design that takes into account future climate conditions.</li> <li>- Managing development in hazard prone locations (eg along the coast or low lying areas).</li> </ul>	State Government – in particular Department of Planning, Transport and Infrastructure (DPTI) Western Adelaide Region Councils	AMLR NRMB Australian Institute of Landscape Architects (AILA) Botanic Gardens Developers

Ref	Priority adaptation option	Timing	Potential actions to progress implementation of priority adaptation options including preparatory work that may be required to commence now for longer term options	Lead This role could include one or more of the following: - Initiation of the action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring, evaluation and reporting	Partners This role could include one or more of the following: - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring, evaluation and reporting
			<p>Key initiatives for progressing the provision of climate ready buildings, spaces and places include:</p> <ul style="list-style-type: none"> <li>- <u>Review of legislation and policy to identify opportunities for reform</u> This review should focus on legislation and policy particularly related to the built environment such as the Building Code of Australia and land use planning (eg Planning Strategy and South Australian Planning Policy Library), to determine whether they are sufficient given what we know about climate change and key hazards such as extreme heat, flooding and sea level rise. Key aspects to consider through planning and design include mitigating climate impacts such as extreme heat and increased rainfall intensity and managing development in areas prone to risks associated with stormwater flooding and sea level rise. This management approach could include preventing development in known risk areas through to requiring design techniques to address climate hazards such as via hard infrastructure protection works, finished floor heights or other approaches. The modelling and mapping identified by A6 can assist with identifying those locations at risk of flooding and sea level rise.  The imminent preparation of the Planning and Design Code to be undertaken as part of the Planning Reforms in South Australia is an ideal opportunity for ensuring climate change considerations are embedded in planning and design processes for the built environment.  Other aspects which could be addressed by legislative and policy reform include: <ul style="list-style-type: none"> <li>- Mandating provisions for water sensitive urban design</li> <li>- Establishing greening or canopy targets and street tree and open space provision and guidelines that enable those targets to be met</li> </ul> </li> <li>- <u>Preparation of Climate Resilient Guidelines</u> Examples of aspects that could be addressed by Climate Resilient Guidelines include: <ul style="list-style-type: none"> <li>- species selection for trees and other vegetation (including shrubs) that provide good shade cover, contribute to urban cooling and have manageable limb drop under heat stress</li> <li>- opportunities for WSUD features to be integrated with street trees/vegetation to enable irrigation</li> <li>- providing shade via vegetation or built structures for playspaces and playgrounds and adjacent to walking and cycling paths</li> <li>- materials that are more resilient to extreme weather such as extreme heat and flooding</li> <li>- designing and constructing footpaths and trails that can cope with extreme heat and flooding from intense rainfall events and storm surge</li> <li>- opportunities to incorporate innovative infrastructure into the public realm that reduces the impacts of extreme heat (eg misting, water play or fans) or flooding/storm surge (eg awnings, verandas, covered walkways, boardwalks)</li> <li>- advice regarding potential for maladaptation. For example, using artificial turf to reduce irrigation and maintenance requirements can result in destroying soil organic matter and contribute to the heat island effect</li> </ul> </li> </ul> <p>To progress the development of the guidelines, an initial step could be to connect with existing research and forums and consolidate and review the wide range of work that has already been done in this area (eg Green Infrastructure Project at the Botanic Gardens, Water Sensitive SA etc).</p>		<p>Housing Industry Association (HIA) LGA Other Regions Property Council of Australia Universities and research institutions Urban Development Institute of Australia (UDIA) Water Sensitive SA</p>

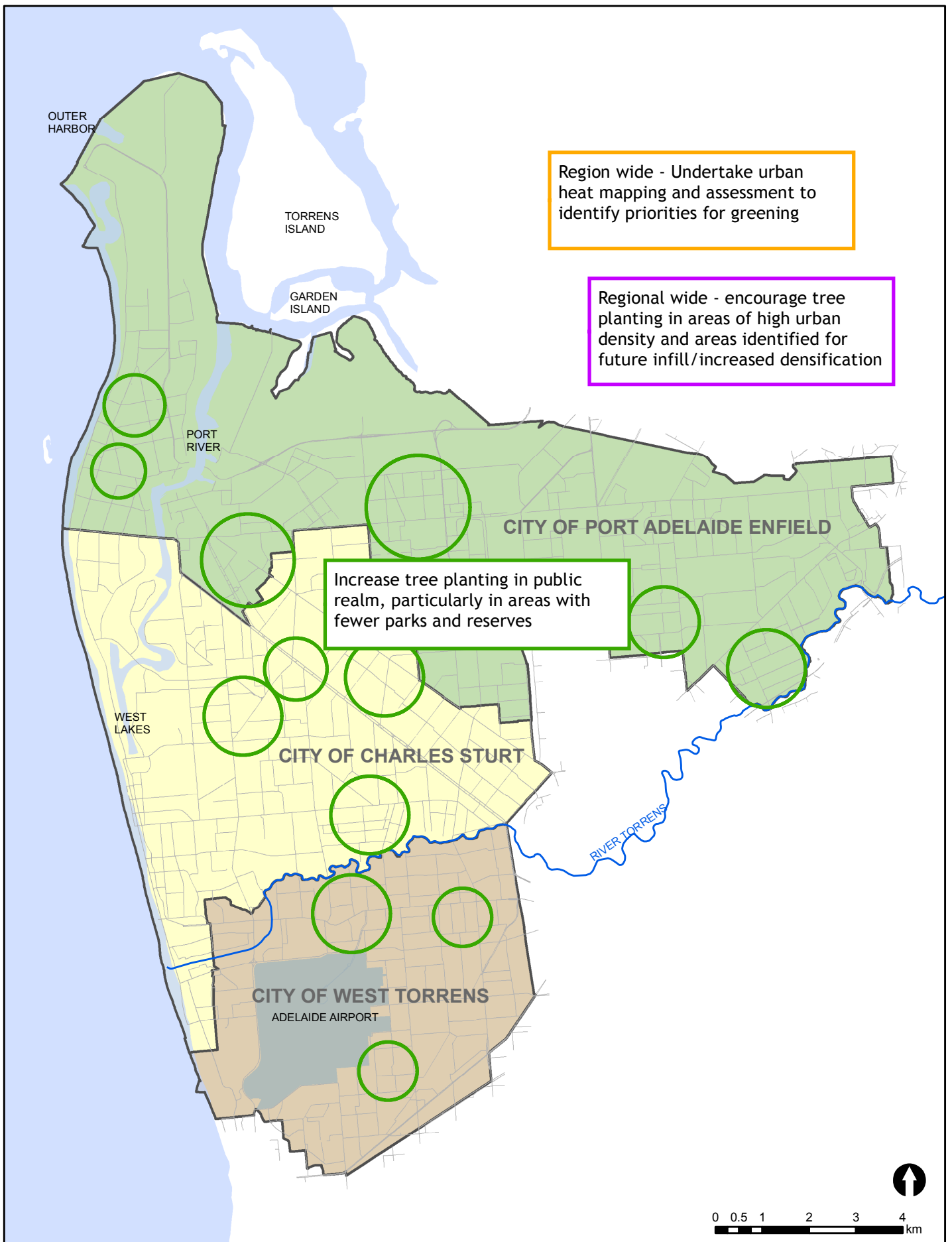
Ref	Priority adaptation option	Timing	Potential actions to progress implementation of priority adaptation options including preparatory work that may be required to commence now for longer term options	Lead This role could include one or more of the following:  - Initiation of the action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring, evaluation and reporting	Partners This role could include one or more of the following:  - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring, evaluation and reporting
			<p>Once completed, to progress implementation, the guidelines can be incorporated into the development and maintenance of spaces and outdoor infrastructure via relevant Council plans and policies such as Asset Management Plans, Playground Strategies, Open Space and Public Realm Strategies, Procurement Policies etc. The guidelines could also be incorporated into State Government planning policies to enable implementation.</p> <p>Priorities for implementing the climate ready guidelines across the Region (could be identified by considering those spaces or places that have poor amenity or comfort during warmer months (eg playgrounds for installation of shade, main street environments with little vegetation to provide relief from heat), during heavy rainfall (eg public realm areas that become damaged, inaccessible or unusable due to flooding) or subject to storm surge/sea level rise.</p>		
A4	*Education and awareness raising	Now	<p>Develop and implement initiatives which raise community awareness and understanding of hazards such as heatwaves and flooding from intense rainfall and sea level rise and how to plan for, respond and recover from extreme events.</p> <p>Initiatives should be focussed on key sectors/target audiences as follows (refer B2):</p> <ul style="list-style-type: none"> <li>- Vulnerable members of the community, particularly in regard to heatwaves and extreme heat</li> <li>- Broader community, particularly in regard to extreme heat and periodic flooding from storm surge</li> <li>- Business and industry, particularly in relation to understanding the risks of climate change and the need to plan for emergencies associated with flooding from intense rainfall events and storm surge (note that there are a number of existing tools and information available from the South Australian Department of State Development and Australian Government Attorney-General's Department regarding resilient organisations and business continuity planning which could be promoted to business and industry across the Region)</li> </ul> <p>Develop and implement initiatives which increase community awareness about the impacts associated with climate change and assist with changing expectations regarding:</p> <ul style="list-style-type: none"> <li>- The management of open space. The impacts of climate change will necessitate changes to management practices including species selection and irrigation and result in the diminishing ability to maintain open space especially in low lying areas close to the coast.</li> <li>- Accessibility and maintenance levels of beaches and dunes. The impacts of sea level rise and associated erosive impacts will influence beach condition and access and the extent to which these can be maintained, especially for the southern beaches.</li> </ul> <p>Develop a program to inform the community about insurance options and limitations (including non-insurability from 'actions of the sea').</p> <p>Develop and implement initiatives which build community stewardship of the estuarine environment and encourage behaviours by local residents and business and industry which:</p> <ul style="list-style-type: none"> <li>- Protect or remediate the estuarine environment</li> <li>- Avoid activities that have a negative impact on the estuarine environment</li> </ul> <p>The mapping provided by Figure B2 can assist with identifying locations to target this action initially.</p> <p>Given the range of existing information materials already available an initial step could be to review existing information, identify gaps and appropriateness for the Western Adelaide Region and develop a coordinated package tailored to the Region. Materials should also be tailored to the needs of the different target audiences identified above (eg using accessible language, visual aids/graphics, information needs etc)</p>	<p>State Government including SA Health, Department of State Development (DSD), State Emergency Service, Department of Environment, Water and Natural Resources (DEWNR) (including Coast Protection Board (CPB), Climate Change Branch and Natural Resource Management).</p> <p>Western Adelaide Region Councils</p> <p>Insurance sector</p>	<p>Australian Red Cross</p> <p>Business and industry</p> <p>Other Regions</p> <p>Community service agencies</p>



Ref	Priority adaptation option	Timing	Potential actions to progress implementation of priority adaptation options including preparatory work that may be required to commence now for longer term options	Lead  This role could include one or more of the following:  - Initiation of the action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring, evaluation and reporting	Partners  This role could include one or more of the following:  - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring, evaluation and reporting
			Utilise a range of methods/techniques for disseminating this information to the community including social media, engagement with special interest groups, linking promotion of information with existing programs and activities and region-wide advertising campaigns		
A5	*Build community connectedness	Now	<p>Community connectedness can be supported by programs, initiatives and activities that occur at a range of scales, from neighbourly interactions that happen on an ad hoc, casual basis through to established groups and networks that meet regularly or organisations that undertake specific activities or provide opportunities for social interaction and community development Through improved community connectedness, people living in the Western Adelaide Region can develop systems of support and establish links with others whether they be individuals or organisations.</p> <p>An initial task could involve reviewing what is currently offered across the Western Adelaide Region to build community connectedness with a focus on determining whether people with vulnerabilities are adequately included in existing services, activities and programs.</p> <p>This review could consider:</p> <ul style="list-style-type: none"> <li>- The mix and scale of programs, initiatives and activities available in the Region ranging from neighbourly interactions that happen on an ad hoc, casual basis through to established groups and networks that meet regularly or organisations that undertake specific activities or provide opportunities for social interaction and community development</li> <li>- Opportunities to leverage off of existing programs, initiatives and activities</li> <li>- Gaps in provision (particularly as they relate to specific localities in the Region)</li> </ul> <p>The mapping provided in Figure B3 can assist with identifying locations to target action initially.</p>	Western Adelaide Region Councils Department of Communities and Social Inclusion (DCSI)	Community service agencies Not-for Profit Sector Other State Government agencies Commonwealth Government funding bodies Community groups
A6	Use risk assessment approaches to prioritise adaptation responses	Now	<p>Risk assessment approaches require a detailed understanding of the likelihood of assets being impacted by climate change. Undertaking modelling and mapping of flood inundation and sea level rise considering projected increases in rainfall intensity and sea level rise is essential for better understanding which assets are at risk and what response options should be considered. Such risk assessment should be used to inform reviews of asset management plans (refer A8).</p> <p>Monitoring, modelling and mapping will be required to plan the approach for West Lakes (refer section 4.11) and will inform when different actions may need to be taken in relation to rising sea levels</p> <p>In the future as new information becomes available, as infrastructure works are undertaken and as the confidence in rainfall intensity projections increases, stormwater and seawater inundation models may need to be updated.</p> <p>Figure B4 identifies a number of related opportunities for infrastructure, planning and policy development.</p>	Western Adelaide Region Councils State Government including DPTI, Renewal SA, DSD, CPB	DEWNR Insurance sector
A7	*Manage urban runoff to mitigate flood risk and improve water quality and reuse	Now	<p>Updating modelling and mapping (using runoff rates that consider the impacts of climate change) to inform stormwater and asset management plans will assist in ensuring infrastructure capacity upgrades can be targeted where assets are most at risk (refer A6). Mitigating flood risk to the community and infrastructure may require infrastructure including retention and detention basins</p> <p>Water sensitive urban design features should be integrated into the design and construction of new developments and as part of infill development. Increasing infill and urban densification is likely to require additional stormwater management.</p> <p>Opportunities to increase stormwater harvest and reuse for irrigation of public open space will reduce reliance on potable and groundwater sources.</p>	Western Adelaide Region Councils Stormwater Management Authority (SMA) DPTI	AMLR NRMB DEWNR LGA Water Sensitive SA Universities and research institutions

Ref	Priority adaptation option	Timing	Potential actions to progress implementation of priority adaptation options including preparatory work that may be required to commence now for longer term options	Lead This role could include one or more of the following:  - Initiation of the action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring, evaluation and reporting	Partners This role could include one or more of the following:  - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring, evaluation and reporting
			<p>Whole of catchment management initiatives that reduce stormwater pollutant loads and manage stormwater flows through initiatives like Water Proofing the West are required.</p> <p>Support and funding options for implementing recommendations of stormwater management plans is required across the Region.</p> <p>Figure B4 identifies a number of related opportunities for infrastructure, planning and policy development.</p>		
A8	*Embed climate considerations into asset management and decision making	Now	<p>This adaptation option can be progressed by embedding climate change considerations into asset management plans and decision making processes. This would involve:</p> <ul style="list-style-type: none"> <li>- identifying future projected climate impacts within asset management plans and other decision making processes (eg review of policies, plans and strategies)</li> <li>- managing assets and make decisions in a way that takes into account these future conditions (particularly in relation to intense rainfall, storm surge/sea level rise and drier conditions)</li> </ul> <p>The embedding of these considerations into everyday practices needs to be coupled with the capacity building of relevant staff</p> <p>It should also be supported by modelling and mapping for example for stormwater management by considering changes in rainfall intensity and ARI and sea level rise and storm surge</p> <p>There is merit in ensuring that different types of assets (eg roads, stormwater infrastructure) are treated in a consistent way and that the approach to asset management planning is similar at a regional scale. While there is unlikely to be a “one size fits all” approach, developing standard criteria for preparing climate-ready asset plans could be undertaken at a regional scale</p> <p>Key strategies and plans to be focussed on as a matter of priority for the Western Adelaide Region include the Adelaide Living Beaches Strategy including the sand replenishment program.</p>	Western Adelaide Region Councils CPB SMA DPTI Infrastructure owners and operators (eg Adelaide Airport, DPTI, SA Water, SA Power Networks, Flinders Ports, Australian Submarine Corporation etc)	LGA
A9	*Establish soft and hard infrastructure protection measures along the coast		<p>Resourcing and implementing key coastal strategies and plans is a priority for the Western Adelaide Region, in particular the Adelaide Living Beaches Strategy and the associated sand replenishment program.</p> <p>Soft protection works such as revegetation and fencing will assist in protecting dunes and beaches.</p> <p>Establishing monitoring points along the coast (eg on jetties and/or boat ramps) to monitor the progress and effects of sea level rise will assist in identifying when particular protection works may be required, or current action is no longer viable. Installation of a SeaFrame monitoring station (currently in progress) will provide detailed sea level data.</p> <p>Figure B4 identifies a number of related opportunities for infrastructure, planning and policy development.</p>	Renewal SA DSD CPB DPTI Western Adelaide Region Councils	AMLR NRMB Developers Private landowners RDA and other infrastructure funding agencies
A10	Establish hard infrastructure protection measures along the coast		<p>Resourcing and implementing key coastal strategies and plans is a priority for the Western Adelaide Region, in particular the Adelaide Living Beaches Strategy and the associated sand replenishment program.</p> <p>Hard infrastructure works such as sea walls will be required to protect built assets and infrastructure over the longer term, and in some locations immediately. Significant detailed investigations have been undertaken in the Port Adelaide River – these recommendations should be implemented as part of the current redevelopment of the waterfront. More detailed investigations will be required to identify other locations where hard structural options are likely to be required (refer A6). The investigations should include modelling to assess the preferred impacts of any structures to avoid maladaptation</p>	Renewal SA DSD CPB DPTI Western Adelaide Region Councils	AMLR NRMB Developers Private landowners RDA and other infrastructure funding agencies

