



FINAL REPORT

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Adapting to a Low Water Future: Climate Change Risk Assessment and Adaptation Plan

A report prepared for the
North East Greenhouse Alliance



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Disclaimer

This report has been prepared in accordance with the scope of services described in the contract or agreement between Marsden Jacob Associates Pty Ltd ACN 072 233 204 and the North East Greenhouse Alliance.

Information and recommendations in the report reflect the views of the authors, reflecting consultations with staff of member and partner organisations of the North East Greenhouse Alliance.

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Executive Summary

INTRODUCTION

1. Climate change is emerging as a vital issue for rural and regional communities across Victoria and Australia. Although climate variability has always been a fact of life for these communities, the prolonged drought in much of eastern and southern Australia through the 2000s, followed recently by severe flooding, has heightened awareness of the potential for greater variability in the future, with more frequent and severe droughts interspersed by periods of intense rainfall.
2. The North East Greenhouse Alliance (NEGHA) comprises local councils and agencies¹. The group has been expanded for this project to include agencies that have primary planning responsibility for water supply and use and the consequences of dealing with climate variability in the region. Collectively these organisations have recognised the need for region wide planning on climate change, reduced water availability and increased rainfall variability.
3. To that end, NEGHA has secured significant funding through the *Strengthening Basin Communities* program to assist in community-wide planning for a future with more variable, but generally less water.
4. This is a report of a climate change risk assessment conducted on behalf of NEGHA by Marsden Jacob Associates (MJA) and the Regional Development Company (RDC) as part of that program.

RISK ASSESSMENT

5. The purpose of the risk assessment was to explore the full range of potential risks posed by low water availability and increased rainfall variability and to prioritise those risks for NEGHA member organisations and partners involved in the project and for the regional community as a whole.
6. The assessment followed the approach set out in the Australian Greenhouse Office / Department of Climate Change publication, *Climate Change Impacts and Risk Management: A Guide for Business and Government* (the Guide), which is based on the Standard AS/NZS 4360 / ISO 31000 for Risk Management.
7. This risk assessment encompasses some of the key roles and responsibilities of councils, water authorities and the NECMA that may be affected by increased rainfall variability and reduced water availability due to climate change. The assessment examines and rates risks from those agencies' perspectives, i.e. their ability to perform their roles and responsibilities over current, medium (2030) and long term (2070) time horizons.

¹ NEGHA members participating in the project are: Alpine Shire Council; Indigo Shire Council; Towong Shire Council; Rural City of Wangaratta; City of Wodonga; North East CMA. Additional partners are: North East Water, Goulburn Murray Water and the Victorian Department of Sustainability and Environment. NEGHA members and partners are represented on this project's Steering Group.

8. The risk assessment commenced with a workshop involving all NEGHA member and partnering organisations and the Department of Sustainability and Environment (DSE) and applying a qualitative risk evaluation framework (e.g. likelihood and consequence scales). This framework described in more detail in Section 2 of the report.
9. The assessment was completed via a series of follow-up consultations with individual councils and agencies.
10. Results from the risk assessment workshop and follow-up discussions are summarised in section 4 of this report. In summary, nearly 60 water-related risks were identified, discussed and rated during or following the risk assessment workshop. Risks considered include both direct, physical risks and indirect, derived risks.
11. Only 40% of risks are rated *High* (33%) or *Extreme* (7%) in the current period.
12. The number of *High* and *Extreme* risks increases significantly in the medium to long terms though (53% in the medium term and 56% in the longer term), reflecting a substantial increase in the likelihood of risks occurring in the medium to long terms and /or a view that existing controls may not be adequate to deal with the potential for an increase in the frequency and/or severity of risk drivers in the longer term.
13. There is a fairly even spread of risks across six main areas (key elements): water supplies, policy & planning; infrastructure; economic development; social and community; and environment. However, the 'Water supply' and 'Environment' key elements have proportionally greater numbers of *High* and especially *Extreme* rated risks across the three time periods than the other key elements.
14. Factors influencing *High* and *Extreme* risk ratings vary from risk to risk and can be quite complex, but in most cases a *High* or *Extreme* rating reflects a moderate to high sensitivity of agencies and councils to that risk and a view that existing controls will not be sufficient to mitigate the risk if the impacts associated with climate change become more marked in the future.
15. Many of the risks that are *Extreme* in the short to medium terms term relate to impacts that councils have already had difficulties in coping with due to prolonged drought (e.g. 1.01, 5.01, 5.02, 5.05) other climate extremes (e.g. 3.09) or multiple climate and non-climate pressures (e.g. 1.07, 6.01, 6.02, 6.03, 6.04).
16. Post workshop consultations were undertaken with individual councils and agencies, enabling agency level risk registers to be produced as supplements to the region-wide register. Table 10 provides a summary of the ratings given by each agency to the *High* and *Extreme* risks.
17. The information in Table 10 shows that there is a very high level of consistency between councils in terms of the ratings each has given to those risks.
18. The level of consistency between councils and agencies and between individual agencies in terms of their risk ratings is not as great but is still quite high. Most of the differences in ratings can be attributed to differences in objectives and functions of councils and the agencies, and between the water agencies, NECMA and DSE.

ADAPTATION PLAN

19. Climate change adaptation can be defined as ‘actions taken in response to actual or anticipated climate change impacts that lead to a reduction in risks or realisation of benefits’. Adaptation can be viewed as a planned, proactive response to climate change and, as such, can be distinguished from reactive adjustments to climate change impacts after they have occurred.
20. Actions considered for the Adaptation Plan are wide-ranging and include changes to institutional frameworks, revised strategies and plans, changes to statutory planning, improved decision making processes and procedures, on the ground works, education and training, monitoring and data collection, and research.
21. If NEGHA members and partnering agencies are to realise the potential benefits of climate change adaptation, it is important that their adaptation actions are well considered and designed prior to implementation. The following generic principles underpin adaptation actions proposed in the Adaptation Plan:
 - focus on priority climate change issues;
 - use an adaptive management approach (i.e. flexible, incremental changes);
 - avoid adaptation constraining decisions or maladaptation;
 - achieve balance between climate and non-climate risks; and
 - prioritise actions.
22. Additional principles, that have been adopted for this Adaptation Plan are:
 - build on existing strategies and plans, in particular the *Hume Strategy for Sustainable Communities* and the *Northern Region Sustainable Water Strategy*; and
 - actions should, as far as possible, reflect the perspectives of stakeholder organisations, specifically NEGHA member and partner organisations.
23. The development of the Adaptation Plan was centred on workshops and consultations with NEGHA member and partner organisations. The adaptation planning process entailed seven major steps:
 - i. priority risk selection;
 - ii. grouping of priority risks into subsets to enable risks that have significant similarities to be considered collectively in the adaptation planning process;
 - iii. identifying and reviewing existing controls;
 - iv. identifying new and revised actions;
 - v. assessing potential new actions;
 - vi. identifying additional actions; and
 - vii. consolidation of inputs and further analysis.

RECOMMENDED ACTIONS FOR PRIORITY RISKS

24. This section presents recommended actions to deal with priority climate change risks. Risks rated 'High' or 'Extreme' by a majority of NEGHA members and partner organisations or 'Extreme' by at least three organisations are addressed in the plan.
25. Priority risks addressed by actions in this section include risks relating to: surface water supply & quality; groundwater supply & quality; stormwater & flood management; economic development; community issues including recreation and emergency management; the environment; and climate change response.
26. It is important to note that implementation of actions by councils and partner organisations will be dependent on available resources and priorities within their respective Corporate Plans. The recommended actions are regionally focussed and will therefore need to be assessed by partner organisations against priorities in those plans. Actions involving a number of councils or organisations will also require extensive dialogue and coordination.
27. Tables Es1 to ES7 following provide summaries of recommended actions including implementing organisations and proposed implementation timeframes.

Table ES.1 Surface Water Supply and Quality – Issues, Gaps and Recommended Actions

Issues and Gaps Addressed	Recommended Actions		Implementing Organisations	Implementation Timeframe ²
Subset A – Surface water supply				
▪ Potential to increase the planning role of local government in water supply and demand decision making	A1	Councils can be more effectively integrated into water supply and demand planning processes by ensuring that strategic and land use planning decisions and supporting guidance are consistent with water demand and supply arrangements.	Councils	Medium term
▪ Potential to improve communication and education on water allocation decision making	A2	Councils should collaborate with each other and with NEW to strengthen and promote consistency in application of demand management and consideration of water service supply options across the region.	Councils, NEW	Short to Medium term
▪ Need to ensure that climate change projections are fully reflected in Water Management Plans	A3	Water authorities should widely communicate (to councils, agencies and the broader community) information on regional water allocation decisions and the process involved in making decisions, including coordination of responses to water scarcity.	G-MW, NEW	Short term
▪ Inconsistent approach to water demand management across councils and agencies	A4	Include the best available climate change projections (including changes to rainfall, runoff and drought frequency and severity) into the rules and streamflow plans associated with unregulated water resources (e.g. NEW’s water plan 2013-18).	G-MW, NEW, NECMA	Short to Medium term

² Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

Subset B – Surface water quality				
- Potential to improve the communication and education on established water quality monitoring programs - Potential to improve the integration of councils into regional water quality monitoring processes - Uncertainty about impacts of climate change on water quality (incl. pollution drivers and key locations) is a barrier to effective pollution management and prevention	B1	Councils should become actively involved in regional water quality management and monitoring processes through the North East Regional Water Monitoring Partnership (NERWMP). This can be facilitated by broadening the role of NERWMP to address issues relevant to council concerns (e.g. research and monitoring of sources of urban sediment and pollution in stormwater) and seeking assistance of councils in integrated catchment management.	Councils and NERWMP	Short term
	B2	Councils should adopt a risk-averse approach to water pollution generating activities that they have a role in managing, including by strengthening relevant strategies and plans for the management of wastewater systems and stormwater.	Councils	Medium term
	B3	The State Government should initiate research through the NERWMP to improve understanding of the potential impacts of climate change (including increased rainfall variability) on the generation of water pollution, and the impact of this on receiving environments and uses.	State Government, NERWMP	Medium to Long term

Table ES.2 Groundwater – Issues, Gaps and Recommended Actions

Issues and Gaps Addressed		Recommended Actions	Implementing Organisations	Implementation Timeframe
Subset C – Groundwater supply				
- Data gaps relating to the number and location of bores and groundwater yields - Lack of consistent information on groundwater levels (e.g. decline and recharge during and following droughts) - Community and other stakeholders not fully informed about emergency bore network.	C1	Councils should be more effectively integrated into groundwater supply and demand planning processes by amending planning schemes to include provisions relating to groundwater management. Planning scheme provisions should be consistent between the region's councils.	Councils	Short to Medium term
	C2	Investigate the feasibility of establishing a 'North East Regional Groundwater Monitoring Partnership' to streamline and consolidate the collection of groundwater data in the region.	DSE, G-MW, NEW, NECMA, DPI and councils	Short term
	C3	A regional groundwater resource education program should be developed to increase community understanding of groundwater resource and quality issues and the interaction and interdependencies between ground and surface water supplies. The program could be developed and led by G-MW, potentially through the proposed North East Regional Groundwater Monitoring Partnership (see Action C2).	G-MW, with assistance from councils, DSE, NEW, NECMA	Short term
Subset D – Groundwater quality				
Deficiency in groundwater monitoring (i.e. no clear understanding about what should be monitored, who undertakes the monitoring, how is this information stored and	D1	See action B2 (management of septic systems and stormwater).	Councils	Medium term
	D2	Councils should consider establishing a monitoring program for high risk septic systems and areas identified through Action B2.	Councils	Medium term

Issues and Gaps Addressed		Recommended Actions	Implementing Organisations	Implementation Timeframe
used)				
Potential to improve monitoring and management of domestic wastewater systems	D3	Drawing on outcomes from Action D2, NEW, working in partnership with councils, DSE and the EPA, should explore techniques and funding sources for improving the treatment of household wastewater in high priority small townships (e.g. less than 100 houses) to an adequate standard.	NEW working with DSE, EPA and councils	Long term
	D4	See action C2 (North East Regional Groundwater Monitoring Partnership).	G-MW, with assistance from councils, DSE, NEW, NECMA, EPA	Short term

Table ES.3 Stormwater and Flood Management – Issues, Gaps and Recommended Actions

Issues and Gaps Addressed		Recommended Actions	Implementing Organisations	Implementation Timeframe
Subset E – Stormwater management				
Plans and guidelines need to be strengthened to take account of likely increases in rainfall intensity	E1	Councils, with support from NECMA, should undertake or commission hydraulic modelling to assess local and regional impacts of climate change to stormwater and drainage systems and urban floodways, drawing on outputs of regional rainfall intensity modelling (see Action E6).	Councils, NECMA	Medium term
Resource constraints present a barrier to the maintenance and upgrade of stormwater and drainage infrastructure in	E2	Councils should prioritise management and/or upgrade of vulnerable stormwater assets at an LGA scale, drawing on outputs of actions E1.	Councils	Long term

Issues and Gaps Addressed		Recommended Actions	Implementing Organisations	Implementation Timeframe
established areas	E3	Councils working cooperatively should develop regional guides and standards for the design of new and upgraded drainage assets.	Councils	Medium term
	E4	Councils should undertake a regional information and education campaign targeting community expectations on levels of service and councils' ability to deliver with regards to stormwater and flood management.	Councils	Short to Medium term
	E5	Councils should develop and implement a regional stormwater professional training and professional capacity building program with a focus on managing and adapting to projected changes in runoff due to increased rainfall intensity and duration.	Councils	Medium term
	E6	NECMA and councils should seek funding from the State Government to commission research into projected changes of rainfall intensities and duration under climate change scenarios with the objective of producing regional and local rainfall-intensity-duration data and other relevant hydrologic tools.	State Government, with assistance from NECMA and councils	Short to Medium
Subset F – Flood management				
Lack of State Government direction on land use planning relating to flood and stormwater management in the context of climate change	F1	Councils, through MAV, should approach the state government to simplify and remove anomalies in natural disaster recovery funding arrangements.	Councils, MAV	Short term
	F2	Councils should develop regionally consistent criteria for quantitatively assessing the vulnerability of major levees, roads, bridges and other key community assets to flooding and other climate extremes, drawing on outputs from Actions E6 and F3	Councils	Long term
Need for improved hydraulic data and technical guidance				

Issues and Gaps Addressed		Recommended Actions	Implementing Organisations	Implementation Timeframe
from professional groups - Council resource constraints are compounded by anomalies in natural disaster recovery funding arrangements - Need for improved community education on the potential climate change impacts on extreme rainfall and flooding	F3	Drawing on outcomes of Action E6, Councils working with NECMA should undertake or commission site specific hydrologic / flood modelling of local priority areas where the perceived risk is high and current Floodplain Management Plans do not fully reflect regional rainfall intensity projections.	Councils, working with NECMA	Short term
	F4	Councils should review and update Planning Scheme overlays relating to floodplains, incorporating outcomes of flood studies (Action F3), and ensure the public is aware of the most up to date flood data and extent of flooding.	Councils	Medium term
	F5	Councils should extend their Business Continuity Plans to improve their ability to cope with the impacts of flooding on staff resources and service provision.	Councils	Short term
	F6	NECMA, working with councils and other agencies should consider developing and implementing a region wide information and education campaign to advise the community on potential climate change impacts on floodplain use and management.	NECMA, councils	Short to Medium term

Table ES.4 - Economic Development – Issues, Gaps and Recommended Actions

Issues and Gaps Addressed		Recommended Actions	Implementing Organisations	Implementation Timeframe
Subset G – Viability of regional industrial sector				
Limit knowledge of threats that low water availability and rainfall variability pose (indirectly) to manufacturing capacity in the region	G1	Councils, through the RMF, should consider developing and delivering a regional training and information sharing program for staff and councillors to increase their understanding on potential implications of climate change for future planning, economic development and other decision making.	Councils, MAV and regional TAFE Institutes and universities	Short term
Small and medium businesses do not have processes (e.g. business continuity and strategic plans) to plan for the impacts of climate change and extreme weather events on operations and supply chains	G2	To build the resilience of the local economy to climate change impacts and extreme events, Councils, working with local chambers of commerce, business associations and local educators, should facilitate and promote a training and capacity building program on business continuity planning for small and medium sized businesses in the region.	Councils, local chambers of commerce, business associations, local educators	Medium term
Potential to increase promotion of water use efficiency by small and medium water using businesses.	G3	Councils, working with local chambers of commerce and industry associations, should review the risk exposure of local industry to climate change, climate variability and water availability.	Councils, local chambers of commerce, industry associations	Short to Medium term
	G4	NEW and councils, working with local industry and business associations, should consider designing and implementing a regional energy and water efficiency program, similar to EREPs but targeting small and medium businesses across the region.	NEW, councils, local industry and business associations	Medium term

Subset H – Viability of regional tourism sector

- Gaps in understanding of changes to the frequency and severity of extreme events and how responses in relation to tourism should be framed - Gaps in understanding of the impacts of climate variability and extremes on the viability of tourism - Tourism businesses do not have processes (e.g. business continuity and strategic plans) to plan for the impacts of climate change and extreme weather events	H1	Councils should develop a regional communications plan aimed at educating and providing timely information to visitors about the risks of extreme weather events and how to act should these events occur.	Councils, working with local tourism associations, BoM, Parks Victoria, SES, CFA, police and broadcasters (local radio and TV)	Short to Medium term
	H2	See Action G2 (capacity building program for small and medium sized businesses).	Councils, working with local chambers of commerce, business associations and local educators	Medium term
	H3	The North East Victoria Regional Tourism Board (NEVRTB) should seek funding to undertake tourism industry and climate change case studies, which identify potential impacts of climate change on key tourism industries, drawing on recent experience.	NEVRTB in consultation with councils and local tourism organisations	Medium term

Table ES.5 – Community Services – Issues, Gaps and Recommended Actions

Issues and Gaps		Recommended Actions	Implementing Organisations	Implementation Timeframe
Subset I – Recreation and amenity				
- Information gaps on water resources available for non-potable use - Lack of a region wide approach to education and engaging the community on water resource planning and decision making - Understanding how council and the community values water resources and the services provided by those resources	I1	Councils should review their open space plans with a view to rationalising and prioritising parks, gardens and playing fields to manage in times of low water availability, and investigate medium to long term actions to ensure ongoing viability of priority parks, gardens and playing fields.	Councils, working with NEW	Short to Medium term
	I2	To increase water availability for watering of parks, gardens, sportsgrounds and other recreation facilities, councils could consider mapping potential non potable water supplies and matching them to 'fit for purpose' uses.	Councils, proposed North East Regional Groundwater Monitoring Partnership	Short to Medium term
	I3	NEW could consider strengthening its water education and information initiatives by developing a program specifically focussed on understanding how the community values water and water-related services and educating the community on water use efficiency.	NEW	Short term
Subset J – Emergency management, bushfires				
Impacts of Code Red days and the potential for an increase in frequency of these is not	J1	Councils should extend their Business Continuity Plans to improve their ability to cope with the impacts of Code Red days on staff resources and service provision.	Councils	Short term

Issues and Gaps		Recommended Actions	Implementing Organisations	Implementation Timeframe
specifically addressed in Municipal Emergency Management Plans and some council business continuity plans	J2	Councils should ensure that effective procedures for dealing with the consequences of Code Red days are in place. The procedures should be summarised in a question and answer (Q&A) template for distribution to all human resources and OH&S staff.	Councils, other members of MEMCs	Short term
Current Municipal Emergency Management Plans and water management strategies do not consider water availability for emergency response	J3	Fire management plans and associated components of the Victorian Fire Risk Register should be reviewed to ensure availability of suitable water supplies for fire suppression, particularly in periods of low water availability.	Municipal Fire Management Planning Committees (MFMPs)	Short to Medium term

Table ES.6 – Environment – Issues, Gaps and Recommended Actions

Issues and Gaps		Recommended Actions	Implementing Organisations	Implementation Timeframe
Subset J – Catchment health				
Decline in the extent and quality of native vegetation and biodiversity	K1	Councils, working collaboratively with relevant agencies, should ensure that planning and management actions in the Hume Strategy and Regional Catchment Strategy aimed at protection of biodiversity, land and water assets are implemented.	Councils, DSE, NECMA	Short to Medium term
Information gap on climate change impacts (in particular increased rainfall variability and reduced water availability) on	K2	DSE, working with NECMA and councils should establish a co-ordinated long term, region wide program aimed at monitoring changes over time to high value conservation assets and ecosystems in the region.	DSE, NECMA, councils	Medium term

Issues and Gaps		Recommended Actions	Implementing Organisations	Implementation Timeframe
catchment health	K3	Education and conservation incentive programs targeting high conservation value vegetation communities and ecosystems threatened by climate change should be enhanced.	DSE, NECMA and councils	Medium term
Subset L – Aquatic ecosystems				
Planning controls do not adequately consider impacts of developments on hydrology and the EWR objective	L1	Councils should analyse existing urban stormwater catchments, identifying areas in need of stormwater redevelopment, so as to achieve flow reductions for the purposes of controlling erosion in receiving waterways and reducing urban flood risks.	Councils	Short to Medium term
- Gap between agency objective for catchment and waterways protection and private land holder responsibilities - Need to improve understanding of the potential impacts of climate change on aquatic ecosystems	L2	Consider establishing an inter-agency working group to assess climate change risks on regionally important aquatic assets. The assessment could then be used to optimise environmental, economic and social outcomes from decisions on water allocations and management. An established regional group, such as North East Dry Inflow Contingency Planning Group, could be a suitable forum for the proposed working group.	DSE, NECMA, G-MW, councils and Parks Victoria	Short term

Table ES.7 – Climate Change Response – Issues, Gaps and Recommended Actions

Issues and Gaps		Recommended Actions	Organisations	Implementation Timeframe
Subset M – Climate change response				
- Need to improve coordination and collective responsibility on climate change at regional level - Lack of regional coordination adds to uncertainties within regional communities about climate change response	M1	Councils should work towards a coordinated regional approach to climate change adaptation planning, by agreeing to priority actions for implementation from this plan and relevant actions in regional strategies such as the Hume Strategy.	Regional Management Forum (RMF)	Short term
	M2	Consider developing and implementing a coordinated regional community education program on climate change impacts and risks.	Councils, agencies	Short to Medium term
	M3	NEGHA partner organisations should seek to encourage a coordinated regional approach to climate change adaptation planning by working with the RMF to prioritise and implement actions from this plan and relevant actions in other strategies such as the Hume Strategy.	DSE, NEW, G-MW and NECMA	Short to Medium term
Subset N – Carbon pricing				
- Lack of consistent or coordinated approach to targeting energy efficiency and emissions reductions - Impact of carbon pricing on the region not clearly understood	N1	Councils should ensure that their greenhouse action plans are current and up to date, and should build on their established emission reduction programs.	Councils	Short term
	N2	Once a detailed carbon price framework has been established by the Australian Government, NEGHA member and partner organisations should initiate a joint study into the impacts of carbon pricing on the north east region and develop region wide measures to reduce those impacts.	Councils and agencies	Short to medium term

REVIEW AND NEXT STEPS

28. The report sets out approximately 50 proposed actions for addressing priority risks. If implemented together, the actions will provide the North East region with a strong basis for responding to the challenges of reduced water availability and increase rainfall variability.
29. A majority of actions are directed primarily at NEGHA member councils, either individually or in cooperation with other councils or organisations (Table ES.8). Most of the remaining recommendations are directed at NEGHA partner organisations, also working in cooperation with councils and other organisations.
30. Table ES.8 provides an overview of the different types of actions proposed in the adaptation plan, noting that there is overlap between the different types of action with some of the actions in the plan having multiple components. Information in the table reveals the wide spectrum of action types.

Table ES.8 Types of Adaptation Actions Proposed in the Plan

Category of action	Actions		
	Councils	Other	Councils & other
Regional institutions and cooperation	A2, B1, M1	-	C2, K1, L2, M3
Statutory planning	A1, C1, F4	A4	-
New or amended strategies and plans	B2, I1, N1	-	-
Improved decision-making processes and procedures	E2, E3, F2, F5, J1	-	J2, J3, L2
Research and data collection	D2, E1, G3, I2, L1	B3, K2	E6, F3, H3, N2
Education and training	E4, E5, F4, G1, G2, H1	A3, C3, F6, I3, K3	M2
'On the ground' management and works	L1, N1	K3	D3, G4, I1, N2
Risk diversification	F1	-	-
Number of actions	28	9	16

31. Ongoing resource and administrative constraints and other regional priorities mean that it will not be feasible to implement all actions in adaptation plan concurrently. It will therefore be necessary to prioritise adaptation actions.
32. Most actions identified in the Adaptation Plan will require a coordinated approach across councils and agencies to achieve effective implementation. To that end, Actions M1 to M3 provide recommendations on achieving regional coordination of the Adaptation Plan.

1 Introduction

“(Adaptation can be defined as) actions taken by individuals, groups or systems to avoid impacts from climate change or to attain potential benefits from climate change” (NCCARF, 2011).

“... the benefits from mitigation occur on a global scale, whereas adaptation generally results in localised benefits”(Cimato & Mullan, 2010).

“Adaptation to current climate variability is already sensible given the direct and certain evidence of the adverse impacts of such phenomena. It can also increase resilience to long-term climate change (although) climate change is likely to require forward-looking investment and planning responses that go beyond responses to current climate variability”(Parry et al., 2007).

1.1 Project scope

Climate change is emerging as a vital issue for rural and regional communities across Victoria and Australia. Although natural climate variability has always been a fact of life for these communities, the prolonged drought in much of eastern and southern Australia through the 2000s, followed recently by severe flooding, has heightened awareness of the potential for greater variability in the future, with more frequent and / or severe droughts interspersed by periods of intense rainfall. This scenario poses challenges to all local communities and to the councils and other agencies that are charged with the responsibility of planning for those communities.

