Australian Capital Territory
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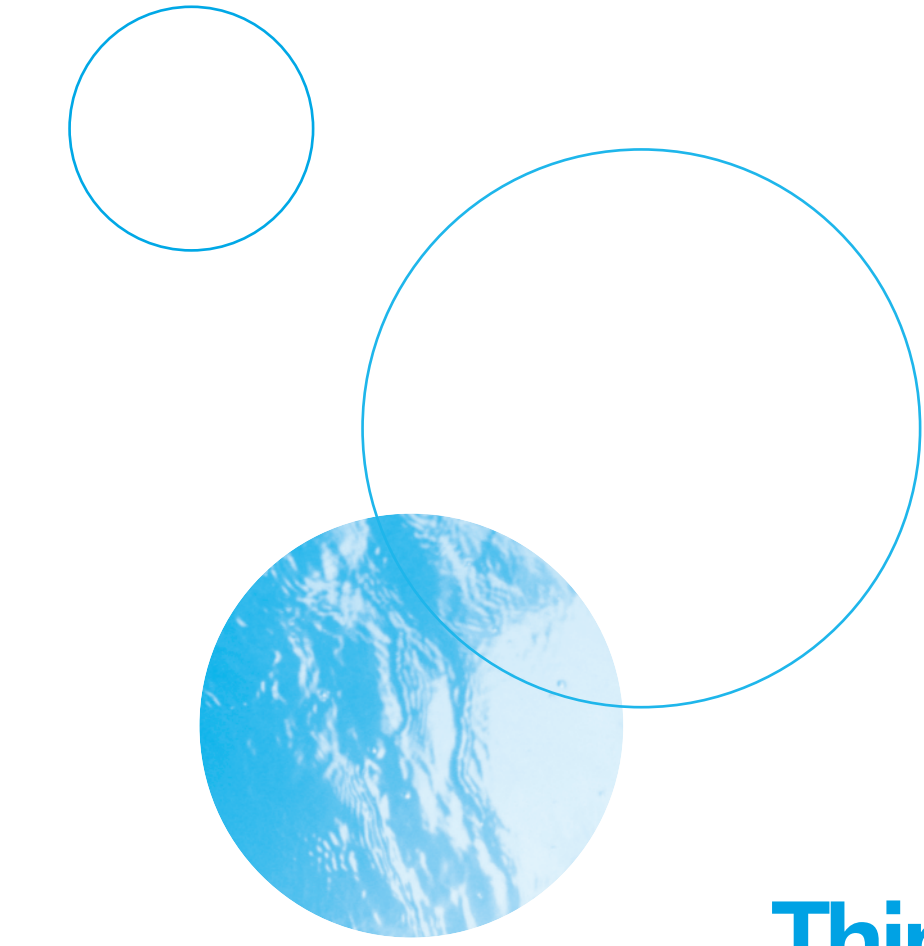

Think water, act water

Volume 2: Explanatory document

April 2004

building **our city**
building **our community**
ACT Government

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1 Navigating the strategy

Volume 1 of '***Think water, act water***—*the strategy*' sets out the strategies and contains an implementation plan of actions needed to manage our water resources in the future.

This document, Volume 2, '***Think water, act water***—*explanatory document*' provides further information and explanation of the strategies and implementation plan.

Volume 3, *'The state of the ACT's water resources and catchments'* describes water sub-catchments in which the ACT has an interest and the flows, allocations and provision for future allocation for sub-catchments.

2 The ACT's water policy framework

2.1 Polices and agreements

2.1.1 International

The United Nations (UN) reports that the world will face a water crisis in a few decades as population growth, pollution and climate change impact water resources.

According to the UN, by 2050 between 2 billion and 7 billion people will be faced with a scarcity of fresh water. There are about 12,000 cubic kilometres of polluted fresh water in the world and, if trends are not slowed or reversed, the total will reach 18,000 cubic kilometres by 2050, nearly nine times the total amount currently used for irrigation.

United Nations Commission on Sustainable Development

Australia is a signatory to the United Nations Commission on Sustainable Development (UNCSD) Framework Convention on Climate Change, Convention on Biological Diversity; Agenda 21, Rio Declaration and Forest Principles.

The Agenda 21 concept was developed to empower local government and communities to implement ecologically sustainable development. UNCSD held its sixth session in New York in April 1998 and made important recommendations on the principles that underpin an effective approach to water resources management. The essence of these principles is that water resources should be developed, used, managed and protected in an integrated manner; management plans as part of Agenda 21 are required; and better information and data is needed.

International treaties

There are a number of international treaties that relate to sustainable management of wetlands and water resources. The most significant is the *Convention on Wetlands of International Importance especially as Waterfowl Habitat* also known as the Ramsar Convention. Ginini Flats Wetlands has been placed on the convention's List of Wetlands of International Importance. The Japan–Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA) provide for cooperation to protect shared migratory birds and their habitats.

2.1.2 National

National Council of Australian Governments Water Reform Framework

In February 1994, the Council of Australian Governments (COAG) agreed to a strategic framework for the efficient and sustainable reform of the Australian water industry. COAG subsequently linked the reform framework to the National Competition Policy Agreement. Water reform is now a central focus of the National Competition Council. The COAG water reforms contained in the National Competition Policy Agreements establish a number of principles in relation to water resource management in Australia, which bind the States and Territories. These principles can be summarised as follows:

- that full-cost pricing regimes without cross-subsidies be adopted
- full disclosure of community service obligations
- adoption of two-part charging arrangements for urban water use
- that publicly-owned utilities aim to earn real rates of return on their assets
- charging on a volumetric basis for metropolitan bulk-water supplies
- investment in new schemes or extensions to existing schemes be undertaken only where it is sustainable
- where trading in water could occur across state borders, pricing and asset valuation arrangements be consistent
- setting aside of funds for future asset refurbishment and/or upgrading of infrastructure
- implementation of water allocations which are separate from land title
- that trading be set up so water is used to maximise its contribution to national income and welfare, within sustainability constraints
- that each jurisdiction develop trading arrangements to facilitate cross-border sales
- that governments develop and adopt integrated catchment management approaches to water resource management
- that consultation processes and public education programs be used to support water reform
- that governments support the National Water Quality Management Strategy
- that governments support the research necessary to progress implementation of the strategic framework.

In 2003, COAG agreed to develop a National Water Initiative (NWI) to refresh and realign the water reform agenda to more fully realise the benefits intended by 1994 COAG water initiatives. While the NWI has not yet been finalised its objectives are clear and include '*encouraging water conservation in our cities, including better use of stormwater and recycled water*'. The ACT has committed support to the NWI and ***Think water, act water*** will allow the ACT to implement this aspect of the NWI and remain at the forefront of urban water management in Australia. The ACT agreed to $5 million over five years to assist in meeting this objective.

National Action Plan for Salinity and Water Quality

The National Action Plan for Salinity and Water Quality was endorsed by COAG in November 2000. The Commonwealth Government is seeking to implement the National Action Plan Inter-Governmental Agreements with each State and Territory setting out the commitment and obligations of jurisdictions. Negotiations are currently underway with the Commonwealth Government about a Bilateral Agreement for delivering of the National Action Plan in the ACT. It is expected that this Agreement will be in place by June 2004.

The goal of the Action Plan is to motivate and enable regional communities to use coordinated and targeted action to:

- prevent, stabilise and start to reverse trends in dryland salinity affecting the sustainability of production, the conservation of biological diversity and the viability of our infrastructure
- improve water quality and secure reliable allocations for human uses, industry and the environment.

National Strategy for Ecologically Sustainable Development

In response to Agenda 21, COAG endorsed a national strategy for ecologically sustainable development (ESD) in December 1992. This strategy sets out principles and objectives for achieving ESD in Australia. It defined ESD as '*using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased*'. ESD is about meeting the needs of people today, while conserving our ecosystems for future generations. ESD requires that we look in an integrated and long-term way at the social, economic and environmental implications of resource use and development decisions.

The Precautionary Principle is part of the National Strategy for Ecologically Sustainable Development and states that, where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

The principles and objectives of this strategy are the basis upon which natural resources are managed in ACT and are enshrined in the *Water Resources Act 1998* and the *Environment Protection Act 1997*.

National Strategy for the Conservation of Australia's Biological Diversity

In 1996, all States and Territories endorsed the national strategy for conservation of Australia's biological diversity. The strategy sets out principles that underpin objectives and actions that are needed to protect Australia's biological heritage. Included in the strategy are actions needed in relation to the impacts of water management on biodiversity.

National Water Quality Management Strategy

Ministerial Councils that preceded the Natural Resource Management Ministerial Council (NRMMC) and the Environment Protection and Heritage Ministerial Council (EPHMC) formally endorsed the National Water Quality Management Strategy (NWQMS) in 1992. It is now widely recognised as the basis for water quality policy development throughout Australia.

In the ACT, the NWQMS provides the basis for water quality standards under the *Environment Protection Act 1997*.

National principles for the provision of water for ecosystems

Predecessor councils to NRMMC and EPHMC jointly developed the national principles for the provision of water for ecosystems in July 1996. These 12 principles help guide jurisdictions in providing water for ecosystems within the broader context of water allocation.

Other policies

A number of subordinate strategies and principles have been agreed across Australian jurisdictions as part of the COAG Water Reforms. They are helping States and Territories with implementation by developing national policies for various water issues. Relevant examples for the ACT are *A National Framework for Improved Groundwater Management in Australia* and *A National Framework for Improved Wastewater Reuse and Stormwater Management in Australia*.

2.1.3 Intergovernmental arrangements

Murray–Darling Basin initiative

Collaborative arrangements between the Commonwealth Government and the New South Wales, Victorian and South Australian Governments for regulating and sharing water within the Murray–Darling Basin have existed since 1914 when the first *River Murray Waters Agreement* was signed. In 1988 the partnership, which has become known as the *Murray–Darling Basin Initiative*, was expanded to cover the whole of the Murray–Darling Basin and the issues of water quality and environmental management were addressed. Queensland joined the Initiative in 1996 and the ACT joined in 1998.

The Murray–Darling Basin Ministerial Council (MDBMC) determines major policy issues of common interest to the partner governments concerning the sustainable use of the water, land and other natural resources of the Murray–Darling Basin. The MDBMC has endorsed a number of important strategies, including those for salinity and drainage, fish management, algal management, floodplain wetlands, communication, facilitation of interstate trade and caps on diversions.

Water trading

One of the objectives of the 1994 COAG Water Reforms was development of a water trading market. Trade in permanent water rights is well established within particular states but operates only in a limited manner between states. Most trading is also limited to within particular reaches of the river system. Interstate temporary trade also occurs on a wider scale.

The Murray–Darling Basin Commission began a pilot interstate water-trading project in the Mallee Region of New South Wales, Victoria and South Australia in 1998. The varying forms of water property rights have hindered the expansion of permanent trading rights over water in each state and resulted in disagreements between states about management of traded water.

The *Water Resources Act 1998* makes provision for trade both within the ACT and with other jurisdictions. But interstate trading would need the agreement of all jurisdictions on the terms and conditions of trade.

Cap on water diversions

Caps on diversions for New South Wales, Victoria and South Australia have been in place since 1997 and were based on rapidly growing water use, which had already exceeded safe levels in their streams by 1994. As a result, the Murray–Darling Basin Ministerial Council decided to set a cap on water diversions at the level of development in 1994 so further deterioration would not occur. The ACT Government has made a commitment to participate in the cap and is currently investigating what it might be.

The Queensland Government has also not finalised its cap on water diversions.

2.1.4 ACT policies

ACT Nature Conservation Strategy

The ACT's water resources must be managed in a way that is sympathetic to the goal of the *ACT Nature Conservation Strategy*, which is to protect biological diversity and maintain ecological processes and systems.

The *Nature Conservation Act 1980* requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration of a threatened species or ecological community.

An Action Plan outlines conservation and protection proposals for the species or community concerned. The primary objective is to maintain long-term, viable, wild populations of each species (or elements of the ecological community) as components of the indigenous biological resources of the ACT. Action Plans

have been finalised for the following aquatic species: Macquarie Perch, Murray River Crayfish, Northern Corroboree Frog, Silver Perch, Trout Cod, and Two-spined Blackfish.

Integrated catchment management

Integrated Catchment Management (ICM) can be defined as *'the coordinated and sustainable management of land, water, vegetation and other natural resources, on a water catchment basis, to balance resource use and conservation'*.

An *Integrated Catchment Management Framework for the ACT* is a statement of the ACT Government's commitment to ICM. It is reflected in sub-catchment plans, which are prepared in consultation with the community, take a holistic view, and seek to draw together statutory and policy responsibilities.

This approach has been embraced in planning the management of water resources in the ACT. Adoption of a catchment approach facilitates achievement of a balance between water use and conservation. Water allocation is managed at a sub-catchment level and will take into account the various factors that contribute to catchment processes.

Environment protection policies

Environment Protection Policies (EPP) are designed to help people understand and apply the *Environment Protection Act 1997* and the *Environment Protection Regulations 1997*. There are general offences in the Act that carry substantial penalties. Environment Protection Policies provide guidance on meeting these legislative requirements.

The Water Pollution Environment Protection Policy offers practical advice to people at home and in business on how their actions can affect water quality in the ACT and the need to adopt the general environmental duty, as specified in the Act to minimise environmental harm. The Water Pollution EPP also explains the strategy and procedures the Environment Protection Authority will use to protect and enhance water quality and quantity within the ACT.

The ACT Wastewater Reuse for Irrigation EPP sets out health and planning requirements for use of reclaimed water to help developers and operators of reuse systems with these requirements. In addition, this EPP explains the levels of environment protection and general performance the Environment Protection Authority will use to determine if users of reclaimed water have adopted their general environmental duty.