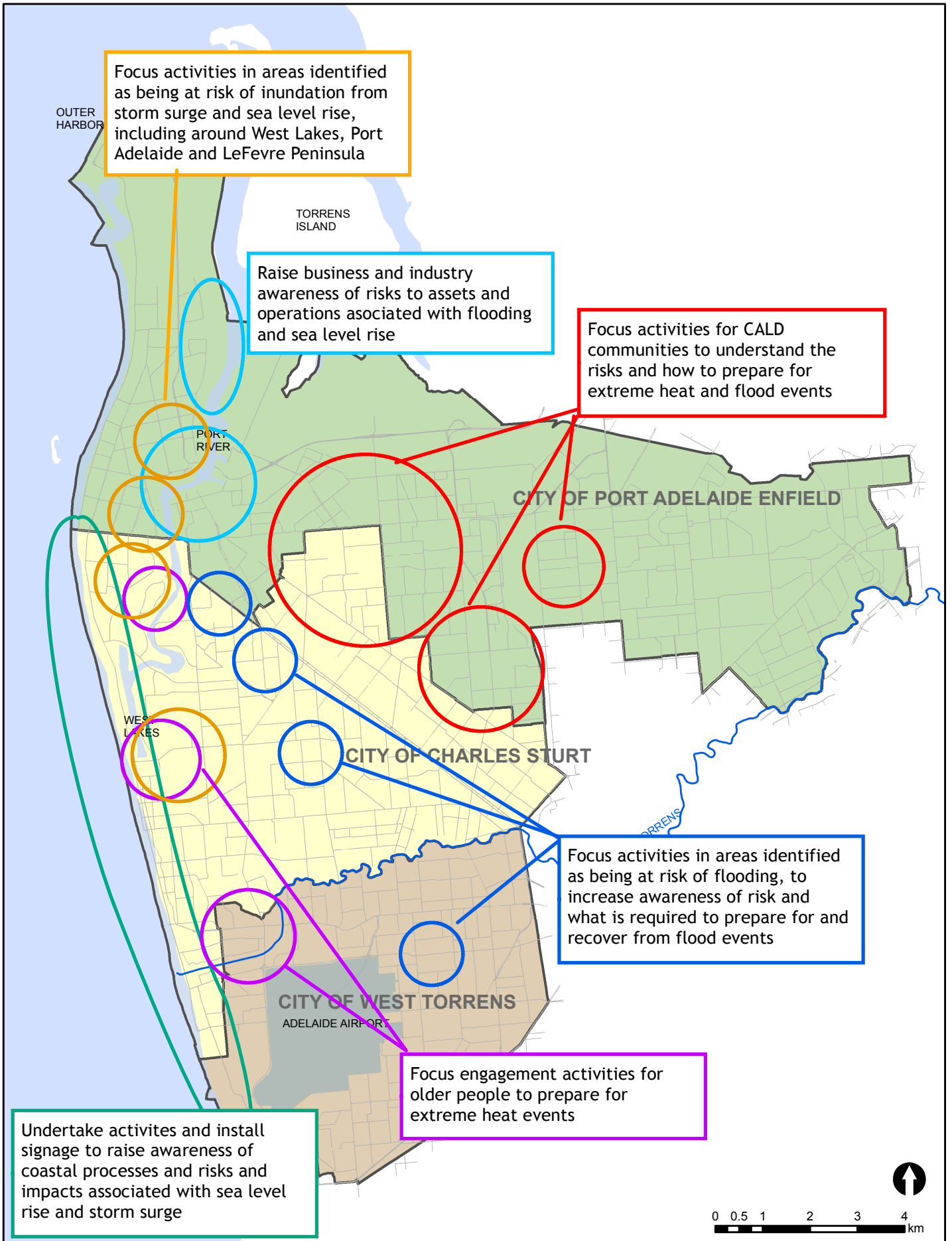
Ref	Priority adaptation option	Timing	Potential actions to progress implementation of priority adaptation options including preparatory work that may be required to commence now for longer term options	Lead This role could include one or more of the following: - Initiation of the action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring, evaluation and reporting	Partners This role could include one or more of the following: - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring, evaluation and reporting
			<p>It will be critical to work with adjacent metropolitan coastal Councils (outside of the Western Adelaide Region) to establish a coordinated approach to implementation of hard structural options</p> <p>Establishing monitoring points along the coast (eg on jetties and/or boat ramps) to monitor the progress and effects of sea level rise will assist in identifying when particular protection works may be required, or current action no longer viable. Installation of a SeaFrame monitoring station (currently in progress) will provide detailed sea level data.</p> <p>Figure B4 identifies a number of related opportunities for infrastructure, planning and policy development.</p>		
A11	Relocate assets and infrastructure away from high risk areas	20 years	<p>Past residential, commercial and industrial developments have occurred in areas that are now understood to be subject to flood and sea level rise risk. As the risk of climate hazards increases in the future, impacts could be minimised by limiting further development or relocating development in hazard prone areas. This is considered an important adaptation option for further exploration by the Region. It is also an aspect that other regions across the State are grappling with and warrants coordinated consideration</p> <p>An initial steps could include convening a round table discussion with the other planning regions and the State Government to discuss current approaches to adaptation in known hazard zones, issues associated with continuing to allow development to remain in these areas, barriers to changing the current approach and opportunities for change. This discussion could also include exploring strategies for transitioning development from known hazard areas.</p>	State government	LGA Other regions Western Adelaide Region Councils Insurance sector



**AdaptWest**

Figure B1 - Opportunities for increasing urban greenness

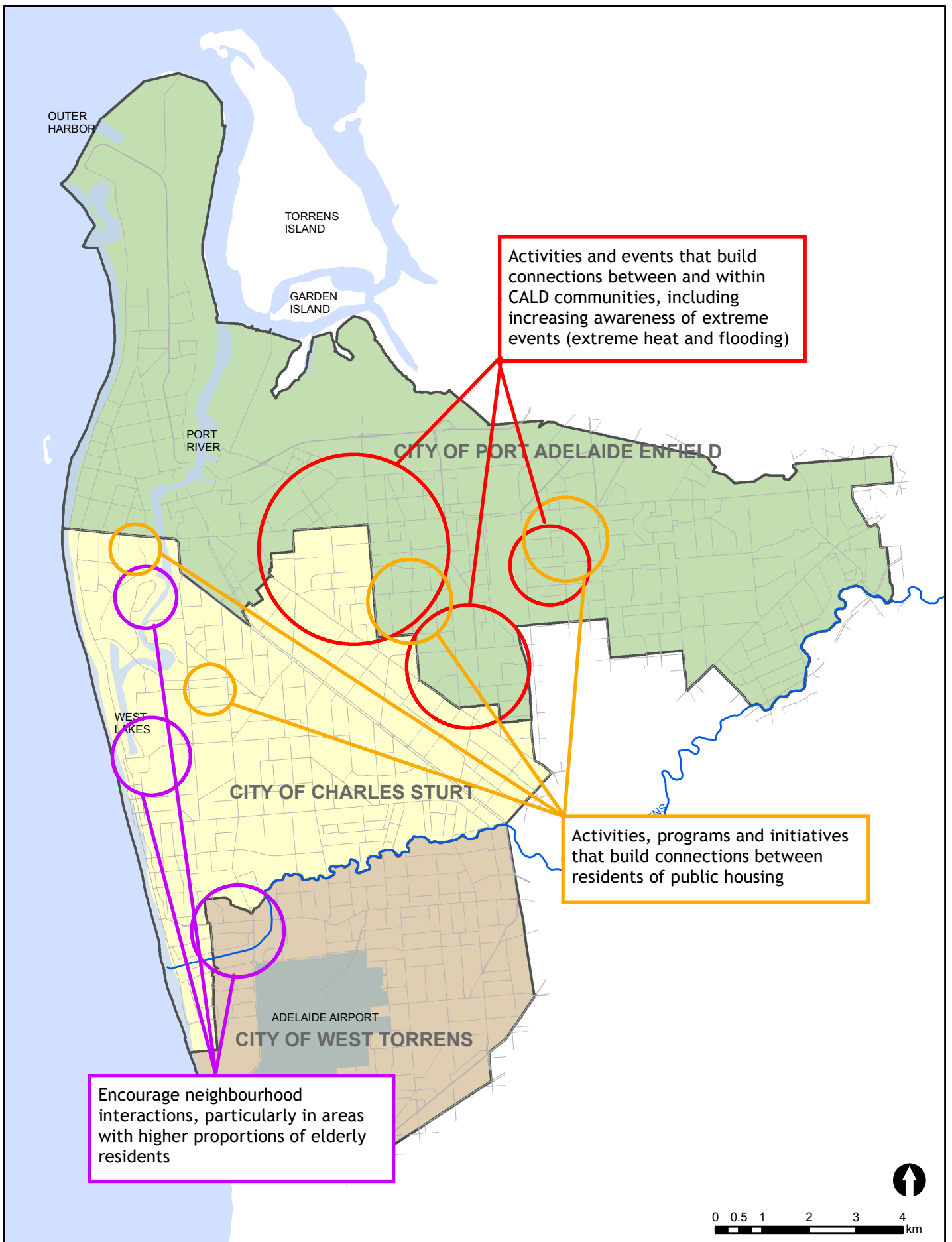
Data Source: DEWNR, DPTI



# AdaptWest

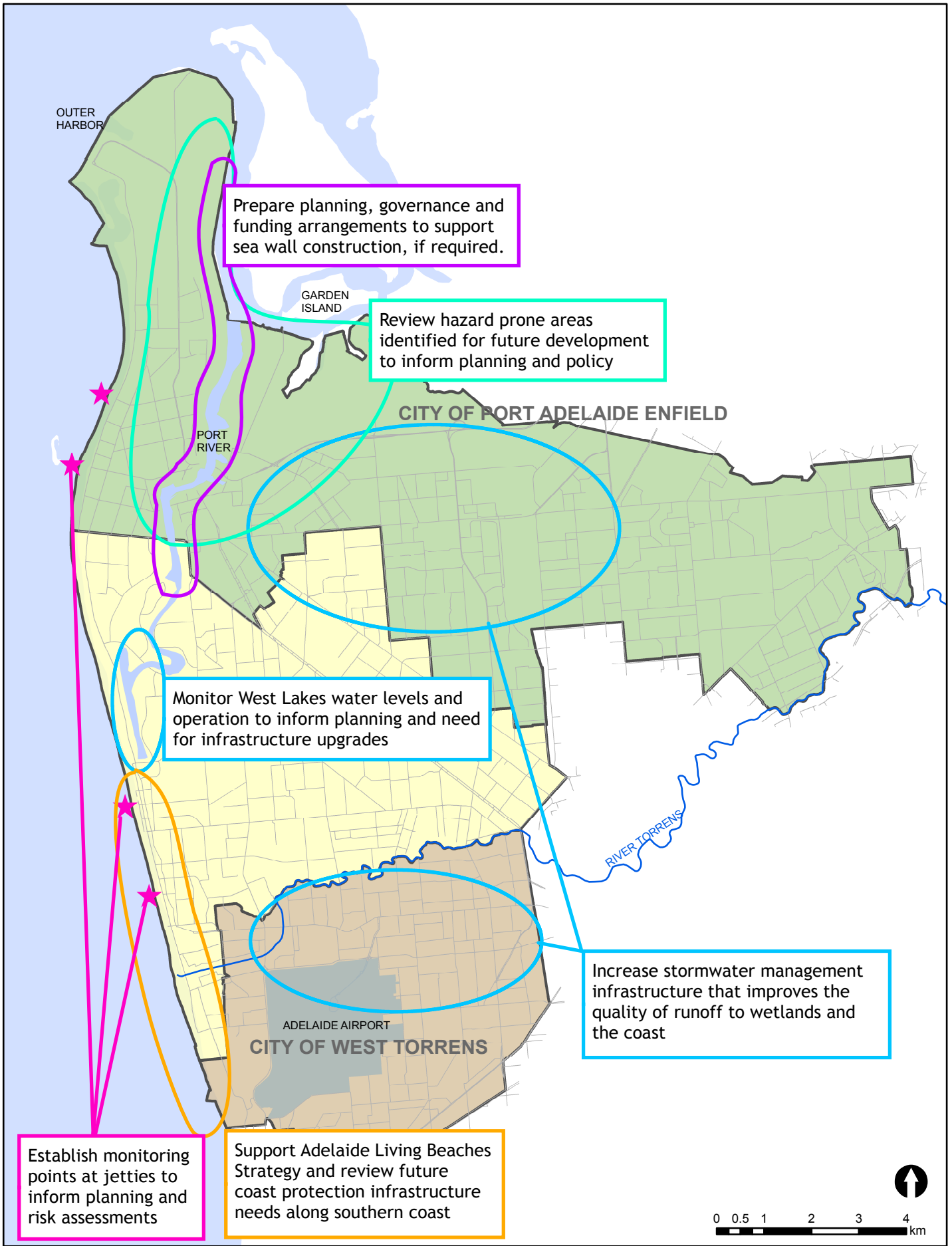
Figure B2 - Opportunities for education and awareness raising

Data Source: DEWNR, DPTI



## AdaptWest

Figure B3 - Opportunities for building community connectedness (focusing on people with vulnerabilities)



# AdaptWest

Figure B4 - Opportunities for infrastructure, planning and policy

Data Source: DEWNR, DPTI

# Appendix C

## Mapping of vulnerability to sea level rise and flooding



Using spatial datasets, the relative vulnerability of key features to climate variables that impact at different intensities depending on their location (eg sea level rise and flood inundation) was modelled to provide maps that would enable identification of ‘hot-spots’ of vulnerability.

Exposure to sea level rise (including storm surge from the Highest Astronomical Tide (HAT)<sup>23</sup> in calm conditions and a 1:50 year storm event<sup>24</sup>) was mapped at 4 inundation levels equating to 4 exposure scores, using Table 10. The levels were identified using the Climate Projections Report<sup>25</sup> and the *Coastal and Inundation Modelling – Phase 1 Report* and with reference to the Coastal Flooding Visualisation Tool (Vistool) tide and storm surge values. The Adelaide 2009 LiDAR data was used to identify the areas subject to sea level rise inundation includes sea level rise in 20cm increments, requiring the mapping extent to be aligned to the closest available increment. Map 1 shows exposure to sea level rise for the Western Adelaide Region.

**Table 10 Exposure scoring (sea level rise)**

Exposure Score	Exposure descriptor	Level includes	Mapping extent
1	Rare	SLR + 1:50 yr storm lower range of sea level	3.0m AHD
2	Unlikely	SLR + 1:50 yr storm upper range of sea level	2.8m AHD
4	Likely	SLR + HAT (calm conditions) lower range of sea level	2.2m AHD
5	Very likely	SLR + HAT (calm conditions) upper range of sea level	2.0m AHD

Exposure to flood inundation was mapped at 3 inundation levels equating to 3 exposure scores according to Table 11. Model outputs from stormwater management plans completed from across the Region were used to map the inundation extent associated with each exposure level. Map 2 shows exposure to flood inundation across the Western Adelaide Region.

<sup>23</sup> Highest Astronomical Tide (HAT) is the highest tide level which can be predicted to occur any combination of astrological conditions. It does not include any allowance for weather conditions such as storms or wind.

<sup>24</sup> A 1-in-50 year storm surge event has a one in fifty (or 2%) chance of being equalled or exceeded in any one year. In other words, inundation from a 1-in-50 year storm surge event is expected to be met on average once every 50 years. This does not mean that a 1-in-50 year event cannot occur, for example, twice in ten years, or three times in fifty years, simply that on average a 1-in-50 year storm surge event is expected to be met once every 50 years (Vistool, 2015)

<sup>25</sup> AdaptWest (2014) *Identifying climate variables for use by the Integrated Vulnerability Assessment for the Western Adelaide Region*

**Table 11 Exposure scoring (flood)**

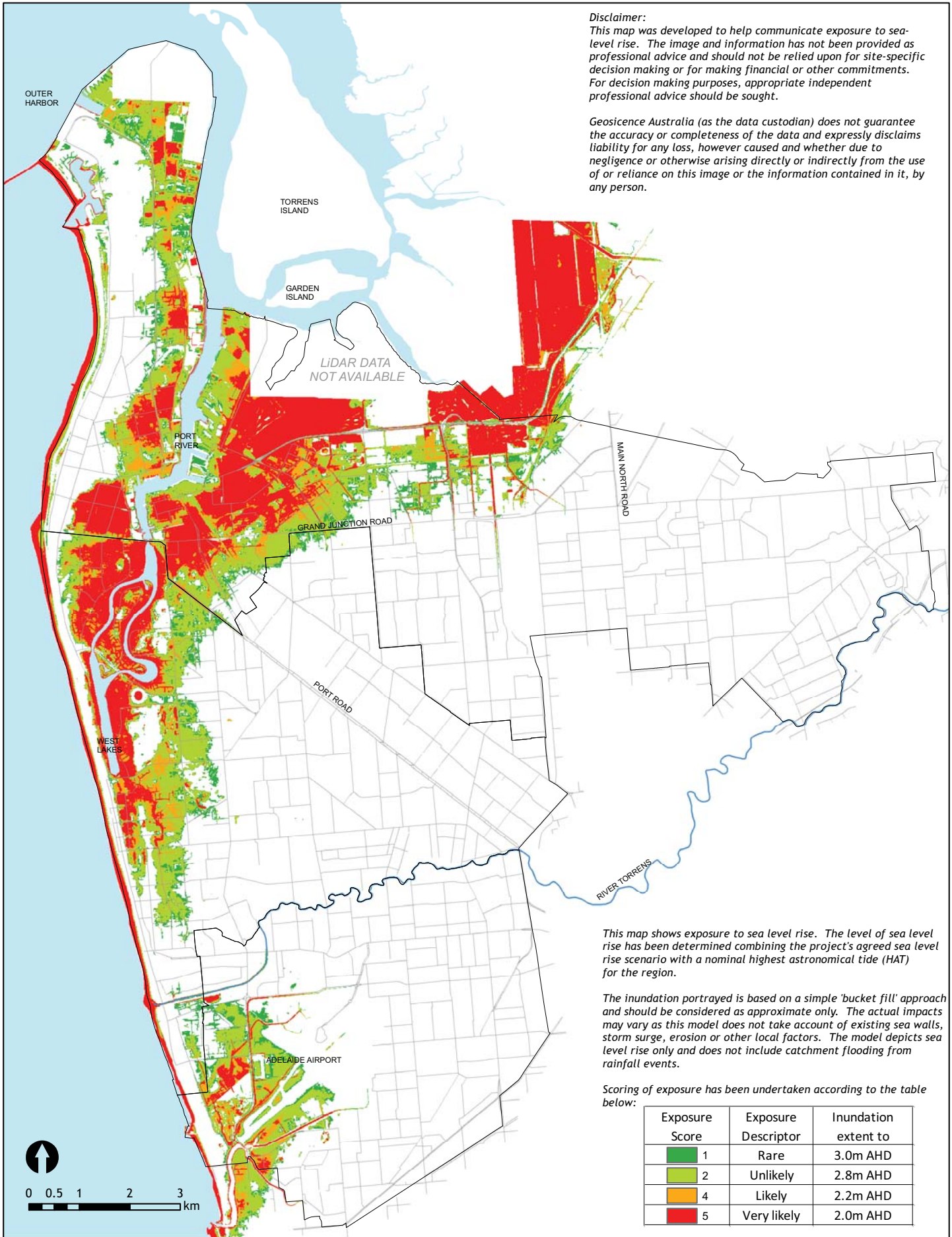
Exposure Score	Exposure descriptor	Level includes
2	Unlikely	100 year ARI flood extent
4	Likely	20 year ARI flood extent
5	Very likely	5 year ARI flood extent