The North East Greenhouse Alliance (NEGHA) comprises local councils and agencies (as well as additional project partners). The group has been expanded for this project to include agencies that have primary planning responsibility for water supply and use and the consequences of dealing with climate variability in the region. Thus for this project it comprises:

- Alpine Shire Council (member);
- Indigo Shire Council (member);
- Towong Shire Council (member);
- Rural City of Wangaratta (member);
- City of Wodonga (member);
- North East CMA (partner);
- North East Water (partner); and
- Goulburn Murray Water (partner).

Collectively these organisations have recognised the need for region wide planning on climate change, reduced water availability and increased rainfall variability. To that end, NEGHA has secured significant funding through the *Strengthening Basin Communities* program to assist in community-wide planning for a future with more variable, but generally less water. Planning has entailed three main phases:

1. contextual analysis relating to water availability and use;

2. a climate change risk assessment and adaptation plan; and
3. delivery of economic, social, engineering and corporate governance responses.

This is a report of Phase 2, the risk assessment and adaptation plan. It has been produced on behalf of NEGHA by Marsden Jacob Associates (MJA) and the Regional Development Company (RDC), drawing substantially on consultations with NEGHA member and partner organisations. The plan is intended to build on relevant sections of established regional plans and strategies, in particular the *Hume Strategy for Sustainable Communities* and the *Northern Region Sustainable Water Strategy*.

The risk assessment explores the full range of potential risks posed by low water availability and increased rainfall variability and prioritises those risks for NEGHA member and partner organisations and for the regional community as a whole. Risks were assessed using a qualitative risk evaluation process that closely follows the Australian and International Standard AS/NZS ISO 31000:2009. In total, almost 60 water-related risks have been identified, discussed and rated in the assessment. The risks relate to a range of operational and service delivery areas relevant to NEGHA member and partner organisations and potentially impacted by greater variability in rainfall and water availability. They include water supply, water related infrastructure and assets, policy & planning, economic development, social and community issues and the environment.

The adaptation plan focuses on response options for a defined set of 'priority risks'. The selection of priority risks was based on a number of criteria, notably their initial risk rating and also the regional significance of the risks. The rationale for this focus is that, given resource constraints, adaptation efforts are best targeted in the short term at issues that matter most. Response options proposed in the plan include specific actions and tools directed at NEGHA members and partnering agencies, working individually or in partnership with other organisations. Options also include follow-up, co-ordinated regional research. The plan should be viewed as an initial step towards ongoing, regional climate change adaptation.

1.2 Report Outline

The remaining sections of the Climate Change Risk Assessment and Adaptation Plan are as follows:

Section 2 provides background contextual information for the report.

Section 3 details the framework and approach that was applied to the risk assessment.

Section 4 sets out the major findings of the risk assessment, focussing on highly rated risks.

Section 5 discusses the concept and principles of climate change adaptation, and discusses the process that was used to identify new actions.

Section 6 provides a detailed review of current policies, programs and measures relevant to identified 'priority risks' and sets out recommendations for new adaptation planning actions.

Finally, section 7 provides an analysis of the proposed new actions and provides recommendations on next steps.

2 Context

To assess and manage the risks of climate change it is important to have an understanding of the climate changes projected for the region, other factors affecting future water availability (e.g. economic growth and demographic change) and how local councils and other organisations in the region are already responding to climate change and related challenges.

2.1 Climate change scenarios

Scenarios that present challenging but realistic information (both quantitative and qualitative) provide the best means of understanding potential future climate change for the region. Tables 6 and 7 set out the climate change scenarios that were used to inform the risk assessment for NEGHA. The general, region wide scenarios (Table 6) provide indicative changes for a range of climate variables, assuming a high emissions scenario. As such, they are at the high end of current projections but are not necessarily worst cases. The river basin scenarios (Table 7) provide ranges of change reflecting results from different models. Given the nature of the assessment, the high ends of these ranges were used to inform the risk ratings.

The use of 2030 and 2070 as the reference dates in the tables enables short, medium and long time horizons to be captured in the risk assessment. Participants were asked to use 2030 and 2070 as general reference periods, rather than specific points in time.

It is also important to note that the rainfall and runoff data presented in Table 6 provides potential changes to averages. As such, small changes in averages could 'mask' more significant changes to rainfall variability or extremes. Specific projections relating to seasonality of runoff and frequency and duration of extreme dry and wet periods were not available for this study. As a general indication though, some preliminary modelling undertaken by the project team for the entire lower Murray-Darling basin, drawing on scenarios presented in the CSIRO sustainable yields project, indicates that with a 19% reduction in average rainfall the frequency of 'dry' years (1st decile) could increase from 10% of years (based on the historical record) to 26% of years. Alternatively, the frequency of 'wet' years (10th decile) could decrease from 10% of years to 2% of years. Changes to runoff are even more marked.

It is important to note that all of the climate change projections, which provide the basis for the scenarios presented in Tables 6 and 7, have significant ranges of uncertainty associated with them, a point noted in all of the relevant studies. The uncertainties stem from inherent complexities of the climate system and regional hydrology, methods applied in different climate models and uncertainty about the future pathway of global greenhouse gas emissions. In general terms however, there is a quite high degree of certainty associated with temperature-related projections but less certainty associated with changes to patterns of rainfall and associated changes to runoff, recharge and streamflow.

Even so, in general uncertainties are not so great as to preclude judgements being made for a qualitative risk assessment of this nature. To that end, workshop participants were advised to

focus primarily on the direction rather than the magnitude of changes to climate variables when considering how those changes might influence risk.

Table 1. General Climate Change Scenarios, North East Victoria Region

Climate variable	Current ³	Indicative change ⁴		Notes
Average rainfall		2030	2070	Average annual rainfall could decrease by up to 28% by 2070 in the worst case. In the decade to 2007, the region's average rainfall was 12% below the 1961 to 1990 average.
Annual	1089 mm	- 3 %	- 10 %	
Spring	295 mm	- 7 %	- 19 %	
Summer	180 mm	uncertain	uncertain	
Autumn	249 mm	uncertain	uncertain	
Winter	367 mm	- 7 %	-15 %	
Runoff		2030	2070	Reductions in runoff are linked to a number of variables including reduced rainfall, higher evaporation and lower soil moisture.
Entire region		- 8 %	- 17 %	
Inflows to Murray system		- 20 %	- 40 %	
Rainfall intensity		2030	2070	Rainfall in the region is projected to become more variable, with fewer rainy days but rain falling in more intense bursts.
Annual rainfall intensity		+ 2 %	+ 10 %	
Maximum flood heights		+	+	
Flood return intervals (ARI)		+	+	
Number of rainy days	130	- 5 %	- 15 %	
Fire weather		2020	2050	The length of the fire season is projected to increase also.
Number of high and extreme forest fire danger days	18	+ 4	+ 12	
Other		2030	2070	Average annual temperature could increase by up to 4 °C by 2070. Average annual temperatures in the last decade have warmed by 0.5 °C, reflecting increases in both daily maximum and minimum temperatures.
Average annual temperature	12.3	+ 1 °C	+ 3 °C	
Potential evaporation		+ 3%	+ 9%	
Solar radiation		+ 0.7 %	+ 2.2 %	

Sources: CSIRO 2006, 2008; DPI 2010

³ Average 1961-1990, 'typical' location

⁴ Given high emissions scenario

Table 2. Water Balance Scenarios, North East River Basins

Climate variable	Indicative change ⁵		
	1995-2005	2030	2070
Kiewa basin			
Average rainfall	- 5 %	-3 to -6 %	-5 to -16 %
Runoff	- 3 %	-18 to -27 %	-25 to -48 %
Recharge	- 9 %	-6 to -12 %	-12 to -31 %
Streamflow	- 14 %	-4 to -11 %	-11 to -33 %
Mitta basin			
Average rainfall	- 5 %	-3 to -6 %	-6 to -17 %
Runoff	- 8 %	-25 to -36 %	-34 to -60 %
Recharge	- 13 %	-7 to -11 %	-15 to -39 %
Streamflow	- 16 %	-7 to -11 %	-15 to -43 %
Ovens basin			
Average rainfall	- 4 %	-1 to -4 %	-4 to -15 %
Runoff	- 0.3 %	-20 to -30 %	-28 to -50 %
Recharge	- 12 %	-5 to -13 %	-12 to -37 %
Streamflow	- 14 %	-1 to -10 %	-9 to -35 %
Upper Murray basin			
Average rainfall	- 2 %	-4 to -7 %	-6 to -16 %
Runoff	- 7 %	-30 to -42 %	-40 to -64 %
Recharge	- 11 %	-10 to -18 %	-18 to -42 %
Streamflow	- 10 %	-10 to -18 %	-18 to -45 %

Source: DPI 2010

⁵ Relative to 1957-2005 average

2.2 Drivers of water use

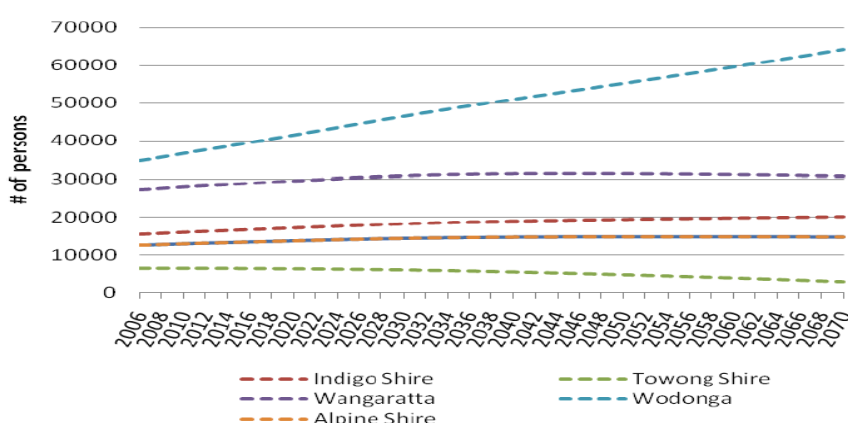
Many of the risks arising from climate change will build on existing risks faced by councils, water agencies and the NECMA due to local attributes and drivers such as population and economic growth and associated increases in water demand and water extractions. To that end, the following summary information⁶, was considered helpful in informing understanding of non-climate factors contributing to the sensitivity of the region to the potential impacts of climate change and low water availability, was also provided to workshop participants.

Residential water consumption accounts for approximately 64 percent of total urban water use and therefore population growth is likely to add to the pressure on urban water supply.

LaTrobe University has forecast positive population growth for all LGAs, except Towong Shire (Figure 1). Projections for Wodonga show particularly strong growth over the coming decades.

However, it should also be noted that urban water demand has been declining in recent years. It seems that restrictions and associated behavioural change have offset population growth during this time period.

Figure 1: Projected Population to 2070



Source: LaTrobe University, 2010, North East Greenhouse Alliance, Project Context Setting, User Groups, Access to Water and Current Usage

The economy of the region is diversified, major industries including manufacturing, tourism, agriculture and forest products.

Industrial and commercial water demand account for about a third of the urban water used, with the manufacturing industry being a major user. Similar to the residential water use, the volume of water consumed by the industrial sector has been declining in recent years.

Nevertheless, future demand and supply imbalance are likely to arise due to residential, and industrial and commercial growth and a resulting increase in water demand, and a reduction in water availability due to climate change.

⁶ Sourced from a context study undertaken for NEGHA by La Trobe University (2010).

Water is a crucial input for economic growth in any region and a shortage of water will be a constraint on the prosperity of a region.

2.3 Local and regional responses

Numerous local and regional strategies and plans have been developed by councils and other agencies in response to the medium and long term challenges faced by the region including the challenges of climate variability and water availability. As discussed further in section 5.2, an important principle underpinning the development of the adaptation plan, presented later in this report, is that it should build on existing plans and strategies. Many of the relevant strategies and plans are specific to individual councils or agencies; others have a region-wide focus. Two of the latter, which are especially relevant to this plan, are the *Hume Strategy for Sustainable Communities* (Hume Regional Management Forum, 2010) and the *Northern Region Sustainable Water Strategy* (DSE, 2009). This Adaptation Plan seeks to build on outputs of those two strategies.

2.3.1 Hume Strategy for Sustainable Communities

The *Hume Strategy for Sustainable Communities* is a 10 year strategic plan that was developed by the Hume Regional Management Forum to provide advice and make recommendations to inform decision making and investment in the Hume Region⁷. The *Hume Strategy for Sustainable Communities* is underpinned by a vision of a '*resilient, diverse and thriving Hume Region; one that 'capitalises on the economic, social and environmental competitive strengths of its four sub regions to harness growth ... and develop liveable and sustainable communities'*' (Hume Regional Management Forum, p.22). This vision is to be advanced by focusing effort on the five themes of natural resources, community, economy, transport and land use. Each of the themes comprises a number of key directions, which in turn contain a series of priority actions.

A review of the Hume Strategy suggests that it contains numerous actions that are relevant to this Adaptation Plan, with actions listed under Key Direction 1 (Anticipating and adapting to the effects of climate change) and Key Direction 2 (Managing our water resources sustainably) being particularly pertinent.

2.3.2 Northern Region Sustainable Water Strategy

The Northern Region Sustainable Water Strategy (NRSWS) aims to achieve long-term water resource planning in the Northern Region⁸ by guiding the development, integration and implementation of water management plans prepared by water corporations and catchment

⁷ The Hume Region covers the local government areas of Indigo, Towong and Wodonga (Upper Hume); Alpine, Benalla, Mansfield and Wangaratta (Central Hume); Greater Shepparton, Moira, Strathbogie and Campaspe (Goulburn Valley); and Mitchell and Murrindindi (Lower Hume). Thus it covers a substantially greater area than is covered by this Adaptation Plan.

⁸ The Northern Region includes Victoria's share of the River Murray and the major Victorian tributaries that flow north into the river including the Kiewa, Ovens, Broken, Goulburn, Campaspe and Loddon rivers. Thus it also covers a substantially greater area than is covered by this Adaptation Plan and some water corporations and CMAs responsible for management of water resources and catchments in the region are not partner organisation of the North East Greenhouse Alliance in this project.

management authorities operating within the region. The NRSWS considers all sources and uses of water including the needs of towns, industry, agriculture and the environment.

Similar to the Hume Strategy, the NRSWS contains numerous actions that are relevant to this Adaptation Plan. Chapter 8 of the strategy, containing actions to ensure 'Safe and secure drinking supplies' is particularly pertinent, while other relevant chapters include Chapter 4 (Secure rights to water), Chapter 7 (High-value rivers, wetlands and floodplains) and Chapter 9 (Prosperous, dynamic and resilient communities).

3 The Risk Management Process

3.1 Overview

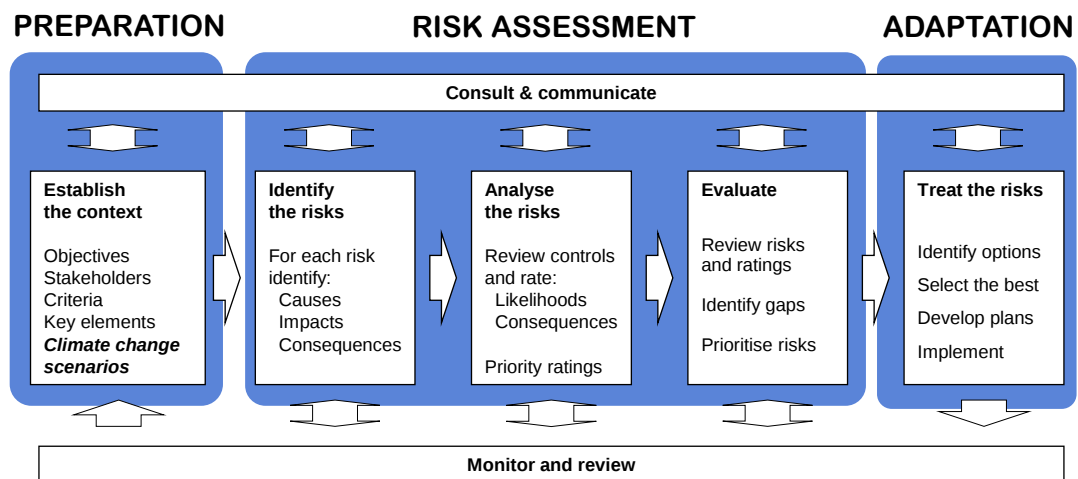
Risk management for low water availability risk has followed the approach set out in the Australian Greenhouse Office / Department of Climate Change publication, *Climate Change Impacts and Risk Management: A Guide for Business and Government* (the Guide), which is based on the Standard AS/NZS 4360 / ISO 31000 for Risk Management.

The process can be summarised very briefly as:

- establishing the context: understanding what is at risk, how risks are to be defined and how they are to be evaluated (e.g. the scales that will be used to estimate consequences, likelihood and risks);
- identifying the risks;
- analysing the risks;
- evaluating the risks; and
- developing and implementing treatments and measures to deal with the risks.

These steps are being implemented in three stages (preparation, risk assessment and adaptation) prior to an iterative monitoring and review cycle. Figure 2 illustrates the stages and steps.

Figure 2: Risk Assessment Process Stages



3.2 Context setting

The preparatory stage of the assessment (establishing the context) was carried out prior to the risk assessment workshop and was summarised in a workshop Briefing Note. Preparation

entailed establishing the scope of the assessment and setting the framework for identifying, assessing and evaluating the risks. It also involved pulling together contextual information, including climate change scenarios that could inform identification and analysis of the risks.

3.2.1 Scope

Assets and services

This risk assessment encompasses all of the roles and responsibilities of councils, water authorities and NECMA that may be affected by increased rainfall variability and reduced water availability⁹ due to climate change.

The focus of the assessment is on urban and domestic water issues (including urban and rural residential, industrial and commercial). Agricultural issues are not entirely excluded from the assessment as this industry is part of the social and economic profile of the region and as such there will be flow-on effects on communities. However, irrigation is out of scope of the assessment.

Geographical Area

The assessment covers the geographic area within the boundaries of five LGAs:

- Alpine Shire Council
- Indigo Shire Council
- Towong Shire Council
- Rural City of Wangaratta
- City of Wodonga

Stakeholders

Councils, water authorities and NECMA not only work together, but also with a range of external stakeholder groups and individuals, including representatives of community and business organisations, special interest groups, and Victoria and Commonwealth government departments and agencies. The climate change risk assessment involved representatives (i.e. employees and advisors) of all NEGHA member and partner organisations and DSE, noting that other stakeholder organisations were involved at the adaptation stage of the process.

3.2.2 Risk assessment framework

Strategic goals and objectives

The goals and objectives of the organisations are well documented in respective plans and strategies:

⁹ There was significant discussion within the project steering group as to the project scope and whether it should be defined in terms of a 'narrow' or 'broad' interpretation of water availability. In the end, a broad interpretation has been adopted encompassing rainfall variability and its impact on councils, agencies and services in terms of both low and high water flows.

- Councils' Plans and Community Vision,
- North East Water's *Strategic Intent 2013*, *Water Plan 2* and *Water Supply Demand Strategy*,
- Goulburn Murray Water's *Corporate Plan* and *Water Plan*, and
- The North East Regional Catchment Strategy (a twenty year strategy that sets the direction for investment in natural resource management across the region).

These were used to inform the consequences criteria and scales used in the assessment.

Rating scales

There are three components of the framework used to analyse and evaluate risks in the initial assessment:

1. a scale to describe the level of consequence of a risk, if it should happen (Table 2);
2. a scale to describe the likelihood of experiencing that level of consequence (Table 1); and
3. a scale to assign a priority rating to each risk, given its consequences and likelihood (Table 3 and Table 4).

The priority ratings used for this risk assessment are an amalgam of ratings used by individual agencies and councils. The same ratings are used for each of the councils and agencies so as to provide region-wide consistency of the process and outputs. The likelihood scales are also the same for all councils and agencies. There are some small differences in the weighting of financial consequences scales between councils and agencies though, reflecting differences in their operational budgets.

Table 3. Likelihood Scale

Rating	Recurrent Risks	Single Event
Almost certain	Could occur several times per year	More likely than not – probability high (e.g. greater than 90%)
Likely	May arise about once per year	As likely as not – at least 50/50 chance or greater
Possible	May arise once in ten years	Less likely than not but still appreciable – less than 50% chance but still quite high
Unlikely	May arise once in ten to twenty-five years	Unlikely but not negligible – probability low but noticeably greater than zero
Rare	Unlikely during the next twenty-five years	Negligible – probability very small, close to zero

Table 4. Consequence Scale

Consequence Rating	Health & Safety	Economy & Community	Service Delivery	Environment & Sustainability	Financial Impacts	Legal	Reputation
Catastrophic	Large numbers of serious injuries, illnesses or loss of lives	General long term regional decline, widespread business failure, loss of employment and community hardship	The organisation would be seen as unable to effectively provide its services, widespread loss of critical service for a crucial period of time	Major widespread loss of environmental amenity and progressive irrecoverable environmental damage	Huge financial loss (e.g. > \$5,000,000 water agencies; > \$1,000,000 councils)	Serious litigation with prosecution and significant penalties	Extreme public outrage Management changes demanded National or International media coverage
Major	Isolated instances of serious injuries , illnesses or loss of lives	Regional economic stagnation, decline in quality of life within local community	Severe and widespread decline in services Critical loss of service for a significant amount of time	Severe loss of environmental amenity and a danger of continuing environmental damage	Major financial loss (e.g. >\$500,000 – \$5,000,000 water agencies; >\$500,000 – \$1,000,000 councils)	Serious breach of policy or regulation and exposure to court imposed penalties	Loss of Community confidence in organisation and damage to reputation Major alarm and anger Statewide media coverage
Moderate	Small number of injuries or illnesses	Significant general reduction in economic performance relative to forecasts or expectations	Appreciable decline in service and/or loss of isolated, but important instances of services	Isolated but significant instances of environmental damage that might be reversed with intensive efforts	High financial loss (e.g. >\$250,000 – \$500,000)	Moderate breach of policy or regulation leading to low level investigations or penalties	Community discussion and concern Widespread complaints and anger, Significant local media coverage
Minor	minor injuries or illnesses or serious near misses	Individually significant but isolated areas of reduction in economic performance relative to expectations	Moderate decline in some services and/or brief loss of services for minimum period	Minor instances of environmental damage that could be reversed	Medium financial loss (e.g. >\$50,000 – \$250, 000)	Minor legal and non compliance issues remedied by prompt attention	Some complaints and anger, Limited local media coverage
Insignificant	Appearance of a threat but no actual harm	Minor shortfall in economic performance relative to expectations	Minor business disruption, resolved in day-to-day management	No environmental damage	Low financial loss (e.g. < \$50,000)	No legal significance	Minimal complaints, No media coverage

Table 5. Priority Rating

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	Extreme	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	High

Table 6. Priority Interpretation

Priority	Interpretation
Extreme	Immediate action required and formal risk management plans will be prepared
High	Senior management attention needed and formal risk management plans will be prepared
Medium	Management responsibility must be specified and risk management tasks integrated with general plans
Low	Manage by routine procedures with no additional tasks or changes to routine procedures

Key elements and risk categories

Key elements and risk categories are a list of topics that were used to work through risks to councils' and agencies' assets, services and responsibilities in a systematic manner. The elements and categories used for this assessment are shown in Table 5.

Table 7: Key Elements

Key Element	Risk Categories
1 Water supply	Surface water
	Ground water
	Alternative supply sources
2 Policy & planning	Government policy
	Water planning
	Land use planning
	Demand management
3 Infrastructure	Waste water
	Stormwater
	Flood management
	Other
4 Economic development	Industry sectors
	Urban & regional development

5	Community & social	Recreation
		Health & wellbeing
		Emergency services
		Community services
		Other
6	Environment	Catchment health
		Aquatic ecosystems

3.3 Risk assessment process

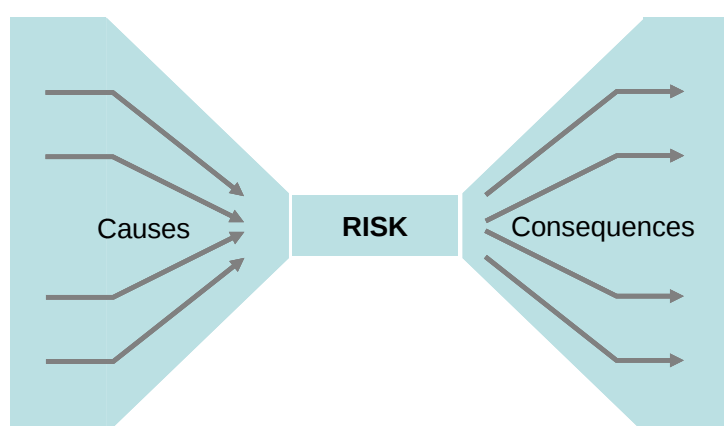
3.3.1 Identification and analysis of risks

The first and second steps of the risk assessment (identifying and analysing the risks) were carried out at a risk assessment workshop, conducted with council and agency staff over two days in October 2010. Taking each key element in turn, the risks associated with that element were reviewed and then the consequences and likelihoods of the risks analysed. Risks were recorded in the form illustrated in Figure 3 with a central description linked to a note of what could cause it and what consequences it could have, noting that most risks have multiple causes or drivers (both climate and non-climate related) and consequences.

During the risk assessment workshop, existing controls were discussed and the likelihood ratings adjusted to (implicitly) take account of control effectiveness. The approach enabled climate change risks to be identified and rated on the basis of residual risk, taking into account programs and measures that are already in place.

Output from the workshop was recorded in a comprehensive 'region-wide' register of climate change and water risks.