2.2 Legislation

There is a range of federal and ACT legislation relating to managing water resources in the ACT along with a number of statutory instruments prepared under this legislation. The relevance of the various pieces of legislation and instruments to water resources is set out below.

2.2.1 Federal

The ***Seat of Government Acceptance Act 1909*** gives the Commonwealth Government the land (and water) of the Australian Capital Territory as well as the paramount right to the use and control of the New South Wales' waters of the Queanbeyan and Molonglo Rivers and their tributaries for all purposes of the Territory.

The ***Canberra Water Supply (Googong Dam) Act 1974*** enabled the Commonwealth Government to exercise its 'paramount right' to the waters of the Queanbeyan River for the purposes of the ACT, through construction of Googong Dam, and for the Territory to manage the waters of the Googong Dam area for use in the ACT on the government's behalf.

The ***Australian Capital Territory (Self-Government) Act 1988*** gives the Territory Executive responsibility for water resources in the Territory.

The ***Australian Capital Territory (Planning and Land Management) Act 1988*** provides for preparation of the National Capital Plan, and declaration of declared national land (which includes Lake Burley Griffin and a small section of the Molonglo River).

The ***National Capital Plan***. Under the Constitutional provision, the Commonwealth Government remains the owner of land in the Territory, even after the granting of self-government. *The Planning and Land Management Act 1988* provides that land used by or on behalf of the Commonwealth may be declared National Land, and managed by the Commonwealth. The remaining lands of the Territory are Territory Land. These lands are managed by the ACT Government on behalf of the Commonwealth.

The *Planning and Land Management Act* requires development of the National Capital Plan, which controls the use and development of Designated and National Land within the ACT and provides overall direction for management of other land.

The Act also requires that the ACT prepare a Territory Plan, which is consistent with the National Capital Plan.

The ***Lakes Ordinance 1976*** enables the National Capital Authority to control and license taking water from Lake Burley Griffin.

The ***Commonwealth Environment Protection and Biodiversity Conservation Act 1999*** provides that Commonwealth approval must be gained for any action that may have a significant impact on a matter of national environmental significance, including nationally-listed threatened species (flora and fauna), listed migratory species and Ramsar wetlands.

2.2.2 Territory

The ***Land (Planning and Environment) Act 1991*** provides for preparation of the Territory Plan that identifies water use and catchment policies, consistent with the requirements of the National Capital Plan.

The ***Territory Plan*** sets out the principles and policies that guide development of the ACT. Amongst the goals of the Territory Plan are:

- to conserve and enhance valued features of the Territory's natural environment
- to promote ecologically sustainable development, protect biodiversity, and provide for high standards of environmental amenity and landscape.

The Water Use and Catchment Policies of the Territory Plan recognise the competing and often conflicting demands made on the Territory's water resources. They protect the waters and catchments of the ACT by specifying permitted uses and environmental values for each water body. They have been divided into three types of Water Use Catchments according to the predominant water use or environmental value within that catchment. These are:

- conservation of aquatic habitat
- provision of domestic water supply
- provision of drainage and open space.

Specific objectives are set for each category of use, along with a number of policies that are designed to facilitate meeting those objectives.

Secondary uses are also permitted for individual waterways, as long as they do not compromise maintenance of the standards required to meet primary environmental value.

Protection and conservation of the water quality of the groundwater resources of the ACT is a policy objective for all types of Water Use Catchment.

The ***Environment Protection Act 1997*** provides protection for the environment from pollution and other forms of environmental harm, and includes integration of environmental, economic and social considerations in decision-making processes. It sets water quality standards and establishes the Environment Protection Authority.

The objective of the ***Public Health Act 1997*** is protection of the public from public health risks. It provides for the framework to regulate drinking water quality including the ACT Drinking Water Quality Code of Practice 2000. It also includes broad-ranging powers to control unsanitary conditions, which are relevant in the control of reuse of reclaimed water.

The ***Water Resources Act 1998*** provides for management and use of the Territory's water resources in a way that sustains the physical, economic and social well being of the people of the Territory while protecting the ecosystems that depend on those resources.

The ***Environmental Flow Guidelines*** is a statutory instrument under the *Water Resources Act*, which sets the environmental flow requirements for all waterbodies in the ACT, including groundwater.

The ***Water Resources Management Plan*** is a statutory instrument under the *Water Resources Act* that describes Territory water resources, proposed allocations, water allocations for various uses, and action to be taken to manage water resources.

The ***Utilities Act 2000*** establishes a complex regulatory framework of industry participation, pricing, technical standards, regulations, customer service standards and quality of service.

The ***Water and Sewerage Act 2000*** makes provision in relation to supply of plumbing or sanitary drainage services; controls the certification, approval and inspection of water and sewer installations; and provides regulations specifying detailed technical requirements.

3 Water planning variables—detailed information

3.1 Population growth

Think water, act water uses population projections prepared by the ACT Demographer.

The basis of the projections for the ACT is contained in the report, *Australian Capital Territory Population Projections 2002–2032 and beyond*, which is available on the internet at: http://www.cmd.act.gov.au/demography/2002to2032/ACT_pop_proj_02_32.pdf. Using these projections, a regional population (Canberra, Queanbeyan, Yass and Yarrowlumla Part A) of 460,000 by 2050 can be derived. This median population projection reflects the most likely growth scenario and is used as a basis for ***Think water act water***.

Where decisions based on population growth may need to be taken many years in advance, for example planning for a new water supply or urban development, it is also important to plan for possible higher population growth. The Spatial Plan identifies a high growth scenario that would lead to a population of 500,000 for Canberra and Queanbeyan by 2032. Planning for possible new water supply infrastructure, in particular, will take account of such projections.

3.1.1 Long-term climate change

Climate change projections for the ACT region have been developed using simulations from 13 climate change models. There are uncertainties in projections, particularly variations in climate due to local topography.

3.1.2 Temperature change

The latest climate change projections for the ACT region indicate an annual increase of 0.4ºC to 1.6ºC in mean temperature by 2030 and of 1.0ºC to 4.8ºC by 2070. There are slight variations among the seasons. The ranges of projected annual and seasonal average temperature changes for the ACT region for both 2030 and 2070 are shown in Table 1. Projected changes in temperature can be applied to both daily maximum and minimum temperatures.

Table 1: Temperature change (ºC) for the ACT by 2030 and 2070, relative to 1990

Season/Year	2030	2070
Annual	0.4 to 1.6	1.0 to 4.8
Summer	0.4 to 1.8	1.0 to 5.6
Autumn	0.4 to 1.5	1.0 to 4.6
Winter	0.3 to 1.3	0.9 to 4.1
Spring	0.4 to 1.7	1.1 to 5.3

Source: Climate change projections and the effects on water yield and water demand for the Australian Capital Territory. CSIRO Land and Water, CSIRO Atmospheric Research, CSIRO Sustainable Ecosystems

Increases in temperature will lead to changes in the frequency of extreme temperatures in the ACT region.

3.1.3 Rainfall change

The seasonal and annual ranges of projected average percentage rainfall for the ACT for both 2030 and 2070 are shown in Table 2. The simulated direction of rainfall changes is not clear during summer and autumn, but decreases predominate in winter and spring.

Table 2. Rainfall change (%) for the ACT by 2030 and 2070, relative to 1990

Season/Year	2030	2070
Annual	-9 to 2	-29 to 7
Summer	-9 to 12	-28 to 36
Autumn	-5 to 5	-17 to 15
Winter	-11 to 2	-34 to 6
Spring	-11 to 0	-34 to -1

Source: Climate change projections and the effects on water yield and water demand for the Australian Capital Territory. CSIRO Land and Water, CSIRO Atmospheric Research, CSIRO Sustainable Ecosystems

Changes in rainfall under climate change conditions are expected to have a significant affect on the frequency of extreme dry and wet years. Even during wet years, run-off would be reduced as a result of the higher evaporation associated with higher temperatures. Models also indicate an increase in the frequency and intensity of extreme rainfall under climate change conditions.

3.1.4 Evaporation change

The changes in annual evaporation for the ACT for 2030 and 2070 are shown in Table 3. Projected annual and seasonal evaporation values have been taken from nine climate models. Greater increase in potential evaporation is expected as a result of increased temperature.

Table 3: Projected evaporation for the ACT for 2030 and 2070, relative to 1990

Season/Year	Present (mm)	2030 (%)	2070 (%)
Annual	1575	+1.4 to +9.1	+3.8 to +28.0
Summer	626	+0.5 to +11.0	+1.5 to +33.8
Autumn	329	+0.8 to +10.8	+2.2 to +33.3
Winter	184	+2.2 to +12.8	+5.9 to +39.4
Spring	436	+2.1 to +12.0	+5.8 to +36.8

Source: Climate change projections and the effects on water yield and water demand for the Australian Capital Territory. CSIRO Land and Water, CSIRO Atmospheric Research, CSIRO Sustainable Ecosystems

3.1.5 Temporal shift

Historical rainfall in the Murrumbidgee catchment has shown considerable temporal variability. There is evidence of shifts in the last 20 years, with several locations (except Michelago) near Canberra showing a small decline in rainfall and a decrease in inter-annual variability after the mid to late 1980s. A similar shift has been well documented in the southwest of Western Australia. It is possible that the climate will shift in a short period to a new state, rather than show a smooth progression. Global climate change models do not pick up such shifts.

Projected global climate change scenarios show that for the period 2035 to 2065, rainfall occurrence is expected to decrease by about 6 per cent and annual rainfall amounts to decrease by about 8 per cent. These scenarios suggest there will be a decrease in the run-off into ACT storages. Additionally, increases in temperatures are likely to result in an increase in water use by ACT residents.

The hydrological modelling results, based upon the above rainfall projections, show decreases of annual run-off in the ACT region of up to 20 per cent by 2030 and up to 50 per cent by 2070. The modelling results also indicate changes in summer/autumn run-off by about +5% to -20% and +10% to -50% by 2030 and 2070 respectively, relative to 1990, and winter/spring run-off by about -5% to -20% and -10% to -50% by 2030 and 2070 respectively. In general, the percentage changes in run-off are higher in the drier Queanbeyan River catchment than the wetter Cotter River catchment.

Analysis of the potential climate change impacts is continuing as new information becomes available.

4 Meeting the objectives—background information

4.1 Provide a long-term, reliable source of water for the ACT and region

4.1.1 Water supply options

Augmentation of the ACT's water supply may or may not be needed, but work is being done to identify the best available option in case it is.

Major factors in determining the effectiveness of our current or any future water supply storages are the capacity, the inflow and variability of inflow. Variability of inflow is particularly important as this varies significantly between our water supply storages and determines their reliability. Corin and Bendora reservoirs are our most reliable.

Preliminary investigations have been conducted on about 30 water source options. So far no attempt has been made to quantify the environmental, social and broader economic costs of each option. There are also inter-jurisdictional issues to be considered. This initial analysis has identified preferred major supply options for more detailed analysis. A comprehensive analysis of environmental, social, economic and inter-jurisdictional impacts is needed, along with further assessment of likely supply requirements, before a decision on a future supply source is made.

Details of the supply options that will be examined in more detail are given in Volume 1, Section 4.1.3.

4.2 Increase the efficiency of water usage

How will we know if we are using 12 per cent less water in 2013?

Weather is a predominant driver of the ACT's water consumption, so when comparing consumption over time it is necessary to correct for changes in climate. To calculate current average usage it is necessary to adjust for consumption over wet and dry years. Table 4 includes data for the 10 years prior to the onset of the current drought as has been used to calculate current climate corrected water usage.

Table 4: Annual per capita mains water consumption

Year	Total Consumption (GL)	Total Popluation served ('000)	Use (KL/person)
1992	60.0	329.7	182.1
1993	50.2	334.9	149.8
1994	59.4	337.2	176.1
1995	60.6	340.9	177.7
1996	53.3	345.1	154.3
1997	61.8	347.5	177.9
1998	73.1	346.5	211.0
1999	59.4	347.7	170.9
2000	58.0	350.1	165.7
2001	63.0	352.6	178.7
Average			174.4

Source: Data from ACTEW and ACT demographer

Average consumption across all sectors over the period 1992–2001 is 174 kilolitres per person per year. To determine whether we have met the mains water target in 2013, a climate-adjusted model is needed to correct for climate effects on usage in 2013. To meet this target in 2013, climate-adjusted consumption will need to be 153 kilolitres per person per year.

4.2.1 Valuing water as a scarce resource

Since 1999, water users in the ACT have paid a Water Abstraction Charge (WAC). At 10 cents per kilolitre, this charge was set to place a value on water as a resource. The ACT is the only jurisdiction in Australia that values water this way. In the 2003–04 Budget, the ACT Government announced its intention to increase the WAC to 20 cents per kilolitre on 1 January 2004 and to 25 cents per kilolitre on 1 July 2005.

4.2.2 Water efficiency measures

Cost effectiveness

One consideration in determining what water use efficiency measures to consider for Canberra is comparative cost.