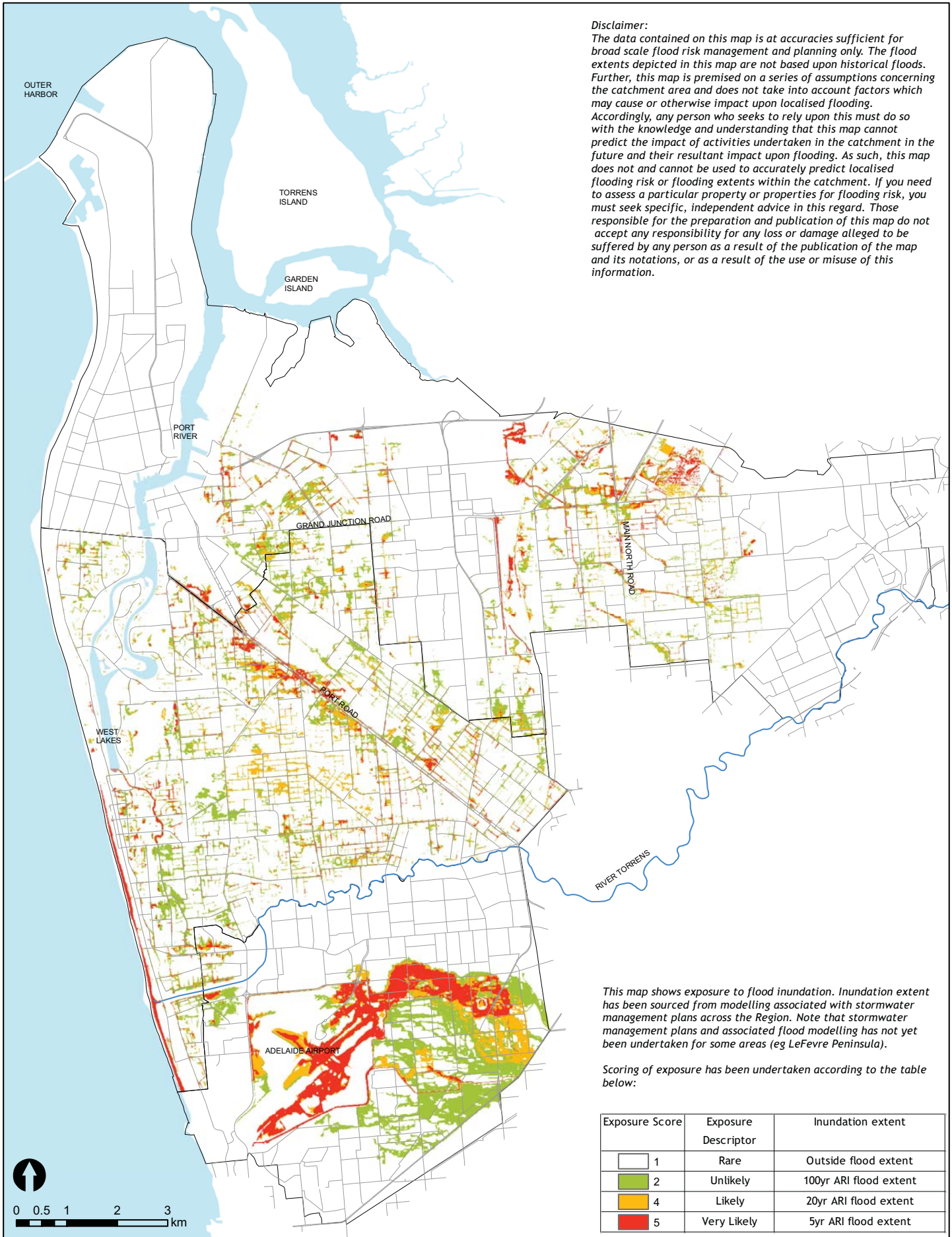
On the following pages, Maps 3 to 15 show the outputs of the spatial analyses showing vulnerability to sea level rise or flood inundation of valued features or aspects in the Western Adelaide Region.

To generate these maps the sensitivity and adaptive capacity scores from the IVA were applied and using ArcView Spatial Analysis, converted to a grid of asset sensitivity and asset adaptive capacity to the relevant climate variable. The exposure layers (sea level rise and flooding) were also converted to a grid and these grids were then added together to calculate vulnerability across the Region (using the formula described in Box 1). A 10m grid size was used for all analyses. Table 12 summarises the focus of maps 3 to 15.

**Table 12 Focus of maps**

Map	Area of focus
Map 1	Exposure to sea level rise for the Western Adelaide Region
Map 2	Exposure to flood inundation across the Western Adelaide Region
Map 3	Vulnerability of vulnerable members of the community (those requiring assistance for core activities or aged over 75) to flood inundation
Map 4	Vulnerability of public coastal built assets (including jetties, boat ramps, coast access paths, sea walls, marinas and playgrounds) to sea level rise
Map 5	Vulnerability of open space and recreation areas to sea level rise
Map 6	Vulnerability of open space and recreation areas to flood inundation
Map 7	Vulnerability of coastal landscapes (including beaches and dunes and coastal shrubland) to sea level rise
Map 8	Vulnerability of mangrove and samphire landscapes to sea level rise
Map 9	Vulnerability of residential properties to sea level rise
Map 10	Vulnerability of stormwater infrastructure to sea level rise
Map 11	Vulnerability of stormwater infrastructure to flood inundation
Map 12	Vulnerability of commercial and industrial properties to sea level rise
Map 13	Vulnerability of commercial and industrial properties to flood inundation
Map 14	Vulnerability of transport networks (road and rail) to sea level rise
Map 15	Vulnerability of transport networks (road and rail) to flood inundation





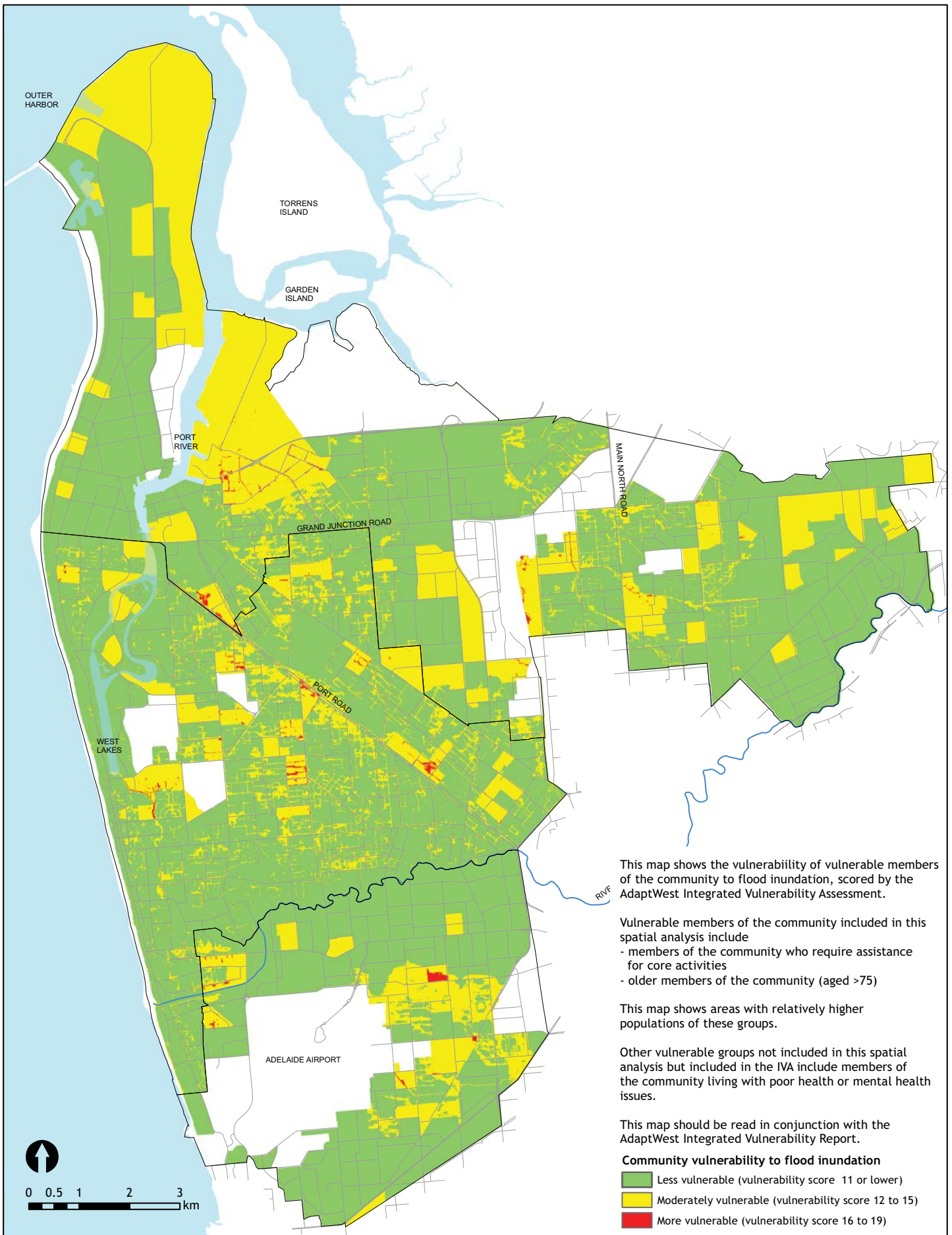
**Disclaimer:**  
 The data contained on this map is at accuracies sufficient for broad scale flood risk management and planning only. The flood extents depicted in this map are not based upon historical floods. Further, this map is premised on a series of assumptions concerning the catchment area and does not take into account factors which may cause or otherwise impact upon localised flooding. Accordingly, any person who seeks to rely upon this must do so with the knowledge and understanding that this map cannot predict the impact of activities undertaken in the catchment in the future and their resultant impact upon flooding. As such, this map does not and cannot be used to accurately predict localised flooding risk or flooding extents within the catchment. If you need to assess a particular property or properties for flooding risk, you must seek specific, independent advice in this regard. Those responsible for the preparation and publication of this map do not accept any responsibility for any loss or damage alleged to be suffered by any person as a result of the publication of the map and its notations, or as a result of the use or misuse of this information.

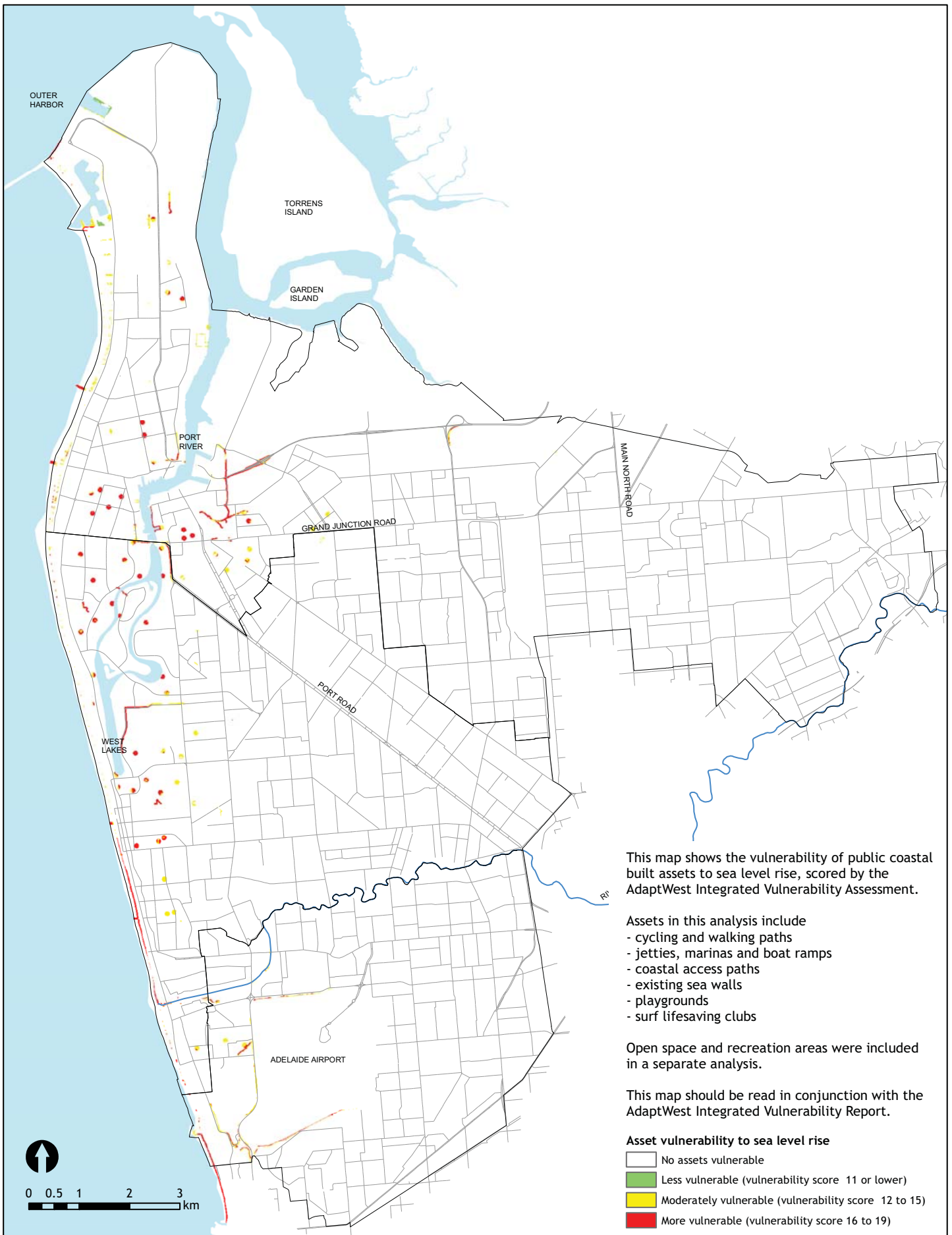
This map shows exposure to flood inundation. Inundation extent has been sourced from modelling associated with stormwater management plans across the Region. Note that stormwater management plans and associated flood modelling has not yet been undertaken for some areas (eg LeFevre Peninsula).

Scoring of exposure has been undertaken according to the table below:

Exposure Score	Exposure Descriptor	Inundation extent
1	Rare	Outside flood extent
2	Unlikely	100yr ARI flood extent
4	Likely	20yr ARI flood extent
5	Very Likely	5yr ARI flood extent