Figure 3: Risk Recording

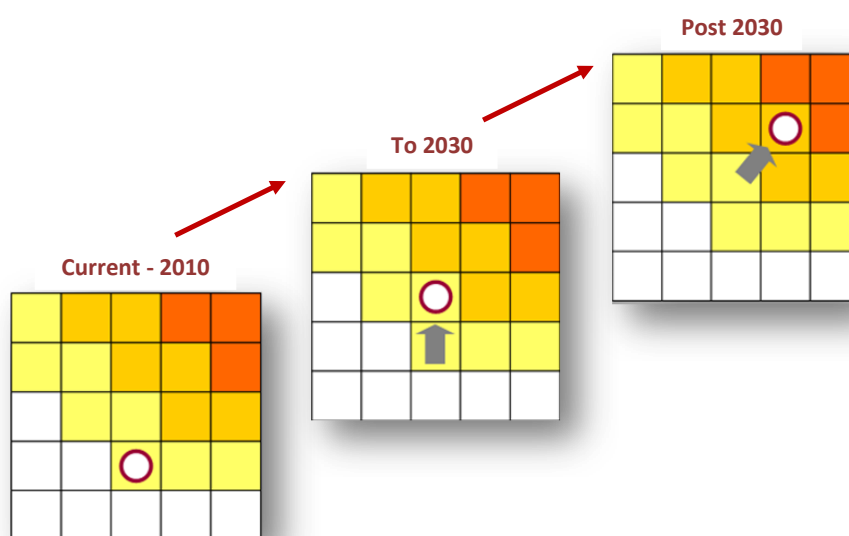


3.3.2 Risk rating periods

The risk assessment was carried out at three points in time (Figure 3):

- current, and extending through the life of existing plans and strategies of councils and agencies;
- beyond this to 2030, when we have an initial projection of climate changes that might arise; and
- beyond 2030, using 2070 climate change projections as an indication of very long term prospects.

Figure 4: Risk Rating Time Periods



In carrying out the assessment we stressed to participants that although some risks will not become serious until beyond 2030, they might be affected substantially by council and agency actions and decisions in the next few years.

A proportion of these risks might be seen as alerting councils, water authorities and NECMA to potential future opportunities and liabilities that should be taken into account in short-to-medium term decision-making. That is, some decisions might have unforeseen implications for the future, due to the ongoing effects of climate change and reduced water availability.

While the time scale of some of the risks may appear to be so long that they fall outside the scope of immediate planning processes, in future they might be seen to be linked to decisions made now.

3.3.3 Evaluation of risks

The evaluation step of the risk assessment was completed via a series of follow-up consultations with individual councils and agencies¹⁰. Through those consultations, amendments and additions were made to the region-wide risk register and revisions were

¹⁰ An overview of the consultations is provided in a separate report to NEGHA.

made to risk ratings, enabling a series of agency level climate change and water risk registers to be produced as supplements to the region-wide register.

3.4 Adaptation

The adaptation stage of the process (risk treatment) was undertaken as a discrete but linked exercise following the risk assessment. The adaptation planning process is described in section 5 of this report, with the outcomes of the process (proposed adaptation actions) being detailed in section 6.

4 Risk Assessment Results

Nearly 60 water-related risks were identified, discussed and rated during or following the risk assessment workshop, taking into account expert advice from council and agency staff. As previously noted, the risks have been rated at both a region wide level and by individual agencies. The discussion in section 4.1 below focuses on the region wide ratings and trends. This is followed in section 4.2 by a discussion of the differences in ratings between agencies, focussing in particular on risks rated *High* and *Extreme*.

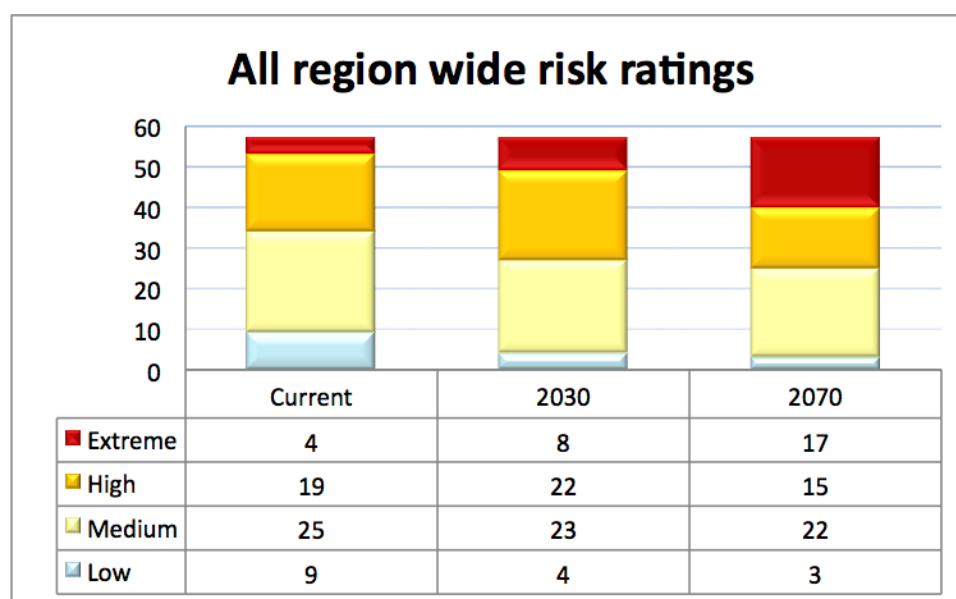
Full registers of risks, region wide and for individual councils and agencies, are held by NEGHA and NEGHA member organisations.

4.1 Region wide ratings and trends

4.1.1 Risk ratings

A summary of risk ratings across the Key Elements is given in Figure 5 for the current period, the medium term (2030) and the longer term (2070).

Figure 5: Summary of Water-related Climate Change Risks for the Region



The summary distribution shows that only four risks (~7% of all risks) are rated as *Extreme* in the current period: 1.01 (reduced reliability of unregulated surface water supplies); 1.07 (uncertainty of data relating to sustainable yield under climate change scenarios); 5.02 (degradation of parks, gardens and streetscapes); and 6.03 (decreased water reliability in unregulated systems [standing water bodies, wetlands and waterways]) (see Table 10).

A further 19 (~33% of all risks) are rated as *High*. Thus there is a predominance of *Low* and *Medium* rated risks in the current period. This is not surprising given that many of the more

substantial impacts of climate change, in terms of changes to rainfall and water availability, are not expected to occur until the medium or long terms. Furthermore, because few of the risks are new – in the sense that they are extensions or variations of existing risks – agencies and councils may already have substantial controls in place to deal with them, at least in the short term.

On the other hand, the number of *High* and *Extreme* rated risks increases significantly in the medium to long terms - to 30 (~ 53% of all risks) in the medium term and to 32 in the long term (~ 56% of all risks) – reflecting a substantial increase in the likelihood of risks occurring in the medium to long terms and /or a view that existing controls may not be adequate to deal with the potential for an increase in the frequency and/or severity of risk drivers in the longer term. As well, there are a few *High* and *Extreme* rated risks (e.g. 2.02 relating to the impacts of carbon pricing, 5.07 relating to increase in the number of Code Red days) that are entirely ‘new’ risks. In these instances, it is less likely that agencies and councils already have substantial controls in place.

In all cases, it is important to note that the *High* and *Extreme* ratings are for residual levels of risk, suggesting that they are either *untreated* or that existing controls are inadequate and hence there is a need for additional, focussed adaptation planning requiring to ensure that they are effectively addressed. On the other hand, risks that are rated *Low* and *Medium* over all time periods suggests either a low level of inherent risk or a high degree of confidence among agencies that existing controls are sound and will be able to keep pace with increases to climate stressors. An examples of the latter group includes risk 3.03 relating to disruption to water and waste water services associated with power outages – all relevant sites are covered by effective contingency plans, remote monitoring and back-up generation.

In general terms, climate change-related risks can be grouped into four broad categories:

- risks associated with the direct, physical impacts of climate change on natural systems;
- risks associated with the direct, physical impacts of climate change on infrastructure;
- indirect, derived risks associated with the economic and social ‘flow on’ effects (or consequences) of the physical risks; and
- indirect risks associated with policy responses linked to climate change.

It is useful to consider climate change risks in these terms because adaptation planning for direct, natural systems risks will tend to be quite different in nature to adaptation planning for risks to infrastructure, which in turn will be different to adaptation planning for indirect risks. Give that, it is interesting to note that the 31 risks rated *High* or *Extreme* in the medium term (Table 8) are split fairly evenly between direct and indirect risks, which in turn are split fairly evenly between derived and policy related risks.

Table 8. Categories of *High* and *Extreme* Rated Risks (medium term)

Category of risk	Risks	Number
Direct, natural systems	1.01, 1.02, 1.05, 1.06, 1.10, 5.08, 6.01, 6.02, 6.03, 6.04, 6.06, 6.07	11
Direct, built infrastructure & services	3.04, 3.05, 3.09, 3.10, 3.11, 5.01, 5.02,	7
Indirect, derived	2.07, 2.08, 4.04, 4.05, 5.03, 5.08	6
Indirect, policy and community response	1.03, 1.04, 1.07, 1.08, 2.02, 5.05, 5.07	7

4.1.2 Ratings by key element

A breakdown of risk ratings by key element is provided in Figure 6, indicating a fairly even spread in the number of risks across the six key elements. However, the 'Water supplies' and 'Environment' key elements have proportionally greater numbers of *High* and especially *Extreme* rated risks across the three time periods than the other key elements. By contrast, the 'Infrastructure' key element has a relatively low proportion of *High* and *Extreme* rated risks.

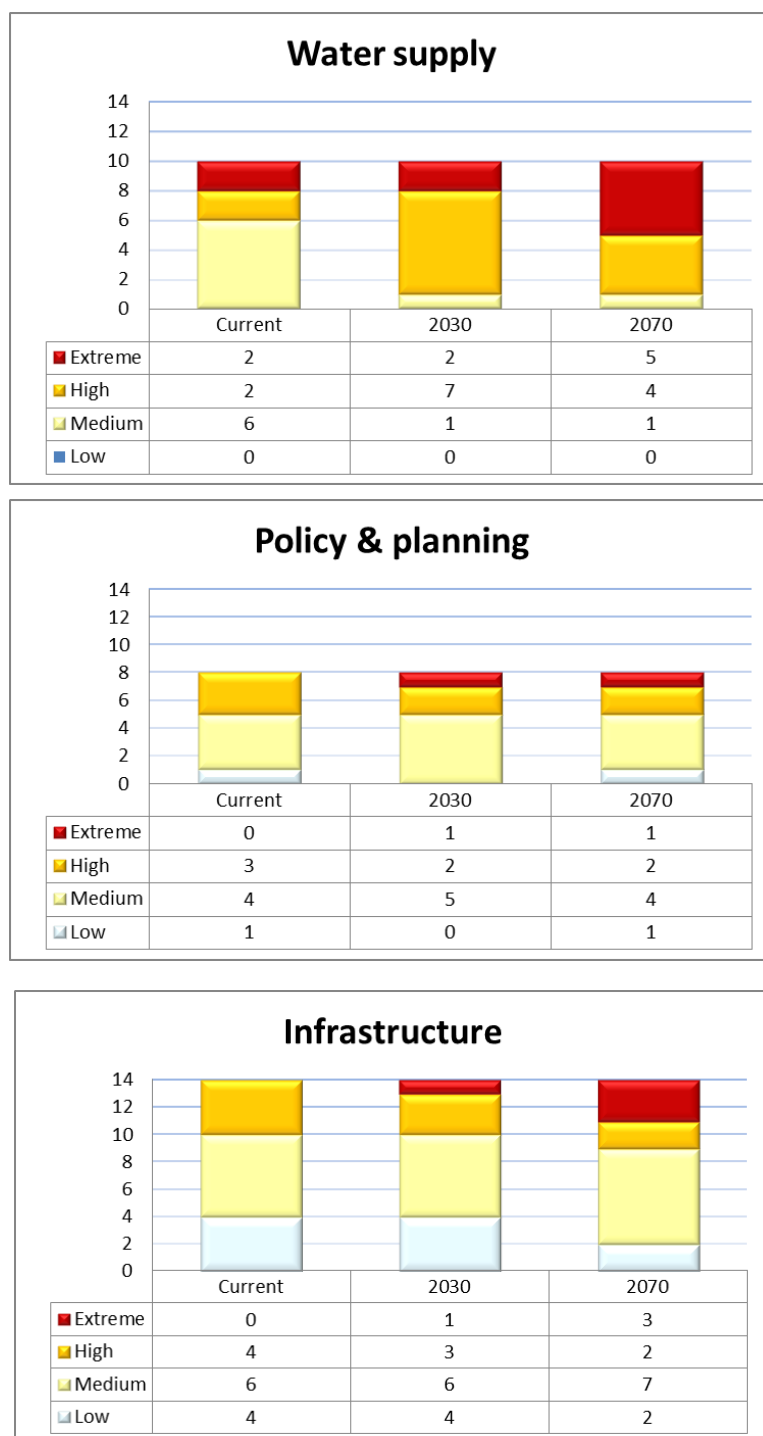
There is no clear explanation for these outcomes, although the following factors provide possible pointers to the relatively high ratings given to the 'water supplies' and 'environment' risks:

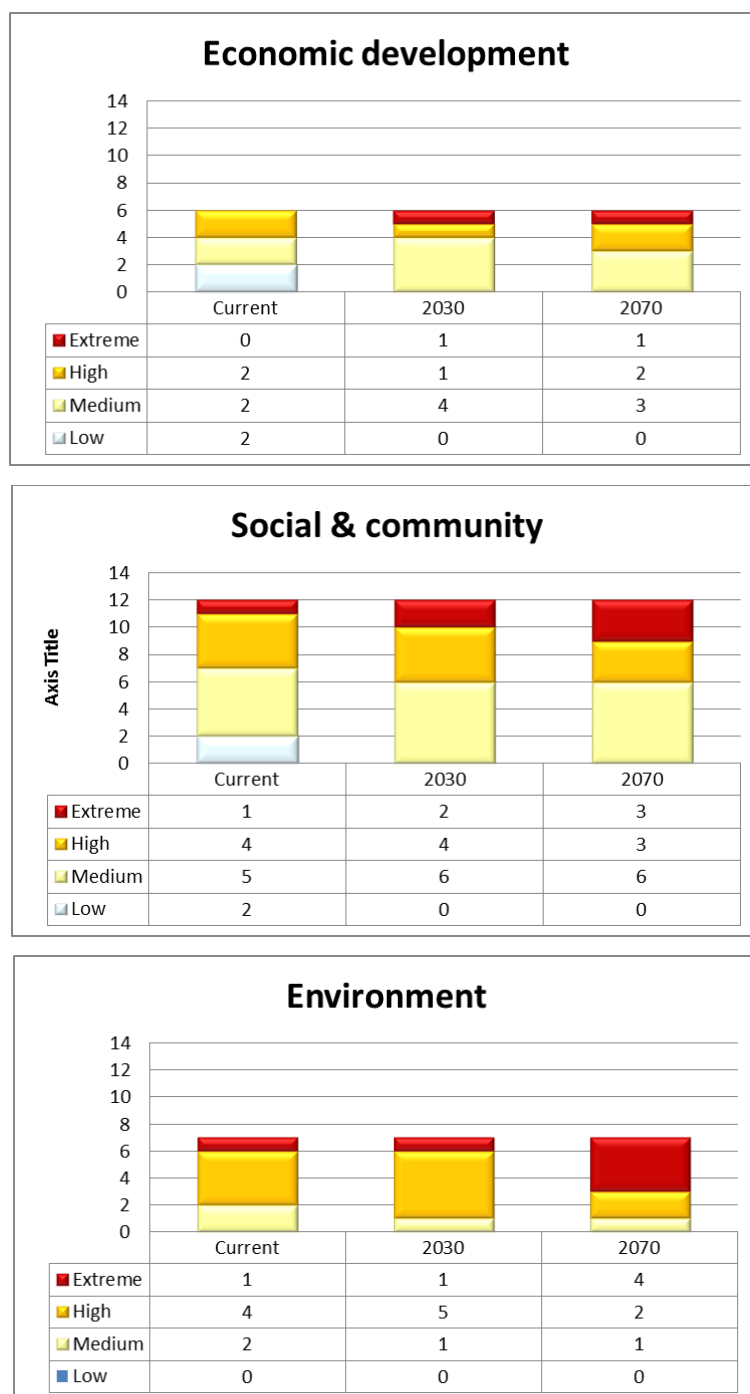
- direct, natural systems risks are strongly represented in the 'water supplies' key element and dominate in the 'environment' key element;
- natural systems in the region already face significant pressures irrespective of climate change (e.g. natural climate variability, development pressures); and
- risks to natural systems are not necessarily treatable through technical responses alone but tend to require multi-pronged approaches.

Conversely, the following factors provide possible pointers to the relatively low ratings given to the 'infrastructure' risks:

- not surprisingly, direct risks to infrastructure dominate in this key element; and
- by their nature, these risks are often readily treatable through technical solutions (e.g. design modifications).

Figure 6: Risks by Key Element





4.1.3 Risks rated *High* and *Extreme*

Table 9 provides a full list of *High* and *Extreme* risks. Remaining Medium and Low priority risks are not shown here, but can be viewed in the complete register of risks, a copy of which is held by NEGHA and NEGHA member organisations.

Factors influencing *High* and *Extreme* risk ratings vary from risk to risk and can be quite complex, but in most cases a *High* or *Extreme* rating reflects:

- a moderate to high sensitivity of agencies and councils to that risk, with economic and / or social consequences being particularly pertinent to councils and service delivery and /or reputational issues being important for water agencies;

- an increase over time in likelihood of the risk as climate change becomes more marked; and
- a view that existing controls, while possibly adequate at present, will not be sufficient to mitigate the risk if the impacts associated with climate change become more marked in the future.

Many of the risks that are *High* and/or *Extreme* in the short to medium terms relate to impacts that agencies and councils already have experienced difficulties in coping with due to prolonged drought (e.g. 1.01, 1.03, 5.01, 5.02, 5.05) other climate extremes (e.g. 3.09) or multiple climate and non-climate pressures (e.g. 1.07, 6.01, 6.02, 6.03, 6.04). Any increase in the frequency and/or magnitude of impacts due to climate change in the future will only exacerbate those risks. Particular attention will need to be given to these risks in the adaptation planning process.

There are a number of other risks, rated *Medium* or *High* in the short term, but which have the potential become *Extreme* in the longer term. These risks tend to fall into two groups:

- The first group comprises risks that, as with those discussed above, agencies and councils have already been grappling with. Agencies and councils have been able to mitigate these risks in the short to medium terms though, as a consequence of controls they have successfully introduced. There is a very possibility however, that impacts will become more striking with climate change and related stressors in the longer term, making it substantially more difficult for agencies or councils to manage the risk without a specific adaptation plan in place (encompassing new or additional measures). Examples of these risks include 1.05, 1.10, 3.04, 3.10, 3.11 and 5.08.
- The second group comprises risks that could be described a 'new risks' in the sense that the risks and associated impacts are not significant issues for agencies and councils at present. Climate change or climate change in consort with other stressors could result in significant impacts in the future however. Examples of these risks include 1.04, 1.08, 2.02, 6.06 and 6.07.

Two risks rated *High* over all three time periods are worth drawing attention to – risks 1.02 (reduced reliability of regulated surface water supplies) and 3.05 (increased damage to dam infrastructure). In both cases the consequences of these risks have been rated as *Catastrophic*. Recognising this, relevant agencies have put a great deal of effort into ensuring that these risks due not eventuate. As a result, the likelihood of these risks, even under worst case scenarios, is rated as *Rare* (over all three time periods in the case of risk 3.05 and over the first two time periods in the case of risk 1.02), which suggests that further adaptation planning may not be required for these risks, in particular risk 3.05.

Table 9: Region-wide High and Extreme Risks

Risk descriptions					Ratings - region wide			Other information	
Risk ID	Category	Causes/Stressors	Risk	Consequences	Priority (Current)	Priority (2030)	Priority (2070)	Controls	Key Locations
1.01	Surface Water	Reduced average rainfall Increased rainfall variability Increased evaporation and evapotranspiration Reduced and/or more variable streamflows. Lack of monitoring of water extractions	Reduced reliability of <u>unregulated</u> surface water supplies	Decreased long-term security of supply to small communities and farms - viability threatened Failure (of water agencies) to meet service delivery obligations - reputation.	Extreme	Extreme	Extreme	Alternative supplies (obtain water from secure sources) and storage. Demand restrictions, leading to irrigation bans, restrictions on public open space, outdoor residential gardening. Shift communities to regulated system.	Beechworth, Bright, Yackandandah, Corryong, Myrtleford
1.02	Surface Water	Reduced average rainfall Increased rainfall variability Increased evaporation Reduced or more variable inflows	Reduced reliability of <u>regulated</u> surface water supplies	Decreased long-term security of supply to urban centres Increase in water restrictions - community outage. Failure (of water agencies) to meet service delivery obligations	High	High	High	Water trading, carry-over of bulk entitlements and development of alternative supplies. Water restrictions, conservative approach to allocations (assume worst case), reduced losses.	All serviced users, especially Murray River towns and Wangaratta
1.03	Surface Water	(Poor) planning decisions Reduced average rainfall Increased rainfall variability Increase frequency of droughts	Interceptions (e.g. farm dams, forestry) reduce runoff and yield of surface water supplies	Reduced reliability of surface water supplies	High	Extreme	Extreme	Regulation (with the exception of S&D) Land use planning	catchments with high proportion of dams (Happy Valley Creek)
1.04	Surface Water	Reduced runoff and inflows Imbalance of consumptive/environmental flows, Public pressure.	Regulators require more environmental flows	Reduction of net pool of resources for consumption Unable to meet service obligation. Water restrictions	Medium	High	Extreme	Water Resource Plans (BEs), regulation	

Risk descriptions					Ratings - region wide			Other information	
Risk ID	Category	Causes/Stressors	Risk	Consequences	Priority (Current)	Priority (2030)	Priority (2070)	Controls	Key Locations
1.05	Surface Water	Persistently raised temperatures Reduced steamflows. More frequent and severe droughts, intense rainfall events, flooding. Increased frequency and severity of bushfires.	Increased incidence of poor water quality (e.g. algal blooms) impacts on water supply	Disruption to services - impacts on legal obligations and reputation (NE Water). Extreme water restrictions. Increased treatment costs. Public health issues. Increased costs to customers.	Medium	High	High	Treatment systems in major towns, emergency supplies for smaller towns	Tallangatta, Wodonga, Rutherglen, Bundalong and users on stock and domestic Rural users
1.06	Ground Water	Increased frequency and severity of droughts Increased rainfall variability Reduced recharge Falling water table	Reduced capacity of groundwater affects accessibility	Failed bores, rivers, other groundwater-dependent water supply options. Increased capital and operating costs. Access to groundwater more difficult and expensive - threatens viability of small communities (excludes environmental use).	Medium	High	High	Regulation and engineering responses	Users accessing shallow groundwater (unconfined aquifers), rural users
1.07	Ground Water	Inadequate monitoring of groundwater. Reduced reliability of surface water. Reduced average rainfall. Increased rainfall variability. Increase frequency of droughts.	Uncertainty of data relating to sustainable yield under climate change scenarios	Supply demand imbalance Failure to meet service delivery obligation. Disruption to service Water restrictions required Emergency supply required Untimely investment decisions (too early, too late).	Extreme	High	High	Regulation, precautionary approach built into legislation, on-going research and investigation, monitoring	Where there are groundwater users, where existing monitoring has been sparse.
1.08	Ground Water	Reduced rechargeIncreased frequency and severity of droughtsIncreased rainfall variability	Regulators limit extraction of groundwater	Reduced supply availabilityUnable to meet service obligations. Water restrictions. Viability of small communities threatened	Medium	High	Extreme	Water Resource Plans (BEs), regulation	Upper Ovens River Catchment
1.10	Ground Water	Persistently raised temperatures Reduced steamflows. More frequent and severe droughts, intense rainfall events, flooding	Increased incidence of poor groundwater quality impacts on water supply	Disruption to services Increased treatment costs Public health issues Reputation issues Increased costs to customers	Medium	High	Extreme	Emergencies supplies required for rural areas and rural residential (no towns on groundwater)	Stock and Domestic users

Risk descriptions					Ratings - region wide			Other information	
Risk ID	Category	Causes/Stressors	Risk	Consequences	Priority (Current)	Priority (2030)	Priority (2070)	Controls	Key Locations

Policy & planning

2.02	Government Policy (fed/state)	State, national and international greenhouse gas mitigation	Introduction of CPRS or other carbon pricing instrument	Increased cost of water and waste water services (e.g. pumping costs) Increased operating costs	High	Extreme	Extreme	compensation	High energy consuming systems
2.04	Government Policy (fed/state)	Uncertainty over climate change projections and competing objectives / priorities result in governments lacking political will to implement water reforms	Lack of government funding / support for climate change and water initiatives	Regional economic, social and environmental objectives not met	High	Medium	Medium	Political awareness, changing community expectations, lobbying, local knowledge and networks, existing commitments	Small rural councils
2.05	Water planning	Uncertainty over climate change projections. Competing objectives / priorities in different bodies involved in water planning	Inconsistent or uncoordinated regional responses to climate change and water planning	Regional economic, social and environmental objectives not met	High	Medium	Medium	Strategic Planning in areas such as water, health, economic development and biodiversity	
2.07	Demand Management	Increase frequency and intensity of droughts. Increased frequency and intensity of heatwaves. Population growth. Tourism growth. Increased rainfall variability.	Increased peak demand due to changing water use patterns (unserved areas)	Reduced system reliability	Medium	High	High	Regulation	Unserviced areas with supply demand imbalance
2.08	Demand Management	Increase frequency and intensity of droughts. Increased frequency and intensity of heatwaves. Population growth. Tourism growth. Increased rainfall variability.	Increased peak demand due to changing water use patterns (served areas)	Reduced system reliability	Low	High	High	water planning	Served areas

Risk descriptions					Ratings - region wide			Other information	
Risk ID	Category	Causes/Stressors	Risk	Consequences	Priority (Current)	Priority (2030)	Priority (2070)	Controls	Key Locations