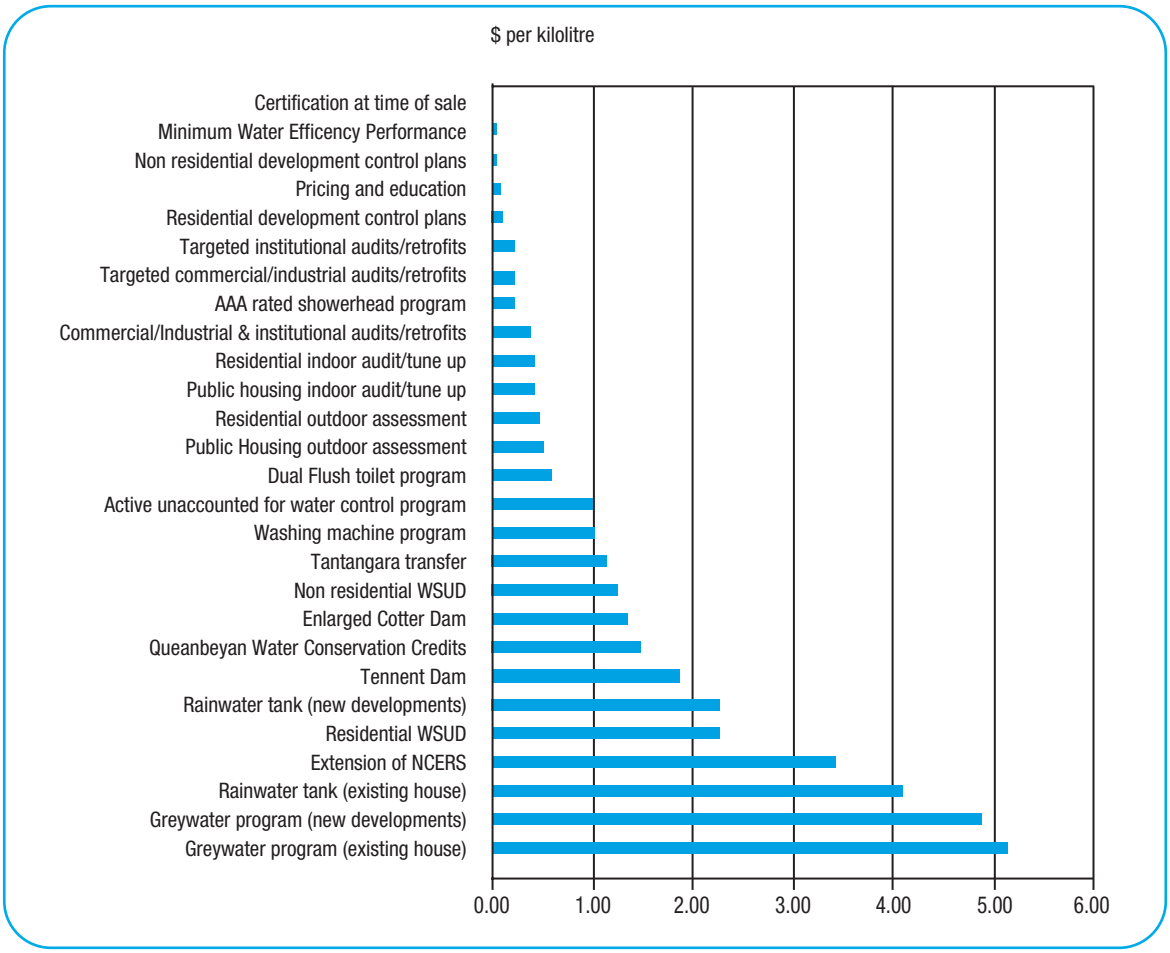
Work has been done for Canberra that compares the relative total costs for a variety of measures. The work ensures the measures are compared on the same basis by calculating the average cost per unit of extra water generated over a period by the measure, taking into account all expenditure by the Government, water supplier, customers or others to achieve the measure.

Typical comparative cost to the community for a range of measures is shown in Figure 1. The costs of three water supply options and of effluent reuse have been included for comparative purposes.

The measures considered include such components as water efficient household appliances, education, pricing, and regulation. Full details on the individual measures are provided in the Institute of Sustainable Futures report *Preliminary demand management and least cost planning assessment* available at http://www.thinkwater.act.gov.au

Whether these measures are introduced by regulation or incentive does not change these values, as the total cost to the community remains the same. Of course, any cost comparison method is only capable of comparing the costs that can be described in dollars. Further analysis is being carried out to assess environmental, lifestyle, convenience and other impacts of these measures. This information will be used to further evaluate the best efficiency measures to be introduced but is also necessary when comparing the water efficiency measures to supply options and source substitution options such as use of reclaimed water and stormwater.

Figure 1: Water efficiency measure cost comparison



Source: Data from Institute of Sustainable Futures, University of Technology, Sydney.

Minimum performance standards and labelling

Australia is to develop a compulsory water efficiency labelling scheme such as that shown in Figure 2. Australia's Environment Ministers agreed to this in May 2003 and expect the scheme to commence in mid to late 2005.

Figure 2: Water Services Association of Australia's Water Efficiency Labelling Scheme

A moderate level of water efficiency | A good level of water efficiency | A high level of water efficiency | A very high level of water efficiency | An excellent level of water efficiency

The Water Services Association of Australia administers the existing voluntary water efficiency product rating and labelling scheme, the National Water Conservation Rating and Labelling Scheme. It is based on Australian Standard 6400:2003, *Water efficient products—rating and labelling*. The rating specifications are shown in Table 5.

Table 5: AS 6400:2003 rating specifications

Product		Rating Unit	Rating 1A	2A	3A	4A	5A
Showerheads		Litres (L)/min	>12 but not >15	>9 but not >12	>7.5 but not >9	>6 but not >7.5	not >6
Dishwashers		L/place setting	>2 but not >2.8	>1.5 but not >2	>1 but not >1.5	>0.8 but not >1	not >0.8
Clothes washers		L/kg of dry load	>28 but not >34	>22 but not >28	>15 but not >22	>9 but not >15	not >9
Taps & flow regulators	Hand basins	L/min	>6 but not >7.5	>4.5 but not >6	>3 but not >4.5	>2 but not >3	not >2 with automatic shut off
	Kitchen & laundry sinks	L/min	>12 but not >15	>9 but not >12	>7.5 but not >9	>6 but not >7.5	not >6
Toilet suites		L (avg flush volume)	>5.5 but not >6.5	>4 but not >5.5	>3.5 but not >4	>2.5 but not >3.5	not >2.5

Source: Standards Australia

AAA showerheads

Data obtained from interstate studies on water savings show AAA showerheads that cost about $30 each have an average payback period of less than one year on water costs alone. Even the more elaborate models, which cost $150 to $200 each, have a payback period of between three and four years on water costs alone. There are also economic savings from the use of less energy to heat the water.

Inefficient showerheads use up to 24 litres of water per minute. AAA rated showerheads (the best rating) use as little as 7.5 litres per minute, a saving of about 17 kL per year on average in Canberra. In 2001, 32 per cent of Canberra homes had water efficient showerheads.

AAA showerheads are the most cost effective appliance to achieve water savings. Their cost compared with other water efficiency measures is 22 cents per kilolitre. AAA showerheads suffer from their association with old style low flow showerheads that, it was commonly felt, provided an unsatisfactory shower. Modern water efficient showerheads which meet the AAA standard are required to meet performance standards which produce much more satisfactory results.

The ACT Government ran a showerhead subsidy program for three weeks in December 2002 and January 2003, which resulted in rebates of up to $30 being provided for nearly 3,900 showerheads. A survey conducted later showed that over 70 per cent of those who got the showerheads thought they gave a shower that was as good or better than their old showerhead. A further 25 per cent thought the new showerhead was only slightly worse than their old one. The survey also showed that the 3,900 showerheads are saving 81 ML of water per year or 21 kL each. The final point to highlight from the survey is the recommendation that, for any future subsidy program, a rebate of $20 be considered to promote installation of more water efficient showerheads.

AAA showerheads have a payback period of less than one year, based only on the value of water and not including energy savings. The 3,900 showerheads in the ACT's subsidy program also reduce greenhouse emissions by almost 2,000 tonnes of carbon dioxide equivalent each year.

There are advantages to be gained by subsidising the fitting of AAA showerheads in combination with a water tune-up program, which provides advice to the community about other demand management issues on their properties. Subsidised showerheads can attract some in the community to participate in a water tune-up, while there are others interested in a water tune-up who can be informed through the tune-up about the merits of an AAA showerhead.

Implementation of a compulsory water efficiency labelling scheme (as discussed above) provides the opportunity to require that showerheads with ratings of less than AAA not be allowed to be sold. Such a regulatory approach would be effective if implemented widely across Australia.

Showerheads are the most effective water efficiency measure to subsidise. The Government has decided to reintroduce a subsidy to encourage maximum take up of showerheads.

Water tune-up programs

Water tune-ups can be used to obtain clear pictures of water usage in individual homes, businesses and other places. These tune-ups promote water use efficiency by encouraging installation of low water use appliances and plumbing fittings, and through introduction of water saving practices.

Water tune-ups can be a personalised marketing approach to provide information and advice on water use efficiency. The objective of such a program is to reduce personal water consumption by providing interested property holders with specific water efficiency information relating directly to their individual situations.

As previously discussed, there are advantages in combining a tune-up program with a showerhead replacement program.

Further synergies may be possible by combining water tune-ups with similar tune-up programs in relation to energy and waste generation, although careful thought is needed before combining tune-ups across such a broad range of expertise. Inside water auditors will require plumbing skills while outside auditors will

need gardening knowledge to provide advice to Canberrans on water efficiency. It would be very difficult to equip auditors with the skills needed to provide information to consumers on all aspects of a combined tune-up on water, energy and waste.

In addition, tune-ups should be offered first to consumers who are least efficient in the field being audited. High water users might not necessarily be high waste producers. In the case of water, information is available from ACTEW's billing system to identify high water users who can be approached first for tune-ups. Tune-up priority for energy and waste should be based on more appropriate criteria than high water use.

Dual flush toilets

An Australian Bureau of Statistics survey in March 2001 showed that about 58 per cent of Canberrans have a dual flush toilet in their residence. Apart from New South Wales, this is the lowest proportion in Australia with over 70 per cent of Victorians, South Australians and West Australians having dual flush. Existing regulations mean that within two to three decades the vast majority will be changed over as old ones become unserviceable or are replaced as part of redevelopments.

A dual flush toilet cuts water use by 18 kL per year and is a good demand measure because once installed it continues to deliver water savings for many years with little concern about the behaviour of those using it.

Regulations could be changed so that, when a cistern over an older pan requires replacement, the entire toilet unit must be replaced with a 6/3 litre unit. Currently the cistern can be replaced with a 9/4.5 cistern and the older pan left in place. Unilaterally making such a change to regulations in Canberra, which is not done in other states, is not recommended given the ease of circumventing such a regulation by purchasing a cistern in New South Wales.

Retrofitting dual flush toilets has a payback period of around 15 years, depending on the actual value of water savings. A fully subsidised replacement program for older toilets is not justified for Canberra given the high relative cost of retrofitting dual flush toilets compared with other demand measures and the existing regulatory controls which will ultimately see all toilets changed.

AAAA Washing machines

In Canberra, about 15 per cent of washing machines are AAA rated or better, a proportion that is increasing by 1 per cent per year. For an average household, water savings with an AAA or AAAA rated washing machine are estimated at 15 kL per year. Front-loading machines are typically about 50 per cent more expensive per kilogram of capacity. This will reduce as their market penetration increases.

Studies indicate that the average life of a washing machine is 18 years and front-loading washing machines have a payback period of around five years, based on the value of water, energy and detergent savings. An incentive program would help to ensure consumers purchase more water efficient machines.

It has already been mentioned that a compulsory National Water Efficiency Labelling Scheme will soon be in place across Australia. The presence of these labels will provide encouragement for consumers to purchase water efficient models.

It will also be possible, with agreement across Australia, to require manufacturers to produce washing machines that meet a certain standard and/or to ban the sale of less efficient models. It would seem opportune to seek such an agreement now, as many jurisdictions are currently facing water security issues similar to ours.

No subsidy for washing machines is supported at this stage—on the basis of cost effectiveness.

Regulations

A range of activities can be controlled through the passage of regulations. At present there is an Environment Protection regulation that requires vehicles to be washed on pervious surfaces where such a surface is available. Further regulations have been considered which will contribute to reduced consumption, and best practice behaviour and serve as a constant reminder of the need to conserve water.

The Government has considered a range of possible regulations and has decided not to proceed, at this stage, with the following regulations that either impose undue expense on the community and/or do not produce adequate water savings.

The Government **will not** introduce regulations that:

- permanently restrict sprinkler use, based on the current odds and evens house numbering system
- limit daily watering times to between 7 p.m. and 8 a.m.
- require swimming pools to be covered, while not in use, to reduce evaporation losses.

Experience gained from water restrictions, and the difficulty of retrofitting existing properties to use reclaimed water, support introduction of regulations to reduce some of the water wasted during outdoor activities, and to spend more on new and redeveloped properties to make water reuse feasible.

The Government **will**, therefore, introduce permanent water conservation measures to:

- restrict watering of lawns and gardens to morning and evening hours
- ban hosing of hard surfaces, including driveways and windows
- control the use of sprinklers for dust suppression
- introduce compulsory use of trigger hoses for car washing.

New plumbing practice notes will be introduced to:

- require separation, in new houses, of washing machine and bathroom drainage from the remainder of the wastewater system to enable future reuse
- require separation, in new houses, of the water supply to toilets and washing machines to enable future rainwater use.

Rainwater tanks

Surveys of Canberra households indicate that 6% of households (approximately 6,000) have rainwater tanks. Enquiries received by the ACT Government indicate that the number of tanks installed would probably be higher if the approval and subsidy systems were not so complex.

When assessed solely as a source of water, rainwater tanks are not as cost effective as other water efficiency measures. However, they serve two additional functions in urban water management. Firstly, rainwater tanks reduce the run-off from urban areas so fewer pollutants are transported to our lakes and streams, protecting the environmental values in those water bodies. Secondly, rainwater tanks in developed areas reduce the size of the peak storm flow, delaying the need for augmentation of stormwater infrastructure in suburbs with significant residential infill.

In addition, the cost of installing a rainwater tank can vary widely depending on whether the householder carries out some of the work, and whether a pump and plumbing work is required. In calculating the levelised cost of a rainwater tank, a number of assumptions about the system were made. It was assumed the house is 200 square metres in area and the entire roof is connected to the tank. It was also assumed that the system is installed professionally, includes a pump and is plumbed into the toilet and laundry. With a simpler set-up, installed by the householder, the levelised cost of a rainwater tank could be lower.