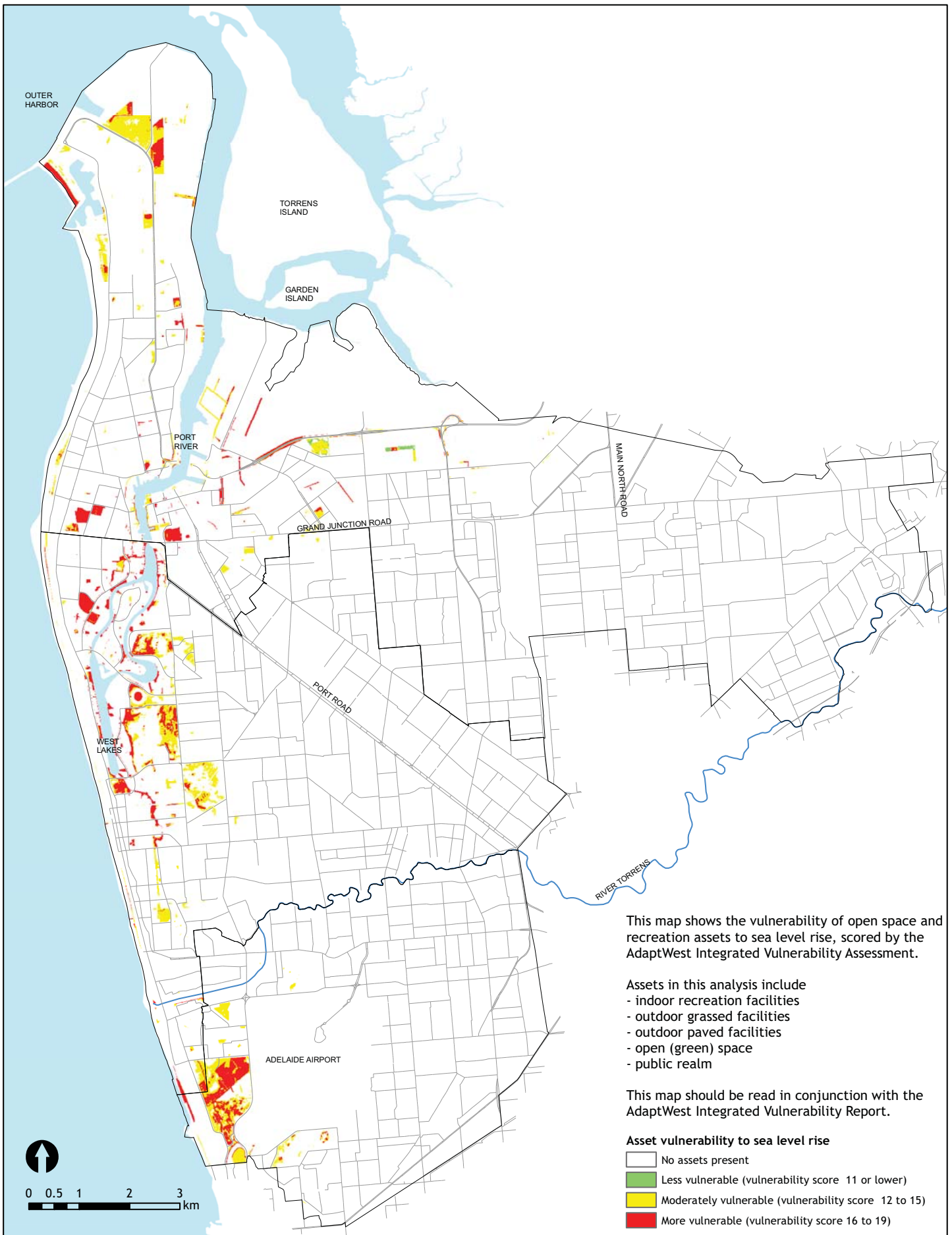
— River Torrens  
 □ Council boundary





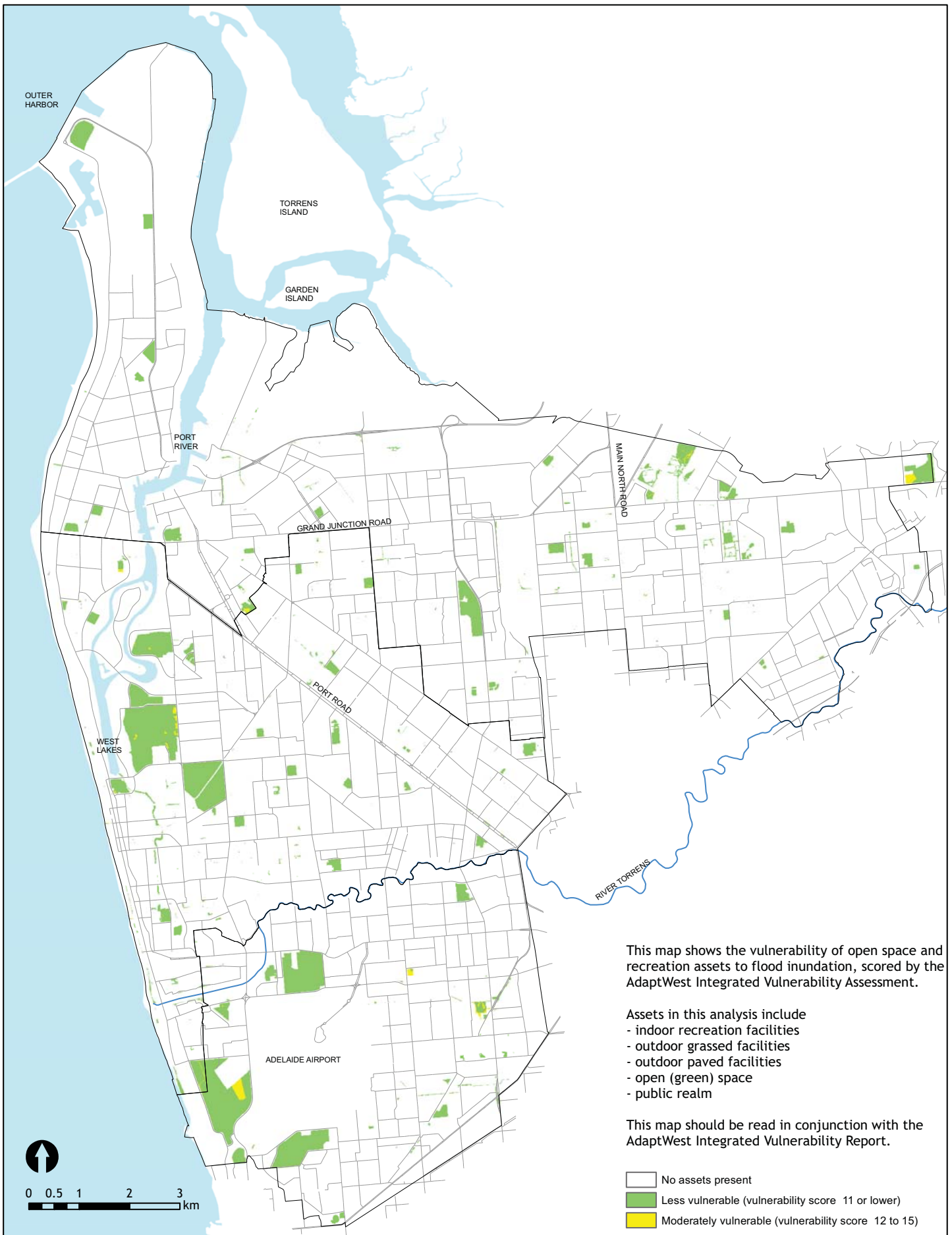
AdaptWest

## Map 4 Vulnerability to Sea Level Rise - Coastal Built Assets

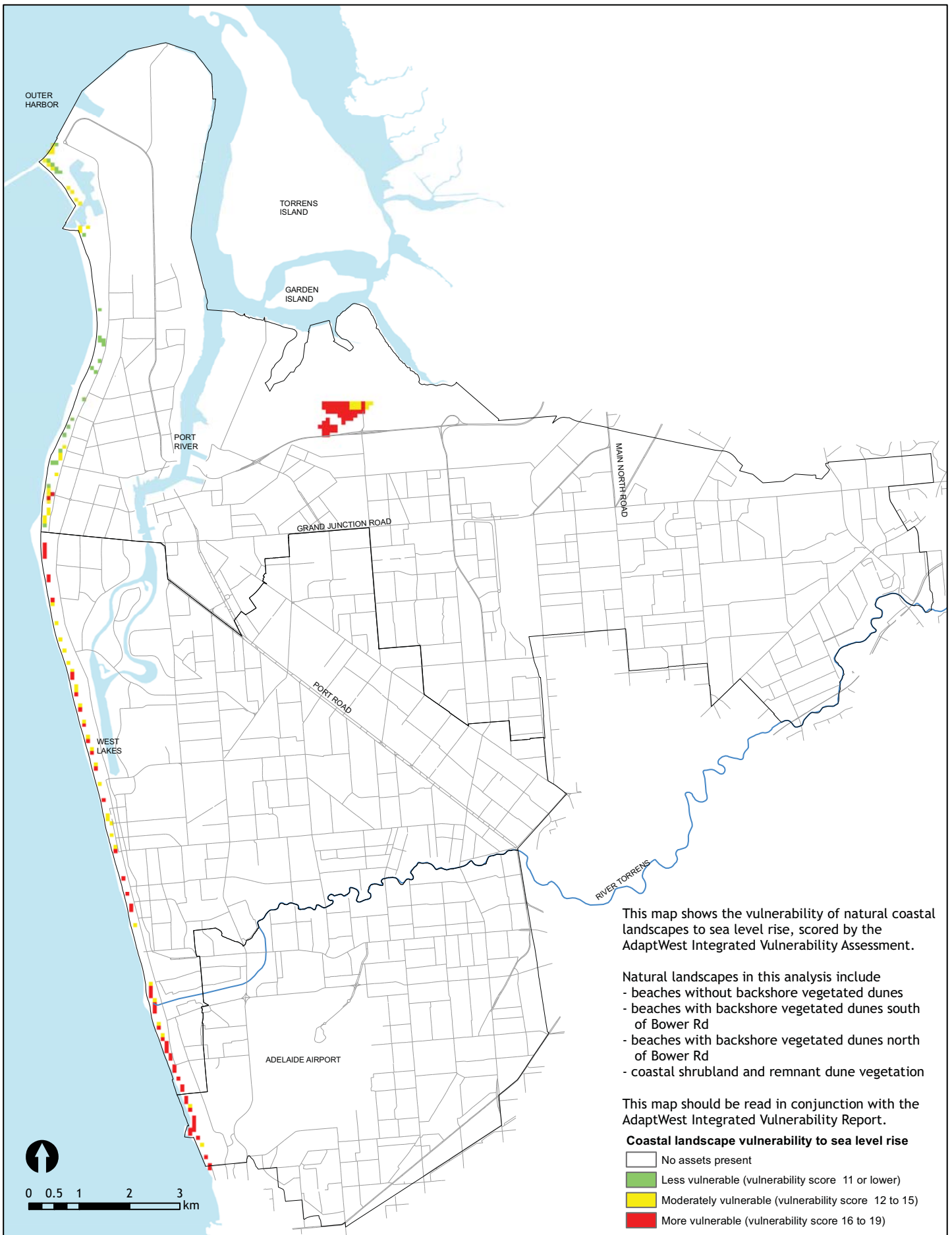


AdaptWest

## Map 5 Vulnerability to Sea Level Rise - Open Space and Recreation Areas

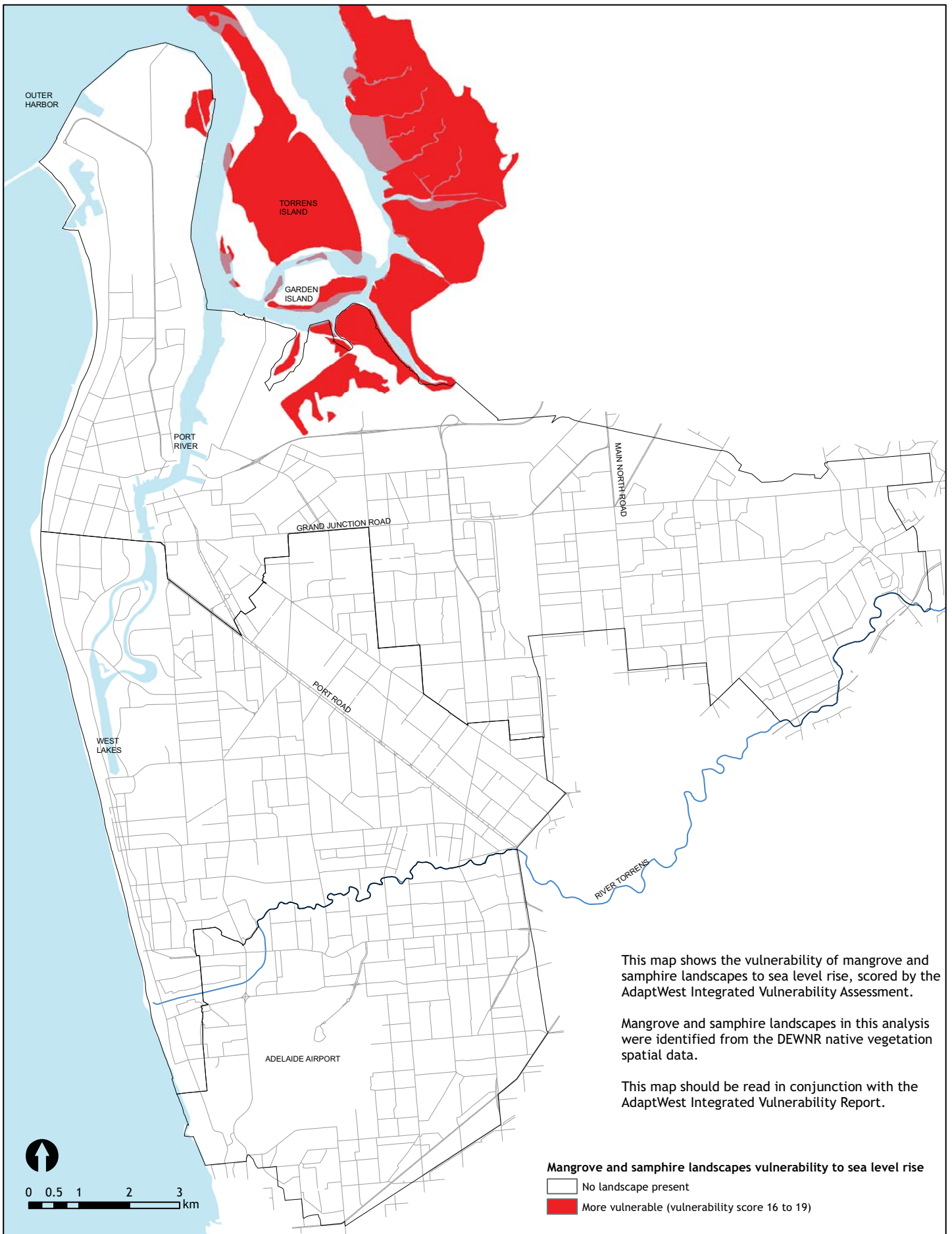






AdaptWest

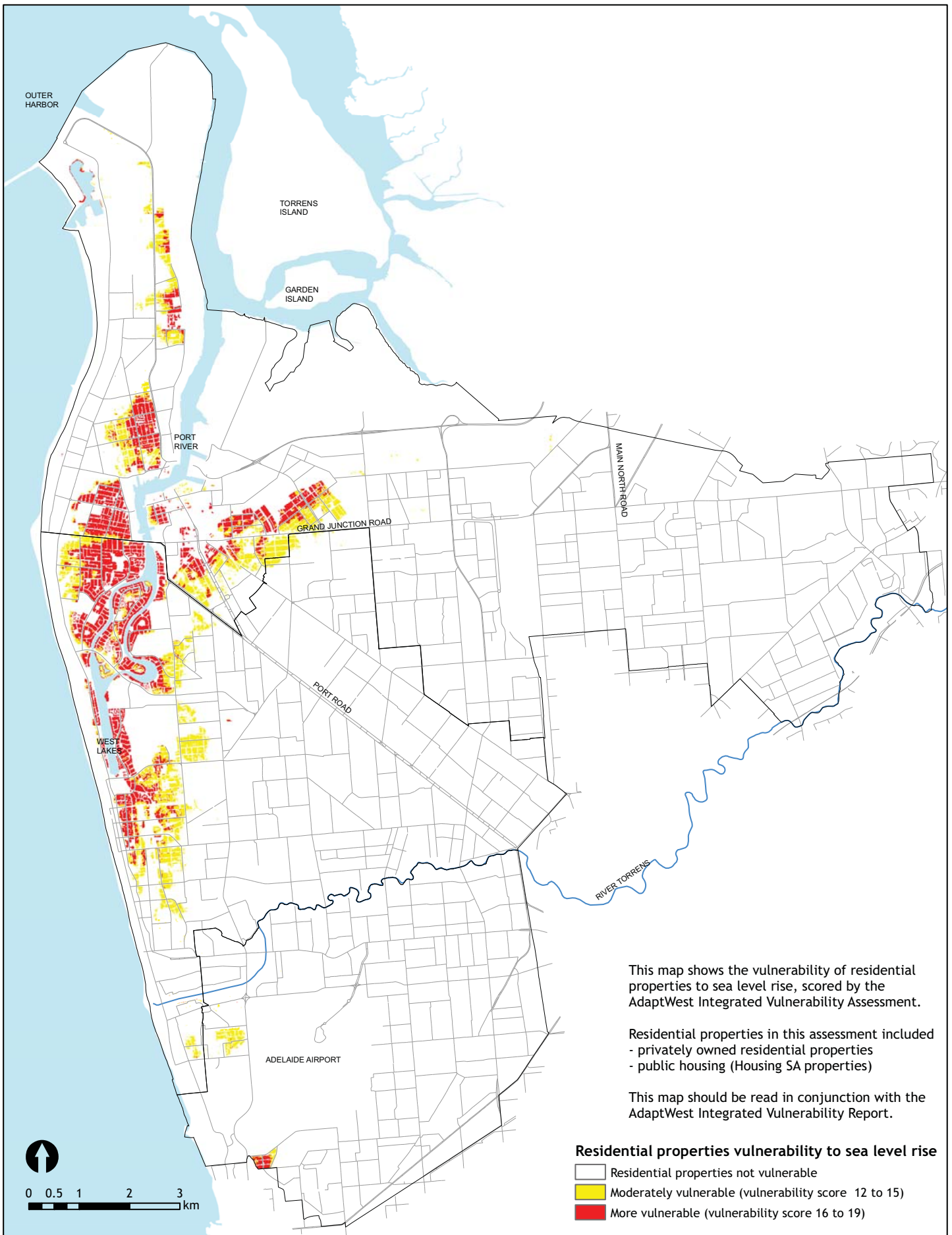
## Map 7 Vulnerability to Sea Level Rise - Coastal Landscapes



# AdaptWest

## Map 8 Vulnerability to Sea Level Rise - Mangrove and Samphire Landscapes

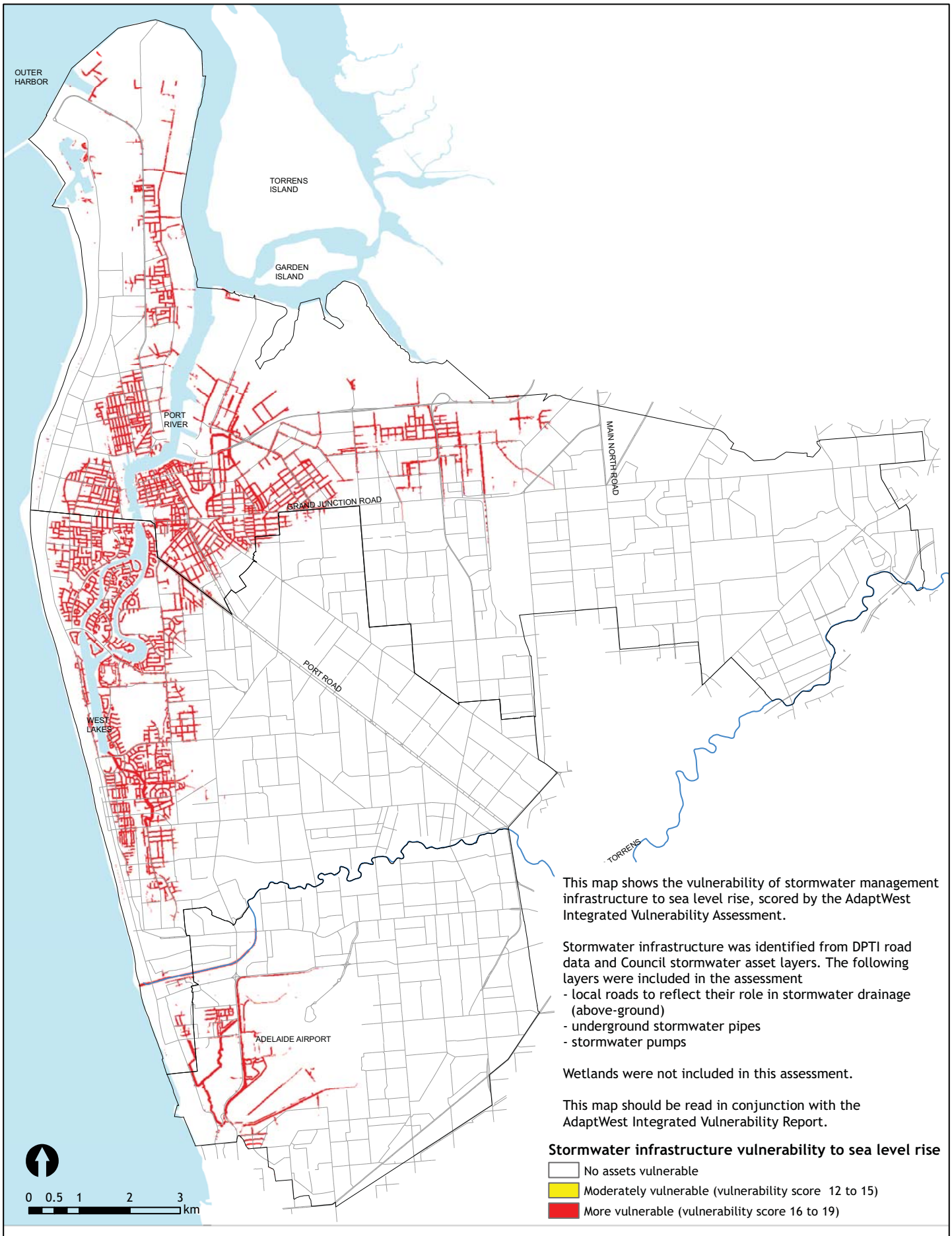
Data Source: DEWNR (native vegetation), DPTI (roads)



AdaptWest

## Map 9 Vulnerability to Sea Level Rise - Residential Properties

Data Source: DEWNR (Housing SA properties), DPTI (roads, landuse)



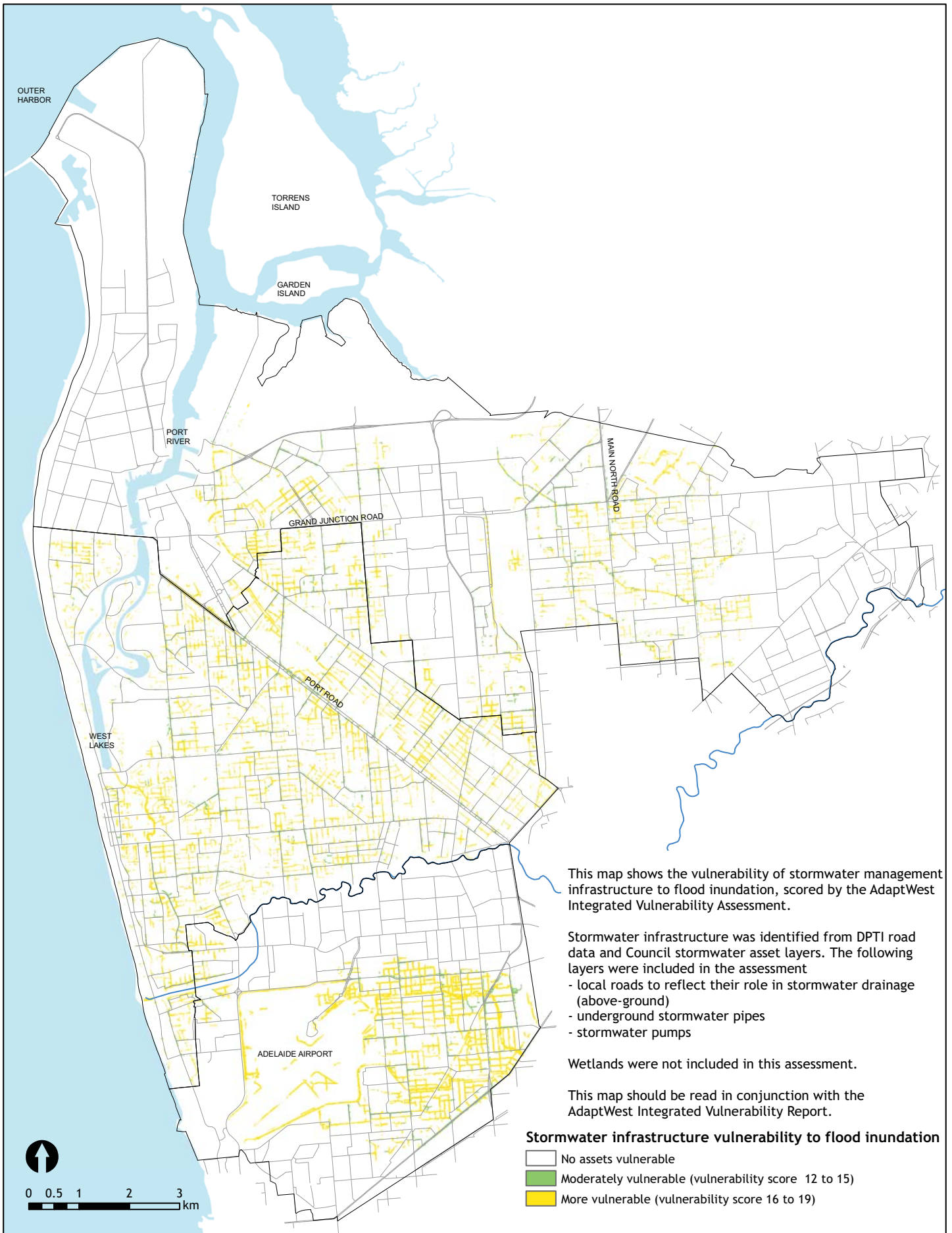
This map shows the vulnerability of stormwater management infrastructure to sea level rise, scored by the AdaptWest Integrated Vulnerability Assessment.