Infrastructure

3.04	Water Supply Infrastructure	Ground movement associated with increased rainfall variability and increased frequency and severity of droughts Increase in frequency and severity of bushfires	Increased damage to pipelines and other water supply infrastructure	Increased maintenance costs Increased capital costs disruption of service	Medium	Medium	High	Maintenance programs, design and siting, construction techniques, monitoring programs,	
3.05	Storage	Increased rainfall variability and increased frequency and severity of droughts causes ground movement	Increased damage to dam infrastructure	Dam safety	High	High	High	ANCOL standards Maintenance programs, design and siting, construction techniques, monitoring programs,	
3.09	Stormwater	Increased frequency and severity of intense rainfall events Increased rainfall variability	Stormwater systems overwhelmed or damaged	Increased maintenance and capital costs. Limited availability of stormwater for harvesting / re-use. Increased flooding. Damage to creeks which form part of stormwater management system	High	Extreme	Extreme	Engineering Guidelines for Subdivisions & Development Standards (NE Water). Stormwater pipes installed in new developments and retrofits are designed for 1:10 year peak flow, up from 1:5. Design incorporating overland flow paths, detention systems, stormwater reuse systems.	Wodonga and Wangaratta
3.10	Flood management	Increased frequency and severity of intense rainfall events Increased rainfall variability	Damage to or failure of flood mitigation structures (e.g. levees)	Increased maintenance and capital costs Increased flooding	High	High	Extreme	Inspection & maintenance programs. However, these are not uniform or consistent between councils. Furthermore, condition/status of levees is often difficult to know until there is a flood!	Myrtleford, Wangaratta,
3.11	Flood management	Increased frequency and severity of intense rainfall events	Increased damage to regional transport infrastructure (roads, bridges, culverts)	Increased maintenance and capital costs Disruption to services Community hardship	High	High	Extreme	Rock beaching, headwalls, tends to be retrospective	rail

Risk descriptions					Ratings - region wide			Other information	
Risk ID	Category	Causes/Stressors	Risk	Consequences	Priority (Current)	Priority (2030)	Priority (2070)	Controls	Key Locations

Economic development

4.04	Economic Development	Reduced water availability Increased water costs	Decline in viability of regional industrial sector	Regional economic decline Reduced employment Reduced rate base	High	High	High	WaterMAP, Planning for water scarcity by industries	
4.05	Economic Development	Reduced water availability Reduced streamflows and resulting damage of environmental assets. Decrease in snow cover. Increase in extreme temperatures and heatwaves. Increased frequency and severity of droughts. Impacts of climate on wine region.	Decline in viability of regional tourism sector	Regional economic decline Reduced employment Reduced rate base	High	Extreme	Extreme	Tourism strategies focus on diversification, products, event-based tourism, ski resorts have strategies	Beechworth, Bright Tallangatta

Social & Community

5.01	Recreation	Increased rainfall variability Reduced water availability	Degradation of playing fields and golf courses	Loss of community access to playing fields. Reduced community wellbeing and health. Community complaints. Increased maintenance costs	High	High	High	Water reuse and recycling, water use planning, playing field species	All LGAs
5.02	Recreation	Increased frequency and severity of droughts. Increased rainfall variability. Reduced water availability	Degradation of parks, gardens and streetscapes	Loss of community access to gardens. Reduced community wellbeing and health. Community complaints	Extreme	Extreme	Extreme	Water reuse and recycling, water use planning, playing field species	All LGAs
5.03	Recreation	Increased frequency and severity of droughts. Increased rainfall variability. Reduced streamflows. Reduced water quality (e.g. algal blooms).	Reduced community access to waterways for recreation (e.g. swimming, boating)	Reduced community amenity and wellbeing	High	High	Extreme		

Risk descriptions					Ratings - region wide			Other information	
Risk ID	Category	Causes/Stressors	Risk	Consequences	Priority (Current)	Priority (2030)	Priority (2070)	Controls	Key Locations
5.05	Health & wellbeing	Reduced reliability of water supplies to residential areas	Increased frequency and/or severity of water restrictions	Gardens can't be watered Reduced amenity Increased stress and mental health issues	High	High	High		
5.07	Emergency services	Increased rainfall variability Reduced moisture in forests and grasslands. Increased frequency of other severe fire weather conditions.	Increase in frequency of code red days	Increased disruptions to services and community (voluntary evacuations) Economic and tourism impacts	High	Extreme	Extreme		
5.08	Emergency services	Increased rainfall variability Increased frequency and severity of droughts	Reduced availability of water for emergency services (esp. bushfire fighting)	Loss of life Loss or damage to property Increased insurance costs	Medium	High	High	Planning controls, local and regional planning to incorporate reduced availability into fire response (Municipal fire prevention planning)	

Environment

6.01	Catchment health	Reduced average rainfall Increased rainfall variability Persistently raised temperatures Changed evapotranspiration	Loss or change in composition of native vegetation (including instream vegetation)	Reduced catchment health Loss of communities or biodiversity	High	High	Extreme	Connectivity, biodiversity planning at CMA and State level, roadside management at council level	
6.02	Catchment health	Reduced average rainfall Increased rainfall variability Increase frequency of droughts	Increase in invasive weed species	Reduced catchment health Loss of communities and biodiversity Agricultural impacts. Increased costs of weed control	High	High	Extreme		National parks and other public land reserves
6.03	Aquatic Ecosystems	Reduced average rainfall Increased rainfall variability Increased surface or groundwater extractions. Reduced reliability of surface water. Reduced groundwater recharge	Decreased water reliability in <u>unregulated</u> systems (standing water bodies, wetlands and waterways)	Increased pressure on aquatic and amphibious species and communities Impaired ecosystem function	Extreme	Extreme	Extreme	Demand restrictions, leading to irrigation bans. Other water restrictions including watering of public open space and outdoor residential gardening.	Wetlands, Ovens and King River Tributaries and unregulated Ovens River, Kiewa River tributaries

Risk descriptions					Ratings - region wide			Other information	
Risk ID	Category	Causes/Stressors	Risk	Consequences	Priority (Current)	Priority (2030)	Priority (2070)	Controls	Key Locations
6.04	Aquatic Ecosystems	Reduced average rainfall Increased rainfall variability. Increased surface or groundwater extractions. Reduced reliability of surface water. Reduced groundwater recharge	Decreased water reliability in regulated systems (standing water bodies and wetlands)	Increased pressure on aquatic and amphibious species and communities Impaired ecosystem function	High	High	High	Environmental flows, environmental water plans Regulation of pumping See also controls for risk 1.02	Murray and Mitta Mitta River floodplains
6.06	Aquatic Ecosystems	Reduced average rainfall. Increased rainfall variability. Increased surface or groundwater extractions. Reduced reliability of surface water Reduced groundwater recharge.	Increased frequency of poor water quality	Increased pressure on aquatic or amphibious species and communities. Decreased breeding opportunities for birds	High	High	Extreme	Revegetation, land use planning, riparian management, environmental flows	All
6.07	Aquatic Ecosystems	Reduced average rainfall Increased rainfall variability Increased surface or groundwater extractions. Reduced reliability of surface water. Reduced groundwater recharge	Reduction in groundwater recharge	Increased pressure on aquatic or amphibious species and communities. Decreased breeding opportunities for birds, impacts on wetlands, groundwater dependent ecosystems.	Medium	High	High	Planning, licencing, regulation	

4.2 Council and agency risk ratings

As outlined in section 2.3.3, post workshop consultations were undertaken with individual councils and agencies, enabling council and agency level risk registers to be produced as supplements to the region-wide register. The council and agency level registers have been provided to the respective councils and agencies and are not reproduced in full in this report. Table 10 however, provides a summary of the ratings given by each agency to the High and Extreme risks listed previously in Table 9.

The information in Table 10 highlights a couple of important points:

- First, there is a very high level of consistency between councils in terms of the ratings each has given to the risks listed in Tables 9 and 10. This indicates a high level of agreement between councils as to regional priorities linked to rainfall variability and low water availability. The few cases where there are differences in ratings between the councils (e.g. risks 1.05 and risks 5.02, 5.03, 5.05, 5.07 and 5.08) can be explained largely by differences in local conditions and circumstances rather than fundamental disagreement about the issues.
- Second, the level of consistency between councils and agencies, and between individual agencies in terms of their risk ratings is not as great but is still quite high.

Most of the differences in ratings can be attributed to differences in objectives and functions between councils, the water authorities, NECMA and DSE. That is certainly the case with respect to differences in social and community risk ratings between councils and agencies. In contrast to the councils, agencies tend to have only minor responsibility for recreation, local community wellbeing and emergency management. Stormwater management (risk 3.09) is also primarily a responsibility of councils rather than agencies. Similarly, in relation to the environment risks, North East Water and (to some extent) Goulburn-Murray Water, tend to have less responsibility for local environmental management than NECMA, DSE and councils.

Differences between councils and agencies and between individual agencies and authorities in the rating given to risk 1.10 (groundwater quality) is a notable exception to this general principle. Councils generally rate risk 1.10 as 'High' or 'Extreme', as does NECMA. The water authorities and DSE however, have rated this risk as 'Low' or 'Moderate'. There is no clear explanation for this outcome but it could reflect uncertainty about groundwater resources in the region and especially the impacts of future climate change on those resources (see Box 2, section 6.3).

Table 10: High and Extreme Risk Ratings by Agencies and Councils

Risk ID	Risk	Alpine	Indigo	Towong	Wangaratta	Wodonga	NECMA	NEW	G-MW	DSE
Water supply										
1.01	Reduced reliability of unregulated surface water supplies	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓	✓✓
1.02	Reduced reliability of regulated surface water supplies	✓	✓	✓	✓	✓	✓✓	✓	✓	✓
1.03	Interceptions (e.g. farm dams, forestry) reduce runoff and yield of surface water supplies	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	-	✓✓	✓✓
1.04	Regulators require more environmental flows	✓	✓	✓	✓	✓	✓✓	✓	✓	✓✓
1.05	Increased incidence of poor water quality (e.g. algal blooms) impacts on water supply	-	-	✓✓	-	-	✓✓-	✓✓	-	✓✓
1.06	Reduced capacity of groundwater affects accessibility	✓	✓	✓	✓	✓	✓✓	✓	✓	✓
1.07	Uncertainty of data relating to sustainable yield under climate change scenarios	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓	✓	✓
1.08	Regulators limit extraction of groundwater	✓	✓	✓	✓	✓	✓✓	✓	✓	✓
1.10	Increased incidence of poor groundwater quality impacts on water supply	✓	✓	✓	✓	✓	✓✓	-	-	-
Policy & planning										
2.02	Introduction of CPRS or other carbon pricing instrument	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓	✓
2.04	Lack of government funding / support for climate change and water initiatives	nr	nr	nr	nr	nr	nr	✓✓	nr	nr

Risk ID	Risk	Alpine	Indigo	Towong	Wangaratta	Wodonga	NECMA	NEW	G-MW	DSE
2.05	Inconsistent or uncoordinated regional responses to climate change and water planning	nr	nr	nr	nr	nr	nr	✓✓	nr	nr
Infrastructure										
3.09	Stormwater systems overwhelmed or damaged	✓✓	✓✓	✓✓	✓	✓✓	✓✓	-	-	✓
3.10	Damage to or failure of flood mitigation structures (e.g. levees)	nr	nr	nr	✓✓	-	✓	nr	nr	nr
3.11	Increased damage to regional transport infrastructure (roads, bridges, culverts)	nr	nr	nr	nr	nr	✓	nr	nr	nr
Economic development										
4.04	Decline in viability of regional industrial sector	✓	✓	-	✓	✓	✓	✓	✓	✓
4.05	Decline in viability of regional tourism sector	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	-	✓	✓
Social & community										
5.01	Degradation of playing fields and golf courses	✓	✓	✓✓	✓	✓	✓	-	-	-
5.02	Degradation of parks, gardens and streetscapes	✓✓	✓✓	✓✓	✓	-	✓✓	-	-	✓
5.03	Reduced community access to waterways for recreation (e.g. swimming, boating)	✓	✓	✓✓	-	✓✓	✓	-	-	-
5.05	Increased frequency and/or severity of water restrictions	-	✓	✓✓	✓	✓	✓	✓	✓	-
5.07	Increase in frequency of code red days	✓✓	✓✓	✓✓	-	✓✓	✓	-	-	-

Risk ID	Risk	Alpine	Indigo	Towong	Wangaratta	Wodonga	NECMA	NEW	G-MW	DSE
5.08	Reduced availability of water for emergency services (esp. bushfire fighting)	✓	✓	✓	-	✓	-✓	-	-	-
Environment										
6.01	Loss or change in composition of native vegetation (including instream vegetation)	✓	✓	✓	✓	✓✓	✓✓	-	-	✓
6.02	Increase in invasive weed species	✓	✓	✓	✓	✓	✓✓	-	✓✓	✓
6.03	Decreased water reliability in unregulated systems (standing waterbodies, wetlands and waterways)	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	-	✓	✓✓
6.04	Decreased water reliability in regulated systems (standing water bodies and wetlands)	✓	✓	✓	✓	✓	✓✓	-	✓	✓
6.06	Increased frequency of poor water quality	✓	✓	✓	✓	✓	✓	-	✓	✓
6.07	Reduction in groundwater recharge	✓	✓	✓	✓	✓	✓✓	-	✓	✓

Key: ✓✓ = generally 'Extreme' rating (over all time periods); ✓ = generally 'High' rating; - = generally 'Low' to 'Moderate' rating; nr = not yet rated by members

5 Climate Change Adaptation Planning

5.1 Climate change adaptation

There is an increasing level of national and international research aimed at building awareness and understanding of climate change adaptation (e.g. Brooks 2003, Smit & Wandel 2006, Preston & Stafford-Smith 2009). This research has drawn, in turn, on established literature in the fields of risk management (particularly in relation to natural disasters) and resilience building (especially in relation to economic and social change) (e.g. Maguire & Cartwright 2008).

Notwithstanding this research, there is still no universally agreed definition of climate change adaptation. For the purpose of this Adaptation Plan however, climate change adaptation can be defined as ‘actions taken in response to actual or anticipated climate change impacts that lead to a reduction in risks or realisation of benefits’¹¹. Adaptation can be viewed as a planned, proactive response to climate change and, as such, can be distinguished from reactive adjustments to climate change impacts after they have occurred.

Actions in this Adaptation Plan have been defined broadly to include any policy, program or measure that, once implemented, will work to reduce the financial, social or environmental costs stemming from a climate change impact, either:

- directly, by reducing the magnitude or likelihood of an impact occurring - i.e. by reducing the risk; or
- indirectly, by increasing the capacity of vulnerable communities and systems to respond to an impact should it occur - i.e. by enhancing adaptive capacity.

As outlined in Table 11, actions considered for the Adaptation Plan are wide-ranging and include changes to institutional frameworks, revised strategies and plans, changes to statutory planning, improved decision making processes and procedures, on the ground works, education and training, monitoring and data collection and research. At first glance, actions falling into the latter three categories might not be regarded as ‘actions’. In fact, improved data collection, research and education and training can be crucial to increasing the capacity of communities to respond to climate change, a issue discussed further in section 7.1.

¹¹ This is an abridged version of a definition provided by the IPCC (Parry et al. 2007).

Table 11. Types of Adaptation Actions Considered for the Plan

Adaptation types	Description and examples
Institutional changes	Changes to institutional arrangements or governance: - Reform governance of a program, strategy or organisation - Establish new institution, alliance or network - Share framework or approach (with other organisations)
Strategies and plans	Local strategies and plans: - Strategic plans - Management plans
Regulations / standards	Regulations, standards and statutory planning frameworks: - Local planning schemes - Building design standards - Planning provisions that prevent new infrastructure from being built in high risk areas - Council by-laws
Internal procedures	Practices and procedures at an organisational level: - Improve decision making processes - HR management practices - OH&S practices
Structural or 'on-ground' works	Engineering solutions and practices: - Infrastructure protection measures - Inherent design of infrastructure maximising resilience - Environmental protection or remediation works - Energy / water efficient design
Spread or displace risk	Insurance and diversification strategies: - Use of insurance products to off-lay the risk - Risks shared between different councils / agencies - Geographical diversification (e.g. of raw materials)
Monitoring and data collection	Monitoring of changes to quality, condition and use of resources: - Water quality - Water availability and consumption - Catchment condition
Research	Improve understanding of relationship between climate change and risk: - Research on relationship between past and potential future variations in climate and performance of economic, social and environmental systems - Research on relationship between changes to frequency and magnitude of extreme events and critical thresholds - Assessment of adaptation options
Education and training	Educate and inform community about climate change impacts, risks and adaptation responses Training of council and agency staff about new practices or procedures

5.2 Principles underpinning adaptation actions

If NEGHA members and partnering agencies are to realise the potential benefits of climate change adaptation, it is important that their adaptation actions are well considered. To that end, a range of principles have been considered when developing this adaptation plan.

5.2.1 Generic principles of adaptation

To the extent feasible, every effort has been made to ensure that actions in this plan are consistent with generic principles of good practice climate adaptation that have been established in the climate change adaptation literature over recent years. Principles include:

1. **Focus on priority climate change issues.** The climate change risk assessment has provided NEGHA with a process for identifying and prioritising climate change issues. As discussed further in section 5.3, the Adaptation Plan focuses on a defined list of priority risks, ensuring that it is targeted at the issues most important to NEGHA members and partnering agencies.
2. **Use an adaptive management approach.** Adaptive management is an important strategy for dealing with climate change uncertainties. It is the process of putting into place, flexible, incremental changes based on regular monitoring and revision of plans as new information arises. At a general level, this Adaptation Plan incorporates the principle of adaptive management, seeking to build on existing plans and strategies (see section 5.2.2).
3. **Avoid adaptation constraining decisions or maladaptation.** Actions in this Adaptation Plan should not lead to perverse outcomes, such as constraining the ability of NEGHA members and partnering agencies or local communities to adapt to climate change in the future.
4. **Achieve balance between climate and non-climate risks.** Implementing a climate change adaptation plan is not itself risk free. Councils and agencies need to take a balanced approach to managing climate and non-climate risks. This is best achieved by each Council integrating its climate change risk assessment with its broader risk management processes. An important criterion for assessing priority actions (see below) is that they are 'no-regrets' actions, i.e. they will have net benefits to NEGHA members and partnering agencies or to the local community beyond climate change (see below).
5. **Prioritise actions.** It is important that NEGHA members and partnering agencies have a clear understanding of the pros and cons, costs and benefits and of adaptation actions. To that end, criteria for selecting priority actions are identified later in this report. As discussed further in section 7.2, selection of priority actions is best undertaken by NEGHA member councils drawing on these criteria. More detailed assessment (e.g. financial costs) of some of the actions may be required to complete the process.

5.2.2 Principles specific to this plan

Build on existing strategies and plans

A key rationale underpinning actions in this adaptation plan is that they should build on existing plans, strategies and actions, either at a regional or individual council/agency level. This approach acknowledges:

- that most of the risks from climate change to rainfall variability and water availability in the region are not ‘new’ risks but add to or compound existing risks;
- that considerable effort has already gone into developing regional strategies and plans and that they contain directions and actions that go some way to addressing the climate change-related risks discussed earlier in this report; and
- the worth of the generic principles of good practice adaptation outlined earlier.

As discussed in section 2.3, the *Hume Strategy for Sustainable Communities* and the *Northern Sustainable Water Strategy* are particularly relevant to this Adaptation Plan. It is noted however, that most of the actions in the two strategies are relatively ‘high level’ actions. Options listed in this plan will, as far as possible, establish links with those actions, while seeking to reinterpret them in a manner that increases specificity.

Reflect stakeholder perspectives

Another important principle underpinning actions in this plan is that they should, as far as possible, reflect the perspectives of stakeholder organisations, specifically NEGHA members and partnering agencies. This principle acknowledges that adaptation is best undertaken locally, since local attributes, including physical and socio-economic characteristics and the policy environment, will substantially determine the appropriateness of climate change actions and local stakeholders are best placed to understand those attributes.

There are provisos to this general principle however, namely that actions proposed by stakeholders should:

- 1 be consistent with the principles outlined above (e.g. build on existing strategies and plans);
- 2 take account of policies and actions being implemented in other jurisdictions; and
- 3 be realistic and feasible.

5.3 Adaptation planning process

The process used to develop this adaptation plan centred on workshops and consultations with NEGHA members and partnering agencies. Two ‘issues based’ workshops were held with council and agency staff collectively. The workshops were followed by consultations held, in the form of small focus group discussions, with each council and agency separately.

In all, the adaptation planning process entailed seven main steps, with steps 1 and 2 being undertaken prior to the workshops, steps 3 and 4 being completed at the workshops, steps 5 and 6 through the consultations and step 7 following the consultations:

1. **Priority risk selection.** The principal basis for selecting priority risks was their overall risk rating. Generally, a risk has been classified as a priority risk if it has been rated 'High' or 'Extreme' (averaged over the three time periods) by a number of NEGHA member and partner organisations. Using this approach, a total of 25 priority risks were selected for initial assessment at the adaptation workshops. Those 25 priority risks are addressed in this Adaptation Plan (Table 10).
2. **Priority risk categories and subsets.** Priority risks were grouped into categories and subsets (see Table 11, section 6.1). The purpose of the grouping was to enable risks that have significant similarities (and are therefore likely to require common adaptation responses) to be considered collectively in the adaptation planning process.
3. **Review existing controls.** Existing controls (policies, programs and measures) relevant to each priority risk subset were identified and then reviewed against a range of criteria, such as effectiveness, resourcing and flexibility, with the purpose of establishing where there are significant gaps or deficiencies with current controls.
4. **Potential new and revised actions.** For each priority risk subset, potential actions for overcoming gaps or deficiencies were identified. Both region wide actions and Council specific actions were identified. Noting the adaptation principles discussed in section 5.2, an initial assessment of the actions was undertaken against a range of criteria such as timeframe for implementation, budgetary implications, Councils' roles vis-à-vis other agencies and barriers to implementation.
5. **Assess potential new actions.** Council and agencies were separately requested to assess the potential new actions and consider whether the actions are appropriate and achievable and to provide further information on how to ensure effective delivery of those actions (e.g. how, who and when the actions should be delivered).
6. **Identify additional actions.** Council and agencies were also requested to provide suggestions on additional relevant actions.
7. **Consolidation of inputs and further analysis.** Outputs from workshops and consultations were consolidated and scrutinised to ensure consistency. Further analysis of actions was then undertaken considering current strategies, plans and policies. All outputs were then refined and consolidated into climate change adaptation actions, which are presented in the next section.

6 Adaptation Actions

6.1 Overview

6.1.1 Risks addressed

This section presents a review of existing controls and outlines recommended actions to deal with priority climate change risks. The full suite of risks identified through the risk assessment has been prioritised for adaptation planning. Risks rated 'High' or 'Extreme' by a majority of NEGHA members and partnering agencies or 'Extreme' by at least three organisations are addressed in this plan (see Table 10). Thus priority risks addressed by actions in this section include risks relating to:

- surface water supply & quality;
- groundwater supply & quality;
- stormwater & flood management;
- economic development;
- community issues including recreation and emergency management;
- the environment; and
- climate change response.

Table 12 details all of the priority risks. As discussed in section 5.3, in order to undertake efficient adaptation planning for the priority risks the risks have been grouped into alphabetically-ordered subsets. The purpose of this approach is to enable risks with similar themes and likely therefore to require common adaptation responses to be considered collectively for the adaptation planning.

Table 12. Priority Risks & Subsets

Category / subset	Risk ID	Risk
Surface water supply & quality		
Subset A <i>Surface water access & supply</i>	1.01	Reduced reliability of unregulated surface water supplies
	1.02	Reduced reliability of regulated surface water supplies
	1.03	Interceptions (e.g. farm dams, forestry) reduce runoff and yield of surface water supplies
	1.04	Regulators require more environmental flows
Subset B <i>Surface water quality</i>	1.05	Increased incidence of poor water quality (e.g. algal blooms) impacts on water supply

Category / subset	Risk ID	Risk
Groundwater supply & quality		
Subset C <i>Ground water access & supply</i>	1.06	Reduced capacity of groundwater affects accessibility
	1.07	Uncertainty of data relating to sustainable yield under climate change scenarios
	1.08	Regulators limit extraction of groundwater
Subset D <i>Groundwater quality</i>	1.10	Increased incidence of poor groundwater quality impacts on water supply
Stormwater and flood planning & management		
Subset E <i>Stormwater management</i>	3.09	Stormwater systems overwhelmed or damaged
Subset F <i>Flood management</i>	3.10	Damage to or failure of flood mitigation structures (e.g. levees)
	3.11	Increased damage to regional transport infrastructure (roads, bridges, culverts)
Economic Development		
Subset G <i>Viability of industry</i>	4.04	Decline in viability of regional industrial sector
Subset H <i>Viability of tourism</i>	4.05	Decline in viability of regional tourism sector
	5.07	Increase in frequency of code red days (tourism impacts)
Community services		
Subset I <i>Recreation & amenity</i>	5.01	Degradation of playing fields and golf courses
	5.02	Degradation of parks, gardens and streetscapes
	5.03	Reduced community access to waterways for recreation (e.g. swimming, boating)
	5.05	Increased frequency and/or severity of water restrictions
Subset J <i>Emergency management - bushfires</i>	5.07	Increase in frequency of code red days
	5.08	Reduced availability of water for emergency services (esp. bushfire fighting)
Environment		
Subset K <i>Catchment health</i>	6.01	Loss or change in composition of native vegetation (including instream vegetation)
	6.02	Increase in invasive weed species
Subset L <i>Aquatic ecosystems</i>	6.03	Decreased water reliability in unregulated systems (standing water bodies, wetlands and waterways)
	6.04	Decreased water reliability in regulated systems (standing water bodies and wetlands)

Category / subset	Risk ID	Risk
	6.06	Increased frequency of poor water quality
	6.07	Reduction in groundwater recharge
Climate change response		
Subset M <i>Climate change response</i>	2.04	Lack of government funding / support for climate change and water initiatives
	2.05	Inconsistent or uncoordinated regional responses to climate change and water planning
Subset N <i>Carbon pricing</i>	2.02	Introduction of CPRS or other carbon pricing instrument

6.1.2 Scope and presentation of adaptation actions

Recommended adaptation actions relating to the priority risk subsets are detailed in sections 6.2 to 6.8. Within each subset, recommended actions are accompanied by discussion of the underlying issue(s), existing controls and gaps and deficiencies with those controls. Given the inter-related nature of many climate change impacts, any grouping of risks and actions, is somewhat arbitrary. Recognising this, actions having relevance to more than one risk subset are cross-referenced.