There is a range of actions that could improve the success of a rainwater tank subsidy program. Firstly, consideration needs to be given to waiving development and plumbing approval fees to encourage installation of larger tanks that might otherwise not go ahead because these fees add too much to the cost. Secondly, consideration needs to be given to the structure of the ACT's rainwater tank subsidy scheme to encourage the installation of tanks of between 2,000 and 4,000 litres that are often the only size that can be fitted, and to encourage connection of tanks to a washing machine cold water tap or a toilet. Finally, arrangements should be made, through manufacturers and local suppliers, for the supply of rainwater tanks at the lowest cost possible based on bulk purchase.

Greywater systems

Greywater fittings such as diversion valves, hoses from washing machines to the garden and buckets carried from the laundry are popular ways to recycle greywater during the drought.

Greywater treatment systems remove nutrients and other particles, and disinfect the water so it can be used for purposes that require higher quality water or so it can be stored for periods longer than one day. Victoria is the only jurisdiction in Australia that subsidises greywater systems, providing $500 for systems that cost over $1,500.

No subsidy is recommended for greywater treatment systems at this stage—on the basis of cost effectiveness.

4.2.3 Residential water use efficiency

Water use efficiency program

Canberra's experience with reducing water demand is relatively limited compared with other cities in Australia. We have some experience with short-term demand reduction during water restrictions that shows that Canberrans can easily exceed restriction targets—with savings of 25 per cent last summer and savings of 40 per cent during Stage 3 restrictions, when other water authorities would have expected much less in their cities.

We have some experience with a short but successful showerhead replacement program last summer and with a poorly subscribed rainwater tank subsidy program that has run for a number of years. We have not had an extended awareness campaign in Canberra that provides people with information on how to be more water efficient and upon which to base their decisions. The hardest factor to predict is how well Canberrans will respond to subsidies and education programs aimed to encourage a particular behaviour.

Table 6: Initial water efficiency incentive program

Residential	Incentive	
	First Year	Subsequent Years
AAA Showerhead Rebate	Provide showerhead rebate	To be reviewed
Indoor water tune-up program	Subsidise cost to householder	Subsidise cost to householder
Dual flush toilets	Subsidise supply and fitting 6/3 dual flush toilet to replace single flush toilet	Subsidise supply and fitting 6/3 dual flush toilet to replace single flush toilet
Rainwater Storage Systems	Provide rebates for rainwater tanks in the following categories: 2,000-3,999L 4,000-9,000L, and larger tanks, and for connection to toilet or washing machine	To be reviewed
Pricing—Water abstraction Charge Component	Increased to 20c per kilolitre in January 2004	Increased to 25c per kilolitre in July 2005
Garden water tune-up program	Subsidise cost to householder	Subsidise cost to householder

The design of a water use efficiency program for Canberra will rely, in the first instance, on interstate experience and be modified over time as local experience indicates the need.

The program in Table 6, based on relative effectiveness and past experience in the ACT and elsewhere, is a good model to begin a water efficiency campaign. As experience is gained through managing the program it can be modified. The program will be reviewed annually and modified if necessary. The program is a significant commitment by Government to ensure water is used more efficiently in the ACT.

4.2.4 Non-residential water use

It is estimated that the top 150 non-residential water users consume more than 50 per cent of the total water used in the sector. This includes government, commercial and institutional users. To ensure a cost-effective approach to the non-residential sector obtaining water savings, the Government will be working closely with this high water use group in the first instance to identify if water efficiencies can be made. Other users in this sector will be approached in the longer term to obtain additional savings, but we will be encouraging them to put in place best practice management as soon as is practicable to help achieve the efficiencies needed.

4.2.5 Government water use efficiency

The Commonwealth and ACT Governments are significant users of mains water in Canberra. The ACT Government is committed to ensuring all mains water users (whether government, commercial, institutional or residential) make an equitable contribution to the ACT's water targets.

According to ACTEW data, the Commonwealth and ACT Governments use an average of 11 per cent of the mains water supplied by ACTEW or about 7,000 megalitres (million litres) per year. Some of this water is used to water grass in parks, playing fields and school grounds. With about 70,000 people in government employment in Canberra, water use in offices and other workplaces is also significant.

In the early 1990s, the ACT Government achieved a 30 per cent reduction in its use of mains water to irrigate grass through a program of reducing areas needing watering, fitting of more efficient watering systems and computerisation of larger water systems. These savings in water use have been maintained over the last decade.

The ACT Government has continued to seek ways to reduce water use. In 2001, sports ground pavilions and toilets across Canberra were equipped with water and energy saving fittings. Fitting low-flow showerheads, aerated flow control valves on sinks, reconditioning taps, modifying cisterns to reduce water use and other measures resulted in water savings at these facilities of over 30 per cent.

At ACT Government schools, reviews of water use have resulted in a reduction in the number of toilets. A replacement program to change high water use toilets and taps to more water efficient models has begun.

The ACT Government has also been involved in a research project with CSIRO to determine whether there is some capacity to refine the software that operates its already highly efficient computerised irrigation systems, with a view to reducing water usage. There are early indications that improvements of 10 to 20 per cent may be possible.

In a move aimed at more efficient use of facilities that use water, multiple uses of irrigated sports grounds and pools are being promoted as an objective in the draft Plan of Management for Enclosed Sports grounds and Public Pools for which public comment recently closed.

These and other cost effective water efficiency measures need to be encouraged across government so this sector can meet its obligation to contribute to the water savings target.

What about Parliament House and the Parliamentary Triangle?

ACTEW has been working with the Commonwealth agencies that manage Parliament House and the Parliamentary Triangle, both in the short term to reduce water use during the drought and in the longer term to help these water users contribute to overall water saving measures.

The watered grass on top of Parliament House is actually an important structural part of the building, acting like a roof, ensuring that soil erosion does not expose the rubber membrane covering the structure that protects the building from water leaks. Essential as it is, the roof uses a lot of water and the Joint House Department is investigating the use of reclaimed water on its landscape so mains water use can be dramatically decreased.

The National Capital Authority, which is responsible for much of the water use elsewhere in the Parliamentary Triangle, is also studying the possible use of reclaimed water to irrigate landscaped areas and is investigating opportunities to increase the use of water from Lake Burley Griffin in place of mains water.

Public housing

Nine per cent of Canberra's housing stock is government owned and consumes about 8 per cent of the mains water used in residences. As these properties are constructed, refurbished or as showerheads become unserviceable, water efficient showerheads are fitted. In addition, tap aerators are fitted wherever practical during refurbishments.

The ACT Government used to pass the full cost of water on to its tenants. Since 1995, public housing tenants have not paid for water.

A program, specifically aimed at reducing mains water use in public housing, could be put in place. Such a program would seek to replace water inefficient appliances that become part of the property, and provide information to tenants. A voluntary tune-up and showerhead replacement program has been used with success elsewhere for tenanted properties.

ACT Government sports grounds and parks

The ACT Government has been working with ACTEW over the last couple of years on a scheme—the North Canberra Effluent Reuse Scheme (NCERS)—to use reclaimed water from the Fyshwick Sewage Treatment Plant to irrigate parks and sports grounds in North Canberra (see Section 4.2.6). All pipes have been installed and the final phase of the project has been an upgrade of the treatment plant to meet health requirements for water quality. The scheme is expected to be operational early in 2004, enabling substitution of mains water with reclaimed water to irrigate about 62 hectares of turf, including about 15 hectares of ACT Government sports grounds (approximately 5 per cent of total sports ground area). This will result in the saving of 280 megalitres each year of irrigation water, when the treatment plant is fully operational. In a drought year, this amount could rise to 800 megalitres.

Northbourne Avenue median strip

One of the sights that is often mentioned when Canberrans are being asked to save water is the watering of the Northbourne Avenue median strip from Dickson to Civic.

The Commonwealth Government requires the ACT Government to maintain the watered grass median along Northbourne Avenue from Dickson to Civic. Even if the National Capital Plan did not require the grass to be irrigated, the trees on the median strip need watering. They are *Eucalyptus elata* or river peppermints, which grow naturally along the New South Wales south coast and in eastern Victoria in narrow belts along watercourses and small valleys. Their natural habitat is in higher rainfall areas than Canberra and they would not grow well here without watering.

While changing the management of the Northbourne Avenue median strip will take some time, as it requires a change to the National Capital Plan, the ACT Government has begun exploring options to change the landscape there. Of course any landscape change would have to maintain the high quality standard appropriate for the main entry into Canberra.

The idea of a native landscape similar to the Anzac Parade verge behind the memorials is being discussed with the National Capital Authority. This would involve replacing the watered grass and river peppermints. Such a landscape would be expensive to establish but ultimately would not require watering and maintenance costs would be lower.

Water efficient ACT Government office buildings

The ACT Government owns only six of the office buildings it occupies around Canberra. Some water saving devices, such as tap flow regulators, have been fitted to these buildings. No specific action has been taken to ensure that the offices that the Government leases are water efficient.

The Government will determine how to modify these buildings to make them best practice water efficient. With a large number of leased office buildings, the Government will develop policies about the minimum standard of water efficiency it will accept in buildings it leases. This standard will be set at best practice levels.

Commonwealth Government contribution

The Commonwealth Government is a major water user in Canberra and the community expects it to achieve its share of water savings. The large areas of public open space irrigated by the Commonwealth provide a good opportunity to expand the use of reclaimed water for irrigation.

Water efficiency in the commercial sector

The commercial sector comprises users such as hotels and motels, irrigators, shopping centres, golf courses, office blocks, clubs and sport grounds, caravan parks, and commercial buildings.

The ACT Government will be working closely with the commercial sector to identify a range of savings to ensure this sector obtains best practice. The Government will initiate a program to identify where the likely savings would be obtained to reduce the commercial sector's use of mains water by 12 per cent in 2013.

An audit program will be developed for the commercial sector to help identify where the most cost effective savings could be made. Programs will be developed for particular industries such as golf courses, institutions, hotels and motels etc. It likely that savings will be achieved in areas such as more efficient irrigation practices; water efficient appliances such as toilets, washing machines, urinals and showers; monitoring cooling tower use; rectifying water leakage; and improved management practices including understanding water usage and cleaning regimes.

4.2.6 Sustainable use of reclaimed water

Achieving the 20 per cent reclaimed water use target will help meet the target for reduction in mains water use. Increased reuse will also accrue a number of other benefits including:

- protecting public assets (for example, sports grounds and parks) during droughts as reclaimed water would not normally be subject to restrictions
- reducing pollutant impacts by reducing effluent discharges to rivers
- reducing flow related impacts of effluent discharges
- reducing the impact of unforeseen system failures by developing a more diversified water supply system
- achieving savings on household water bills where simple on-site use of reclaimed water replaces mains water use
- promoting water efficiency in other areas through education and awareness.

The average sewage volume in the ACT (includes Queanbeyan, which discharges sewage in the ACT) is estimated at 38.1GL per year. It is estimated that the current reclaimed water use in the ACT is around 1.85GL per year. Both sewage inflows and reclaimed water volumes vary from year to year depending on climate.

Four approaches for increasing reuse are described below, ranging from large-scale infrastructure intensive programs to simple domestic options.

North Canberra effluent reuse scheme

The Fyshwick Sewage Treatment Plant provides reclaimed water for the North Canberra Effluent Reuse Scheme (NCERS). Stage 1 of the scheme serves 40 hectares of grassland at the Australian Defence Force Academy—Duntroon; and stage 2 of the scheme, will serve an additional 21.7 hectares of ovals in North Canberra, with potential to increase the irrigated area without additional capital expenditure for infrastructure. Stage 2 is due for completion in early 2004, and will increase the amount of reclaimed water used by the NCERS to 0.5GL per year.

The NCERS scheme could be further expanded to 30 major customers in North and South Canberra. Preliminary estimates indicate a capital cost of $23 million, with the scheme potentially capable of supplying 1.1GL to all major irrigators in North and South Canberra.

Dual reticulation systems

Dual reticulation systems provide domestic customers with two types of water, high quality water for drinking and washing, and reclaimed water for garden watering and possibly toilet flushing. Such systems have not been used in Canberra but have been trialled elsewhere in Australia. Dual reticulation systems are normally only considered for greenfield developments as the cost of installation in developed areas is high.

Dual reticulation systems also have the potential to be accidentally cross-connected, putting reclaimed water into the mains water network. This has happened with some existing systems. Care will need to be taken to protect public health with water reclamation schemes.

Distributed treatment

The distributed treatment option considers the construction of water mining plants (similar to that already installed at Southwell Park) located near major playing fields. For a typical playing field of around 1.6 hectares, a treatment and storage facility would cost around $1.8 million.

Twenty hectares of ovals in Gungahlin and Belconnen that could be appropriate for such a scheme have been identified. In an average year these sites would reuse 0.12 GL. The capital cost would be around $8 million.

Domestic greywater reuse

Greywater can be reused effectively at the individual household scale by diverting it to the garden. Use of domestic greywater for garden irrigation is one of the most cost effective water efficiency measures. As an example, the use of domestic greywater for garden watering over the summer period could save 27KL in mains water per household per year. This would amount to a total annual saving of mains water of 3GL if adopted across the residential sector. Alternatively, greywater can be treated and stored until needed, although domestic greywater treatment systems typically cost several thousand dollars per household.

Further analysis, including the environmental, economic and social costs and benefits of increasing the use of reclaimed water will be carried out and compared to similar analysis for the ACT Government's water efficiency program and the options to develop a new water source for the ACT. This will provide a better understanding of the societal costs and benefits of increasing the use of reclaimed water to help reduce water use in the ACT.