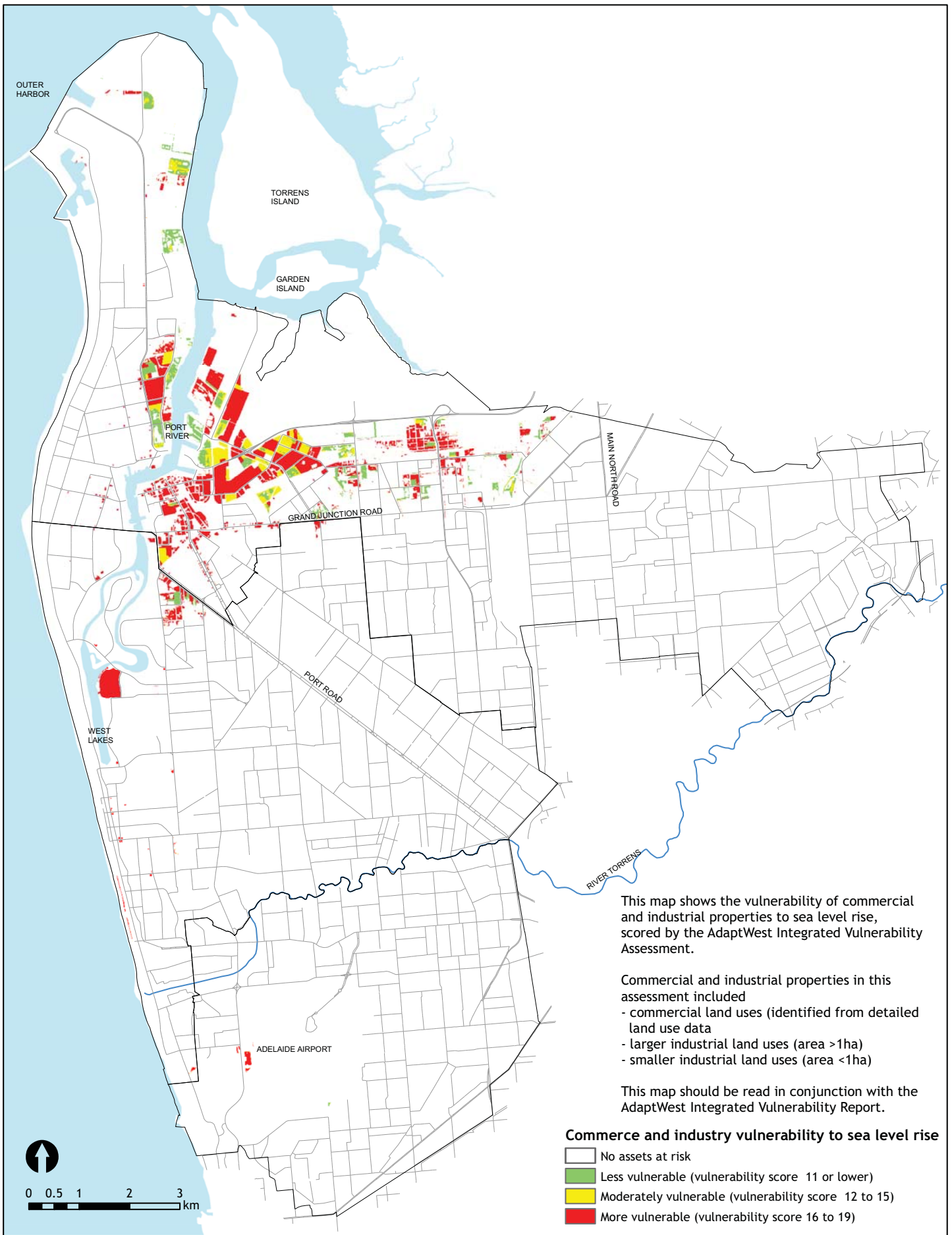
Stormwater infrastructure was identified from DPTI road data and Council stormwater asset layers. The following layers were included in the assessment

- local roads to reflect their role in stormwater drainage (above-ground)
- underground stormwater pipes
- stormwater pumps

Wetlands were not included in this assessment.

This map should be read in conjunction with the AdaptWest Integrated Vulnerability Report.

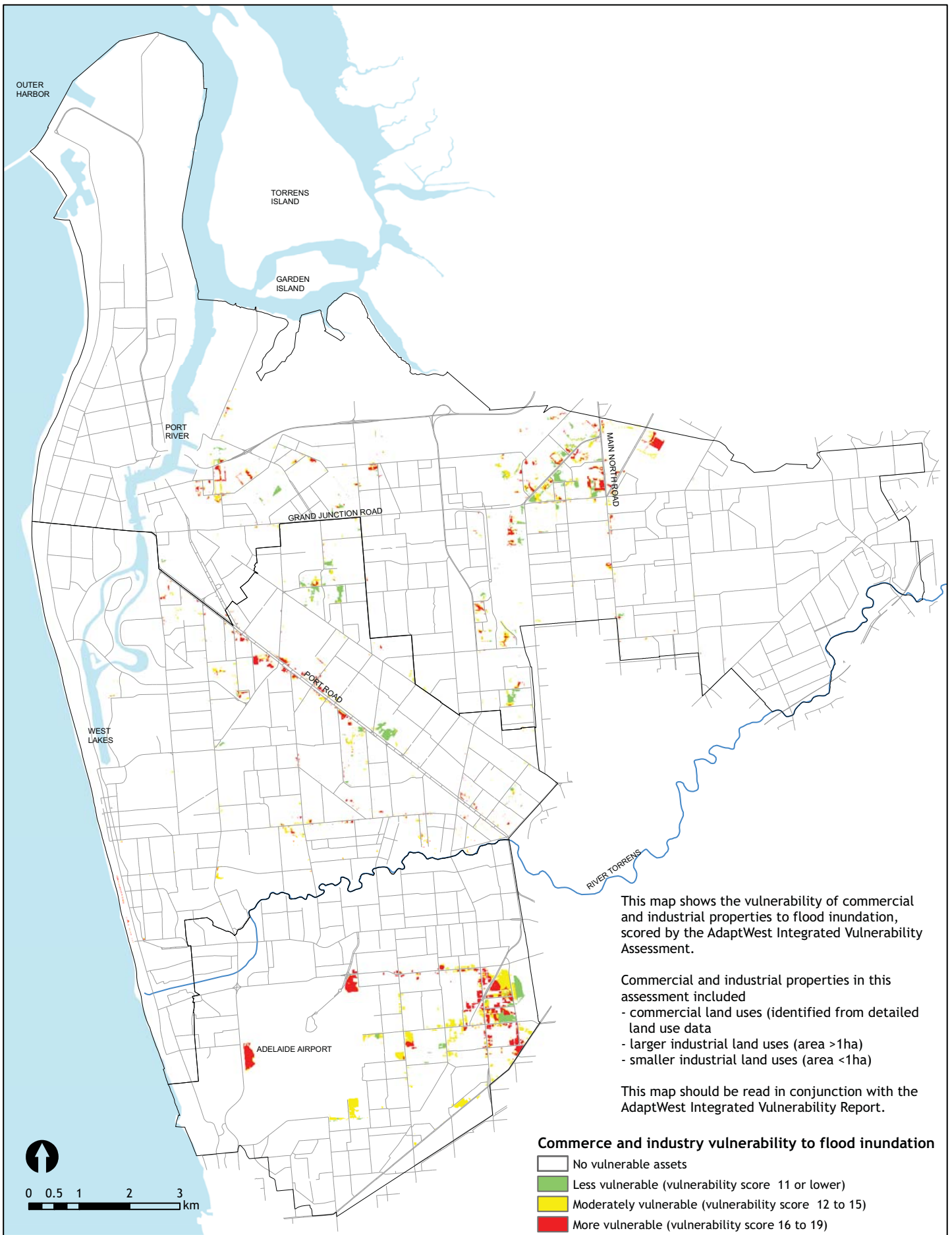




AdaptWest

## Map 12 Vulnerability to Sea Level Rise - Commercial and Industrial Properties

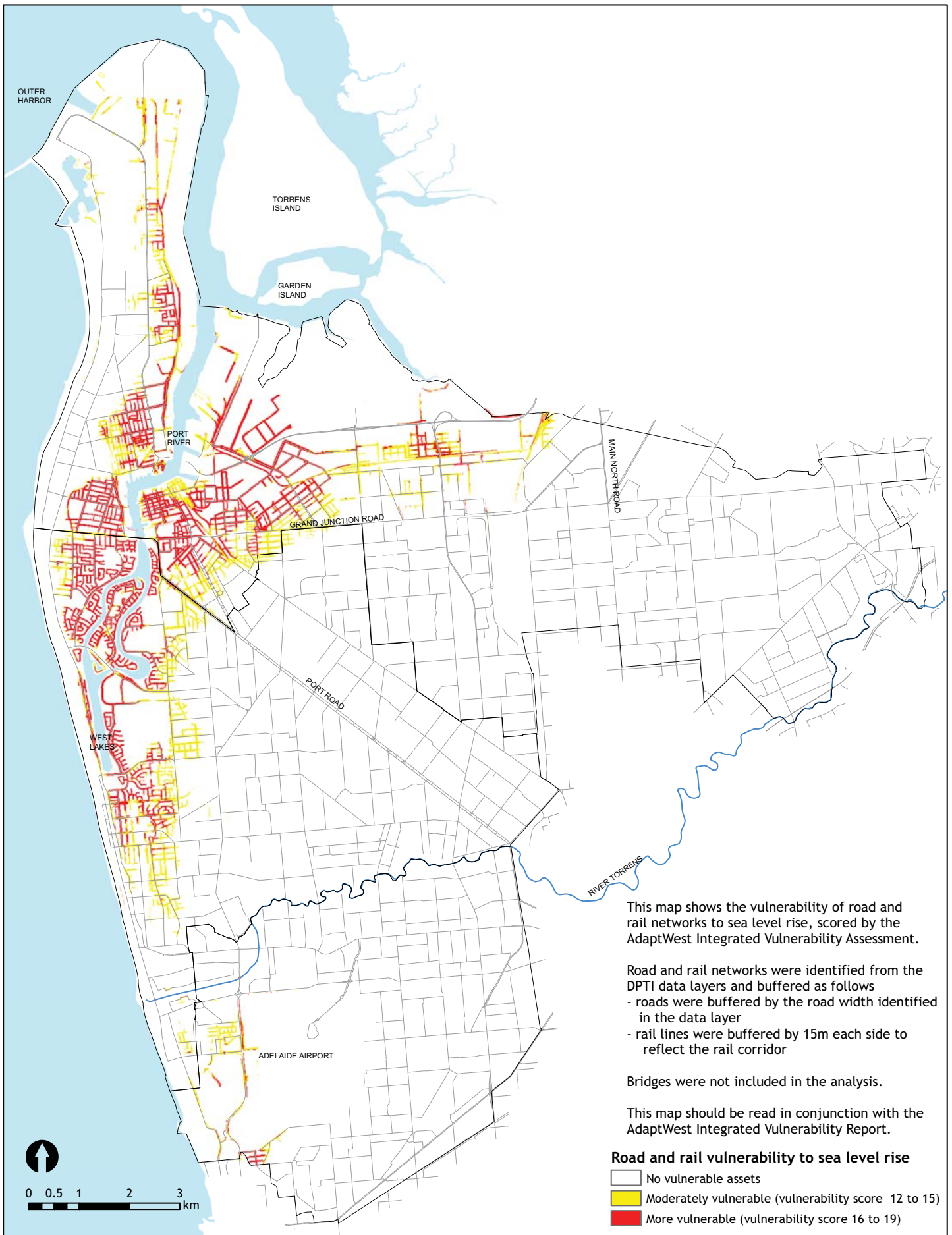
Data Source: DEWNR (Housing SA properties), DPTI (roads, detailed land use)



AdaptWest

## Map 13 Vulnerability to Flooding - Commercial and Industrial Properties

Data Source: DEWNR (Housing SA properties), DPTI (roads, detailed land use)

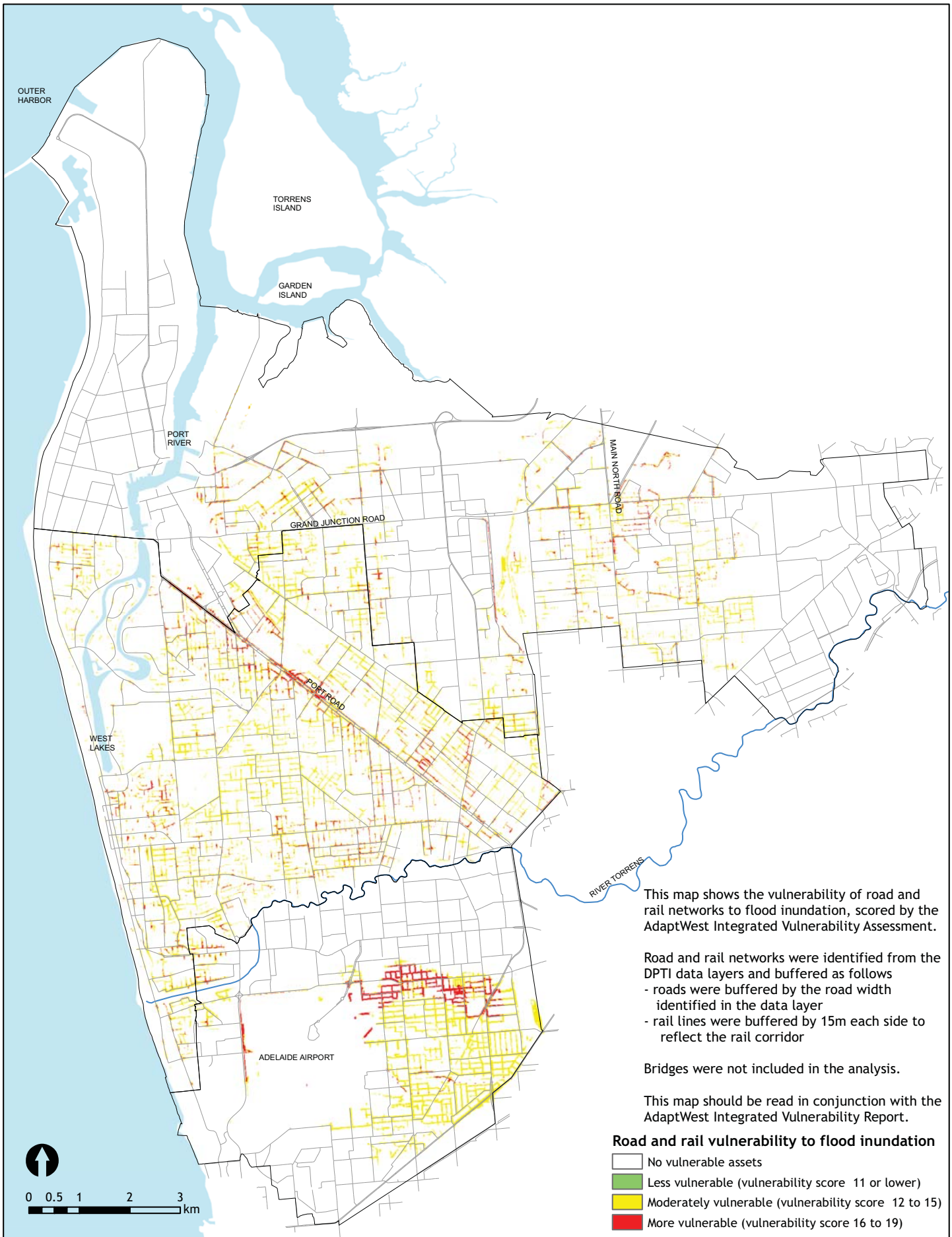


AdaptWest

## Map 14 Vulnerability to Sea Level Rise - Road and Rail Network

Data Source: DPTI (roads and rail)