In summary, nearly 50 recommendations have been made for actions to address risks to the region associated with reduced water availability and increased rainfall variability. These actions fall broadly into two categories – ‘actions recommended for councils’ and ‘actions recommended for other organisations’. This Adaptation Plan is targeted primarily at NEGHA member councils. Thus a majority of actions are directed at councils, either acting internally or working collaboratively with each other or with other organisations. Nevertheless, an effective adaptation strategy for the region cannot be implemented by councils alone. For that reason, numerous actions have been recommended for other organisations (including NEGHA partnering agencies and others), noting that only actions identified as being relevant and important to councils’ objectives have been included in the plan.

It is important to note that implementation of actions by councils and other regional organisations will be dependent on available resources and priorities within their respective Corporate Plans. The recommended actions are regionally focussed and will therefore need to be assessed by partner organisations against priorities in those plans. Actions involving a number of councils or organisations will also require extensive dialogue and coordination (see section 7.2.2).

As noted in section 5.1, the types of adaptation measure covered in the Adaptation Plan is quite wide-ranging and includes revisions to strategies and plans, changes to institutional and management frameworks, amendments to regulations and standards, changes to internal procedures, works, monitoring and data collection and education. Research activities are also addressed in the plan, albeit separately from the other actions.

Timeframes for implementation are provided with each action. Indicative timeframes are as follows: short term: 1-2 years; medium term: 2-5 years; and long term: more than 5 years.

6.2 Surface water

This section provides an overview of existing controls, gaps and deficiencies, and proposed actions for high-priority risks to surface water supply & quality. Priority risk subsets addressed in this section are:

Subset A: Surface water access & supply.

Subset B: Surface water quality.

6.2.1 Surface water access & supply

Subset A	Reduced reliability of unregulated surface water supplies (risk 1.01)
Risks	Reduced reliability of regulated surface water supplies (risk 1.02) Interceptions (e.g. farm dams, forestry) reduce runoff and yield of surface water supplies (risk 1.03) Regulators require more environmental flows (risk 1.04)
Focus	All surface water supplies accessed for residential, industrial and commercial use in the North East Victoria study region, including water supplied to towns and rural residential areas. Towns dependent on unregulated systems are especially at risk.
Context	Climate change projections indicate that there could be small to moderate reductions in average rainfall in the region in the medium to long term, with larger reductions in runoff and streamflows (see Tables 1 and 2). Droughts could also become more frequent and/or severe. These outcomes have the potential to compound existing risks to water security faced by water agencies and councils due to population and economic growth and associated increases in water demand and extractions. There is also some uncertainty about the potential impacts of proposed Australian Government strategies on water security in the region (esp. the Murray-Darling Basin Plan), although these are just as likely to be positive as negative for town water supplies. Water supply risks came to the fore in the 1997-2010 drought, during which record low inflows to water storages such as Lake Hume were recorded. Areas dependent on unregulated systems faced even greater threats to their water security. Notwithstanding the risks of climate change to water security in the region, uncertainty and the long lead time associated with climate change projections suggest that large scale, new infrastructure measures are not necessarily an appropriate response to the issue at present. Instead, the focus should be on improving and integrating water supply and demand planning and implementing and building on existing strategies outlined in established regional strategies including the Northern Region Sustainable Water Strategy (NRSWS).

**Existing
controls**

Water resource planning & management

A cascading suite of water resource planning measures are currently in place at the national, state, regional and agency levels aimed at securing water in the region, including for town water users:

- The Murray-Darling Basin Cap sets limits for water allocations from the major catchments across the Murray Darling Basin. Permissible Consumptive Volumes (PCVs) and Sustainable Diversion Limits (SDLs) set maximum volumes of water that can be used for consumptive purposes from regulated and unregulated systems.
- Victoria's water entitlement framework, established through the *Water Act 1989*, provides the basis for permanent water allocations in Victoria including bulk entitlements, environmental entitlements and water shares:
 - G-MW holds the source bulk entitlement for the north east region, which provides a share of inflows, storage capacity and releases;
 - North East Water holds the delivery bulk entitlements, which provide a set volume each year, subject to restrictions during periods of water shortage – it is noted that water supplied to towns represents only about 2% of consumptive water diverted from regulated waterways (Latrobe University, 2010);
 - Water shares provide perpetual water access rights in regulated systems to individuals;
 - in rural areas, individuals can access surface and groundwater for Domestic and Stock purposes without requiring an entitlement, although registration of stock and domestic dams is now required;
 - bulk entitlements in regulated systems hold the highest level of security, with the potential for water to be reallocated in favour of town water needs in times of water stress.
- The NRSWS, discussed in section 2.3.2, provides a regional basis for water resource planning. DSE, G-MW, NEW and NECMA are all members of the consultative committee that oversaw development of the strategy, as is the Municipal Association of Victoria (MAV).
- G-MW and NEW have developed Water Supply Demand Strategies (WSDS), a 50 year plan identifying actions to maintain the long-term balance between demand for water and available supply, focussing on both supply and demand side measures.
- G-MW and NEW produce annual Water Plans for the ESC to demonstrate how it will efficiently deliver its water service obligations.

- G-MW is in the process of developing Streamflow Management Plans (SFMPs) to provide a sustainable basis for water sharing in unregulated catchments. An integrated management plan, considering both surface and groundwater, is currently under development for the Upper Ovens catchment (G-MW, 2011).

Demand management and drought response

A range of strategies and programs are also being implemented in the region aimed at reducing long term growth in town water demand and/or managing demand during periods of drought:

- As noted above, NEW's WSDS aims to secure urban water supplies throughout the region, linking priority actions with long term planning (NEW, 2007). The majority of these actions are focussed on improving the efficiency of delivery systems and reducing demand by town water users.
- NEW has also developed a Permanent Water Saving Plan, which sets out restrictions and prohibitions on the use of water in NEW's water districts. Developed in 2007 under Section 170A of the *Water Act 1989*, the Plan was essentially a response to the 1997-2010 drought.
- Most NEGHA member councils have introduced programs aimed at reducing water demand, often implemented through sustainable water use plans or similar. Council actions include:
 - water savings measures in parks and reserves, swimming pools and council buildings;
 - grey water reuse projects (working with NEW);
 - implementing or investigating water savings planning permit conditions for new residential/commercial subdivisions (some councils); and
 - community education programs (sometimes working with NEW, see below).

Community and stakeholder engagement and information sharing

G-MW and NEW both have in place ongoing forums for stakeholder and community engagement on water issues.

NEW has a number of community advisory committees in operation in the region. The Committees provide NEW with community input on water issues relevant to them and their towns. Advisory committees are currently operating in Wangaratta, Bright, Yackandandah, Mt Beauty and Myrtleford. A reference group is also being established to provide community input into NEW's Water Plan for 2013/18.

NEW also operates a water education program aimed at educating the community on the region's catchments and water supplies and to provide

information and tools to promote sustainable water use.

G-MW has two Regional Water Services Committees operating in the region (Kiewa/ Mitta Mitta/ Upper Murray and Ovens/ King/ Mid Murray). These committees provide advice to G-MW on a range of operational matters.

Development of the Upper Ovens Water Management Plan (G-MW, 2011) is being overseen by a committee comprising G-MW, NEW, NECMA, a representative of councils and farmers.

Gaps and deficiencies

Water resource planning & management and community and stakeholder engagement

Current water resource planning measures, outlined earlier, provide a generally sound framework for the management of water resources in the region. To the extent that there are weaknesses in the framework a number of these have been identified through the NRSWS, which has recommended actions to address weaknesses both to regulated and unregulated water supply planning and management. Actions in the NRSWS relevant to this strategy include:

- improving monitoring and management of domestic & stock water use (4.1);
- developing and streamlining management plans for priority unregulated and groundwater systems such as the Upper Ovens (4.7, 4.8 and 4.9); and
- amending bulk entitlements for unregulated systems (4.17).

Additional water resource planning & management issues, not specifically addressed in the NRSWS, have also been identified for the North East region. They include:

- potential to increase the planning role of local government in water supply and demand decision making, especially in **unregulated** systems where water security for residential, commercial and industrial users is less assured;
- potential to improve communication and education on water allocation decision making, especially for unregulated systems, noting that there is a lack of understanding within some councils and agencies, the private sector and the broader community about:
 - water resource supply, demand and constraints; and
 - the objectives, priorities and decision making processes on regional water allocation and distribution given those constraints.
- the need to ensure that climate change projections (including changes to rainfall, runoff and drought frequency and severity) are

fully reflected in Water Management Plans.

Demand management and drought response

Notwithstanding water demand management plans being initiated by NEW, G-MW and through councils, it is apparent from a review of plans that approaches to water demand management are not regionally consistent, particularly with respect to Water Sensitive Urban Design (WSUD) for new residential developments being instigated by councils through their planning schemes.

Recommended actions for councils

Action A1

Increasing the role of councils in WS&D planning

Councils can be more effectively integrated into Water Supply and Demand (WS&D) planning processes in the region. This can be achieved by:

- i. councils ensuring that planning schemes integrate Water Supply Demand Strategies (WSDS) into new developments (especially in areas supplied by unregulated systems);
- ii. councils, in consultation with NEW and G-MW, pursuing (to the extent feasible) a consistent approach regionally to consideration of WSDS in planning schemes (e.g. water accounting, provision of dual water supplies, water sensitive urban design);
- iii. councils, in consultation with NEW and G-MW, pursuing a regionally consistent approach to demand management (see Action A2); and
- iv. ensuring that councils are involved in information sharing on regional water allocation and distribution, especially in unregulated systems, through their participation in regional water planning and advisory bodies (see Actions A3 and L1).

This action builds on actions in the Hume Strategy - Priority Strategy 2.3, such as Action 2.3.4. It is likely to be a medium term action.¹²

Action A2

A regionally consistent approach to demand management and water service supply

Councils should collaborate with each other and with NEW to strengthen and promote consistency in demand management and consideration of water service supply options across the region including through:

- i. the provision of community information and education on the potential implications of climate change for water availability and further community education on water efficiency and water service

¹² Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

supply options – potable and non-potable;

- ii. investigating innovative water supply projects (e.g. grey water reuse, stormwater capture and storage, serviced stock and domestic supply networks) to increase diversity and sustainability of water supply, especially in areas supplied from unregulated systems or where security of supply could be a problem in the longer term; and
- iii. developing a regionally prioritised schedule for the implementation of these projects considering a range of criteria including potential to enhance water security, cost-effectiveness (levelised cost), feasibility and environmental and social impacts (see Box 1).

This action builds on actions in the Hume Strategy - Priority Strategies 2.1 and 2.2. It should be implementable in the short to medium term.

Recommended actions for other organisations

Action A3

Information and communication on water allocation decision-making

Information on regional water allocation decision making (e.g. who gets what water, loss calculations) should be produced and widely communicated, utilising established regional water forums and networks such as the Dry Inflow Contingency Interagency Working Group, the Kiewa/ Mitta Mitta/ Upper Murray and Ovens/ King/ Mid Murray regional water services committees.

The information should be produced in a user friendly format and aim to provide councils, agencies and the broader community a common understanding of how water is shared in the region, how decisions on water allocations are made and who has responsibility for what aspects of water management in the region. There should be multiple points of dissemination for the information.

This action builds on actions in the Hume Strategy - Priority Strategy 2.1. It could be implemented in the short term.

Action A4

Incorporating climate change projections into water management plans

G-MW, NEW, NECMA and other agencies involved in the development of water management plans should ensure that best available climate change projections (including changes to rainfall, runoff and drought frequency and severity) are fully incorporated into those plans. NEW's water plan 2013-18, for example, is a key planning document that should include consideration of potential climate change impacts.

This action builds on actions in the Hume Strategy - Priority Strategy 2.1. It could be implemented in the short to medium term.

Box 1: Residential and small business water efficiency options

A wide range of water efficiency options are now available to household and small business (non-industrial) water customers. State and local governments and water agencies in many parts of Australia offer rebates for many of these options to encourage their take up. Reviews of programs in Perth, Sydney and Melbourne indicate that there can be significant differences in the water savings achieved by the different water savings options and in the cost-effectiveness of options (measured as levelised cost, \$/kL of water saved - see Table 13). Clearly however, some options have low levelised costs (e.g. leakage reduction), while others are not cost effective (e.g. rebates for water efficient washing machines). Other programs can be ineffective because of low take-up rates (e.g. greywater re-use). The reviews also indicate that cost effectiveness of options can vary depending on program design and on local conditions (e.g. demography and patterns of rainfall). It is also apparent that some options (e.g. subsurface irrigation schemes and tap timers) can lead to anomalous outcomes such as increases in water consumption.

When considering the implementation of residential and business water efficiency programs, it is important that councils and NEW establish clear and consistent program objectives and design and carefully assess the cost-effectiveness of alternative options, considering potential interactions between different measures and local circumstances.

Table 13. Cost to Agencies of Residential and Business Water Savings Measures

Water saving measures	Savings/ customer (kL/yr)	Levelised cost (\$/kL)
Residential		
Shallow Bore New	136	0.46
Bore Repair	51	2.40
Greywater Re-Use	0	-
Rain Sensor	Increase	-
Rainwater Tank	12	2.70
Rainwater Tank, Plumbed	33	3.00-3.77
Soil Wetting Agent	Increase	-
Subsurface Irrigation	Increase	-
Swimming Pool Cover	19	1.75
Tap Timer	Increase	-
Efficient Showerhead	17	0.32
Water Efficient Washing Machine	15	9.69
Other Indoor Retrofits	n.a.	0.50-0.60
Business		
General water efficiency rebates	n.a.	0.30-0.50
General		
Requirements for new residential developments (e.g. BASIX)	200-270	0.30-4.00
Pressure and leakage reduction	n.a.	0.20

Sources: ISF, 2006; MJA 2009 n.a. - not available

6.2.2 Surface water quality

Subset B Risks	Increased incidence of poor water quality (e.g. algal blooms) impacts on water supply (risk 1.05)
Focus	Quality of surface water supplies accessed for residential, environmental, industrial and commercial use in the North East Victoria study region, especially unregulated supplies.
Context	As in other parts of Australia and Victoria, comparatively little is known or understood about the likely impacts of climate change on water quality in the north east region. Possible impacts include: - increased sediment and nutrient loading associated with greater runoff, erosion and flooding of wastewater systems; and - increased frequency or severity of blue-green algae (<i>Lyngbya majuscula</i>), associated with elevated water temperatures and increased rainfall variability from climate change, compounding an ongoing issue of nutrient run-off into waterways¹³. Smaller towns and rural residential areas dependent on unregulated (and untreated) supplies may be particularly susceptible.
Existing controls	Council level controls – planning and development Council planning, development and environmental management controls implemented through their planning schemes, stormwater management plans and waterway management plans (some councils) are designed to limit impacts of developments on waterways and estuaries by: - requiring Water Sensitive Urban Design; - restricting the location of developments, especially in close proximity to waterways so as to maintain riparian corridors; - minimising site impacts and associated runoff; and - controlling septic system siting, design & maintenance. Regional level controls – water quality monitoring Agency level NEW uses a Drinking Water Quality Management System (DWQMS), to ensure that water quality in the region meets minimum requirements in line with the Victorian <i>Safe Drinking Water Act</i> (2004). The DWQMS

¹³ NEW notes that no toxic algae blooms have been identified in any of its water supplies since monitoring commenced about 10 years ago (<http://www.nerwa.vic.gov.au/water/quality/>).

includes:

- a Drinking Water Quality policy;
- water quality risk management plans; and
- community information on water quality.

NEW also has a water quality monitoring program in line with the Act that includes weekly testing for E. Coli, turbidity and blue-green algae.

G-MW's major storages are monitored under the Major Storages Operational Monitoring Program (MSOMP) for nutrients, pH and electrical conductivity.

Interagency

The North East Regional Water Monitoring Partnership (comprising DSE, NEW, G-MW, NECMA, Councils and Parks Victoria) aims to achieve a coordinated approach to surface water monitoring and cost sharing of water sampling and analysis.

Regional level controls – pollution management and prevention

Agency

NEW has a comprehensive network of sewers, wastewater treatment plants and reuse systems in place designed to reduce or divert effluent from discharging into waterways. Reclaimed water reuse schemes have been implemented across the region in line with the requirements of the State Environmental Protection Policy (SEPP) *Waters of Victoria*.

Catchment management strategies, developed and implemented through NECMA, have objectives and a range of strategies aimed at enhancing water quality through improved landholder practices (e.g. fertilizer application and nutrient runoff).

Interagency

A number of regional water partnerships and plans are in place, designed to achieve regional coordination of water quality monitoring and management including:

- the North East Catchment Regional Response Plan and Partnership Agreement for Waterway Incidents (convened by the EPA and including membership of DSE, NEW, G-MW, NECMA, Parks Victoria and DHS) meets a number of times each year to discuss waterway risks and responses to waterway incidents; and
- a Blue-Green Algae Co-ordination Plan is in place to provide regional response to blue-green algae. A coordinating committee for the plan is convened by G-MW.

Gaps and deficiencies	Water quality monitoring Established regional level partnerships and intra-agency monitoring programs provide a generally comprehensive framework for water quality monitoring in the region. Nevertheless, it is important that relevant agencies and the community are clear on the intent and connection of the various monitoring programs and how program outputs are used to drive improved water quality management and outcomes in the region. To those ends, councils need to be fully integrated into regional water quality monitoring processes. Pollution management and prevention An important barrier to understanding requirements for effective water quality management, in the context of climate change, is uncertainty about impacts of climate change on water quality including pollution drivers and key locations. Councils and agencies should seek to review plans relevant to pollution management and prevention as information on the impacts of climate change on water quality develops.
Recommended actions for councils	
Action B1	Integrate councils into regional water quality monitoring processes Efforts should be made to more effectively integrate councils into regional water quality management and monitoring processes in the region. This can be achieved by: i. actively involving councils in the North East Regional Water Monitoring Partnership and the North East Catchment Regional Response Plan and Partnership Agreement for Waterway Incidents; ii. increasing the role of the partnership to be more relevant to council needs, such as research and monitoring of sources of urban sediment and pollution in stormwater and assistance in integrated catchment management; and iii. actively working with councils to disseminate information on water quality produced by agencies and the Partnerships to the broader community. This action could be implemented in the short term.¹⁴
Action B2	Management of septic systems and stormwater

¹⁴ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

	Councils should adopt a risk averse approach to pollution generating activities, including septic systems and stormwater, by identifying high risk areas and updating or developing relevant strategies and management plans to address these priority areas. i. Septic systems In the case of septic systems, councils working with NEW, should identify the number, location and nature of vulnerable septic systems with high potential to contribute to surface and/or groundwater pollution, allowing for re-prioritising of vulnerable areas as relevant information on climate change impacts becomes available (see Action B3). Councils should prepare strategies for high risk systems (including for example installation of new, innovative and fit-for-purpose waste water systems) and implement the strategies through their asset planning and management and on-site sewage management programs. ii. Stormwater In the case of stormwater, Councils should consider revising and updating stormwater management plans to account for projected climate changes taking into account outcomes from the pollutant load modelling and hydraulic modelling (see Action B3, E1). This action builds on actions in the Hume Strategy - Priority Strategy 2.3, in particular Action 2.3.5. Part i. is a medium term action. Part ii. is a long term action linked to rainfall intensity modelling.
Recommended actions for other organisations	
Action B3	Understanding the impacts of climate change on water quality and water pollution The State Government should initiate research through the <i>North East Regional Water Monitoring Partnership</i> to improve understanding of the potential impacts of climate change (including increased rainfall variability) on water quality, water pollution and the condition of waterways. Research could include modelling to identify water and nutrient runoff in basins and catchments under extreme rainfall scenarios and pollutant load modelling. Outputs from the modelling should be used to guide a review of relevant strategies and plans including the North East Regional River Health Strategy and the Regional Catchment Strategy. This is a medium to long term action.

6.3 Groundwater

This section provides an overview of existing controls, gaps and deficiencies, and proposed actions for high-priority risks to groundwater water supply & quality. Priority risk subsets addressed in this section are:

Subset C: Groundwater access & supply.

Subset D: Groundwater quality.

6.3.1 Groundwater access & supply

Subset C Risks	Reduced capacity of groundwater affects accessibility (risk 1.06) Uncertainty of data relating to sustainable yield under climate change scenarios (risk 1.07) Regulators limit extraction of groundwater (risk 1.08)
Focus	Groundwater supplies accessed for residential, industrial and commercial use in the North East Victoria study region, especially by towns and localities dependent on groundwater.
Context	Groundwater constitutes only about 2% of water supplied to towns and rural residential areas in the region (Latrobe University, 2010). Nevertheless, it represents an important rural residential supply source, in some major towns (e.g. Wangaratta, Springhurst) where groundwater is used as a backup/emergency supply when surface water availability diminishes in the drier months. In many areas surface water and groundwater resources are highly connected. Notwithstanding recent groundwater modelling regionally, the impacts of climate change on groundwater, recharge and yields, are uncertain at present, although a CSIRO study into the impact of climate change on groundwater resources should help to reduce that uncertainty, at least at the Basin level (see Box 2). Based on available information though, the potential for reduced average rainfall and runoff, combined with a long term increase in extraction rates and the absence of accurate and consistent data on groundwater use, poses long term risks to the sustainability of groundwater supplies.
Existing controls	Groundwater planning and management Groundwater planning and management should be viewed in the context of overall water resource planning discussed in section 6.2.1, noting the connectivity between surface and groundwater resources. Within that context, specific planning measures are in place for groundwater in the region:

- DSE is responsible for coordinating state wide groundwater management activities and providing Victoria's groundwater policy direction. G-MW is delegated to manage the sustainable use of groundwater resources in the region, in accordance with the *Water Act 1989*, including the use and licensing of groundwater and the construction of bores. Licences limit the level of extractions and set conditions on water use from bores.
- Councils, through statutory plans, can place additional conditions on new licences, with the objective of managing overall resource use in their respective LGAs.
- Groundwater management plans are being developed by G-MW in areas where groundwater is being intensively developed. These set caps on total extraction and local management rules. The first of these plans, an integrated management plan, considering both surface and groundwater, is currently under development for the Upper Ovens catchment (G-MW, 2011).

Groundwater monitoring and information

The State Observation Bore Network (SOBN) is a collection of bores installed by the State Government, for the purpose of monitoring groundwater availability and quality. G-MW monitors groundwater levels for SOBN bores in the Oven-Kiewa groundwater management area, with relevant information being published on DSE's website (see <http://www.water.vic.gov.au/monitoring/groundwater/sobn>). NEW monitors its own bores in Wangaratta.

Emergency groundwater supplies

A network of emergency supply groundwater bores is established in the region, having been refurbished as recently as 2006-2009. The basis of the network is to ensure that all landholders reside within 20 km of supply points. Arrangements for access to these bores are made through the relevant councils.

Gaps and deficiencies

Groundwater planning and management

As with surface water, current approaches provide a generally sound framework for groundwater planning and management in the region. Weaknesses in the framework have been identified through the NRSWS, which has recommended a number of actions to address them including:

- reviewing Ministerial guidelines for licensing of unregulated and groundwater supplies (4.4);
- developing local management rules for groundwater and unregulated river systems (4.6); and
- developing and streamlining management plans for priority unregulated and groundwater systems such as the Upper Ovens (4.7)

and 4.8).

Groundwater monitoring and information

Notwithstanding the SOBN, there remain significant data gaps relating to the number and location of bores and groundwater yields. This is particularly so of stock & domestic bores. There is also a lack of consistent information regionally on groundwater levels, especially information on decline and recharge during and following droughts.

Furthermore, there appears to be a lack of understanding – among agencies not involved in groundwater management and the community more generally - of groundwater demand and availability in the region. This situation can, at least partly, be attributed to a mismatch between the desire for improved information on groundwater and bores and the legislated role of agencies to collect that information.

Emergency supplies

The established network of emergency supply groundwater bores provides co-ordinated access to emergency supplies of groundwater. It is apparent however, that some stakeholders and the community generally are not fully informed about the network.

Recommended actions for councils

Action C1

Increasing the role of councils in regional groundwater planning processes

Consistent with actions A1 and B1, councils should be more effectively integrated into groundwater planning processes in the region. This can be achieved by:

- i. councils, in consultation with G-MW and NEW, amending planning schemes to include provisions relating to groundwater management - to the extent feasible planning scheme provisions should be consistent between the region's councils; and
- ii. involving councils in the proposed 'North East Regional Groundwater Monitoring Partnership' (see Action C2).

This action builds on actions in the Hume Strategy - Priority Strategy 2.3. It could be implemented in the short to medium term.¹⁵

Recommended actions for other organisations

Action C2

North East Regional Groundwater Monitoring Partnership

Agencies, including DSE, G-MW, NEW, NECMA, DPI and councils,

¹⁵ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

should investigate the feasibility of establishing a 'North East Regional Groundwater Monitoring Partnership' to streamline and consolidate the collection of groundwater level and quality data in the region. The partnership would add value to the State Observation Bore Network in terms of improved co-ordination of decision-making on groundwater at the regional level and enhanced local knowledge. Functions of the partnership could include:

- coordinating information and decision making on groundwater access;
- reviewing existing bores (numbers and yields);
- coordinating region wide groundwater modelling, ensuring that best available climate change projections are fully incorporated;
- developing a shared understanding of the objectives of different organisations in relation to groundwater management and use; and
- monitoring the State Observation Bore Network.