4.3 Protect water quality in ACT rivers, lakes and aquifers, to maintain and enhance environmental, amenity, recreational and designated use values and to protect the health of people in the ACT and down river

4.3.1 Land use planning

Land use is an important determinant of the pattern and quantity of run-off, as well as the nature of the material transported by that run-off. A change in land use from rural to urban may have significant impacts on the pattern of streamflow and water quality of local waters. Canberra's expansion has led to large areas of land being modified for urban development and to increasing demands on limited water resources, including more water for domestic use, irrigation and more water-based recreation. There are also community pressures to preserve the scenic and ecological values of the waterways.

Planning systems in the ACT

The ACT has a unique land tenure system due to its role as the National Capital. The Commonwealth has a major interest and involvement in land management and ownership, including Designated and National Land defined in the National Capital Plan administered by the National Capital Authority. The ACT Planning and Land Authority administers the Territory Plan that controls land use planning and development of Territory Land.

Land use planning in practice

Planning in relation to water is underpinned by a set of planning principles:

- water resources in the ACT fulfill multiple uses, and planning should recognise these uses
- an integrated catchment management approach is required for achievement of water quality objectives
- a total water cycle perspective is required as there are fundamental interactions between different water components.

A range of planning approaches is used to achieve water resource outcomes. Within the urban context a number of measures are applied to minimise impacts on water resources. Construction is limited by the land capability, development is restricted in creeks and river corridors, and appropriate landscaping is required to intercept run-off. Finally, infrastructure measures, such as ponds and retardation basins, are used to restore the quality of water impacted by urban activities.

Best management practices needed for urban land include implementation of state-of-the-art stormwater controls and changes to individual house block management. Effluent from sewage treatment plants is recognised as a problem requiring either higher discharge quality or reclaiming for further use. Best management practice requires that only sites with appropriate land capability are used for rural residential estates, and that more rigorous attention is given to design and management of effluent disposal systems.

Additionally, recent urban design changes have led to a trend of smaller house blocks and larger houses. Together these have resulted in much smaller gardens than previously, resulting in significant reduction in external water use in newer suburbs.

4.3.2 Environmental flow review

When they were published in 1999, the *Environmental Flow Guidelines* contained an undertaking that they would be reviewed in 2004. The current level of environmental flows was determined in 1999 by a panel of scientific experts using the information available at the time. The Cooperative Research Centre for Freshwater Ecology is currently undertaking a significant scientific study in the Cotter catchment. The results of this study and other relevant information will form the basis of the review of the *Environmental Flow Guidelines*.

4.3.3 Water resource monitoring

A key component in the effective management of our water resources is information on their status, their condition and on the factors impacting on that condition.

Following identification of clear objectives, a monitoring program can be designed to achieve those objectives. Monitoring is expensive and needs to be tailored to address key objectives. Monitoring may take the form of a single study examining a particular issue, or ongoing monitoring to detect trends in resource status or condition.

Information on river and lake condition is presented in a range of places, including the *ACT Water Report* and technical reports on biota produced by Environment ACT, the annual report on Lake Burley Griffin produced by the National Capital Authority, and the State of the Environment Report produced by the Commissioner for the Environment.

What components of our water resources should we monitor?

The condition or health of our water resources is ultimately reflected in their ecological integrity. Aquatic biota are a key indicator for assessment of ecological integrity, and the ability of waterbodies to provide the range of environmental values we expect. Impacts to biota are usually the final point of environmental degradation and pollution.

In addition to aquatic biota it is important to monitor the hierarchy of components that affect ecological condition—habitat and hydrological characteristics operate at larger scales, and water quality and biological interactions influence ecological condition at smaller scales. Assessment of these components requires information on hydrology, habitat features, water quality, and aquatic biota.

Water resource assessment requires information on streamflow, groundwater, rainfall and other meteorological parameters.

What monitoring has been done?

A range of agencies or groups is responsible for water resource monitoring in the ACT. Monitoring effort can be classed into four broad categories—agency monitoring conducted across the entire ACT (for example, water quality monitoring conducted by Environment ACT), agency monitoring of a particular area (for example, National Capital Authority monitoring of Lake Burley Griffin), community monitoring across the entire ACT, and monitoring required in relation to a licence or authorisation.

How well does the ACT monitoring meet our information needs?

The ACT has a reasonable monitoring program that meets many of our needs. A range of monitoring objectives is listed in Appendix A. These objectives are relevant for the ACT and are the basis for the monitoring effort across the Territory. As examples, water quality monitoring conducted by Environment ACT provides a measure of the condition of streams affected by urban development and other activities. ACT Health monitors the suitability of ACT waters for body contact recreation.

However, not all the current monitoring has clear, explicit objectives. Consequently it is not possible to establish if these monitoring programs are well designed to meet their objectives. We need to clarify our objectives so that we can provide a more effective program.

Another area which needs consideration is the adequacy of monitoring to test the effectiveness of some of the more recent water management activities implemented and proposed, such as water sensitive urban design, including wetlands, gross pollutant traps, swales, etc; and the effects of demand management on water consumption within the home (long-term and seasonal).

Consideration must also be given to whether groups collecting the data are appropriately trained and accredited under National Standards.

A more detailed discussion of monitoring is presented in Appendix A.

4.3.4 Riparian zone management

The ACT's system of land use planning means that some riparian zones such as the Murrumbidgee and Lower Molonglo River corridors are well managed, with statutory protection, plans of management and status as nature reserves. Other areas, such as parts of Jerrabomberra Creek, have passive management with no particular objectives.

Riparian zones are a vitally important part of aquatic systems, filling roles ranging from pollutant filters and nesting sites to wildlife movement corridors.

The issue of riparian management is discussed in detail in Appendix B.

One problem in managing these areas has been to define what 'riparian zone' means. It is suggested that the following definition be used:

> *'The riparian zone is that region along lakeshores, streams and rivers where the existing or original emergent vegetation has distinctly different structure and/or floristics from that of adjacent terrestrial areas.'*

Riparian zones for individual waterbodies are still difficult to identify and it is suggested that fixed-width riparian management zones be specified which will include the actual riparian zone.

Appendix B goes on to suggest that:

- a range of riparian zone values be identified
- values be assigned to each waterbody or stream reach
- management responsibility be clarified
- management actions be identified which are needed to protect or restore riparian zone values
- a program be put in place to undertake the necessary actions
- the program be evaluated regularly to ensure it is achieving its objectives.

4.3.5 Adaptive management

We need to manage our water resources in an environment of changing information, active community participation, and often incomplete knowledge of our systems. Adaptive management techniques have been evolved for resource management in such an environment. These techniques have been used and will continue to be used to effectively manage the water resources of the ACT. Adaptive management can be defined as '*a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs*.'

The concept of adaptive management was born from the need to manage resources when the risk of trial-and-error methods is too high but decisions cannot be postponed while further data are collected. The process works through active participation and learning, ongoing experimentation, and review. Actions and objectives are based on improved understanding and outcomes of monitoring and review. The adaptive management process is particularly useful where integrated knowledge is needed.

Adaptive management is based on the following principles:

- management decisions should examine economic, social and environmental values in an integrated way
- there may be many different stakeholders in environmental management issues
- there is uncertainty inherent in our understanding and management of environmental processes.

For practical implementation of adaptive management, a framework comprising the six following components is used:

- Core components comprise agreed stakeholder processes and community stewardship.
- Information collation in which information is pooled to refine the understanding of water resources and explore options. This component identifies knowledge links as well as gaps, and develops better communication between scientists, managers and other stakeholders.
- Systems analysis and vision identifies institutional arrangements and allows stakeholders to gain a broad understanding of the catchment systems in order to define their aspirations for the catchment. A range of participatory processes and engagement tools may be used in this step. Aspirations for catchments should be consistent with the current legislation and strategic plans from catchment coordinating bodies and government.
- Plan making in which management goals and targets are established and social, economic and ecological impacts are evaluated to negotiate and define a preferred strategy. A range of impact assessment techniques can be used during this phase of the framework.
- Implementation of the necessary management actions and definition of responsibilities. Implementation may also include establishment or reinterpretation of relevant codes of practice, guidelines, licenses, or permits.
- Monitoring and reviewing the effects of implementing the plan against the agreed environmental values, management goals and targets.

The process of adaptive management is iterative, with additional information from the monitoring and review process leading to a new cycle of systems analysis, plan making and implementation.

4.4 Facilitate incorporation of water sensitive urban design principles into urban, commercial and industrial development

4.4.1 Planning and development controls

Larger water sensitive urban design (WSUD) measures, such as ponds and wetlands, can more easily be implemented during new development or major redevelopment activities. At these times, measures that are very expensive to install in existing buildings or landscapes, can often be incorporated with minimal expense.

Planning and development controls are needed to ensure advantage is taken of all opportunities. These will be required at all levels of the planning, land development and building processes. At the higher level, we need to identify major water features that must be protected, enhanced and incorporated into the urban structure. Specific strategies and major elements (such as lakes and ponds) to be incorporated into the urban landscape then need to be established. For new subdivisions, specific measures need to be identified. On-block measures need to be applied through the development control and building control phases.

4.4.2 Research and development

A continuing research and development program will be needed, as WSUD is a new and rapidly changing field. Some of this research has already started, for instance the investigation of generic WSUD approaches, and ACT Government investigations into more efficient use of water in public areas. Continuing this work with the demonstration of innovative ideas as part of new development, redevelopment and day-to-day living will be an important element in building our capacity to perform as a water resource management leader and in handling the issues before us.

4.4.3 Developer contributions to water sensitive urban design

Reducing a new development's contribution to stormwater flows is a requirement of the development approval system. For some developments, particularly multi-unit developments, this is achieved by construction of a stormwater retention tank, usually underground. This is costly and the outcome only meets this objective without gaining added benefit such as reusing the water for irrigation as is possible on larger sites.

On such sites it would be sensible to permit the developer to contribute the cost of the stormwater retention tank to an off-site work that would deliver the added benefits. This could be an urban wetland in the same sub-catchment as the development. Approving off-site works to achieve WSUD should not be needed routinely. It should only be made available for large developments on small sites where there is little space for WSUD.

4.5 Promote and provide for community involvement and partnership in management of the ACT Water Resources Strategy

4.5.1 Information and awareness

The drought and water restrictions have demonstrated the high level of community willingness and commitment to change water use practices. Underpinning the community's ability to make these changes is access to reliable, accurate and practical information about water resources, particularly on supply and demand issues and water sensitive urban design.

If the impetus to continue efficient water use practices can be maintained after the drought, the long-term behaviour change needed from the general community, business, industry and government to meet the ACT's water resource targets is possible. Without an information and awareness program to support ongoing learning and behaviour change these targets will be unachievable.

An advantage of information and awareness programs is that they are relatively inexpensive per unit of water saved, compared with building new infrastructure or demand measures such as incentives for showerheads or other water efficient appliances.

To be effective, information and awareness programs need to:

- be targeted to reach all facets of the community—general community, schools, business and industry, government and institutions, using a range of methods or mediums
- create a direct call to action that encourages everyone to take responsibility for their water usage
- be reinforced by demonstration of the measures, through practical, hand-on workshops and displays and also through government leading by example
- actively engage and involve community groups, business and industry to develop and deliver community-based learning strategies
- incorporate a dedicated water web site with more extensive information; interactive DIY water tune-up kit; interactive water use calculators; an education resource area for schools, general community, industry and business; access to brochures and links to other web sites
- incorporate the services of a special purpose technical unit accumulating knowledge, acting as a conduit to other water experts, providing advice to householders, industry, and government
- take account of the needs of people from different cultural backgrounds, with different literacy levels and those speaking a language other than English.

General community

Elements of the information and awareness program needed to reach the general community include:

- a media campaign incorporating seasonal newspaper features, television advertisements, a bus-back campaign, radio advertisements
- 'how to' information including new brochures and fact sheets, accessible through a range of venues, including shopfronts, libraries, community centres, web site, displays at nurseries, hardware stores and community events
- participatory programs including demonstration site visits; hands-on workshops (for example, water wise garden design); water conservation kits (for example, dye, displacement bag, information, water tune-up template, flow regulator); community-based projects
- a range of promotional products such as posters, fridge magnets, mirror or shower stickers and water bottles to reinforce required behaviours.

Community groups have indicated they are ready and willing to engage in activities to educate and involve the community in community-based projects around sustainable water use and management. This will be supported through:

- development of a community oriented learning and action package which can be tailored by various groups based on what is relevant for their needs

- support and funding to groups to undertake development and delivery of community water learning projects (for example, the Australian Government's Cool Communities model which provides successful communities with information, support and financial assistance to help undertake easy practical actions to achieve a reduction of household greenhouse gas emissions).

Schools based programs

Today's children will decide the future use of our water resources. Education can help raise the next generation with knowledge and attitudes that promote wise use of water.

A school water efficiency program, based on the model of 'Waste Wise Schools' recently adopted in the ACT, will lead to lasting behavioural and cultural change in schools, which will flow on to the families and local communities of participating schools.

Such a program, together with 'Waste Wise Schools' would provide a staged approach to the future development of a 'sustainable schools' program in the ACT, incorporating water, waste, energy and biodiversity.

The program will require:

- development of resources, including teacher kits and other information resources
- development and delivery of a professional development program on water efficiency and stormwater issues
- establishment of model schools
- retrofitting of these schools with water saving appliances
- web site development
- an awards program.

Business and industry

Development of effective programs for this group will involve working with industry and business to develop a range of measures to provide access to information about products, services, regulations and approval processes. Measures will include:

- web-based access to information
- workshops and forums on issues and case studies
- water wise awards
- showcasing of water efficient and/or sensitive homes and developments
- access to water auditing services
- access to a special purpose technical unit providing a conduit to water experts and information
- accreditation.