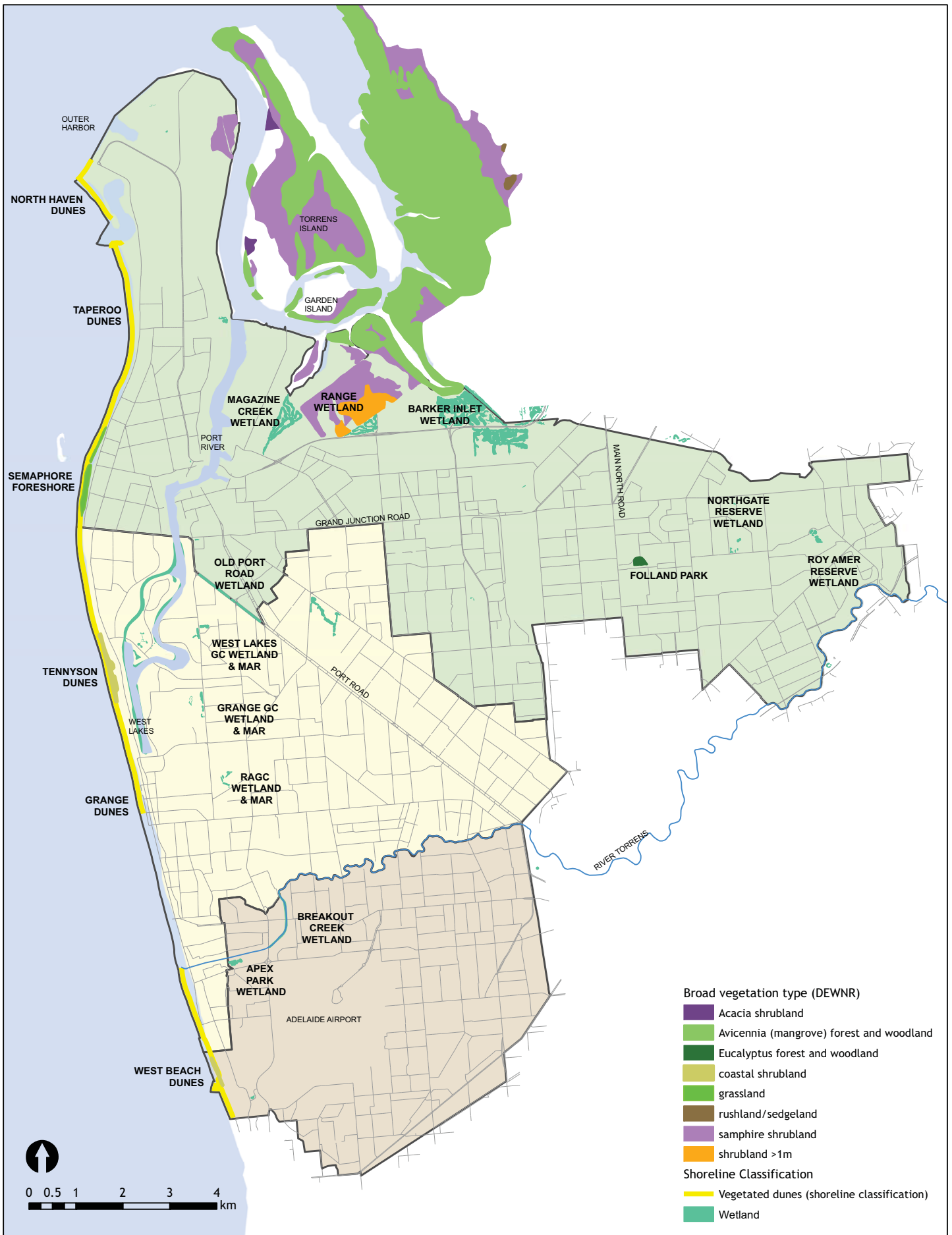


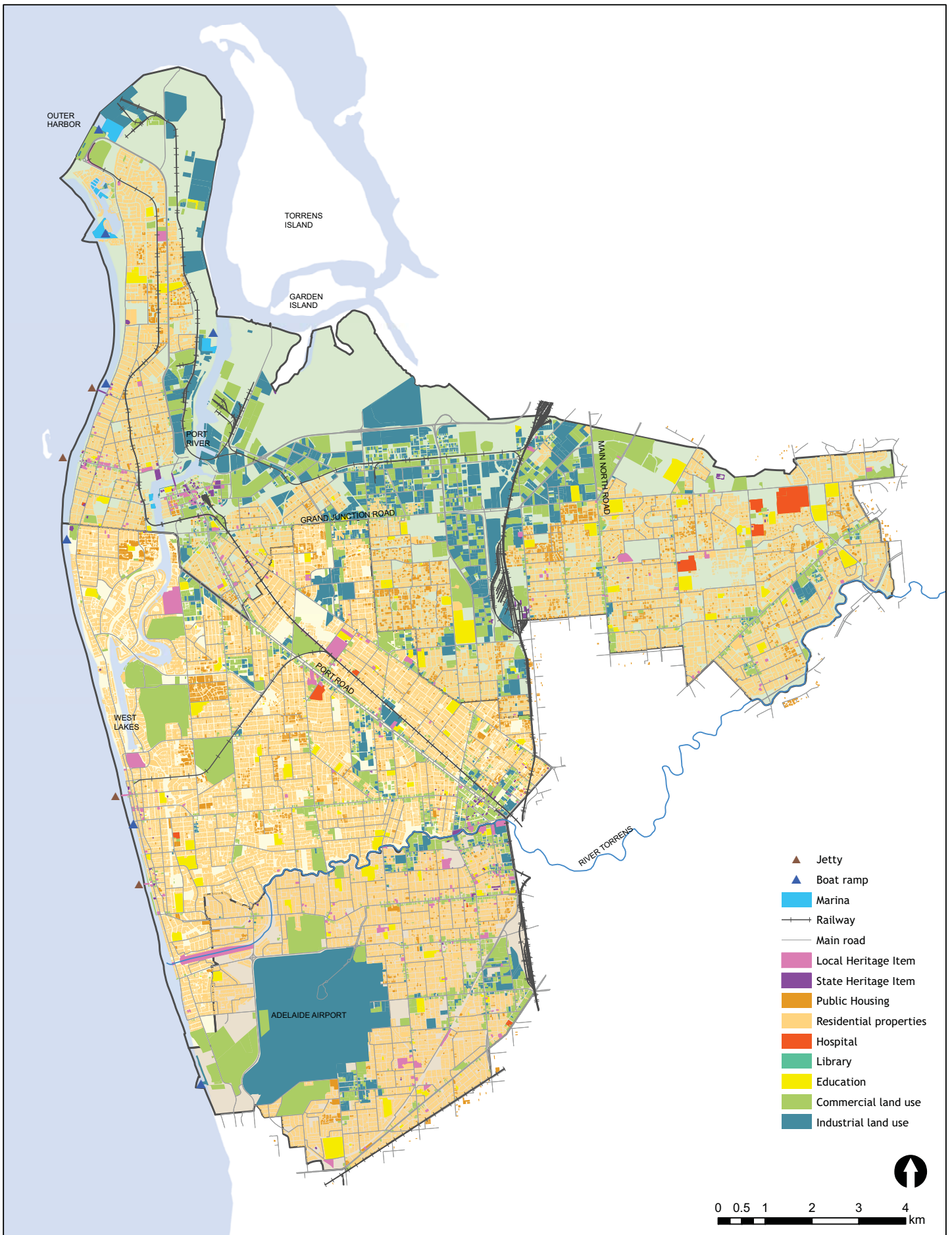


# Appendix D

## Mapping of key features and characteristics of the Western Adelaide Region

Map	Key features
Map 16	Biodiversity
Map 17	Buildings and infrastructure
Map 18	Business and industry
Map 19	Coast, marine and aquatic
Map 20	Open space and recreation
Map 21	Water and stormwater infrastructure
Map 22	People with vulnerabilities - CALD members of the community and members of the community living in public housing
Map 23	People with vulnerabilities - Members of the community under financial stress and living with mental health problems
Map 24	People with vulnerabilities –Members of the community with need for assistance with core activities and fair or poor self-assessed health
Map 25	People with vulnerabilities – Younger and older members of the community
Map 26	Location of key employment sectors
Map 27	Volunteering rates and community support