The partnership could be modelled on the North East Regional (Surface) Water Monitoring Partnership, with DSE acting as lead agency.

Decisions would need to be made on resourcing the Partnership and its work program. The Partnership would need to meet on a regular basis (e.g. quarterly).

This action builds on actions in the Hume Strategy - Priority Strategy 2.1, especially Actions 2.1.7 and 2.1.8. It could be implemented in the short term.

Action C3

Groundwater resource information and education program

A regional groundwater resource education program should be developed. The purpose of the program would be to increase community understanding of groundwater resource and quality issues and the interaction and interdependencies between ground and surface water supplies. Initiatives undertaken through the program could include workshops, forums, field days and information dissemination (e.g. newsletters) through councils and agencies. One specific component of the program would be improved community information on how and where to access emergency bores. Information developed through the program should be consistent with and build on existing public information on the SOBN.

The program could be developed and led by G-MW, potentially through the proposed North East Regional Groundwater Monitoring Partnership (see Action C2). It would need to be resourced on an ongoing basis to be effective.

This action builds on actions in the Hume Strategy - Priority Strategy 2.1, especially Action 2.1.6. It could be implemented in the short term.

Box 2: Groundwater resources and climate change

The potential impacts of climate change (and other pressures such as land development and regional growth) on the region's groundwater resources are uncertain at present.

Groundwater systems are complex and each system is unique in its geology, volume, flow path and recharge and discharge behaviour. Time lags of sometimes decades or centuries in the responses of groundwater systems to changes make it difficult to observe resulting impacts and to establish a correlation between cause and effect. The interdependencies between individual groundwater systems as well as groundwater and surface water systems are not well understood.

Several studies have been undertaken to assess potential changes in groundwater recharge and yield in the North-East region of Victoria (see below). The magnitude of variation in these climate change impact predictions is due to variability in the underpinning data, simulation model constructs, and scenarios and assumptions adopted with model applications.

A consistent approach in assessing the impacts of climate change and other pressures on the region's groundwater sources is required, including a suite of plausible climate change scenarios covering several time periods, e.g. 2030, 2070 and 2100. This will allow uniform decision making and comprehensive water planning over long-term planning horizons, e.g. for a 50 year water supply demand strategy. The study should take into account interdependencies between all of the regions groundwater and surface water systems. Additionally, the model should provide a sufficiently fine scale to allow informed decision making and management of groundwater sources on a local level.

CSIRO Murray Darling Sustainable Yields Project – Ovens Region

- Covers the Ovens region, incl. two GMUs (Barnawartha GMU, Murmungee GMU) and unincorporated area;
- 8 Scenarios:
 - A - historical climate and current development
 - B - recent climate and current development
 - C - future climate and current development (dry, mid, wet)
 - D - future climate and future development (dry, mid, wet);
- Timeframe: 2030;
- Used a simplified rainfall recharge approach;
- The report notes that “recharge, extraction, aquifer hydraulic conductivity and surface-groundwater connectivity in the region are poorly quantified, thus the results of simple assessments undertaken are relatively uncertain.”

GHD Ovens Valley Water Resource

- Covers Lower Ovens GMA, Upper Ovens WSPA and includes surface water because of the known high degree of interaction between groundwater and the

Appraisal Study	Ovens River (and other watercourses); 3 Scenarios: 'Most likely' 2050 B1 (Warmer with little change in Precipitation); 'Likely' 2050, IPCC A1Fi (Hotter and Drier); - continuation of the last 12 years (extended drought); - Timeframe: 2050; - Groundwater component was modelled using MODHMS, a variant on the widely-used MODFLOW code; - PERFECT model used for the rainfall-runoff-recharge calculations;
CSIRO/SKM Southern Riverine Plains groundwater model	- Covers the major irrigation districts of Victoria including the Shepparton Irrigation District, the Campaspe region and the Loddon-Avoca regions as well as the New South Wales extent of the Murray region; - Reported groundwater water balance for specific groundwater management units and regions (Campaspe, Goulburn-Broken, Loddon-Avoca and Murray); 9 Scenarios: - A - historical climate and current development - B - recent climate and current development - C - future climate and current development (dry, mid, wet) - D - future climate and future development (dry, mid, wet) - Without development scenarios.
DPI Climate Change Predictions	- Covers North-East CMA region; - Used multilayered fully distributed groundwater model MODFLOW; - Finer spatial scale and more detail than the CSIRO Southern Riverine Plains groundwater model; - Greater extent than the GHD Ovens Valley model; 3 Climate change scenarios (in line with IPCC B2, A2 and A1Fi scenarios): Low, Medium, High; - Timeframe: 2030 and 2070.

Source: Beverly, C., Hocking, M., 2010

6.3.2 Groundwater quality

Subset D Risks	Increased incidence of poor groundwater quality impacts on water supply (risk 1.10)
Focus	Quality of groundwater supplies accessed for residential, industrial and commercial use in the North East Victoria study region.
Context	As noted in the previous section, the impacts of climate change on groundwater yields and recharge are very uncertain. Even less certain are the links between climate change and groundwater quality. Possible impacts include increased salinity in shallow aquifers (associated with increased extraction rates) and increased pollution of aquifers from industrial activities and septic systems linked to high intensity rainfall events. Uncertainties about the impacts of climate change on groundwater are compounded by a lack of regional monitoring and information on groundwater resources generally, relative to surface water, especially groundwater quality. As groundwater is an important source of water for rural residential areas an, emergency source for some towns and pollution of aquifers can potentially be irreversible, it is important that potential threats to the resource are better understood.
Existing controls	Groundwater planning and management Most of the controls for groundwater supply, discussed in the previous section, are relevant to groundwater quality. Additionally, it is important to note that councils have the potential to influence groundwater quality outcomes, over the long term, through established planning and development controls. Groundwater monitoring As previously noted, G-MW monitors groundwater levels and quality for SOBN bores in the Oven-Kiewa groundwater management area. Monitoring of groundwater quality in other areas is less comprehensive.
Gaps and deficiencies	Groundwater monitoring Monitoring of groundwater quality regionally appears not to be as comprehensive or as well co-ordinated as for surface water quality - i.e. there is not a clear understanding between relevant agencies about what should be monitored, who undertakes the monitoring and how that information is stored and used. This is a quite fundamental deficiency, as sound knowledge of the (groundwater) resource will be crucial to its

effective management in the future.

There also appears to be scope to improve the monitoring and management of domestic wastewater systems potentially impacting on groundwater quality, particularly in areas where old and small township blocks have septic systems that don't meet current standards and where sewerage is not seen as cost effective.

Recommended actions for councils

Action D1 Management of septic systems and stormwater

See Action B2

Action D2 Monitoring of high risk septic systems

Councils should consider establishing a monitoring program for high risk septic systems and areas identified through Action B2. This will reinforce directions established through Action B2 relating to the management of those systems.

Data from the monitoring program could also be used by members of the proposed NEGWP for more informed management decisions relating to groundwater, e.g. pesticide contamination, heavy metal contamination, E coli etc.

This action could feasibly be implemented in the medium term.¹⁶

Recommended actions for other organisations

Action D3 Addressing high risk septic systems

Drawing on outcomes from Action D2, NEW, working in partnership with councils, DSE and the EPA, should explore techniques and funding sources for improving the treatment of household wastewater in high priority small townships (e.g. less than 100 houses) to an adequate standard.

This is a long term action.

Action D4 North East Regional Groundwater Monitoring Partnership

See action C2

¹⁶ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

6.4 Stormwater and flood planning & management

This section provides an overview of existing controls, gaps and deficiencies, and proposed actions for high-priority risks relating to stormwater and flood planning and management. Priority risk subsets addressed in this section are:

Subset E: Stormwater management.

Subset F: Flood management.

6.4.1 Stormwater management

Subset E Risks	Stormwater systems overwhelmed or damaged (risk 3.09)
Focus	All stormwater drains and other drainage systems managed by councils, especially older parts of the system. Low lying areas subject to flash flooding.
Context	Limited available rainfall projections for north east Victoria indicate that the intensity of extreme rainfall events could increase significantly over the coming decades. This will lead to increased peak flows and runoff, reduced drainage system performance and greater frequency and/ or severity of flash flooding. Moreover, many parts of the drainage system in the region are aging. In most LGAs only relatively new components of the underground system are designed for a 1:10 year peak flow average recurrence interval (ARI). Although a 1-in-5 year event (for which many parts of the system are designed) does not necessarily cause major problems, low lying areas including roads are often affected. An increased frequency or intensity of extreme rainfall events could also lead to an increase in environmental impacts from overwhelmed stormwater treatment systems.
Existing controls	Stormwater planning and management (new developments) Stormwater planning and management processes for new developments are guided by councils', Floodplain Management Plans, Stormwater Management Plans and by the <i>Engineering Guidelines for Subdivisions & Development Standards</i>, a regional version of which has been developed by NEW. The Guidelines establish minimum design requirements for stormwater drains in new developments, overland flow paths and detention systems and system capacity for stormwater treatment systems. Stormwater pipes installed in new developments and retrofits are designed for 1:10 year peak flow, up from 1:5.

Stormwater and on-site detention systems, implemented through the Guidelines aim to ensure stormwater is controlled and managed in a way that reduces flood risk in urban areas and is consistent with the principles of integrated water cycle management (IWCM). Stormwater Management Plans focus on water quality, aiming to:

- reduce soil erosion and sedimentation; and
- minimise urban run-off pollutants to watercourses.

Other relevant modelling and design guidelines available to councils include:

- *Australian Rainfall & Runoff*, which provides the basis for flood modelling; and
- Water Sensitive Urban Design (WSUD) Guidelines, which provide guidance on reducing runoff from buildings/impervious surfaces in new developments.

Asset management (established areas)

Councils also have in place measures that have the objectives of maintaining and (where resources allow) upgrading the stormwater system. These include:

- Strategic Resources Plans and associated Asset Management Plans, which guide the works program and procedures for infrastructure maintenance; and
- community feedback/complaints, which help to inform prioritisation and budget allocations for works, particularly in areas prone to flooding.

Gaps and deficiencies

Stormwater planning and management (new developments)

Established management plans and guidelines provide a generally sound basis for the management of stormwater under the current climate. Emerging information though, suggests that plans will need to be strengthened to take account of likely increases in rainfall intensity. There are significant barriers to achieving this though, including:

- the need for improved hydraulic data and technical guidance from credible professional groups (e.g. revised Australian Rainfall & Runoff (AR&R) guidelines from Engineers Australia);
- lack of State Government direction on development controls relating to flood and stormwater management **in the context of climate change**; and
- council resource constraints.

Stormwater management (established areas)

Resource constraints, especially in smaller councils, also present a major

barrier to the maintenance and upgrade of stormwater and drainage infrastructure in established areas.

Given this, and climate change projections, there is a need for an education campaign to manage the community's expectations on stormwater management.

Recommended actions for councils

Action E1

Hydraulic modelling and changes to plans and planning schemes

Drawing on outputs of regional rainfall intensity modelling (see Action E6), councils with support from NECMA should undertake or commission hydraulic modelling to assess local and regional impacts of climate change to stormwater and drainage systems.

This information should then be reflected in changes to Floodplain Management and Stormwater Management plans and to planning schemes (for example, land use changes to accommodate higher projected flows in some areas).

This action builds on actions in the Hume Strategy - Priority Strategy 20.1, in particular 20.1.3. This is a medium term action¹⁷, requiring outputs from Action E6.

Action E2

Prioritise upgrades of vulnerable stormwater assets

Drawing on outputs of actions E1, councils should prioritise management / upgrade of vulnerable stormwater assets at an LGA scale.

Full implementation of this action will have major budgetary implications. Given this, councils, with support from MAV, could consider lobbying federal and state governments to provide additional funding for implementation of their stormwater adaptation priorities.

This action builds on actions in the Hume Strategy - Priority Strategy 6.3, in particular Action 6.3.1. It is a long term action, having major budgetary implications and requiring outputs from Actions E1, E4.

Action E3

Regional guides for the design and management of new and upgraded drainage assets

Drawing on outputs of Action E1, councils working cooperatively should develop regional guides and standards for the design of new and upgraded drainage assets.

This action builds on actions in the Hume Strategy - Priority Strategies 6.3 and 20.1, in particular Actions 6.3.1 and 20.1.1. It is a medium term action, requiring outputs from Action E1.

¹⁷ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

Action E4

Stormwater information and education campaign

Councils should consider undertaking a regional information and education campaign targeting community expectations on levels of service and councils' ability to deliver with regards to urban stormwater and flood management.

This action builds on actions in the Hume Strategy - Priority Strategy 1.2, in particular Action 1.2.6. It could feasibly be implemented in the short to medium term.

Action E5

Stormwater professional training and capacity building program

A regional stormwater professional training and capacity building program should be developed for councils drawing on integrated water cycle management and water sensitive urban design approaches to managing stormwater and flooding. The focus of the program would include:

- managing and adapting to projected changes in runoff due to increased rainfall intensity and duration; and
- design / upgrade of new and existing stormwater and drainage systems to encompass IWCM / WSUD principles in the context of climate change.

This action can be implemented over the medium term and is likely to have minor budgetary implications (if shared between Councils and other agencies).

Recommended actions for other organisations

Action E6

Regional modelling of changes to extreme rainfall intensities

NECMA and councils should seek funding from the State Government to commission region wide modelling of changes to extreme rainfall intensities and duration under climate change scenarios¹⁸. This information, in conjunction with Australian Rainfall & Runoff (AR&R) Guidelines, can then be used in hydrologic modelling to assess local and regional impacts of climate change to stormwater and drainage systems (see Action E1) to floodplain hazards (see Action F3) and to waterways (see Action B3). It would complement AR&R Guidelines that are currently being updated.

This action builds on actions in the Hume Strategy - Priority Strategy 17.1, in particular Action 17.1.4. Agencies should aim to implement the action in the short to medium term.

¹⁸ CSIRO and two or three academic institutes in Australia can provide this service.

6.4.2 Flood management

Subset F Risks	Damage to or failure of flood mitigation structures (e.g. levees) (risk 3.10) Increased damage to regional transport infrastructure (roads, bridges, culverts) (risk 3.11)
Focus	Regional flood mitigation structures including levees and weirs. All council roads, bridges and causeways, especially those subject to frequent flooding, landslides and/or degradation due to extreme rainfall. Note, issues relating to emergency response to floods are not addressed in this
Context	An increase in rainfall variability - increased in the frequency and/or magnitude of extreme rainfall events, alternating with prolonged dry periods – poses a number of challenges for councils in north east Victoria relating to infrastructure and service provision and the viability of communities. Particular difficulties faced by councils and agencies include: - increased damage to flood mitigation structures such as levees, leading to higher maintenance costs and or their potential failure – a levee protecting Wangaratta township, for example, came close to failure during recent (2010) floods; and - increased damage to and degradation of roads and other transport infrastructure leading to higher maintenance costs, disruption to services and community hardship.
Existing controls	Floodplain planning and management Local government planning schemes, initiated under Victorian Planning Provisions (VPP), provide the basis for floodplain planning in the region. Each planning scheme contains: - the State Planning Policy Framework (SPPF), which establishes state wide planning policies; and - the Local Planning Policy Framework, which sets out specific local policies, zoning and overlays including in relation to flood management. The SPPF establishes broad objectives and strategies for floodplain management and associated waterways for the protection of people, infrastructure and the environment situated in land affected by flooding; land affected by flooding generally being defined as land inundated by a 1 in 100 year flood event. Local implementation of these objectives and strategies are established through Floodplain Management Plans and associated flood mapping and overlays for declared 100 year flood levels. These have been

developed by NECMA as the responsible flood management authority. The plans and overlays can be used by councils to control development in land affected by flooding. NECMA's floodplain management activities also include:

- advising councils on planning applications associated with floodplains;
- collecting new and historic flood information; and
- assisting in flood warning processes.

Asset management

Councils undertake ongoing roads and other transport infrastructure maintenance works to their rural, main and urban roads. Works are generally programmed through an assets management plan and forward works program and maintenance schedule that has been developed from inspections by council officers and requests from community that have been lodged with the relevant council. Works include upgrading of unsealed roads, pothole patching, sign replacement, maintenance of culverts and drains and sealing of road shoulders. Although much of the maintenance is reactive, it can also help to prevent further deterioration of road surfaces and other assets. Subject to funding, more substantial road and bridge upgrades are also undertaken from time to time on main roads and other state significant infrastructure through grants and regional strategies. Works are generally undertaken by VicRoads on shared funding basis between the Australian and Victorian Governments and the relevant council. Upgrades are undertaken in accordance with various Australian Standards and Guidelines for road design and planning.

Responsibility for maintaining and managing flood protection works is shared between councils, NECMA and G-MW depending on the type and location of works. Councils for example, are generally responsible for levees protecting towns.

Gaps and deficiencies

Flood planning and management

The flood planning and management framework in place for the region appears to be sound. Emerging information though, suggests that flood management plans need to be updated to take account of likely increases in rainfall intensity and resulting changes to floods levels and ARIs. There are significant barriers to this though. As noted in discussion in the previous section, barriers include:

- lack of State Government direction on land use planning relating to flood and stormwater management in the context of climate change;
 - the need for improved hydraulic data and technical guidance from credible professional groups (e.g. revised Australian Rainfall &
-

Runoff (ARR) guidelines from Engineers Australia); and

- council resource constraints.

There is also a need for improved community education on the potential for climate change to impact on extreme rainfall and flooding and on the respective roles of agencies and councils in flood planning and management.

Asset management

Ongoing council resource constraints relating to infrastructure management and maintenance are compounded by anomalies in the way that Natural Disaster Relief and Recovery funding is currently structured and administered. Anomalies include:

- administrators of the fund being reluctant to fund response and recovery works by council staff work during normal working hours (but prepared to fund similar work by contractors); and
- a time lag between councils' expenditure on response and recovery works and reimbursement through the fund.

Repercussions of these anomalies for councils could become more apparent in the longer term if climate change projections eventuate.

Recommended actions for councils

Action F1

Clarified and simplified natural disaster relief funding

Councils, in conjunction with the MAV, should approach the state government to simplify and remove anomalies in the Natural Disaster Relief and Recovery funding arrangements including:

- clarified and simplified natural disaster declarations and relief funding arrangements from a central body;
- a more consistent and prompt payment schedule for natural disaster relief funding;
- council works (undertaken by council staff) are included in natural disaster relief funding;
- definitions of natural disasters and eligibility are clarified and take account of the changing climate.

It should be feasible to implement this action in the short term.¹⁹

Action F2

Planning for vulnerable assets

Drawing on outputs from Actions E6 and F3 and research and guidelines

¹⁹ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

of established professional bodies, councils should consider:

- developing regionally consistent criteria for quantitatively identifying vulnerability of major levees, roads, bridges and other key community assets to flooding and other climate extremes;
- identifying and rank vulnerability of the community assets to flooding at a regional scale;
- developing design standards to account for changed climate parameters in construction of new or upgraded works for roads and bridges; and
- actively seek funding from state and federal Governments for a program to upgrade vulnerable infrastructure.

This action builds on actions in the Hume Strategy - Priority Strategy 13.1. It is a long term action, which is dependent on outputs from Actions E4 and F3.

Action F3

Flood modelling and changes to Floodplain Management Plans

Drawing on outcomes of Action E6, councils working with NECMA should undertake or commission site specific hydrologic / flood modelling of local priority areas where the perceived risk is high (including key minor tributaries subject to flash flooding) and current Floodplain Management Plans do not fully reflect region wide rainfall intensity projections. Modelling outputs should then be incorporated into revised Floodplain Management Plans

This action builds on actions in the Hume Strategy - Priority Strategies 17.1 and 20.1, in particular Actions 17.1.4 and 20.1.3. It should be feasible to implement it in the short term.

Action F4

Review and update of Planning Scheme Overlays

Councils should review and update Planning Scheme overlays relating to floodplains, incorporating outcomes of flood studies (Action F3) and ensure that the public is aware of the most up to date flood data and extent of flooding.

This is an iterative action. It should be feasible to commence implementation in the medium term.

Action F5

Flooding and Business Continuity Plans

Councils should extend their Business Continuity Plans to ensure that they can cope with the impacts of flooding on staff resources and service provision. Councils should also ensure that their Business Continuity Plans take account of other potential disruptions to service delivery with the impacts of climate change and extreme weather events (e.g. bushfires, storms and heatwaves).

This action could be implemented in the short term.

Recommended actions for other organisations

Action F6

Community information and education on flood planning

NECMA, working with councils and agencies should consider developing and implementing a region wide information and education campaign to advise the community on climate change impacts on flood modelling, management and planning processes (see also Action E4).

This action builds on actions in the Hume Strategy - Priority Strategy 1.2, in particular Action 1.2.6. It could feasibly be implemented in the short to medium term.

6.5 Economic development

This section provides an overview of existing controls, gaps and deficiencies, and proposed actions for high-priority risks relating to economic development. Priority risk subsets addressed in this section are:

Subset G: Viability of industry.

Subset H: Viability of tourism.

6.5.1 Viability of industry

Subset G

Risks

Decline in viability of regional industrial sector (risk 4.04)

Focus

Impacts of reduced water availability and increased rainfall variability on commercial and industrial sectors in the region, in particular on key water dependent industries such as food processing, wood and wood products, paper and textiles.

Context

More than 20% of businesses in the North East Victoria are from the manufacturing and construction sector, with a further 50% being in the services sector. While many of these businesses are only minimally reliant upon water, in aggregate the businesses consume approximately 36% of all urban water in the region (22% commercial, 14% industrial). (Latrobe University, 2010)

Some key manufacturers in the region having a high dependence on

water (e.g. food processing, packaging and fabrication facilities). Moreover, the risks of climate change to these industries come not simply from reduced water availability or increased water costs, but from potential disruptions to inputs and supply chains (e.g. farm and forestry produce) associated with climate change and climate extremes.

Existing controls

EREPs

Environment and Resource Efficiency Plans (EREPs) is a Victorian EPA program targeting large industrial and commercial users of energy and water (licensed sites), which requires them to assess energy, water and waste flows at relevant sites and identify and implement cost-effective opportunities for reducing those flows. A number of industrial sites in North East Victoria are covered by the program.

Cooperation on industrial and commercial water issues

Most industrial and commercial water users in the region are supplied through North East Water (NEW). NEW maintains a significant relationship with major customers, including through initiatives implemented under its Water Supply-Demand Strategy and through businesses involvement on advisory committees including on the Water and Waste Water Advisory Committee.

Planning and development

Planning approval processes, initiated through planning schemes, generally ensure that councils will refer industrial and commercial development applications to NEW where there is a potential for a significant increase in water consumption.

Gaps and deficiencies

Understanding the risks of climate change to regional industry

As a consequence of the recent drought and associated water restrictions there is now reasonable understanding of the direct impacts of reduced water availability on individual industries in the region, especially of large water users. Less is known about the threats that low water availability and rainfall variability pose to manufacturing capacity in the region or indirectly to manufacturers as a result of disruptions to supply chains (e.g. farm produce).

Business preparedness

In contrast to some larger industries, small and medium businesses do not currently have processes in place (e.g. business continuity and strategic plans) to plan for the impacts of climate change and extreme weather events on their operations, supply chains etc.

Business water efficiency strategies

Through EREPs and cooperative work with NEW, considerable work has gone into identifying the opportunities for reducing water consumption

by large industrial water users. Significantly less work has gone into promoting efficient water use by small and medium waster using businesses.

Recommended actions for councils

Action G1

Regional training program – climate change, planning and economic development

Councils, through RMF and with support from the MAV and regional TAFE Institutes and universities, should consider developing and delivering a regional training and information sharing program for staff, councillors and potentially the broader community to increase their understanding and agreement on:

- potential implications of climate change, rainfall variability and low water availability on the region;
- the implications of this for future planning, economic development; and
- associated implications for council decision making.

This action could be implemented in the short term.²⁰ It builds on actions in the Hume Strategy - Priority Strategy 11.2, in particular Action 11.2.2.

Action G2

Capacity building program for small and medium sized businesses

To build the resilience of the local economy to climate change impacts and extreme events, Councils working with local chambers of commerce, business associations and local TAFE Institutes or universities, should consider developing a training and capacity building program on business continuity planning for small and medium sized businesses in the region. The program would train businesses on how to produce business continuity plans and to consider and address disruptions to business associated with the direct impacts of climate change and variability, as well as disruptions to supplies and/or demand for services. Training should be consistent with Australian Standards and best practice on business continuity management as set out in:

- the Business Continuity Management Handbook (HB 221-2004); and
- a practitioner's guide to business continuity management (HB 293-2006).

As this is a new program, potentially entailing significant costs, councils should seek funding for the initiative from Regional Development Australia (RDA) or another appropriate state or federal government

²⁰ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

department or agency.

This action builds on actions in the Hume Strategy - Priority Strategy 11.2, in particular Action 11.2.2. Subject to funding, it could be implemented in the medium term.

Action G3

Understanding the risks of climate change to regional industry

Councils, working with local chambers of commerce and industry associations, should consider undertaking a detailed assessment of the risks of climate change, water availability and climate extremes to local industry viability. The assessment would be reviewed on a regular basis and would consider the impacts of reduced water availability, increased rainfall variability and other climate extremes on:

- the manufacturing capacity of the region;
- the supply chain to manufacturers dependent on agricultural and forestry (e.g. food processing, wood and wood products), especially where local manufacturers are dependent on limited supply sources;
- other indirect impacts, such as disruptions to transport; and
- implications for overall regional economic development.

Councils should seek funding for the initiative from RDA or another appropriate state or federal government department or agency. Subject to funding, it could be implemented in the short to medium term.

Recommended actions for other organisations

Action G4

Water efficiency program for small and medium businesses

NEW and councils, working with relevant local industry and business associations, should consider designing and implementing a regional energy and water efficiency program. The program would be similar in design to existing energy and water efficiency programs, such as EREPs, but target small and medium businesses across the region and could involve:

- regional benchmarking for business and process types;
- audits of energy and water consumption in facilities and processes;
- assistance with energy and water efficiency measures for identified high priority facilities and processes; and
- guidelines and information for new businesses.