Government and institutions

Community consultation has shown strong desire from the community for:

- government and institutions to lead by example in water efficient practices
- Canberra and the ACT to become a showcase for the rest of Australia as a water efficient city.

Programs to support Government and institutions will include:

- development of a workplace information and awareness kit, incorporating a workplace water challenge or accreditation program

- access to water audit services
- access to a special purpose technical unit providing a conduit to water experts and information
- inclusion of water efficiency and water reuse guidelines in procurement policies and contracts
- support to demonstrate water reduction measures in buildings, public open spaces, and sports grounds to the local and regional community.

Overcoming cultural barriers

All members of the community will need to be involved in achieving more effective water resource management in the ACT, particularly for the behavioural change needed to improve water use efficiency. It is also desirable to facilitate involvement of all sectors of the community in community programs, such as Landcare.

Significant cultural and language barriers need to be overcome to facilitate greater involvement of the Indigenous community and people from non-English speaking backgrounds.

An important water resource consideration is Namadgi National Park's role in protecting a significant part of Canberra's urban water supply. Recently a joint Namadgi Management Board was established to prepare a new plan of management for the park. There is scope to build on this impetus and to generate interest among the Aboriginal community for wider involvement.

People of different cultural backgrounds can make significant contributions to demand management programs as a result of their previous experiences. Information and awareness programs need to communicate with people who do not speak English as a first language.

4.5.2 Community partnerships in developing sub-catchment management plans

Community participation in partnerships with government is essential to the successful development of sub-catchment management plans.

Integrated Catchment Management Framework

The ACT's *Integrated Catchment Management Framework* aims to achieve better management of the natural resources in the Territory. The Framework emphasises the importance of the contribution made by all stakeholders including the community.

The Framework recognises that community contribution on the ground can only be effective if it is underpinned by sound planning and the participants have the capacity to deliver the desired outcomes. To this end, the ACT Government supports community sub-catchment planning and provision of information and capacity building services for community groups. The value of grass roots community input into strategic planning for natural resource management is also recognised and adequate community consultation arrangements are also supported.

The Framework identifies five building blocks for effective integrated catchment management. These are:

- an effective partnership between the community and government
- all partners have appropriate knowledge and skills
- appropriate legislative and planning instruments are in place
- mechanisms are in place for management coordination
- resources are used effectively.

Land use and group activities

The ACT community appreciates those features of the Territory's natural, built, social and cultural environment that are necessary for sustainable natural systems. The attributes of the 'Bush Capital', with its open spaces and reserves on the city's doorstep and easy access to outdoor recreation, contribute to the quality of life and well being of the community. Similarly, a significant proportion of the ACT community highly values the protection of ecosystems, the conservation of biodiversity and the safeguarding of natural processes such as clean air and water. This appreciation of the local environment provides the impetus for members of the community to become engaged in natural resource management activities.

Community natural resource management activities are wide ranging and include:

- rural landcare
- urban landcare
- Park Care (on reserves)
- Waterwatch
- sub-catchment planning
- providing advice to government.

Sub-catchment management planning

Sub-catchment management plans are an essential tool for coordinating natural resource management in the ACT. The process brings together community groups that may have previously been working in isolation or focusing on a single issue. Getting together and planning enables a more strategic approach to be taken to sub-catchment activities. The benefits include sharing a goal for the sub-catchment, prioritisation of issues on a sub-catchment basis and more efficient use of resources and effort in delivering on-ground action.

Sub-catchment planning also provides a basis for coordinating community and government activities. Although the community owns the plans, they are developed in association with the government. Participation in the process leads to better understanding between the partners and generates goodwill as they work towards shared environmental outcomes. Significant gains for the environment have already been obtained through this collaborative arrangement as government resources and community effort have been combined on projects such as catchment-wide willow removal in the Ginninderra catchment.

4.5.3 Exploring innovation

Canberra has long prided itself on being a world leader in urban water management. Its system of lakes, ponds, wetlands and floodways has set a standard copied by many other cities. Other cities still look to Canberra for a lead in stormwater management but this is only one part of the urban water cycle and concentrates on improving water quality in public open space after water is gathered in large volumes. This misses the opportunities to more closely imitate nature by allowing urban run-off to infiltrate into the soil and to use urban stormwater as a substitute for mains water.

If Canberra aspires to again set the standard and to benefit from the increased urban and rural amenity which results from good water management, we will need to use all of our innovative skills to develop the systems and products which will best deal with the issues we now face.

Government, industry, and the education and scientific communities in the ACT will need to work together as partners to develop these systems. Our past history as an urban water management leader means we have the skills and capacity to develop the new ideas needed if we work together. History has also demonstrated that being recognised as a leader in water management creates opportunities for Canberra businesses.

A strong research and development program will be needed. Some of this research has already started. ACTEW has already initiated research to ensure we develop a better understanding of the implications of climate change and the impact of the bushfires. The ACT Government is investigating ways to make its use of water in public open space like sports fields more efficient.

Further research will be needed to design the best water sensitive urban design (WSUD) techniques to use in Canberra given that the difference of our soils, climate, run-off, etc. to other parts of Australia means we cannot simply use solutions designed for other environments.

There are some exciting and innovative developments in Canberra and elsewhere in Australia that are incorporating rainwater tanks, infrastructure for recycling treated sewage and greywater, and use of stormwater. These projects are important in demonstrating what can be done to reduce demand on our water supply system.

Examples of innovative solutions that could be considered are:

- new approaches and technologies to use stormwater flows. This work could look at private residential use through to large-scale projects
- new more cost effective greywater systems which still provide adequate levels of health and environment protection
- small sewage treatment plants located within individual neighbourhoods coupled to dual reticulation or other reuse systems which promote such reuse
- develop demonstration buildings to showcase best practice water efficient design
- identifying new ways to make our city more sustainable, for example by exploring the possibility of making new office buildings more self-sufficient by recycling as much water as possible. This could involve reclaiming greywater or even blackwater for toilet flushing and garden watering.

All of these ideas come at a cost and care needs to be taken that any innovation is aimed at developing the solutions that provide the best combination of economic, environmental, social and public health outcomes.

The development of these innovations needs to be closely linked to our Water Resources Goal and Objectives.

5 Appendix A: ACT water monitoring

5.1 Monitoring Categories

Monitoring information can be considered in two categories:

- condition assessment (for example, water quality, habitat condition)
- resource assessment (for example, river flow and rainfall data).

5.1.1 Condition assessment

Condition assessment is conducted for a range of objectives. The document '*Australian Guidelines for Water Quality Monitoring and Reporting by ANZECC and ARMCANZ (2000)*' reports that monitoring is conducted to:

- measure the quality of freshwater
- provide assurance that the water meets appropriate guidelines for its designated use
- investigate why the water may not be meeting such guidelines
- assess the loads of materials entering the water body from the catchment
- characterise the biota within a river or lake
- assess the state of the resource for State of the Environment reporting
- assess the effectiveness of management actions for contaminant control, restoration or rehabilitation of waters
- identify trends in the condition of the water body.

5.1.2 Resource assessment

Resource assessment in the ACT is largely undertaken for the following objectives:

- water resources assessment for drinking water supplies
- public health protection in recreational waters
- flood forecasting for roads, bridges and dams
- flood plain mapping for urban development non-structural flood protection
- extreme flood estimation, particularly for dams
- design for structural flood protection from urban stormwater
- rural flow assessment for resource management
- environmental flow releases determination
- determination of flow quantity for use in conjunction with quality monitoring.

Following identification of clear objectives, a monitoring program can be designed to achieve those objectives. Monitoring is expensive and needs to be tailored to address key objectives. Monitoring may take the form of a single study examining a particular issue, or ongoing monitoring to detect trends in resource status or condition.

The environmental values we seek to maintain in different waterbodies is the starting point to determine what most river and lake monitoring in the ACT should entail. For example, we might be seeking to maintain a catchment for water supply, as well as for aquatic ecosystem values or recreational fishing amenity. We would need to know the condition of water resources in the catchment to manage for these environmental values. We also have responsibilities to protect the environmental values of downstream waters, both in the ACT and downstream.

5.2 What should we monitor?

The condition or health of our water resources is ultimately reflected in their ecological integrity. Aquatic biota are a key indicator for assessment of ecological integrity, and the ability of waterbodies to provide the range of environmental values we expect. Impacts to biota are usually the final point of environmental degradation and pollution.

In addition to aquatic biota it is important to monitor the hierarchy of components that affect ecological condition—habitat and hydrological characteristics operate at larger scales, and water quality and biological interactions influence ecological condition at smaller scales. Assessment of these components requires information on hydrology, habitat features, water quality, and aquatic biota.

Monitoring is also necessary to ensure organisms or contaminants, which could impact on human health, are not a concern in waters humans consume or use for recreational activities.

Water resource assessment requires information on streamflow, groundwater, rainfall and other meteorological parameters.

The components required for condition and resource assessment are:

Aquatic biota includes groups such as fish, macroinvertebrates, algae and frogs.

Water quality—Traditional water quality monitoring can include monitoring of nutrients, trace metals, pesticides and herbicides, hydrocarbons, other chemicals, and physical measurements.

Flow and rainfall—Streamflow normally requires significant infrastructure for accurate and reliable information. Rainfall data is similar, though the infrastructure requirements are smaller.

Groundwater characteristics commonly monitored include depth of the water table, the salinity and the yield at which groundwater can be pumped.

Stream habitats are characterised by the shape and size of the stream, the substrate in the bottom of the stream, and presence of logs and macrophytes. The complexity of stream habitat means it can be difficult to characterise.

The **riparian zone** is that region immediately adjacent to lakes and rivers which is characterised by different vegetation. The riparian zone is an important interface for water bodies, buffering the stream from upslope land uses and providing habitat. The riparian vegetation is the key measure, although the physical condition, for example, gullying, is also important.

5.3 Who is responsible for monitoring?

The range of agencies and groups responsible for water resource monitoring in the ACT is summarised in Table 7. Monitoring effort can be classed into four broad categories—agency monitoring conducted across the entire ACT (for example, water quality monitoring conducted by Environment ACT), agency monitoring of a particular area (for example, National Capital Authority monitoring of Lake Burley Griffin),community monitoring across the entire ACT, and monitoring required in relation to a licence or authorisation.

Table 7: Responsibility for monitoring of water resources in the ACT

Agency or group	Monitoring focus
Environment ACT	Compliance with licence and authorisation conditions
	Condition of lakes and rivers across the ACT
	Aquatic biota and biota in the riparian zone across the ACT
Canberra Urban Parks and Places (CUPP)	Condition of Canberra's urban lakes, ponds and urban waterways
ACT Forests	Water quality in catchments used for plantation forestry
Roads ACT	Flood data for flood warning and infrastructure planning
ACT Health	Microbiological condition of waters used for body contact recreation
National Capital Authority	Water quality and flood operations of Lake Burley Griffin
ACTEW	Water resources in the current and possible future water supply catchments
	Condition of rivers in the ACT water supply catchments and downstream of the Lower Molonglo treatment plant
Waterwatch	Community based monitoring focussed on river and stream condition across the ACT

5.4 What monitoring is done?

Monitoring is conducted for a range of variables, at different frequencies and at different sites. The monitoring conducted across the ACT has been summarised in Table 8. Included is information on the number of sites surveyed in each catchment, classified by the rigour of the survey. Surveys can be at different levels of intensity—from assessments of a number of variables and good quality control of the data, to basic assessments with less rigorous quality control.

Prominent features of the monitoring effort across the ACT are:

- Although there are a significant number of sites monitored across the ACT, only one quarter have high quality data. For catchments with high quality data, the majority are sampled at two or fewer sites, which may not be representative of river or lake condition across a large catchment.
- Biota sampled are fish and the macroinvertebrate community structure (See Table 8). Fish tend to be sampled biennially or even less frequently. Macroinvertebrate sites are sampled twice yearly. Approximately half the catchments have sites with high quality data, focussing on the major streams and urban lakes.
- Water quality sites include lake and river sites sampled for a suite of variables and for microbiological quality. Again, approximately half the catchments have sites with high quality data.
- There is a comprehensive set of flow gauging and rainfall stations across the ACT. Continuous recording at these strategically chosen sites has provided an excellent database for water resource assessment.
- Very limited information on groundwater quality or groundwater flow rates is available.
- In-stream habitat and riparian zone condition are not well sampled across the ACT. The riparian zone information is particularly poor as the assessments reported here are at individual sites. A realistic assessment of riparian condition requires an assessment along the length of a river.