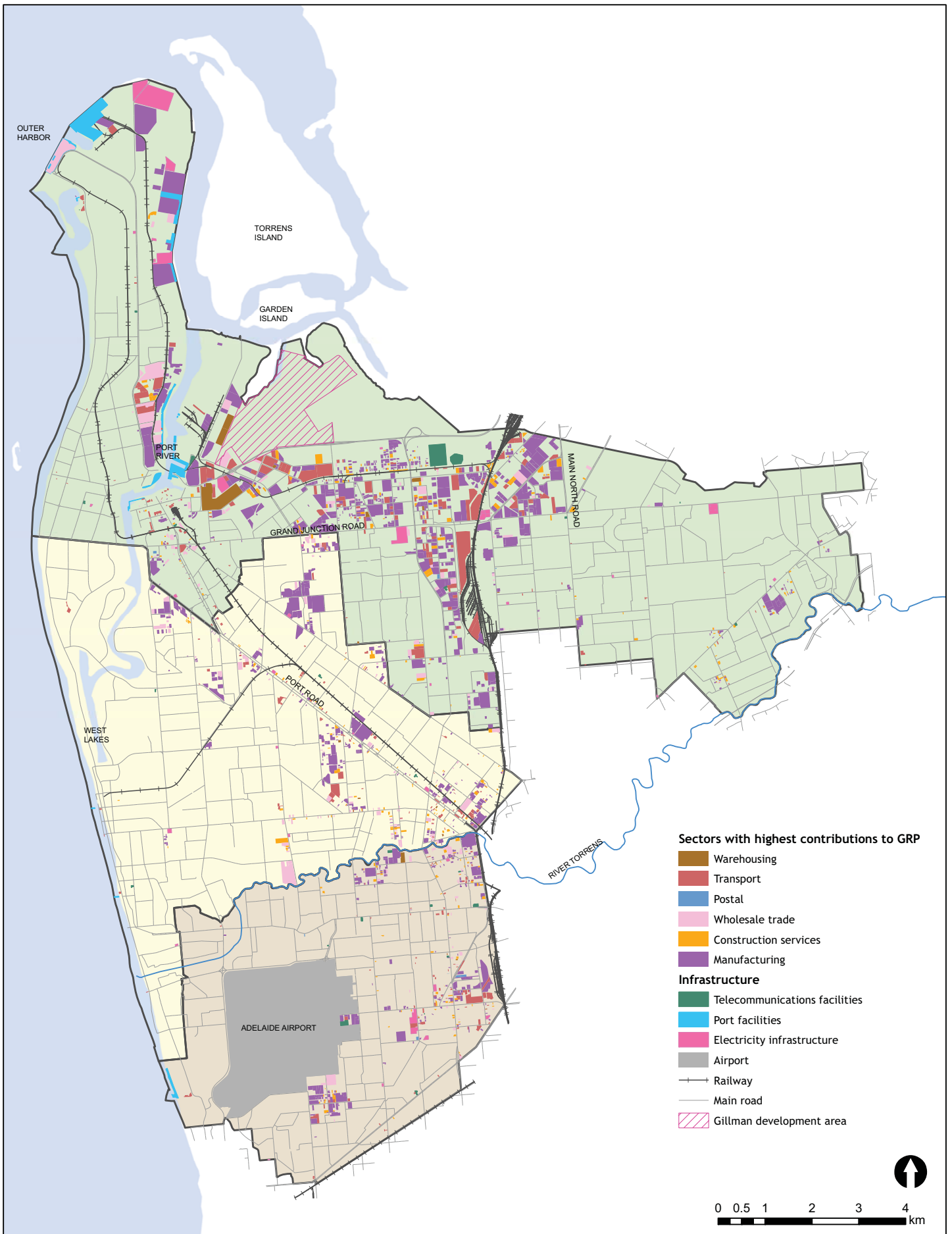




AdaptWest

Map 17 Key Features - Buildings and Infrastructure

Data Source: DEWNR, DPTI

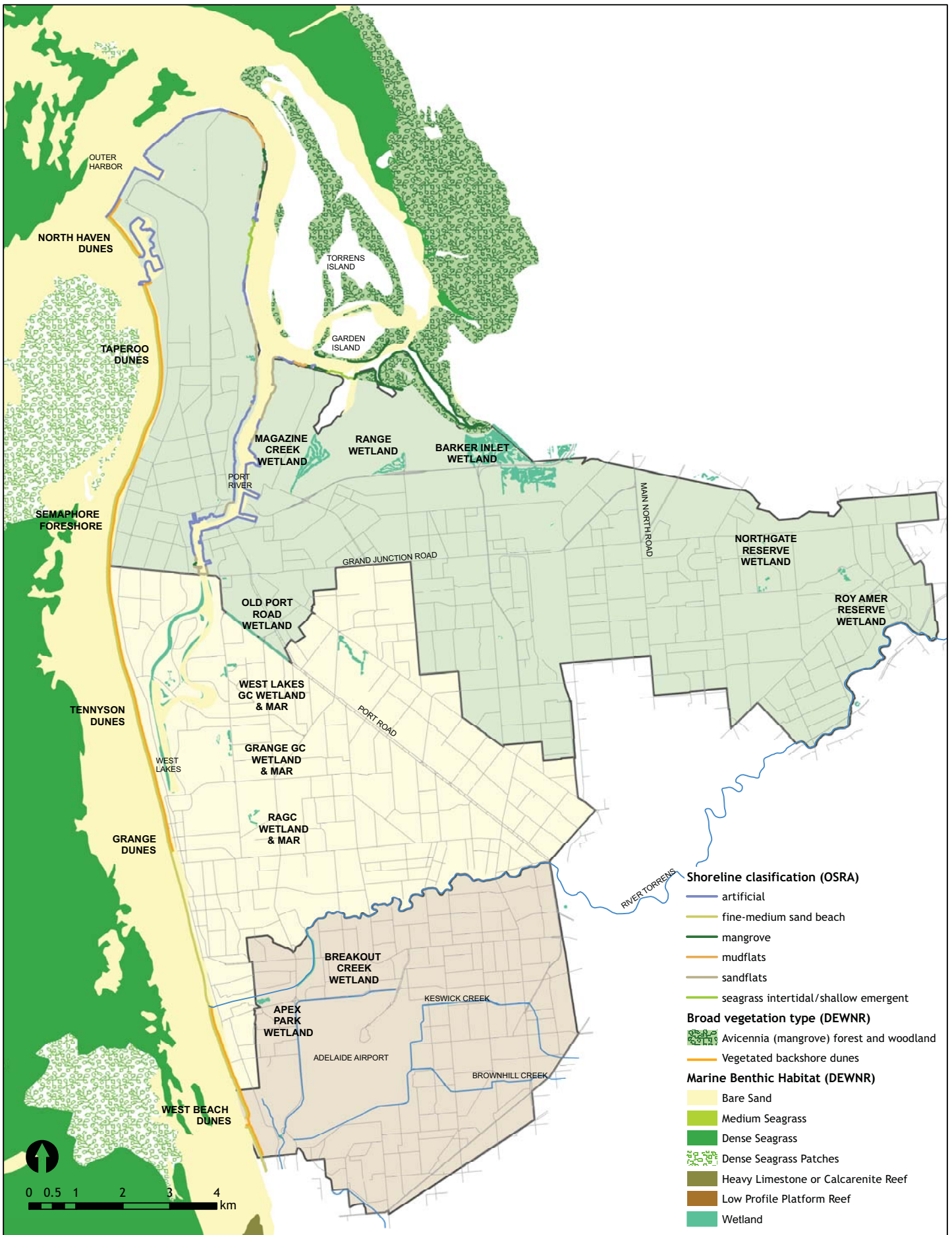


AdaptWest

— Main road  
 □ Council boundary

Map 18 Key Features - Business and Industry

Data Source: DEWNR, DPTI

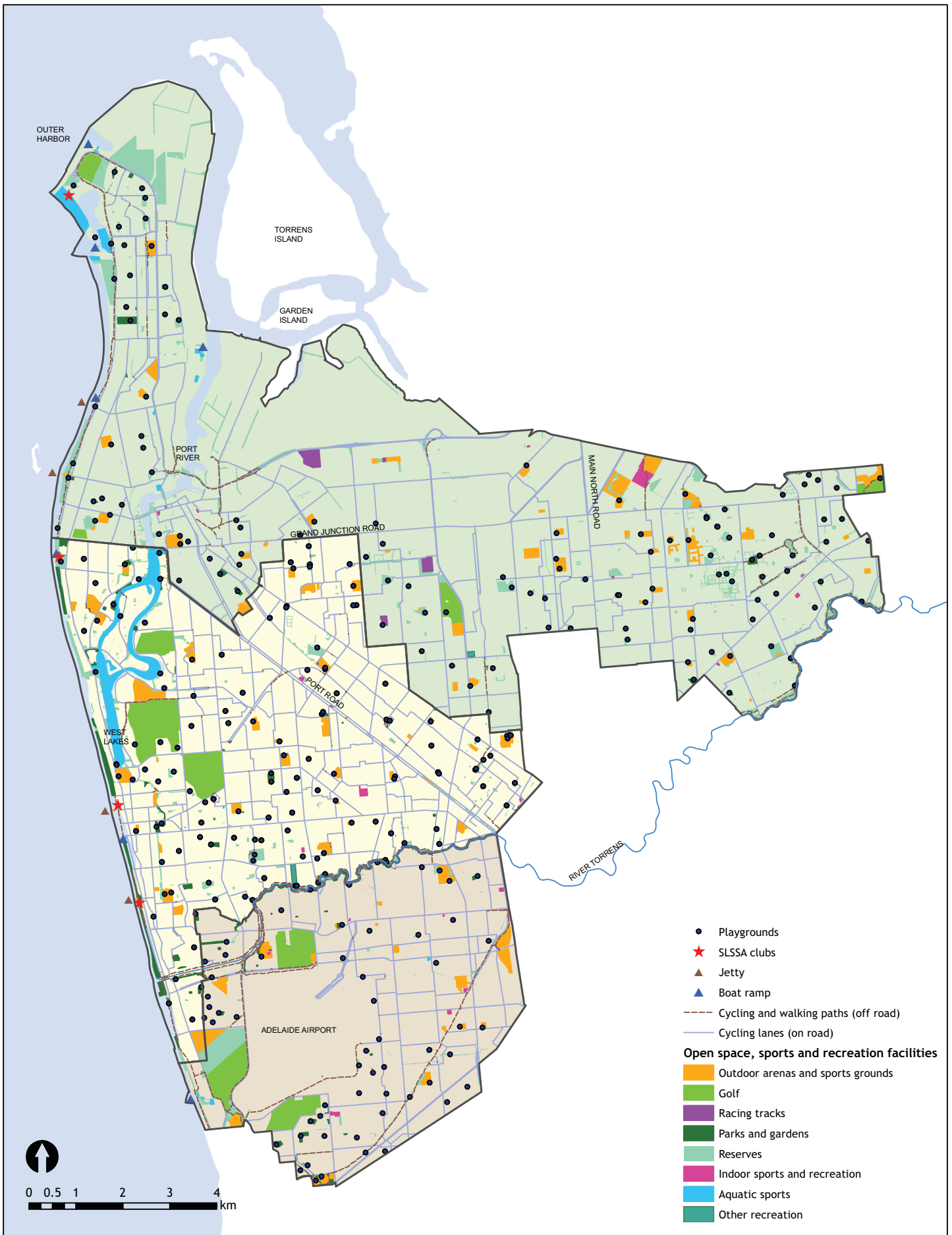


AdaptWest

— River Torrens  
 — Main road  
 □ Council boundary

Map 19 Key Features - Coast, Marine and Aquatic

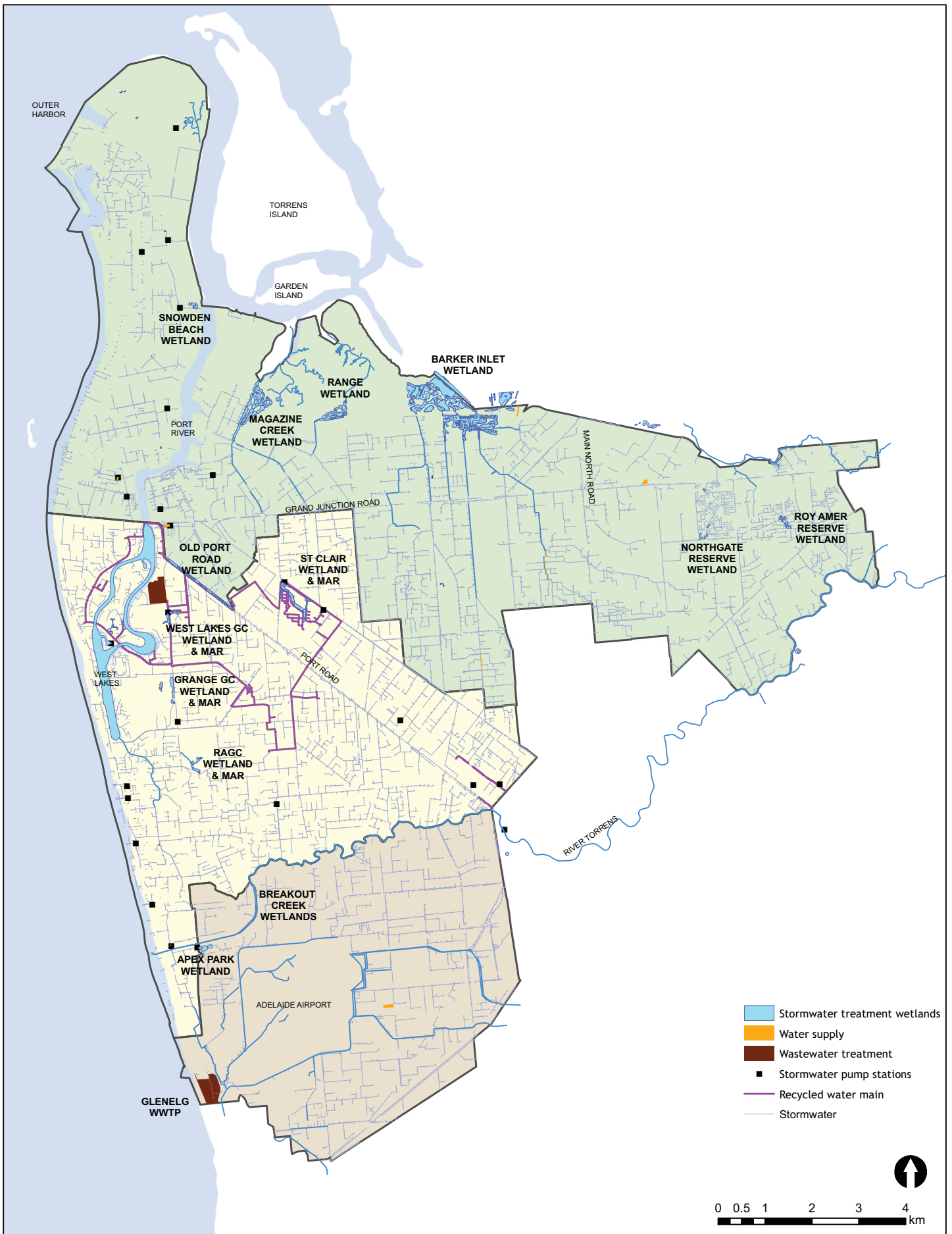
Data Source: DEWNR, DPTI, Councils



AdaptWest

Map 20 Key Features - Open Space and Recreation

Data Source: DEWNR, DPTI, Councils



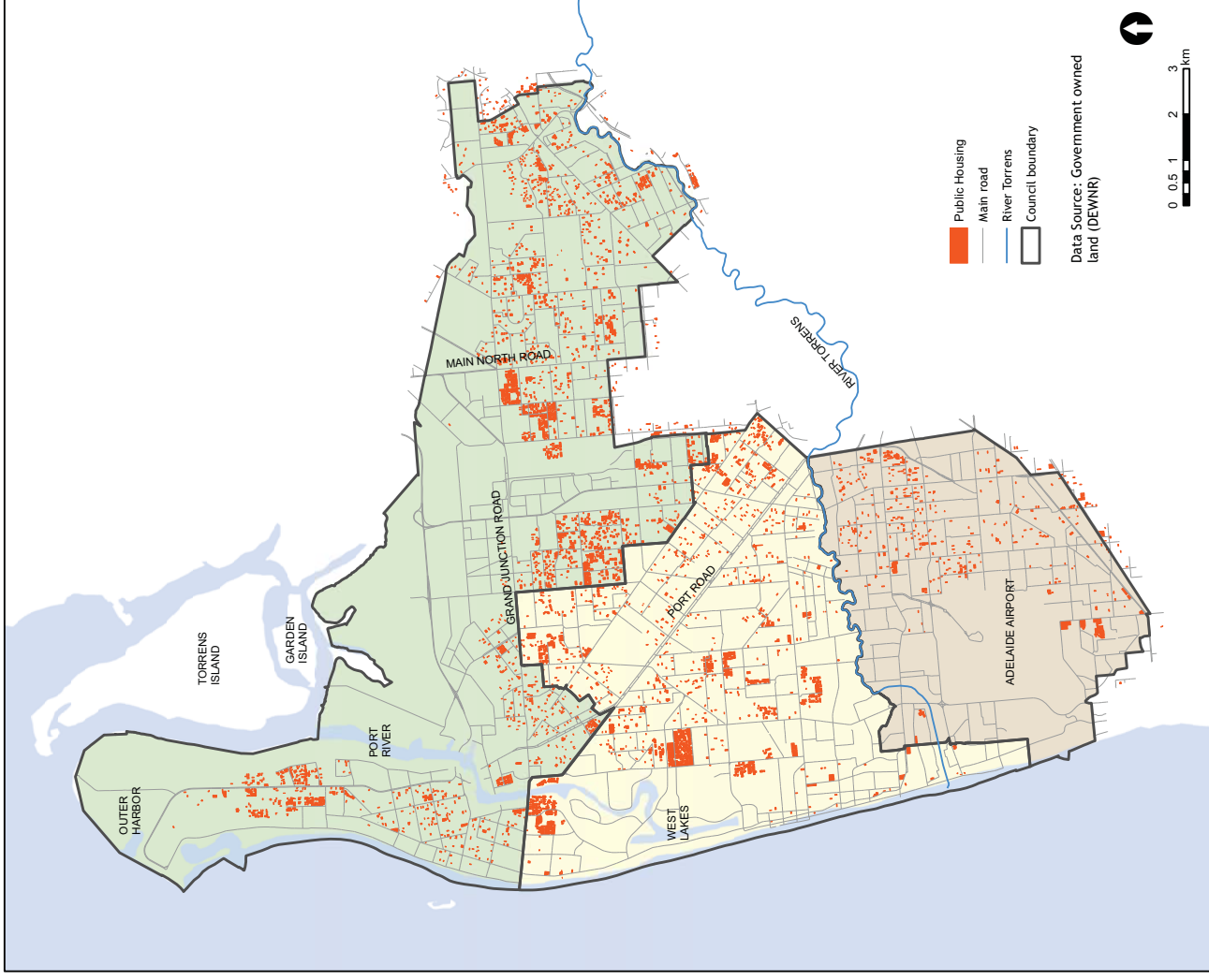
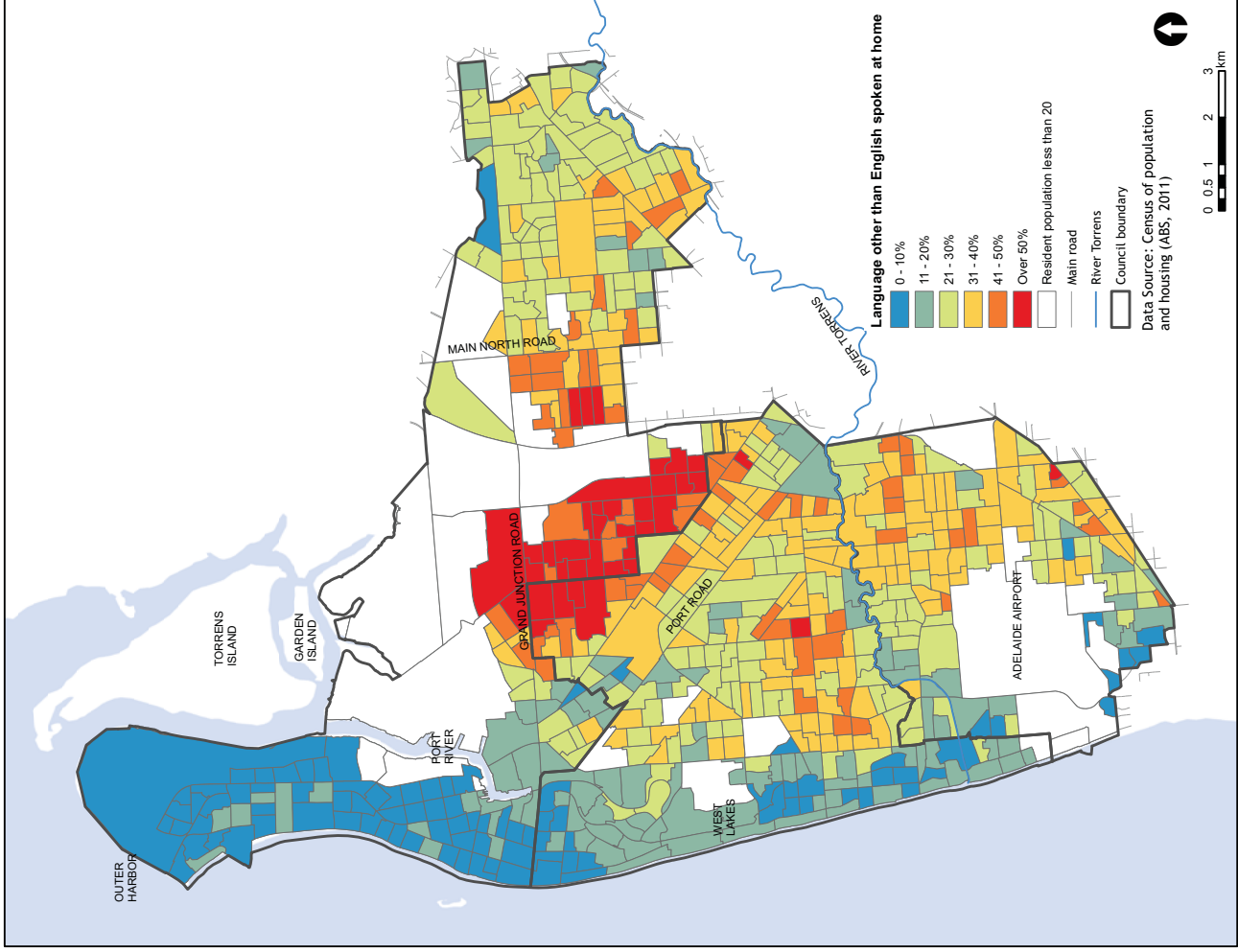
# AdaptWest

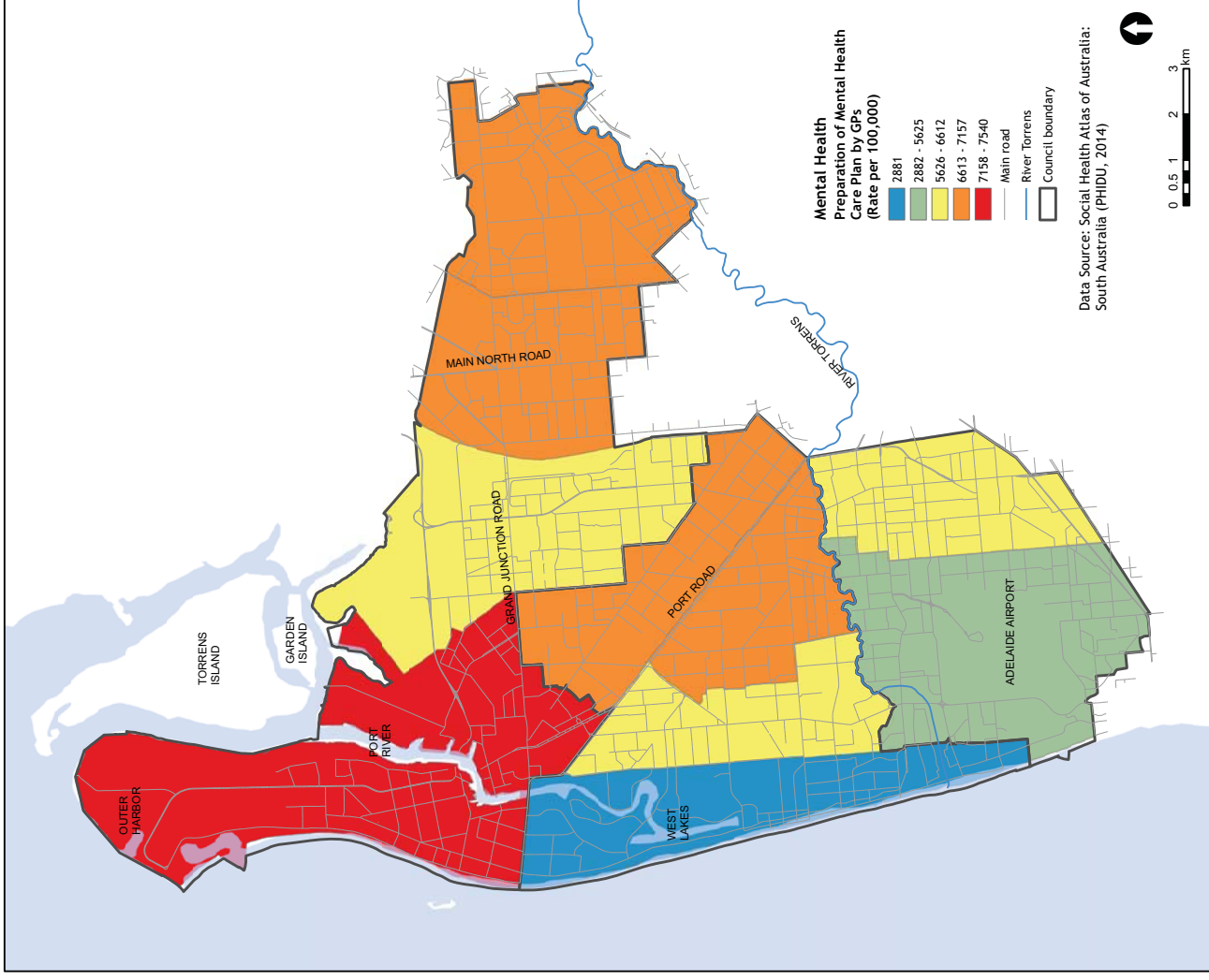
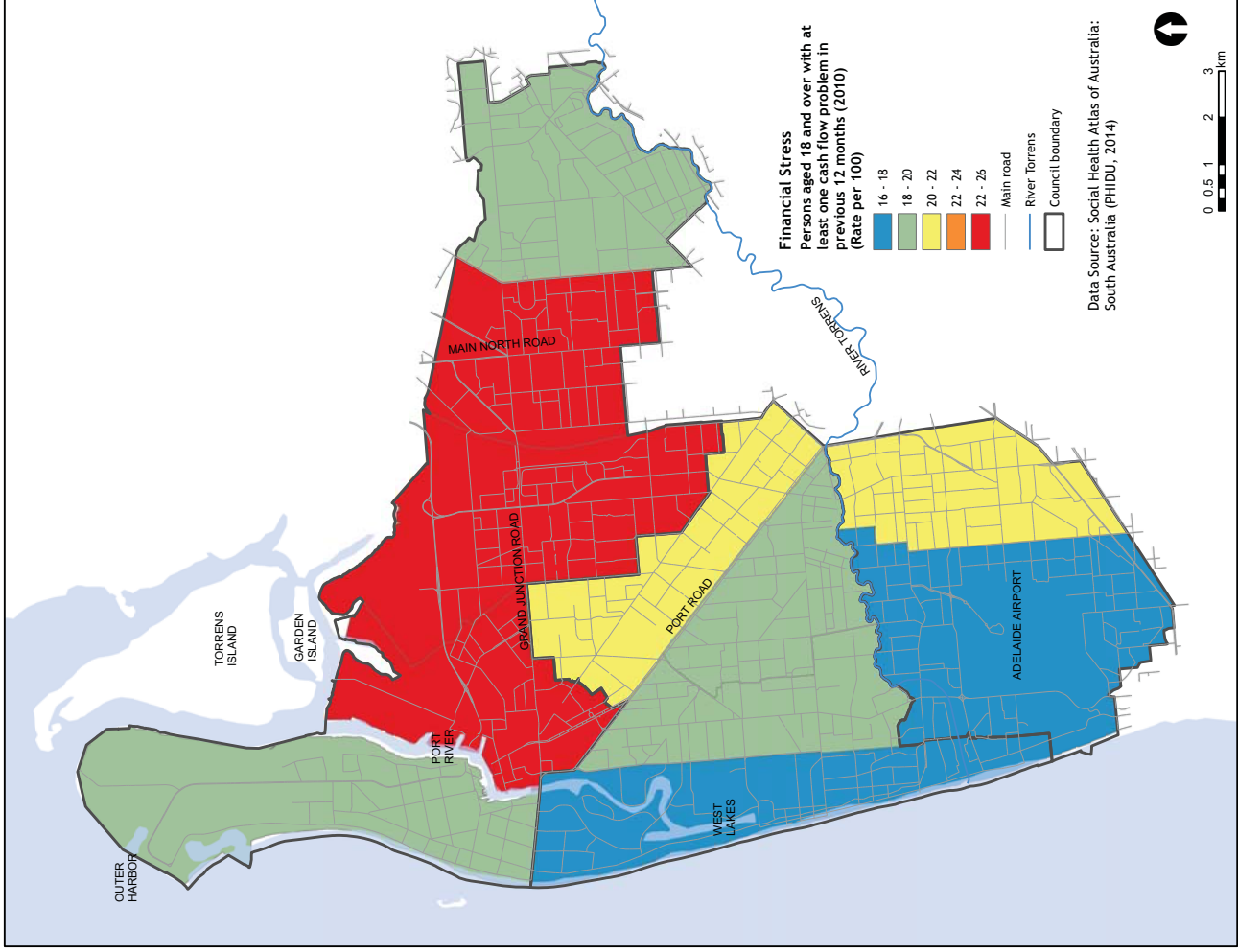
## Map 21 Key Features - Water and Stormwater Infrastructure

— River Torrens  
 □ Council boundary

Data Source: DEWNR, DPTI, Cities of Port Adelaide Enfield, West Torrens and Charles Sturt