New and councils should seek funding for the initiative from RDA or another appropriate state or federal government department or agency.

This action builds on actions in the Hume Strategy - Priority Strategy 2.1, in particular Action 2.1.1 The action could potentially be implemented in

the medium term, subject to funding.

6.5.2 Viability of tourism

Subset H	Decline in viability of regional tourism sector (risk 4.05)
Risks	Increase in frequency of code red days (tourism impacts) (risk 5.07)
Focus	Impacts of reduced water availability and increased rainfall variability on the regional tourism sector, in particular on key climate-linked tourism industries such as snow based tourism, wine based tourism, tourism to major waterways and nature-based tourism.
Context	Tourism is a significant industry in North East Victoria. Approximately 3-7.5% of the region's economic output is based on tourism (depending on the sub-region), proportionally high relative to most other regions in Victoria (Tourism Victoria, 2011). Climate change and reduced water availability have the potential to impact on major attractions in the region, such as the snowfields, wineries, waterways and nature based tourism, affecting industry viability. This could have significant flow on effects to the local economy and community.
Existing controls	Tourism promotion and development A framework is currently in place to assist the development and promotion of tourism in North East Victoria. North East Victoria Tourism Inc (NEVTi), funded through Tourism Victoria, is the regional tourism committee currently charged with the responsibility of ensuring development and marketing of regional tourism in Victoria's High Country (including Alpine Shire, Indigo Shire and Rural City of Wangaratta). NEVTi works with a range of partner organisations. From June 2011 NEVTi it will be replaced by the North East Victoria Regional Tourism Board (NEVRTB). Similarly, the Murray Regional Tourism Board provides the Murray promotes tourism in the Murray region (including Wodonga LGA). Responding to climate extremes Comprehensive Municipal Emergency Management Plans (MEMPlan) plans are in place for the region implemented municipal emergency management planning committees and coordinated through a through a regional emergency response planning committee (see section 6.6.2). A tourism emergency response group is being established as part of NEVRTB to help the regional industry respond to emergencies including

bushfires and floods.

Gaps and deficiencies

Understanding and responding to climate extremes

General programs to promote the region as tourist destination are well targeted and quite effective. However, there are major gaps in understanding of:

- changes to the frequency and severity of extreme weather events in the region and how responses in relation to tourists should be framed when an extreme event occurs; and
- the impacts of climate variability and climate extremes on the viability of tourism in the region.

Also, tourism businesses do not currently have processes in place (e.g. business continuity) to plan for the impacts of climate change and extreme weather events.

Thus there is a need to broaden the scope and skill set of regional tourism boards and associations (e.g. NEVRTB) to enable them to anticipate and co-ordinate responses to climate variability and climate extremes. There is also a need to improve visitor understanding of the potential for extreme weather events in the region and how to act when one occurs.

Recommended actions for councils

Action H1

Visitor extreme weather communications plan

Councils, working with the emergency response group of NEVRTB, local tourism associations, BoM, Parks Victoria, emergency management organisations (SES, CFA, police) and broadcasters (e.g. local radio and TV stations), should develop a communications plan aimed at educating and providing timely information to visitors about the risks of extreme weather events and how to act should these events occur.

This action could be implemented in the short to medium term.²¹

Action H2

Capacity building program for small and medium sized businesses

See Action G2.

Recommended actions for other organisations

Action H3

Regional tourism and climate change strategy

North East Victoria Regional Tourism Board (NEVRTB), in consultation with councils and local tourism organisations, should seek funding to

²¹ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

undertake tourism industry and climate change case studies, which identify potential impacts of climate change on key tourism industries, drawing on recent experience with climate events (incl. droughts, floods and bushfires).

Outcomes from the studies should be used to develop a regional tourism and climate change strategy that aims to build resilience of the regional tourism sector to climate change and variability. An important aspect of the strategy would be contingency planning to deal with disruption to major events and industries from climate-related events (code red days, floods, bushfires etc.).

This action builds on actions in the Hume Strategy - Priority Strategy 11.1, in particular Action 11.1.2. It could be implemented in the medium term.

6.6 Community services

This section provides an overview of existing controls, gaps and deficiencies, and proposed actions for high-priority risks relating to community service issues. Priority risk subsets addressed in this section are:

Subset I: Recreation and amenity.

Subset J: Emergency management – bushfires.

6.6.1 Recreation and amenity

Subset I Risks	Degradation of playing fields and golf courses (risk 5.01) Degradation of parks, gardens and streetscapes (risk 5.02) Reduced community access to waterways for recreation (e.g. swimming, boating) (risk 5.03) Increased frequency and/or severity of water restrictions (risk 5.05)
Focus	All playing fields, golf courses parks, gardens and streetscapes management by councils. Waterways and waterway reserves used for recreational purposes. Residential gardens.
Context	Council managed open spaces, playing fields and waterway reserves are key community assets, being important for the long term health and wellbeing of local communities. Communities have expectations of ongoing access to these areas and that their quality and appearance will continue to be maintained by councils, even during extended dry

periods. During the recent drought, open spaces and playing fields in the region experienced significant degradation, including loss of grass and other groundcover, hardness and loss of shrubs and shade trees. Waterways dried up. In some cases, water restrictions and the high cost of alternative water supplies, prevented access to water for irrigation, resulting in the need to close or restrict access to some playing fields or to shorten playing seasons.

Private gardens are also important individual assets, being highly valued by many community members.

Climate projections for the region of reduced average rainfall, increased rainfall variability and a possible increase in the frequency and severity droughts could increase stress on these areas and increase the difficulty for councils of meeting community expectations regarding their maintenance.

**Existing
controls**

Parks and gardens

Councils have a number of controls in place aimed at monitoring and maintaining parks and gardens. These are implemented through open space plans and tree management policies. Controls include:

- tree and garden bed mulching to support their maintenance during dry periods;
- watering programs for recently planted trees;
- irrigation of some gardens and park areas; and
- (in some cases) service level agreements with NEW.

Playing fields

Similarly, councils have numerous controls in place aimed at maintaining playing fields and maximising access to them. These are implemented through recreation strategies and water use plans. Relevant controls include:

- planting of drought tolerant grass species;
 - alternative water supplies for irrigating playing fields, such as grey water reuse;
 - irrigation efficiency schemes (e.g. automated, underground);
 - installation of synthetic surfaces for some sports and facilities;
 - sportsgrounds safety inspection programs and policies to restrict access or closure of some grounds during prolonged and/or extreme weather conditions; and
 - use of databases and sporting association networks to enable council to communicate with affected user groups and clubs.
-

Private gardens

NEW and councils operate water education programs to provide information and tools to promote efficient water use including in gardens.

Gaps and deficiencies

Information on alternative water supplies and sustainable water use

Notwithstanding controls outlined above, there still appears to be gaps relating to information available to councils and the broader community on alternative water supplies and sustainable water use. Gaps include:

- information gaps on water resources available for non-potable use;
- absence of a region wide approach to educating and engaging the community on water resource planning and decision making on water use and water use priorities; and
- understanding of how councils and the community values water resources and the services provided by those resources (e.g. for parks and gardens).

Recommended actions for councils

Action 1i

Ensure ongoing viability of priority open spaces

- i. Councils should review their open space plans (or other information identifying community requirements in relation to playing fields and open space), with a view to rationalising and prioritising parks, gardens and playing fields to manage in times of low water availability. Criteria for prioritising parks would need to be developed (e.g. gardens valued highly by the community, utilisation rates, economic benefits) and incorporated into relevant plans.
- ii. Councils, working with NEW, should then investigate medium to long term actions to ensure ongoing viability of priority parks, gardens and playing fields including:
 - recycled water;
 - water capture and storage opportunities such as wetlands, tanks and (underground) water storages;
 - increased efficiency of irrigation;
 - planting strategies to more drought/salt tolerant species;
 - alternative, all weather surfaces.

Councils, working co-operatively with each other and with NEW, should actively pursue funding for priority projects through established Commonwealth and State funding programs.

This action builds on actions in the *Hume Strategy for Sustainable*

Communities - Priority Strategy 2.1, in particular Actions 2.1.1. Part i) could be implemented in the short term, with Part ii) implemented in the medium to long term.

Recommended actions for other organisations

Action I2

Mapping of non-potable water supplies

To increase water availability for watering of parks , gardens, sportsgrounds and other recreation facilities, councils working with the proposed North East Regional Groundwater Monitoring Partnership (see Action C2) could consider mapping potential non potable water supplies and matching them to 'fit for purpose' uses.

The action could be implemented in the short to medium term.²²

Action I3

Valuing water - community information and education program

NEW should consider strengthening its water education and information initiatives by developing a program specifically focussed on understanding how the community values water and water-related services and educating the community on water use efficiency. The program, which could be based on the 'sustainable streets' model and be regionally coordinated with councils, would have two distinct but related objectives:

- i. improving information and achieving consensus on how the community values water and the services it provides (e.g. the level of priority it gives to different water uses), with this information being used to inform future decision making on water restrictions; and
- ii. educating and training local communities to improve their water use efficiency and reduce their water consumption.

This action builds on actions in the *Hume Strategy for Sustainable Communities* - Priority Strategy 2.1 and 2.2, in particular actions 2.1.1 and 2.2.4. It could be implemented in the short term.

6.6.2 Emergency management - bushfires

Subset J

Increase in frequency of code red days (risk 5.07)

Risks

Reduced availability of water for emergency services (esp. bushfire fighting) (risk 5.08)

²² Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

Focus	Impacts of reduced water availability and increased rainfall on emergency planning and management in North East Victoria, considering in particular the potential increase in the frequency of Code Red days and bushfire fighting.
Context	North East Victoria has been impacted by major bushfires in recent years including the Alpine Fire (2002-03) and the Black Saturday bushfires (2009). These fires caused significant destruction of public and private property in the region and had significant short and medium term impacts on local economies. The Black Saturday bushfires also resulted in loss of life. In part response to the Black Saturday bushfires, new fire danger ratings were introduced in Australia in 2009, including the highest rating of 'Code Red'. On declared Code Red days all people living in high risk bushfire areas are advised to leave those the night before or early in the day. Visitors are advised to stay away from high bushfire risk areas. A substantial proportion of the community of North East Victoria live in high bushfire risk areas. A substantial number of businesses are also located in high bushfire risk areas - in particular tourism and agriculture based businesses. Thus even if fires do not break out on declared Code Red days, the mere fact of a day being declared Code Red poses significant challenges for emergency management authorities and councils in terms of managing people and service delivery. Climate change projections for North East Victoria point to an increase in the frequency of extreme fire weather over the coming decades, resulting from an increase in the frequency of extreme temperatures and a reduction in moisture. This projection foreshadows an increase in the frequency of Code Red days. An increase in the frequency of extreme fire weather conditions, combined with the potential for increased frequency or severity of droughts points to the need to ensure that both emergency management plans and water management plans ensure that adequate water resources are available for bushfire fighting in the long term.
Existing controls	Regional and municipal emergency management A comprehensive framework is currently in place for the emergency management in North East Victoria, covering preparation, response and recovery to natural disasters such as bushfires. This framework is consistent with the state wide emergency management framework established through the Emergency Management Act and State Emergency Response Plan: ▪ The Office of the Emergency Services Commissioner is the central policy office for emergency management in Victoria. ▪ Regional emergency response planning committees are in place to

managing emergencies at the regional level.

- Municipal Emergency Management (Planning) Committees (MEMCs - coordinated by councils and including the CFA, SES, Victoria Police representatives) oversee the preparation of Municipal Emergency Management Plans (MEMPlans), which cover the management, prevention, response, recovery and support arrangement for emergencies in each municipality. They also monitor the effects and coordinate appropriate actions during emergencies, such as disseminating warnings and other related information to the community.
- Most MEMCs in the region have established Municipal Fire Management Planning Committees (comprising councils, CFA and DSE), whose role includes:
 - Developing a municipal fire prevention plan and township protection plans;
 - Designating Council Neighbourhood Safer Places (also known as Places of Last Resort);
 - developing protocols for notification of code red days; and
 - co-ordinate provision of water for fire fighting.
- The Victorian Fire Risk Register (VFRR) prioritises localities and assets for protection during wildfires in the region.

Internal council procedures

As well as coordinating MEMCs and MEMPs, councils in the region have in place a number of relevant internal emergency management procedures such as:

- ensuring that appropriate resources (including contracted) are available for use in emergencies and are supported by operational and financial systems;
- designating trained response & recovery staff;
- internal procedures for preparation and response to Code Red days;
- developing Business Continuity Plans which cater for loss of service and absent personnel (some councils only).

Gaps and deficiencies

Emergency management

Existing Municipal Emergency Management Plans and some council business continuity plans do not specifically address the impacts and issues associated with the recent change to fire danger ratings, in particular the introduction of Code Red days, and the potential for an increase in frequency of those days in the future.

For councils, this poses a challenge for service delivery including services

provided by staff and contractors, as well as services dependent on volunteers (e.g. meals on wheels).

For councils and other members of MEMCs the challenge is to ensure that effective procedures are in place to dealing with the consequences of Code Red days (as distinct from bushfires).

Emergency water supplies

Current Municipal Emergency Management Plans and water management strategies (e.g. Northern Region Sustainable Water Strategy) do not consider water availability for emergency response, particularly in the context of long term reduced water availability.

Recommended actions for councils

Action J1

Code Red days and Business Continuity Plans

Councils should extend their Business Continuity Plans to ensure that they can cope with the impacts of Code Red days on staff resources and service provision. Consistent with action J2, councils and agencies should also ensure that their Business Continuity Plans take account of other potential disruptions to business associated with the impacts of climate change and extreme weather events (e.g. floods, bushfires, storms).

This action could be implemented in the short term.²³

Action J2

Code Red day procedures

- i. Councils, working with other members of Municipal Emergency Management Committees (MEMCs - CFA, SES, police) should ensure that they have effective procedures for dealing with the consequences of Code Red days, including procedures for dealing with community members (locals and visitors) relocating to council managed properties on those days. The procedures should be incorporated into relevant plans and strategies (e.g. MEM Plans, Municipal Fire Prevention Plans, township protection plans).
- ii. The procedures should also be summarised in a question and answer (Q&A) template for distribution to all human resources, and OH&S staff. Councils should also ensure that customer service and visitor information staff are educated about the Code Red day procedures and, drawing on the Q&A template, are in a position to provide community members with correct and consistent advice on what to do on Code Red days.

This action could be implemented in the short term.

²³ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

Recommended actions for other organisations

Action J3

Emergency water supplies for bushfire fighting

- i. Municipal Fire Management Planning Committees (MFMPCs) should review fire management plans for municipalities in North East Victoria, and associated components of the Victorian Fire Risk Register, to ensure that availability of suitable water supplies for fire suppression, particularly in periods of low water availability. In doing so, they should consult NECMA to ensure that drought refugees for endangered species are not compromised.
- ii. MFMPCs, working with NEW, should also identify existing or potential new water supply sources that could be quarantined for bushfire fighting during the fire season, where gaps have been identified through part i) of this action. Outcomes from action I2 could be used to inform this action.
- iii. MFMPCs should seek funding through the FARSS²⁴ for construction of new supplies identified in part ii).
- iv. They should also consider lobbying the state government to provide for an increase in the state/local government funding ratio for water-related capital works under the FARSS.

Parts i) and ii) of this could be implemented in the short term. Parts iii) and iv) could be implemented in the medium term.

6.7 Environment

This section provides an overview of existing controls, gaps and deficiencies, and proposed actions for high-priority risks relating to the environment. Priority risk subsets addressed in this section are:

Subset K: Catchment health.

Subset L: Aquatic ecosystems.

6.7.1 Catchment health

Subset K Risks

Loss or change in composition of native vegetation (including instream vegetation) (risk 6.01)

²⁴The Fire Access Road Subsidy Scheme (FARSS) is administered by CFA and is a State Government funded subsidy scheme. Subsidies are available for Municipalities for the construction and maintenance of fire access roads or construction of static water supplies.

Increase in invasive weed species (risk 6.02)

Focus	High conservation value vegetation communities throughout the region, in particular in stream and riparian vegetation
Context	North East Victoria encompasses parts of the Australian Alps, South Eastern Highlands, Northern Inland Slopes and Riverina bioregions and contains significant alpine, grassy woodlands, wet forest and grassland ecosystems. The White Paper <i>Land and Biodiversity at a Time of Climate Change</i> (DSE, 2010) identifies two ‘flagship areas’ in the region for maintaining ecosystem services: the Victorian Alps flagship area and the Mega Murray flagship area. The White Paper and other relevant strategies (e.g. <i>North East Regional Catchment Strategy</i> (NECNA, 2004) and sub-regional Biodiversity Action Plans) all point to significant existing threats to the region’s biodiversity and ecosystems associated with population growth and resulting urban development, land clearing, fragmentation and pests and weeds. Climate changes, including increased average and extreme temperatures and water stress associated with increased rainfall variability and more persistent and severe droughts, could add to these threats. Shared management responsibilities between DSE, NECMA, Parks Victoria, councils and private landholders complicate potential approaches to protecting ecosystems, with councils having direct responsibility for protection of communities only on roadside verges and through land use planning strategies and processes.
Existing controls	Legislative and planning frameworks A cascading suite of legislation, strategies and plans, designed to protect biodiversity and ecosystems, are currently in place at the state, regional and local levels. State government legislation and plans include the following: ▪ The <i>Flora and Fauna Guarantee Act 1988</i> is the key piece of Victorian legislation for the conservation of threatened species and communities and for the control of potentially threatening processes. ▪ <i>Victoria’s Biodiversity Strategy</i>, which fulfils commitments in the <i>National Strategy for the Conservation of Biodiversity</i> and requirements under the <i>Flora and Fauna Guarantee Act 1988</i>. ▪ <i>Native Vegetation Management: A Framework for Action</i> is the State Government’s strategy to protect, enhance and revegetate Victoria’s native vegetation. It seeks to achieve a reversal of the long-term decline in the extent and quality of native vegetation, leading

ultimately to a net gain.

- The *Rural Land-Use Planning Program*, which is a State Government initiative that assists councils to resource work on planning schemes to improve the protection of rural land.

Regional and local plans and strategies include:

- The *North East Regional Catchment Strategy* (NECMA), which sets out a strategy to balance environmental, social and economic objectives across the catchment, including in relation to biodiversity protection.
- Local planning schemes, which establish conservation zones in respective LGAs and set requirements for the protection of native vegetation in relation to developments.

Land management

Regional and local management and restoration programs are implemented to give effect to the objective set out in the plans and strategies outlined above. These include:

- Various sub-regional Biodiversity Action Plans (DSE and NECMA), which translate Victoria's Biodiversity Strategy to the regional scale by directing on-ground works by private landholders and government for the conservation of biodiversity, as well as incentives, education and training.
- 'River Tender' which provides financial assistance to landholders for works that maintain the health of riparian areas.
- The *Land Protection Incentive Scheme*, which is coordinated between the Rural City of Wangaratta and the Trust for Nature. The scheme's objective is the voluntary protection of remnant vegetation on private land through the Trust for Native Conservation Covenant Program.
- Weed eradication programs by councils, DSE and NECMA.
- Roadside vegetation protection initiatives by councils.
- Landcare education and works initiatives including weed eradication.

Monitoring

Monitoring and evaluation of outcomes of the North East Regional Catchment Strategy (RCS) and of Native Vegetation Management: A Framework for Action is undertaken respectively by NECMA and DSE. The North East Regional Catchment Strategy Monitoring, Evaluation, Reporting and Improvement Framework (MERIF) is an integral component of the RCS and includes monitoring of catchment condition.

Gaps and deficiencies

Native vegetation and biodiversity decline

Notwithstanding the strategies, plans and programs outlined above, the region is still experiencing a decline in the extent and quality of vegetation, exacerbating fragmentation and habitat decline. This trend has been confirmed in the report *Native Vegetation Net Gain Accounting* (DSE, 2010) a 'first approximation' report on progress with the net gain objective of Native Vegetation Management: A Framework for Action. A major concern is that the trend could be exacerbated in the long term under climate change scenarios in the absence of new initiatives.

The trend indicates that existing programs are having only limited success in meeting their objectives and can, at least in part, be attributed to:

- a lack of financial incentives/economic drivers on private and public land for the protection of native vegetation; and
- inadequate enforcement of planning provisions relating to the protection of native vegetation on private land.

Information on climate change and catchment health

There is a gap in ongoing information on catchment health and the implications of climate change (in particular increased rainfall variability and reduced water availability) for catchment health in the context of other drivers and trends.

Recommended actions for councils

Action K1

Integrating councils into planning and management of biodiversity protection

Councils, working with DSE and NECMA, should work collaboratively to ensure implementation of planning and management actions in the Hume Strategy aimed at protection of biodiversity including:

- development of a Regional Biodiversity Plan to guide local government and local biodiversity plans and strategies (Action 3.1.3); and
- improved planning outcomes for biodiversity protection through the Rural Land Planning Program (Action 3.2.1).

This action builds on actions in the Hume Strategy - Priority Strategies 3.1 and 3.2, in particular 3.1.3 and 3.2.1. It could be implemented in the short to medium term.²⁵

Recommended actions for other organisations

²⁵ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

Action K2	Monitoring changes to high conservation value vegetation communities DSE, working with NECMA and councils should establish a co-ordinated long term, region wide program aimed at monitoring changes over time to high conservation value vegetation communities and ecosystems in the region identified as being particularly vulnerable to climate change and other risk factors including in stream and riparian vegetation communities. This action could be implemented in the medium term.
Action K3	Conservation programs targeting high conservation value vegetation communities and ecosystems threatened by climate change Drawing on information gathered through action K2, DSE, NECMA and councils should: - enhance education and engagement programs with local communities, highlighting the increasing importance of wildlife corridors / 'refugia' for the long term viability of regionally significant ecological communities and the implications of land use decisions; and - actively target conservation incentive and conservation works programs to high conservation value locations. This action builds on actions in the Hume Strategy - Priority Strategy 3.4, in particular 3.2.4, 3.2.5, 3.4.1 and 3.4.3. It could be implemented in the medium term.

6.7.2 Aquatic ecosystems

Subset L Risks	Decreased water reliability in unregulated systems (standing water bodies, wetlands and waterways) (risk 6.03) Decreased water reliability in regulated systems (standing water bodies and wetlands) (risk 6.04) Increased frequency of poor water quality (risk 6.06) Reduction in shallow groundwater recharge (risk 6.07)
Focus	Reduced flow and water quality in the waterways, wetlands and groundwater of North East Victoria and associated impacts on high conservation value freshwater aquatic ecosystems
Context	North East Victoria contains numerous high conservation value, heritage

listed waterways. These support important native fish populations, such as Trout Cod and Mountain Galaxias, as well as significant riparian vegetation communities. There are also eight nationally important wetlands in North East Victoria, as well as significant areas of the state's most depleted wetland habitats and some of the least represented categories in Victoria's network of protected wetlands. Groundwater resources in the region support summer surface water flows and groundwater dependent ecosystems including wetlands and floodplain vegetation communities. The Victorian North East region is home to almost 2,000 wetlands that cover approximately 40,000 hectares.

Available climate change projections and modelling for the region (e.g. CSIRO, 2008) suggest that climate change will reduce the environment's share of water by more than that of consumptive water users. This will add to stresses on the region's waterways and aquatic ecosystems associated with existing water allocations.

Existing controls

Planning frameworks

The water supply and water quality planning frameworks discussed in sections 6.2.1, 6.2.2 are relevant to this section. In particular, the Murray-Darling Basin Cap and Victoria's water entitlement framework, provide for environmental water entitlements, with a share of the available water resource in the region being set aside to meet Environmental Water Resource (EWR) objective. This objective and associated priorities have been defined through a number of regional environmental flow studies commissioned by NECMA.

A number of the plans and strategies discussed in section 6.7.1 in relation to protection of native vegetation also apply to protection of waterways, including in particular:

- Victoria's Biodiversity Strategy; and
- The North East Regional Catchment Strategy.

Additional state and regional strategies provide a specific focus on waterways and wetlands:

- the *Victorian River Health Strategy* is a 2002 strategy setting out the state's long-term direction for the management of Victoria's rivers, providing a framework for regional communities to make decisions on river protection, restoration and use²⁶;
- the *North East Regional River Health Strategy* has been prepared to provide strategic direction for the future management of waterways in the NECMA area, seeking to balance environmental, economic

²⁶ Note, the Victorian Strategy for Healthy Rivers, Estuaries and Wetlands (VSHREW) was under development through 2009-10 to update the Victorian River Health Strategy, but with a change of government in late 2010 it is currently on hold.

and social needs; and

- the *North East Regional Wetland Management Strategy*, also administered by NECMA, provides management guidelines and recommendations for wetlands in the region including in relation to management funding and filling knowledge and data gaps.

Waterways management

Management of catchments, waterways and wetlands in the region is primarily the responsibility of NECMA, but other agencies including G-MW, DSE, Parks Victoria and councils also have an important role in their management and protection.

As noted above, the North East Regional River Health Strategy and the North East Regional Wetland Management Strategy provide the major frameworks for management of rivers and wetlands in the region.

Works programs initiated through the strategies include:

- a waterway rehabilitation works program to re-establish indigenous vegetation and improve in-stream habitat, water quality and stream bed and bank stability; and
- River Tender, which is an auction style incentive program for landholders to undertake works to maintain the health of important floodplain and riparian areas.

Gaps and deficiencies

Planning and management frameworks

The Northern Region Sustainable Water Strategy provides a broadly sound basis for water allocation decision vis-à-vis environmental water entitlements versus allocations for consumptive uses.

However, there is the potential for some 'fine-tuning' of related plans and programs (location and timing) to maximise the benefits of environmental water allocations, especially in the context of climate change projections (i.e. reduced average run-off and stream flows and increased frequency and severity of droughts).