Table 8: Summary of monitoring undertaken in each sub-catchment

Sub-Catchment	Biota	Water quality	Flow & rainfall	Groundwater	Habitat	Riparian zone
Michelago	5 (11)	2 (3)	2 (2)	-	1 (2)	1 (2)
Tharwa	2 (3)	1 (3)	9 (9)	-	-	0 (1)
Kambah	4 (5)	1 (5)	-	-	-	0 (1)
Uriarra	4 (6)	1 (16)	3 (3)	-	-	0 (2)
Woodstock	1 (1)	1 (1)	-	-	-	-
Guises	-	-	-	-	-	-
Naas	0 (1)	0 (1)	2 (2)	-	-	0 (1)
Gudgenby	0 (9)	0 (8)	7 (7)	1 (1)	-	0 (8)
Tennent	0 (1)	1 (2)	2 (2)	-	-	0 (1)
Corin	5 (6)	1 (2)	5 (5)	-	1 (1)	1 (1)
Bendora	8 (8)	2 (2)	1 (1)	-	2 (2)	2 (2)
Lower Cotter	8 (8)	3 (3)	3 (3)	-	3 (3)	3 (3)
Paddys	3 (8)	1 (15)	2 (2)	-	1 (5)	1 (5)
Tuggeranong	4 (8)	7 (10)	6 (6)	-	1 (5)	1 (5)
Upper Molonglo			NSW catchment			
Kowen	-	1 (9)	4 (4)	-	-	-
Fyshwick	-	2 (2)	1 (1)	-	-	-
Jerrabomberra Headwaters			NSW catchment			
Jerrabomberra	2 (6)	1 (3)	6 (6)	-	1 (3)	1 (3)
Lake Burley Griffin	4 (4)	11 (11)	3 (3)	-	-	-
Coppins	2 (3)	1 (8)	3 (3)	-	-	0 (1)
Woolshed	-	-	-	-	-	-
Sullivans	0 (7)	0 (3)	5 (5)	-	-	0 (3)
Woden	-	-	2 (2)	-	-	-
Weston	0 (2)	0 (2)	1 (1)	-	-	0 (2)
Tinderry			NSW catchment			
Googong			NSW catchment			
Lower Queanbeyan	0 (1)	-	2 (2)	-	-	-
Burra			NSW catchment			
Gungahlin	2 (6)	1 (4)	5 (5)	1 (1)	-	0 (3)
Lake Ginninderra	5 (11)	10 (13)	3 (3)	-	2 (5)	2 (5)
Parkwood	1 (13)	2 (7)	-	-	1 (6)	1 (6)

Note: the first number in each cell is the number of high quality sites in that catchment monitored for a particular component, for example, biota. The number in brackets is the total number of sites monitored. This summary does not include monitoring on water supply reservoirs, or on New South Wales catchments by New South Wales agencies.

6 Appendix B: Riparian zone management plan

The riparian zone is the place where aquatic systems are directly influenced by the adjacent terrestrial environment. Virtually all rainwater run-off must pass through the riparian zone before moving into adjacent aquatic or estuarine systems. It has been termed the terrestrial/aquatic interface.

Definition

There is no common agreed definition of the riparian zone across the ACT. In other parts of Australia the riparian zone has been defined in a number of different ways. A review of riparian vegetation by the *National Land and Water Resources Audit* (NLWRA 2000) recommended that a vegetation-based definition be used in upland regions where there is no floodplain development. This approach can be used in the ACT with the modification to include areas from which vegetation has been cleared, giving:

> *'The riparian zone is that region along lakeshores, streams and rivers where the existing or original emergent vegetation has distinctly different structure and/or floristics from that of adjacent terrestrial areas.'*

Waterbodies covered by this management plan

Waterbodies in the ACT range in size from the Murrumbidgee River to ephemeral streams with no defined watercourse, and a series of lakes and ponds. This *Riparian Zone Management Plan* is intended to apply to all the streams, lakes and ponds listed in Table 12.

6.1.1 Functions of the riparian zone

The riparian zone provides a range of functions and services, including ecological functions, bank stability and erosion control, pollutant buffers, recreation and amenity, agriculture and material extraction.

Ecological functions

The riparian zone provides habitat for a range of flora and fauna, generates resources such as organic material for in-stream processes and maintains biodiversity. Examples of habitat provision are the use of riverine areas for nesting and perching by aquatic birds, and large woody debris that creates habitat for a range of aquatic and semi-aquatic species. The riparian zone shades the stream, buffering stream temperature, and is a source of in-stream organic material. It also provides habitat for threatened riparian dependent species, and creates a vegetated corridor for wildlife (honeyeater migration etc.).

In many instances we do not have an adequate understanding of animal–habitat relationships. In the absence of this information management plans may need to be based on knowledge of key species, or on an application of general principles of habitat management. Regional context is also an essential element of riparian management, and should be considered when goals are being formulated.

The riparian zone also affects in stream processes—providing shade, a source of organic material and habitat for some aquatic invertebrate species.

Land and Water Australia recommends that the width of riparian vegetation for habitat and wildlife corridors should range from 50 m to over 100 m depending on local circumstances. However, it was accepted that a minimum of at least 30 m of riparian vegetation was better than none. Connection with other vegetated areas upstream and downstream should be maximised. In some instances the corridor function of the riparian vegetation plays a key role for ecologically important species. In this situation the longitudinal connection of riparian vegetation will need to be clearly defined.

The plant species promoted will depend on the ecological goals—an entirely natural community, protection of a particular wildlife species, or remediation of a degraded system to an acceptable state. Vegetation structural diversity is also important. There should be a full range of plant life forms typical to the area from understorey plants through to canopy trees.

Bank stability and erosion control

The vegetation in the riparian zone maintains bank stability by binding soil with root mats, etc. and reduces erosion. The following issues should be taken into consideration:

- recreation, catchment and adjacent land management practices impact directly on erosion, which in turn impacts on riparian zones
- urban infrastructure—erosion frequently occurs where stormwater pipes deposit surface run-off into the soft landscape or drainage lines adjacent to a waterbody
- riparian vegetation needs to be controlled at outlets entering directly into a stream to prevent blocking of the pipe and localised flooding
- erosion is an issue around formed lakes and for lake islands
- vegetation along soft landscaped drainage lines leading into riparian zones are sometimes controlled using herbicide to maintain a neat appearance. Vegetation along these drainage lines should be encouraged, as long as it does not block the stormwater outlet
- vegetation management in riparian zones is an issue in relation to weed control, i.e. willow removal along the Molonglo River
- recreation activities and exploitive uses have a major impact on riparian vegetation.

Pollutant buffers

Under natural conditions, sediment and nutrients are transported from land to water in run-off. Vegetated riparian land, by acting as a 'buffer', plays an important role in reducing this movement. When riparian vegetation is removed the ability of riparian land to act as a buffer is diminished, and the rate of transfer of sediment and nutrients from land to water increases. Increases in delivery of nutrients or sediment to streams can lead to eutrophication of waterways and smothering of in-stream habitat.

Buffer strips only trap and store sediment and nutrients effectively if the incoming overland flow is diffuse and less than about one centimetre deep. If the flow is concentrated or too deep it will overwhelm the capacity of the vegetation to intercept material.

Buffer strips do not act as effectively on slopes greater than 5 per cent; and such land is often an additional source of sediment. Land and Water Australia recommends that buffer strips be a minimum of 10 m wide for low gradient land, and 5 m for steeper riparian land.

Recreation and amenity

Some riparian zones, particularly those around urban lakes and ponds, are designed principally for providing recreation opportunity and amenity values. These values are detailed in the relevant plans of management. Within these areas approved recreational activities are encouraged as long as they do not impact on other riparian values or the values of the waterbody. For many other riparian zones, recreation and amenity values are a secondary value.

Appropriate management of riparian vegetation in urban areas, natural creek lines and around formed waterbodies needs to be considered for amenity and recreational purposes. Examples are harvesting of Vallisneria and control of Typha where they reduce access and create hazards to the public.

Some sections of the urban lakes in the ACT have a hard-edged riparian zone. This approach is appropriate for specific recreational management objectives and is recognised as a riparian zone value. Nevertheless, future constructed waterbodies should aim to maximise natural riparian vegetation where possible, while taking into account recreation and maintenance.

Agriculture and material extraction

Some commercial activities take advantage of characteristics of the riparian zone. For example, agricultural production can focus on the richer riparian soils and proximity to water. Sand and gravel extraction are often associated with riparian zones.

Commercial uses of the riparian zone, including agriculture, sand and gravel extraction and forestry, differ from uses previously discussed. Preceding uses were for protection and maintenance of assets for the entire community. Commercial uses, while they can be legitimate and appropriate, involve the use of riparian resources and are for the benefit of individuals or commercial entities.

6.1.2 Riparian zones values in the ACT

The riparian zone values in Table 9 have been derived from existing policy that applies to the riparian zone including:

- the Territory Plan (stipulates environmental values for catchments. Riparian zone values have been derived from the catchment in which they occur)
- the Nature Conservation Strategy and Action Plans (include specific requirements for some riparian zones)
- Plans of Management (both urban and non-urban) including those for the River Corridors.

Different levels of some riparian zone values have been identified. For instance three levels of ecological functions have been identified to distinguish the ecological values expected of the pristine riparian zone in Namadgi National Park from those of modified streams and those of urban lakes and ponds.

Table 9: Riparian zone values

Riparian values	Description of value
ECOL1	Ecological values provided by a largely unmodified riparian zone in a pristine catchment. Values will include in-stream and terrestrial habitat, water quality, biodiversity and passage for movement.
ECOL2	Ecological values provided by relatively intact riparian zone but where the catchment has been significantly modified, and longitudinal connection has been disrupted.
ECOL3	Ecological values provided by a riparian zone in an urban area that has been created during the construction of a pond or waterway.
BUFFER	Pollutant interception that would be achieved by a well vegetated, well managed riparian zone without cross-zone rills or gullying.
REC1	Provide appropriate recreational amenity for riparian recreational activities including walking, fishing, picnicking, swimming, sailing, model boat clubs and aesthetic appreciation.
REC2	Provide appropriate recreational amenity for riparian recreational activities in sections of lakes and ponds lined with constructed walls.

6.1.3 Riparian zone condition required to achieve riparian values

There is a direct relationship between the riparian values for waterbodies (for example, ECOL1, BUFFER) and the on-ground conditions needed to meet these values (see Table 10). The condition of the riparian zone should be assessed using structural and functional components of the zone:

- geomorphological structure—ranges from streams with no widening, erosion, or armouring to streams with considerable erosion, aggradation, or widening
- vegetation—ranges from streams with structurally and floristically intact riparian vegetation to those that have lost all riparian vegetation
- fauna—ranges from streams with an intact, fully functioning faunal community to one with many species missing or one dominated by pest species
- longitudinal connection includes streams ranging from those with an uninterrupted riparian vegetation connection upstream and downstream to streams with a riparian zone fragmented by numerous gaps posing significant obstacles to the movement and/or colonisation of biota.

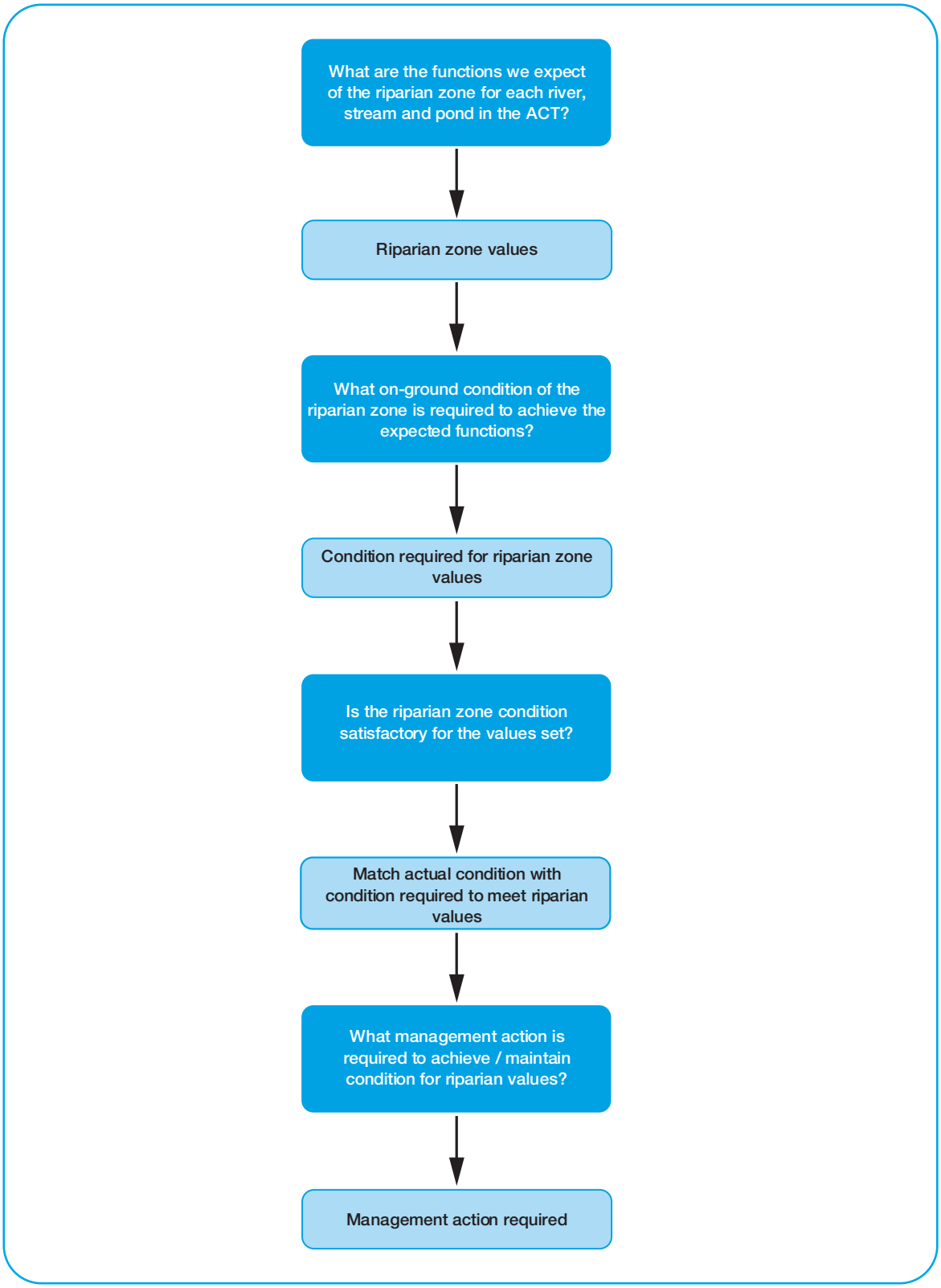
Table 10: Conditions required to achieve riparian zone values

	Geomorphological structure	Vegetation	Fauna	Longitudinal connection
ECOL1	Similar to pre-development condition. No bank or bed erosion, no armouring or deposition	Vegetation structure and floristics similar to pre-development condition. Insignificant weed competition	Fauna similar to pre-development condition. No introduced pests	Vegetation in good condition upstream/ downstream for at least 5 km
ECOL2	Limited bank or bed erosion, limited armouring or deposition	Loss of a limited percentage of expected species, small change to structure, minor weed competition	Loss of a limited percentage of expected species, minor pest problems	Vegetation in good condition though connection disrupted by numerous gaps upstream/ downstream for 5 km
ECOL3	Bank not benched or undercut	Comprises overstorey, understorey and emergent macrophytes—all endemic species. Minor weed competition	Not applicable	Not applicable
BUFFER	No rills or erosion features passing through riparian zone into stream/waterbody	Healthy vegetation, especially groundcover in areas subject to overland flow	Not applicable	Not applicable
REC1	As for ECOL2 (rivers) or ECOL3 (ponds). Frequently require appropriate recreation infrastructure (e.g. access, parking, signage, furniture, boat launching facility, swimming beaches)			
REC2	As for ECOL3 (ponds). Frequently require appropriate recreation infrastructure (e.g. access, parking, signage, furniture, boat launching facility, swimming beaches)			

6.1.4 Management

The schema for riparian zone management in the ACT is described in Figure 3. It takes the form of a series of questions leading from broad objectives to on-ground management actions.