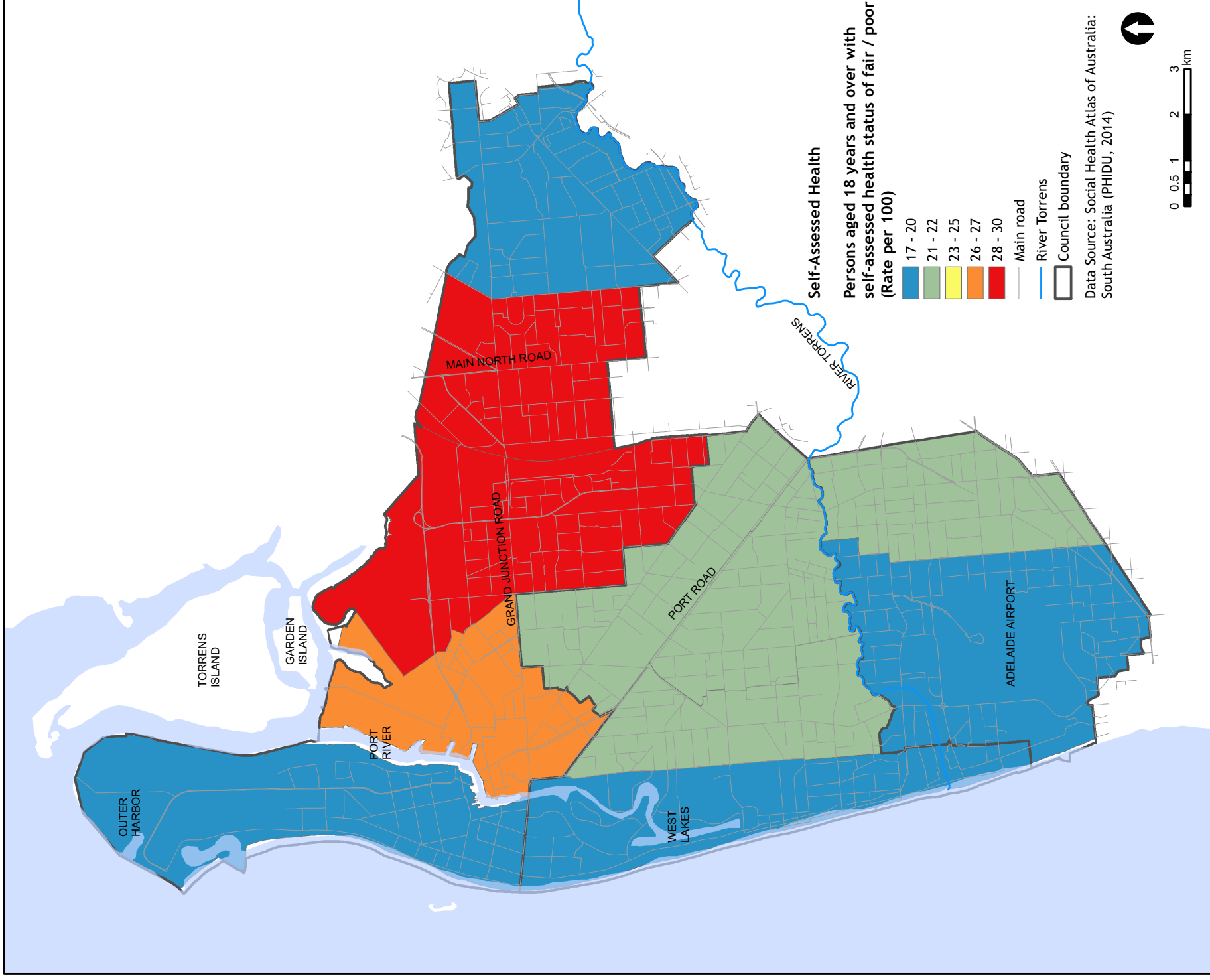
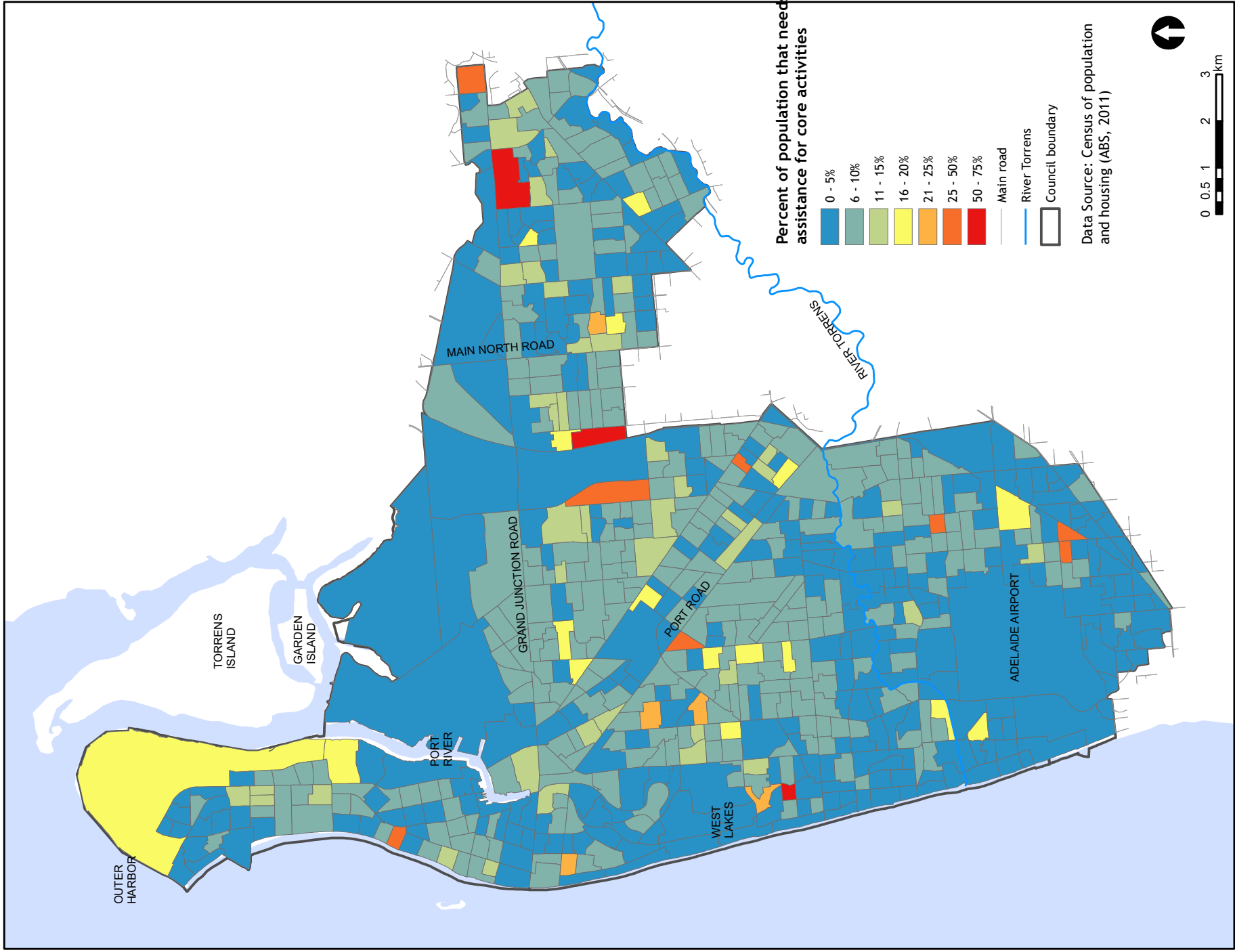






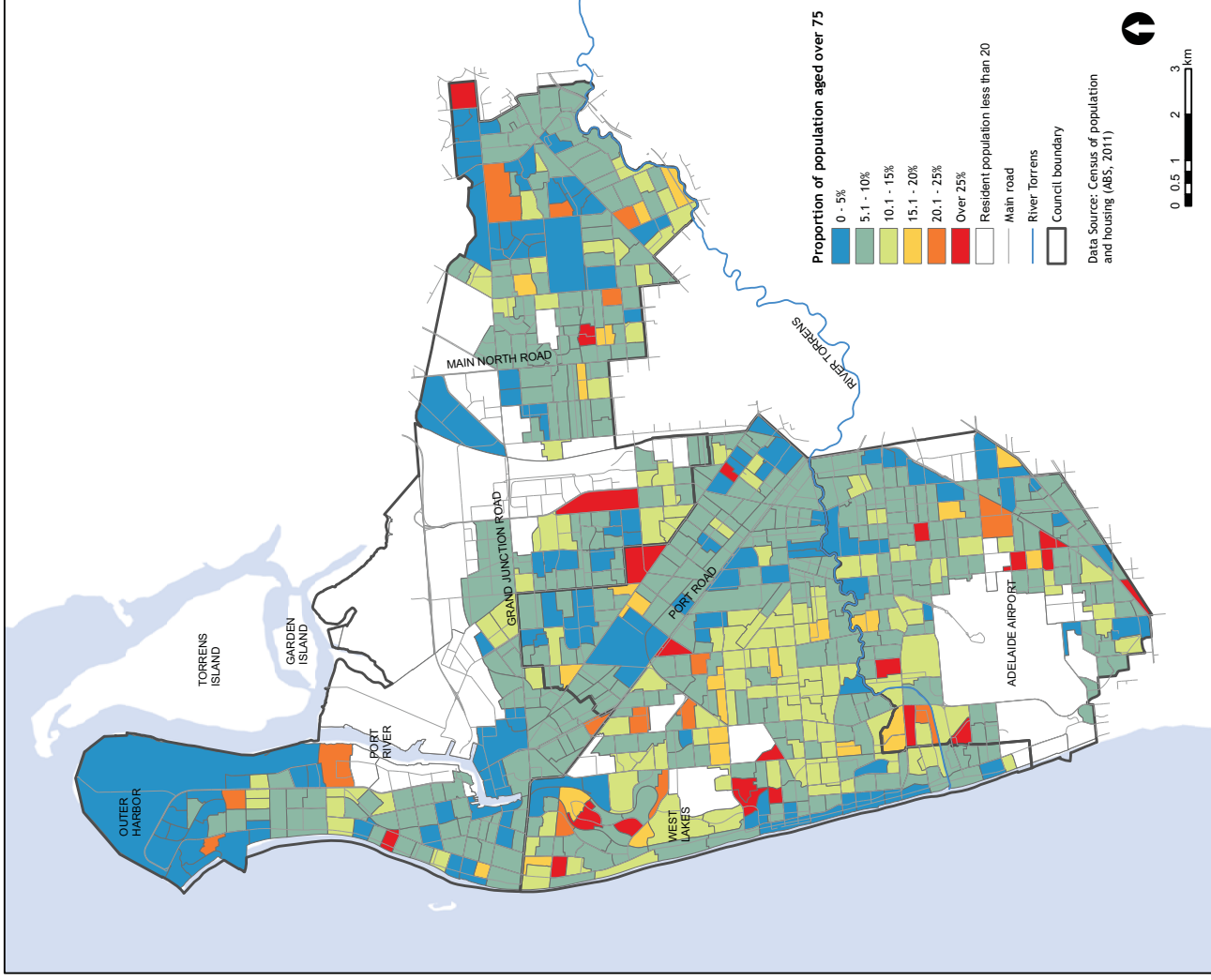
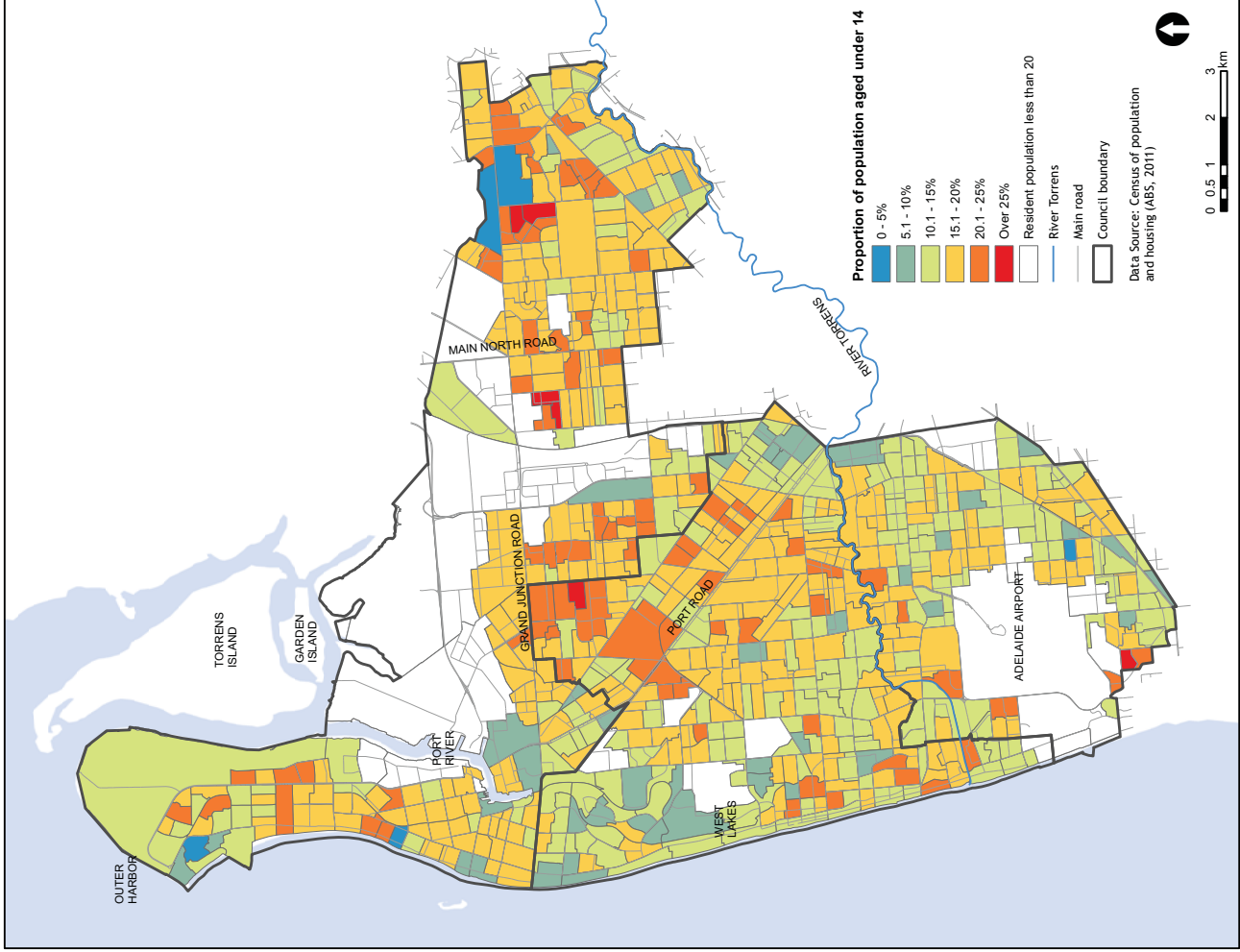
## AdaptWest

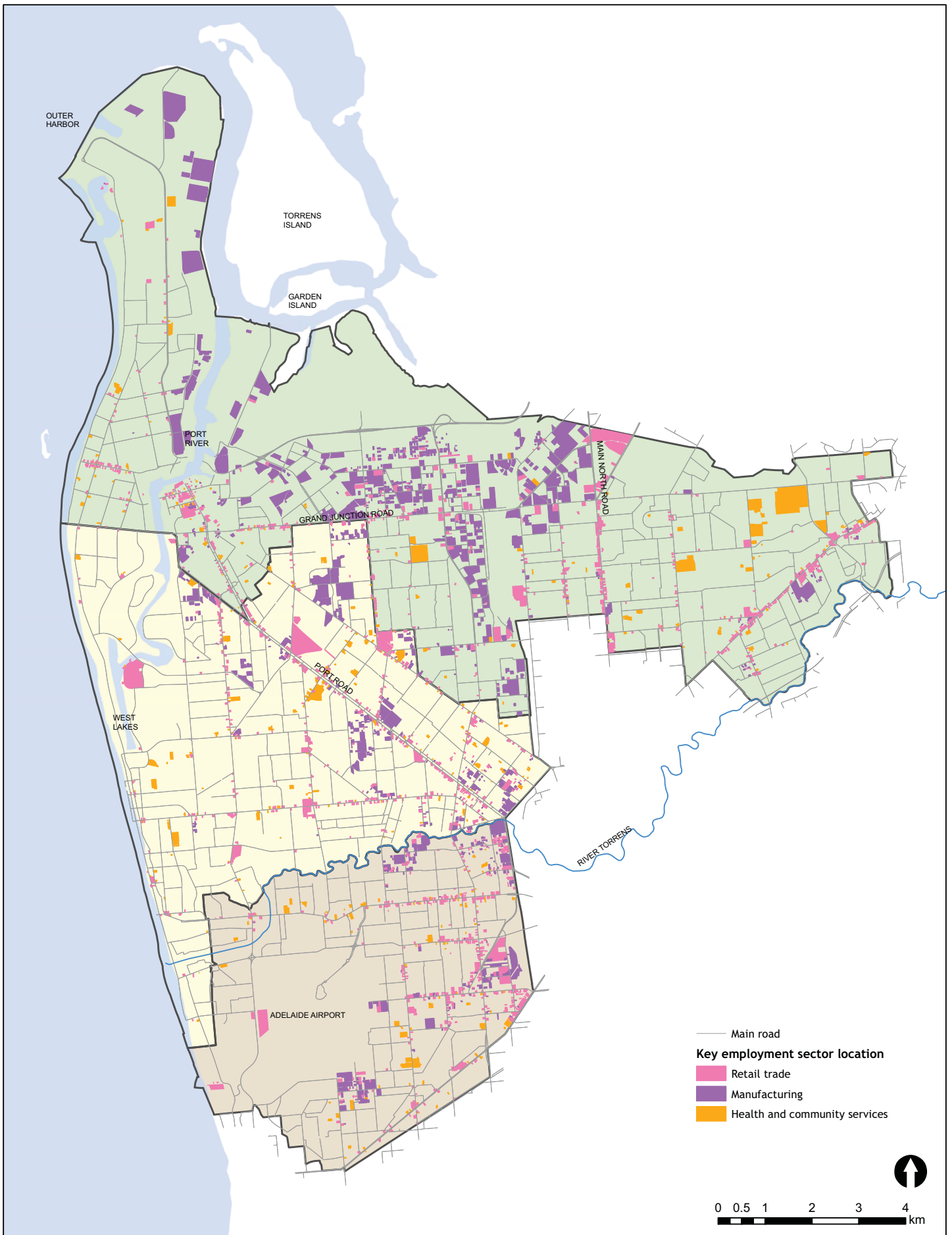
Map 23 Key Features - People with Vulnerabilities (members of the community under financial stress and living with mental health problems)



AdaptWest

Map 24 Key Features - People with vulnerabilities (members of the community with need for assistance with core activities and fair or poor self-assessed health)





AdaptWest

Map 26 Key Features - location of key employment sectors

Data Source: DEWNR, DPTI