There is also a general view among stakeholders that planning controls, as established in local planning schemes, do not adequately consider impacts of developments on hydrology and the EWR objective.

There is also a gap between agency objectives for catchment and waterways protection on the one hand and private land holder responsibilities on the other. This issues is ongoing and not unique to the North East region and will ultimately require better alignment of private and public incentives for waterways protection (e.g. through strengthening landholder incentives programs).

Understanding the impacts of climate change on aquatic ecosystems

There is also a need to improve understanding of the potential impacts of climate change on aquatic ecosystems in North East Victoria.

Recommended actions for councils

Action L1

Reducing erosion in waterways and improving water quality

Councils should analyse existing urban stormwater catchments, identifying areas in need of stormwater redevelopment, so as to achieve flow reductions for the purposes of controlling erosion in receiving waterways and reducing urban flood risks.

Councils should also be more proactive in monitoring the effectiveness of stormwater assets for water quality treatment and rates of retention.

This is likely to be a short to medium term action.²⁷

Recommended actions for other organisations

Action L2

Optimising environmental outcomes from water allocation decisions

- i. DSE, NECMA, G-MW, councils and Parks Victoria should consider establishing an inter-agency working group to investigate means of optimising environmental, economic and social outcomes from decisions on water use for the environment by:

- identifying gaps in information and understanding of the environmental, social and economic objectives of water allocation;
- seeking to align objectives as far as possible;
- looking for opportunities to improve environmental outcomes (while not adversely impacting on social and economic objectives) through, for example, timing and location of releases.

An established regional group, such as Dry Inflow Contingency Interagency Working Group, could be a suitable forum for the proposed working group.

- ii. To enable implementation of part i), the inter-agency working group should ensure that suitable indicators of aquatic ecosystem health are in place to enable the impacts of water availability and water allocations to the environment to be tracked over time and to help

²⁷ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

guide future regional decisions on environmental water allocations.

- iii. The inter-agency working group should also consider establishing a long term, co-ordinated, aquatic ecosystems monitoring program, targeting ecosystems and species potentially sensitive to climate change. Information gathered through the program would initially be used to establish baseline condition data on aquatic ecosystem health.

This action builds on actions in the Hume Strategy - Priority Strategies 2.1, 3.1 and 3.2. It could be implemented in the short term.

6.8 Climate change response

This section provides an overview of existing controls, gaps and deficiencies, and proposed actions for high-priority risks relating to council and agency planning and service delivery. Priority risk subsets addressed in this section are:

Subset M: Climate change planning & coordination.

Subset N: Carbon pricing.

6.8.1 Climate change policy & coordination

Subset M Risks	Inconsistent or uncoordinated regional responses to climate change adaptation and water planning (2.05) Lack of government funding / support for climate change and water initiatives (2.04)
Focus	Resourcing and coordination of council and agency responses to climate change across the region, including in relation to water.
Context	Councils and agencies in north east Victoria have, between them, implemented a range of policies and programs relevant to climate change. These programs are not necessarily regionally coordinated or consistent though. Approaches to stormwater management, discussed in the previous section, is one such example. The Northern Region Sustainable Water Strategy (NRSWS - see sections 2.3.2 and 6.2.1), provides the framework for coordinated, long term response to water management across the region. Notwithstanding the NRSWS however, the way in which climate change is addressed in water planning can still be inconsistent across the region. Assumptions and approaches to groundwater modelling is one example of this.

Lack of resources for climate change response can exacerbate this situation. On the other hand, a more coordinated response to climate change and related issues can help, it least in part, to alleviate resource constraints.

Existing controls

Climate change adaptation planning

The *Hume Strategy for Sustainable Communities*, discussed in section 2.3.2, sets out high level, strategic directions for addressing climate change at the regional level, along with other issues linked to long term sustainability of the region. The Regional Management Forum (RMF) provides an avenue through which the leadership group within councils can drive coordinated action on these strategic directions.

The North East Greenhouse Alliance (NEGHA), through which this project is being implemented, provides a regional forum for councils to address climate change issues, albeit on a project by project basis.

Water planning

As noted above, the NRSWS provides the framework for a coordinated, long term response to water management across the region. A range of regional water committees, discussed in sections 6.2.1 and 6.2.2, provide opportunities for regional information sharing on water supply planning and management and water quality.

Gaps and deficiencies

Regional coordination of climate change adaptation planning

Notwithstanding development of the Hume Strategy, there is a prevailing view within councils and agencies of the need to improve coordination and collective responsibility on climate change at the regional level, including on climate change adaptation planning. This coordination will need to be driven at the leadership level of councils and agencies.

Lack of regional coordination adds to uncertainties within regional communities about climate change response.

Recommended actions for councils

Action M1

Coordinated regional approach to climate change adaptation planning (1)

The Regional Management Forum (RMF) should work towards a coordinated regional approach to climate change adaptation planning, by agreeing to priority actions for implementation from this plan and relevant actions in the Hume Strategy.

A technical reference group could be established by the Regional Management Forum (RMF) to oversee prioritisation, implementation and evaluation of the priority actions.

Individual councils should also seek to integrate priorities into their Council Plans and other relevant management plans and strategies.

This action is consistent with actions in the Hume Strategy - Priority Strategies 1.1 and 1.5, in particular Actions 1.1.1 and 1.5.4. It could be implemented in the short term.²⁸

Action M2

Coordinated regional community education program on climate change adaptation

Councils, in collaboration with other agencies, should consider developing a coordinated regional community education program to ensure that the community is properly informed and does not misinterpret, understate or over state, the risks of climate change to the region. The program could include information on:

- the science of climate change and climate change projections for the region;
- potential regional impacts of climate change;
- associated risks to organisations and the community;
- the concept of climate change adaptation; and
- responses developed and agreed to by councils and agencies.

Various options should be explored for disseminating the information including the online Clearing House recommended in Action 1.2.6 of the Hume Strategy.

This action is consistent with actions in the Hume Strategy - Priority Strategy 1.2. It could be implemented in the short to medium term.

Recommended actions for other organisations

Action M3

Coordinated regional approach to climate change adaptation planning (2)

NEGHA partner organisations (DSE, NEW, G-MW and CMA) should seek to encourage a coordinated regional approach to climate change adaptation planning by working with the RMF to prioritise and implement actions from this plan and relevant actions in other strategies such as the Hume Strategy.

Agreement on priorities could be made through a Memorandum of Understanding (MoU) between agencies and the RMF. Agencies should then seek to integrate those priorities into relevant management plans and strategies.

The Regional Management Forum (RMF) should lobby the state

²⁸ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

government to ensure sufficient resources are allocated to the implementation of priority actions from this plan and the Hume Strategy.

This action is consistent with actions in the Hume Strategy - Priority Strategies 1.1 and 1.5, in particular Actions 1.1.1 and 1.5.4. It could feasibly be implemented in the short term.

6.8.2 Carbon pricing

Subset N Risks

Introduction of CPRS or other carbon pricing instrument (2.02)

Focus

Energy costs associated with service delivery by councils (e.g. operating costs for street lighting, buildings and other facilities, vehicle fleet) and agencies (e.g. water and waste water pumping costs). Impacts of increased energy costs on key regional industries (e.g. tourism).

Context

Although energy costs account for a relatively small proportion of council and agency costs, a significant increase in energy prices (e.g. due to a carbon tax, emissions trading scheme or other carbon pricing initiative), could have a significant budgetary impact long term. In principle, councils could pass these costs onto ratepayers. Similarly, economic regulatory rules administered by the ESC, would allow agencies to pass through costs to customers as taxes are classed as non-controllable costs. Nevertheless, the capacity of councils and agencies to pass on costs could be constrained by social and political factors.

A carbon tax, emissions trading scheme or other carbon pricing initiative could also have regional economic implications long term through flow-on effects to key regional industries.

Existing controls

Greenhouse gas emission assessment and reduction strategies

Most NEGHA member councils were members of the Cities for Climate Protection (CCP) program through the 2000s. Under the program, member councilseach undertook a baseline assessment of their Greenhouse Gas (GHG) emissions and initiated energy savings and emission reduction initiatives through a greenhouse action plan. A few councils have continued emission reduction plan and initiatives beyond CCP, which has now wound up.

The Hume Strategy establishes a framework for the reduction of greenhouse gas emissions at the regional level including recommendations to establish emission targets and develop a Regional Carbon Management Plan (Actions 1.1.3 and 1.1.8).

Gaps and deficiencies

Energy efficiency and greenhouse gas emission reduction programs

Other than the high level response established in the Hume Strategy, in the absence of CCP there is not now a regionally consistent or a coordinated approach to targeting energy efficiency and emission reductions across the region. Lack of such a program can in part be attributed to insufficient resources (within councils and agencies) for developing and implementing relevant programs, but could also reflect an absence of clear lines of responsibility for implementing energy efficiency and other emission reduction measures in councils.

Assessing and monitoring impacts of carbon pricing

At present, there is not a clear understanding of how carbon pricing will impact the region, either at the individual LGA and agency level or at economy-wide.

Recommended actions for councils

Action N1

Revised and updated greenhouse action plans

Councils should ensure that they have current and up to date greenhouse action plans that build on energy efficiency and other emission reduction programs previously implemented through initiatives such as Cities for Climate Protection (CCP). Revised action plans targeting council facilities and services could include:

- emission reduction targets;
- audits of energy consumption in facilities and other assets;
- energy efficiency measures for identified high priority assets;
- carbon offset programs at either the LGA or regional level (see Action H2);
- an accurate and consistent approach to benchmarking energy consumption and emissions to ensure accurate monitoring and assessment of energy and emission reductions pursued through energy efficiency measures; and
- guidelines and design specifications for new (or upgraded) infrastructure to ensure high levels of thermal comfort and energy efficiency.

This action is consistent with actions in the Hume Strategy - Priority Strategies 1.1 and 4.2, in particular Action 1.1.8. It could feasibly be implemented in the short term.²⁹

²⁹ Indicative timeframes in the Adaptation Plan are: short term, 1-2 years; medium term, 2-5 years; long term > 5 years.

Recommended actions for other organisations

Action N2

Understanding the impacts of carbon pricing

Once a detailed carbon price framework has been established by the Australian Government (carbon tax and/or emissions trading scheme), NEGHA member and partner organisations should consider initiating a joint study into the impacts of carbon pricing on the north east region. The study would assess:

- the impacts of a carbon price on member councils and agencies and their ability to meet their service obligations, in particular for water and waste water services;
- the impacts of a carbon price on key regional industries, especially energy and/or water dependent industries; and
- coordinated region wide measures to reduce these impacts.

This is a short to medium term action dependent on outputs from Australian government processes.

7 Review and Next Steps

7.1 Review of risk assessment and adaptation plan

7.1.1 Risk assessment results

Climate change and related drivers pose many challenges for NEGHA member and partner organisations. The risk assessment undertaken for this project identified almost 60 direct and indirect risks associated with reduced water availability and increased rainfall variability. Approximately half of those risks have been rated 'High' or 'Extreme' by multiple councils and/or partner organisations. As such, they have been identified as 'priority risks' for the purpose of adaptation planning by councils and agencies. Of the 29 priority risks:

- Five risks arise from the direct impacts of climate change on water supply and quality for consumptive purposes, with a further six arise from the direct impacts of climate change on water supply and quality for the environment;
- five of the risks are direct risks to infrastructure and other community assets;
- six of the risks are indirect risks associated with the economic and social 'flow on' effects of reduced water availability and increased rainfall variability; and
- seven of the risks relate to government and community responses to climate change.

As previously noted, the split of risks between these categories is instructive, since the different categories of risk will tend to require different adaptation responses.

7.1.2 Adaptation plan actions

Treatment of risks is an essential next step in the risk management process. In climate change parlance, the treatment of risks is generally referred to as 'adaptation'. It is apparent from engaging with staff at workshops and subsequent analysis that councils and agencies already have in place many policies, programs and measures that are relevant to the priority risks. This is unsurprising given that many of the climate change risks to councils and agencies add to or intersect with pre-existing risks. It is equally apparent, from both the risk assessment and adaptation planning processes, that NEGHA member partners and agencies will need to implement additional measures if the risks of reduced water availability and increased rainfall variability are to be effectively addressed.

Section 6 of this report sets out approximately 50 recommended actions for addressing priority risks. When implemented together, the actions will provide the North East region with a strong basis for responding to the challenges of reduced water availability and increase rainfall variability. A majority of actions are directed primarily at NEGHA member councils, either individually or in cooperation with other councils or organisations (Table 14). Most of the remaining recommendations are directed primarily at NEGHA partner organisations, also working in cooperation with councils and other organisations.

Table 14 provides an overview of the different types of actions proposed in the adaptation plan, noting that there is overlap between the different types of action, with some of the actions in the plan having multiple components.

Table 14. Types of Adaptation Actions Proposed in the Plan

Category of action	Actions		
	Councils	Other	Councils & other
Regional institutions and cooperation	A2, B1, M1	-	C2, K1, L2, M3
Statutory planning	A1, C1, F4	A4	-
New or amended strategies and plans	B2, I1, N1	-	-
Improved decision-making processes and procedures	E2, E3, F2, F5, J1	-	J2, J3, L2
Research and data collection	D2, E1, G3, I2, L1	B3, K2	E6, F3, H3, N2
Education and training	E4, E5, F4, G1, G2, H1	A3, C3, F6, I3, K3	M2
'On the ground' management and works	L1, N1	K3	D3, G4, I1, N2
Risk diversification	F1	-	-
Number of actions	28	9	16

Information in the table reveals the wide spectrum of action types on the one hand, but also the substantial numbers of actions in the 'research and data collection' and 'education and training' categories. While these types of action might be perceived as being not particularly relevant to climate change adaptation, research and monitoring and education and training are in fact crucial to enhancing the capacity of councils, other organisations and the broader community to respond effectively to the risks posed by climate change (see Box 2).

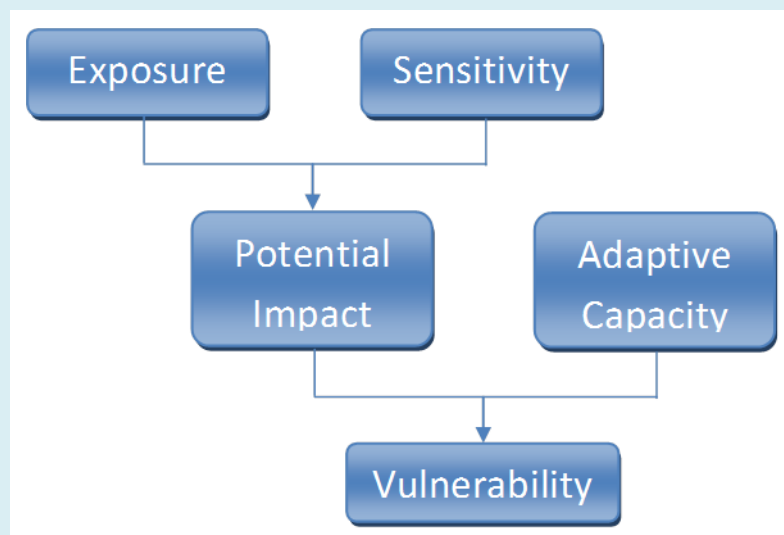
Another way of categorising adaptation actions in the plan is to consider them in terms of incremental or, alternatively, transformative actions. Incremental actions tend to be short term incremental adjustments, responding to risks that are reasonably certain. Most of the adaptation actions in this plan fall into this category. They build on existing controls and won't entail a fundamental change to the ways councils and agencies are already addressing established and related risks (such as risks associated with natural climate variability and/or other stressors such as population growth). As discussed in Box 3 however, some key risks may require a fundamental rethink by councils and agencies if they are to be effectively addressed in the long term – a transformative approach. A few of the actions in the plan can be regarded as the initial, tentative steps in that transformative adaptation.

Ongoing resource and administrative constraints and other regional priorities mean that it will not be feasible to implement all actions in adaptation plan concurrently. It will therefore be necessary to prioritise adaptation actions, a point discussed in the following section.

Box 3: Building Adaptive Capacity

Numerous research & data collection and education & training collection actions are identified in the adaptation plan, highlighting the need for building adaptive capacity on climate change, within councils and agencies and across the broader community. Adaptive capacity is linked to the concept of climate change vulnerability, as illustrated in Figure 7 below. **Vulnerability** refers to the effects of climate change on a community or system after allowing for the potential impacts of climate change and adaptive capacity of the community or system (with potential impact being closely linked to the concept of risk, as discussed in this report). Whether or not a potential impact will cause major or lasting damage or harm to a community, system or organisation will depend on its adaptive capacity. The **adaptive capacity** of a community, system or organisation describes its ability to modify or change its characteristics or behaviour to cope better with actual or anticipated impacts and risks of climate change. Improved data and other information or improved knowledge (through education and training) can build the capacity of the community to implement and effectively target adaptation actions.

Figure 7: Climate Change Vulnerability and Adaptive Capacity



Source: Adapted from Schroter, 2004

Listed below are some of the actions in the Adaptation Plan, containing education & training or research & data collection elements, that will be particularly useful in helping to build the capacity of institutions and the community to respond to climate change:

- Community information strategy on regional water allocation decision making (Action A3)
- A North East Regional Groundwater Monitoring Partnership (Action C2)
- Groundwater resource education program (Action C3)
- Training and information program for councils on the implications of climate change for planning, economic development and decision making (Action G1)
- Understanding how the community values water and water-related services (Action I3)
- Monitoring changes over time to high value ecosystems (Action K2)

Box 4: Incremental v transformative adaptation

A useful way of categorising adaptation actions in this plan is to consider them in terms of incremental or, alternatively, transformative actions. Incremental adaptation tends to involve incremental adjustments to risks that are reasonably certain and have short decision lifetimes relative to the rate of climate change (e.g. up to about 2030). Most of the adaptation actions in the plan fall into that category. They build on existing controls and do not entail a fundamental change to the way councils and agencies are addressing established risks (i.e. risks associated with natural climate variability and/or non-climate stressors such as population growth). Actions relating to improved water efficiency and water planning, for example, fall into this category.

Some of the priority risks identified in this plan though, relate to longer term changes, having the potential to cross major thresholds, leading to the collapse or fundamental realignment of social or ecological systems. These changes may require a fundamental rethink by councils and agencies if they are to be effectively addressed – known as transformative action or adaptation. (Nelson et al., 2007). Stafford-Smith et al. (2011) argue that the need for transformative adaptation will become increasingly likely as the prospects of a ‘40C world’ increase over time.

As Nelson et al. (2007) note, there is not a clear break-off point between incremental adjustments and transformative action. Rather, the two categories of action tend to fall along a continuum. Arguably though, a number of the actions in the plan can be regarded as the initial steps of a transformative process. The table below list some actions that are identifiably transformative in nature. When prioritising actions, councils and agencies should consider applying a different assessment process to consideration of these actions, compared to their consideration of incremental actions.

Table 15. Actions in the Plan Having Transformative Potential

Actions having transformative potential	Potential transformation
Water supply Ensure that planning schemes contain provisions relating to water demand and supply (Action A1 – part) Integrate councils into groundwater planning (Action C1 – part)	Consideration of water supply and demand balance influences development approvals
Stormwater and flood management Revise Flood Overlays, Floodplain Management Plans and Planning Schemes to account for intense rainfall projections (Actions F3, F4)	Revised decision pathway(s) for flood risk management
Stormwater and flood management Clarify definitions of natural disasters and eligibility to take account of the changing climate (Action F1 – part)	Changed understanding of what constitutes a natural disaster
Economic development Implement regional training and information sharing program to increase understanding of climate change for future planning, economic development and decision making (Action G1)	Strategic (economic and social) planning influenced by climate change considerations
Environment Improve decision-making on water allocations & management (Action L2 – part)	Environmental water allocations influences development approvals processes
Carbon pricing Region wide measures to reduce impacts of carbon pricing (Action N2 – part)	Coordinated, regional approach to managing carbon

7.2 Next steps

7.2.1 Risk assessment

It is important that risks are reviewed on a regular basis. This will ensure that the description and ratings of risks remains consistent with current information and perspectives, and that the Adaptation Plan addresses the risks of greatest importance to the region.

At an individual council and agency level, it is important that risk assessment outputs are integrated with other aspects of their strategic risk assessment and planning processes.

As previously noted, the adaptation plan addresses 29 'priority risks'. Nevertheless, risks that are not addressed in this adaptation plan should not be ignored. NEGHA and its member councils should maintain a 'watching brief' on non-priority risks as a part of the review process mentioned above.

7.2.2 Adaptation plan

Integrated and coordinated implementation of actions

Most actions identified in the Adaptation Plan will require a coordinated approach across councils and agencies to achieve effective implementation. Other actions, directed at councils, will require effective internal coordination. Substantial work is required to ensure that there is indeed a coordinated and integrated response to climate change is implemented across the region and that climate change responses are integrated with other key regional strategies such as the Hume Strategy and the NRSWS.

To that end, Actions M₁ to M₃ provide recommendations on achieving regional coordination of the Adaptation Plan. Those actions should be pursued as the starting point for implementation of the Adaptation Plan. Additionally, the NEGHA members and partnering agencies will need to engage with other stakeholders identified in the plan to encourage their participation and support in implementing the adaptation actions that have been identified.

As well as undertaking direct dialogue with relevant stakeholder agencies in the region, NEGHA and its member councils and partners should be mindful of climate change adaptation priorities identified by federal and state governments. Three documents in particular have particular relevance in this regards:

- **National Climate Change Adaptation Framework.** The Council of Australian Governments (COAG) has developed the framework as part of its Plan of Collaborative Action on Climate Change. The framework outlines the future agenda of collaboration between governments to address climate change impacts. A key focus of the framework is to "... support decision-makers understand and incorporate climate change into policy and operational decisions at all scales and across all vulnerable sectors". Priorities identified in the framework that are of relevance to this Adaptation Plan include: water; biodiversity; natural disaster management and tourism.
- **Securing our natural future: A white paper for land and biodiversity at a time of climate change.** This provides a long-term, strategic framework for land, water and biodiversity protection in Victoria in the face of climate change.

NEGHA should draw on these documents and priorities as a basis for active engagement with the Federal and State governments to provide financial and other support to implement its adaptation actions.

Prioritising adaptation actions

Consistent with the good practice principles of adaptation outlined in section 5.2 of this report, it is important that the process of adapting to climate change is not a resource intensive exercise for NEGHA members and partnering agencies. This is one reason why the actions identified in this report focus as much as possible on regional opportunities for collaboration across councils and agencies. A collaborative approach of this nature will significantly enhance the capacity of individual councils to effectively respond to climate change in a timely manner.

Additionally, many of the proposed actions in this report are intended to build on existing measures. Many others aim to improve understanding of the potential impacts of climate change and potential adaptation responses and designed therefore to prevent pre-emptive actions that lead to 'maladaptation' or 'over adaptation'. This approach is consistent with the concept of 'adaptive management', which is about small-scale, incremental responses, rather than major, resource intensive new programs or investments.

Prioritisation of actions is another aspect of the adaptive management approach. Before implementing recommended measures therefore, it is essential that the measures are prioritised, both within each risk subset and between risk subsets. Action M1 in the plan proposes that the Regional Management Forum (RMF), working through a technical reference group, should agree to priority actions for implementation from this plan.

A technical reference group could be established by the RMF to oversee prioritisation, implementation and evaluation of the priority actions. The process of prioritising actions will necessarily be a qualitative one, requiring judgements to be made by reference group members. In undertaking the prioritisation process however, it is recommended that a range of criteria be developed and applied. Suggested criteria would include:

- ***budgetary implications*** – precedence being given to actions that have relatively low costs;
- ***timing*** – precedence being given to actions that can be implemented in the short to medium terms;
- ***administrative burden*** – precedence being given to actions that are not likely to require substantial additional council and agency resources (e.g. staff);
- ***barriers*** – precedence being given to measures are not likely to face other significant barriers to implementation such as institutional or political constraints;
- ***non-climate benefits*** – precedence being given to measures that are likely to generate benefits beyond addressing the direct impacts of climate change (i.e. 'win-win' outcomes); and
- ***driver of other actions*** – precedence being given to actions that are precursors to or drivers of other actions.

This last criterion is particularly important given that implementation of a number of actions in the Adaptation Plan hinge on effective implementation of other actions. Two examples of actions that are key drivers of other actions are:

1. **Modelling of extreme rainfall intensity**(Action E4), which is crucial to better understanding of risks and adaptation responses in a number of areas including stormwater management, flood management and land use planning.
2. **Establishing a North East Regional Groundwater Monitoring Partnership** (Action C2), which could be important to improving information on groundwater resources as well as developing regional responses on bushfire management and management of open spaces.

In some instances, recommended measures may meet most of the above criteria except the first listed. In those instances, NEGHA should consider undertaking more detailed analysis of the measures, using cost benefit analysis or cost effectiveness for example.

7.2.3 Looking for opportunities

The focus of the adaptation plan is on addressing risks of climate change. Climate change however, is likely to create opportunities for councils, agencies or for the broader community. Certain opportunities could stem from favourable climate changes while others could stem from international, national and local responses to the impacts of climate change (e.g. improved building design). NEGHA and its member councils and partners should investigate these opportunities and incorporate measures aimed at realising them into their climate change responses.

7.2.4 Reviewing the Adaptation Plan

The regional adaptation plan should be reviewed on a regular basis (e.g. every 5 years). This will mean:

- reviewing implementation of adaptation actions for priority risks, their timeliness and effectiveness;
- reviewing the ratings of all risks including non-priority risks as new information comes to light and upgrading a risk to 'priority' should new information indicate a 'high' or 'extreme' risk rating in the short to medium terms and an 'extreme' rating in the longer term;
- consideration of new climate change risks in the light of new scientific information and changing circumstances in the region;
- revising adaptation actions for priority risks in light of the evaluation outlined in the first point; and
- identifying adaptation actions for new and upgraded priority risks.

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