Figure 3: Decision making for riparian zone management



Riparian management zone

The width of the riparian zone will depend on the stream size and form, altitude and topography. It may take expert advice to determine the width of the riparian zone at any point. Consequently it is useful to define a riparian management zone for day-to-day management. In that way management actions applied to protect the riparian management zone will protect the 'true' riparian zone contained within it.

The riparian management zone is defined as a fixed distance from the top of the riverbank and is based on the bank full width. The top of the bank can be determined from the presence of flood deposits, the limits of lichen growth on rocks, an abrupt change in the slope of the bank, scour lines or vegetation limits.

Three categories of riparian management zone and one for lakes and ponds are defined:

- Murrumbidgee, Molonglo and Queanbeyan Rivers—the riparian management zone is that strip of land extending 50 m away from the top of the river bank on each side of the river;
- Cotter, Gudgenby, Naas—the riparian management zone is that strip of land extending 30 m away from the top of the river bank on each side of the river
- all other streams—the riparian management zone is that strip of land extending 20 m away from the top of the river bank on each side of the river
- lakes and ponds—the riparian management zone is an area extending back 30 m from the bank at full supply level.

Condition of zone in relation to riparian zone values

Appropriate management of a riparian zone requires an assessment of the riparian zone condition in terms of the quality requirements (see Table 10).

Where the condition falls short of the required outcome, management action activities may be needed. This may take the form of rehabilitation of a riparian zone to an original condition, remediation or protection of the zone.

Additionally, the factors threatening riparian zone condition in an area should also be identified. Factors that threaten the integrity of the riparian zone include:

- **grazing** can damage riparian vegetation (particularly understorey vegetation), prevent regeneration, compact soil and exacerbate erosion and bank slumping in the riparian zone
- **clearing** of the riparian zone
- **flow regime change**—increased frequency of high flows can increase bank and bed erosion and waterlogging. Reduced frequency, seasonal nature and size of flooding can affect regeneration of vegetation. Rapid drops in water levels can leave the bank saturated and can lead to slumping
- **aquatic and terrestrial weeds**
- **excavation construction** clears vegetation, influences flow, and disturbs stream channels, which can accelerate erosion and sedimentation
- inappropriate **recreational activities**.

Management actions

Management actions consist of remediation or rehabilitation; management of threatening processes; and monitoring.

Remediation or rehabilitation

Remediation, rehabilitation and protection actions may address geomorphological, vegetation or faunal condition.

Geomorphological condition

- bank stabilisation—a range of actions may be needed
- restoration of a more natural flow regime
- creation of pools by adding structures to create scour forces (groynes/logs).

Vegetation condition

- removal of grazing and other pressures to encourage natural regeneration
- removal of exotic species
- planting with appropriate species.

Fauna

- restoration of habitat (both in-stream and riparian)
- removal and/or management of pest animal species
- restoration of upstream–downstream connection of habitat.

Management of threatening processes

Management of a riparian zone may be needed without full information on the riparian condition or of the extent of threatening factors. For these circumstances the following default management approaches should be used to deal with threatening factors:

Agriculture

- exclude stock from riparian management zone except for habitat or fire fuel management purposes. This will require provision of alternative stock watering facilities.
- manage agricultural activities to ensure fertiliser, herbicide or pesticide applications; ploughing etc. do not impact on streams.

Clearing of the riparian zone

- prohibit clearing of native vegetation unless required for habitat or fire fuel management, or for approved construction.

Flow regime

- ensure the flow regime in regulated rivers and streams does not compromise streambed and bank condition.

Exotic vegetation

- clear and/or manage exotic plants in the riparian zone, focussing on those identified as weedy species (for example, willows) or those impacting on biota of concern. In the urban area there may be exotic tree species that are protected by tree protection legislation.

Excavation, construction and forestry activities

- exclude excavation, construction and forestry activities from the riparian management zone except when identified in an accepted Code of Practice (for example, road crossing) or for habitat management purposes (for example, controlled sand extraction to reinstate pools)
- require all permitted activities conducted within the riparian management zone to be conducted in accordance with an agreed Code of Practice, development application or management plan.

For guidance on the specific approaches and measures to use for remediation, rehabilitation or protection and for managing threatening processes, river and land managers should refer to the riparian guideline documents produced by Land and Water Australia found on its web site at: http://www.lwa.gov.au/products.asp, including:

- Riparian Land Management Technical Guidelines Vol 1: Principles of sound management
- Riparian Land Management Technical Guidelines Vol 2: On-ground management tools and techniques
- River and Riparian Management Fact Sheet 1—Managing Riparian Land
- River and Riparian Management Fact Sheet 2—Streambank Stability
- River and Riparian Management Fact Sheet 3—Improving Water Quality
- River and Riparian Management Fact Sheet 4—Maintaining In-stream Life
- River and Riparian Management Fact Sheet 5—Riparian Habitat for Wildlife
- River and Riparian Management Fact Sheet 6—Managing Stock

Monitoring

A key component in effective riparian zone management is information on condition, on the factors impacting on condition, and on the effectiveness of management responses. Currently we have little information on any of these areas for the ACT riparian zones. An overview of riparian monitoring, including recommendations, is included in Appendix A.

6.1.5 Riparian zone responsibilities

Responsibility for managing the riparian zone has been delegated to a number of agencies and there are existing policy documents that either deal with the riparian zone or cover the area in which the riparian zone falls. These are listed in Table 11.

Table 11: Areas of responsibility and policies relating to the riparian zone

Management responsibilities	Agency	Management policy	Content of policy in relation to riparian zone
Fundamental riparian management principles	EACT	The National Strategy for ESD	Development in all areas including riparian zone should follow ESD principles
	EACT	Integrated Catchment Management Strategy for the ACT	General recognition that riparian management required
Planning, and its implications for the riparian zone	ACTPLA	Territory Plan	No explicit recognition. Sets broad objectives for land uses including area in which riparian zone falls.
Fauna and flora protection	EACT	Nature Conservation Strategy	Recognises linkages between streams and riparian zone and describes common impacts. Protection of riparian vegetation is an objective.
	EACT	Threatened species action plans	Some action plans make explicit reference to condition / protection of riparian zone
Wetlands	EACT	Draft wetland policy	Wetland definition does not include the riparian zone.
Willows	EACT	Willow Management Strategy of the Upper Murrumbidgee Catchment.	Management of willows in riparian zone.
Construction and operation of infrastructure in the riparian zone in the ACT (chiefly urban)	Roads ACT	Urban Stormwater, Edition 1, Standard Engineering Practices	Specifies infrastructure requirements in streamlines. Does not explicitly acknowledge riparian zone.
Riparian zone in parks and reserves	EACT	Nature park, nature reserve, river corridor, wetland and national park plans of management	Limited explicit recognition of the riparian zone even in plans for river corridors. Natural resource inventories and their management actions tend to focus on either water or terrestrial areas.
Riparian zone in urban open space	CUPP	Plans of management for regions including urban streams and lakes	No explicit recognition of streams or riparian zone.
Riparian zone in rural leases	Rural leaseholders	Property management agreements (standard clauses for management of the riparian zone)	Specifies management actions for the riparian zone.
Riparian zone in forestry land use	ACT Forests	Draft Water quality and riparian protection strategy	Specifies management actions for the riparian zone.
Riparian zone around Lake Burley Griffin	NCA	Lake Burley Griffin Plan of Management	Specifies management actions for the riparian zone.

EACT = Environment ACT
CUPP = Canberra Urban Parks and Places
ACTPLA = ACT Planning and Land Authority
NCA = National Capital Authority

Table 12: Riparian zone values for rivers, streams, lakes and ponds

Name	Riparian zone values	Stream length (km) or pond area (ha)	Management responsibility
Cotter Catchment			
Blundells Creek	ECOL1, BUFFER	3.7 km	EACT
Bullock Head Creek	ECOL1, BUFFER	3.8 km	EACT
Burkes Creek	ECOL1, BUFFER	4.6 km	EACT
Bushrangers Creek	ECOL1, BUFFER	5.2 km	EACT
Condor Creek	ECOL1, BUFFER	12.0 km	EACT, ACT Forests
Cotter River	ECOL1, BUFFER	77.0 km	EACT, ACT Forests
Collins Creek	ECOL1, BUFFER	3.3 km	EACT
Coree Creek	ECOL1, BUFFER	2.5 km	EACT
Cow Flat Creek	ECOL1, BUFFER	4.8 km	EACT
Creamy Flat Creek	ECOL1, BUFFER	6.4 km	EACT
Cribbs Creek	ECOL1, BUFFER	5.1 km	EACT
De Salis Creek	ECOL1, BUFFER	5.5 km	EACT
Franklin Creek	ECOL1, BUFFER	7.2 km	EACT
Gingera Creek	ECOL1, BUFFER	4.1 km	EACT
Ginini Creek	ECOL1, BUFFER	6.1 km	EACT
Jacks Creek	ECOL1, BUFFER	6.0 km	EACT
Kangaroo Creek	ECOL1, BUFFER	8.2 km	EACT
Licking Hole Creek	ECOL1, BUFFER	8.9 km	EACT
Long Creek	ECOL1, BUFFER	7.4 km	EACT
Lees Creek	ECOL1, BUFFER	10.9 km	EACT, ACT Forests
McKeahnie Creek	ECOL1, BUFFER	5.9 km	EACT
Mosquito Creek	ECOL1, BUFFER	3.9 km	EACT
Porcupine Creek	ECOL1, BUFFER	7.2 km	EACT
Pierces Creek	ECOL1, BUFFER	11.0 km	EACT, ACT Forests
Snowy Flat Creek	ECOL1, BUFFER	6.0 km	EACT
Stockyard Creek	ECOL1, BUFFER	11.1 km	EACT
Unnamed1	ECOL1, BUFFER	3.6 km	EACT

Name	Riparian zone values	Stream length (km) or pond area (ha)	Management responsibility
Naas Catchment			
Back Creek	ECOL1, BUFFER	14.5 km	EACT
Bulls Flat Creek	ECOL1, BUFFER	3.8 km	EACT
Gudgenby Creek	ECOL1, ECOL2, BUFFER	9.5 km	EACT, Rural lessees
Left Hand Creek	ECOL1, BUFFER	7.2 km	EACT
Long Flat Creek	ECOL1, BUFFER	7.9 km	EACT
Naas Creek	ECOL1, BUFFER	28.9 km	EACT
Naas River	ECOL1, ECOL2, BUFFER	25.8 km	EACT, Rural lessees
Sheep Station Creek	ECOL1, BUFFER	6.1 km	EACT
Reedy Creek1	ECOL1, BUFFER	7.6 km	EACT
Shanahans Falls Creek	ECOL1, BUFFER	4.2 km	EACT
Unnamed17	ECOL1, BUFFER	3.1 km	EACT
Unnamed2	ECOL1, BUFFER	8.5 km	EACT
Unnamed3	ECOL1, BUFFER	4.7 km	EACT
Gudgenby Catchment			
Bogong Creek	ECOL1, BUFFER	11.4 km	EACT
Booroomba Creek	ECOL1, BUFFER	14.2 km	EACT
Dry Creek	ECOL1, BUFFER	13.2 km	EACT
Gudgenby River	ECOL1, ECOL2, BUFFER	31.3 km	EACT, Rural lessees
Half Moon Creek	ECOL1, ECOL2, BUFFER	7.7 km	EACT, Rural lessees
Honeysuckle Creek	ECOL1, BUFFER	9.5 km	EACT
Hospital Creek	ECOL1, BUFFER	11.6 km	EACT
Hospital Creek East	ECOL1, BUFFER	7.3 km	EACT
Middle Creek	ECOL1, BUFFER	14.3 km	EACT
Nursery Creek	ECOL1, BUFFER	10.1 km	EACT
Orroral River	ECOL1, BUFFER	18.4 km	EACT
Rendezvous Creek	ECOL1, BUFFER	12.6 km	EACT
Sawpit Creek	ECOL1, BUFFER	7.8 km	EACT
Unnamed5	ECOL1, BUFFER	2.7 km	EACT
Unnamed6	ECOL1, BUFFER	3.3 km	EACT
Paddys Catchment			
Blue Gum Creek	ECOL1, ECOL2, BUFFER	16.7 km	EACT, Rural lessees
Billy Billy Creek	ECOL1, ECOL2, BUFFER	3.8 km	EACT, ACT Forests
Gibraltar Creek	ECOL1, ECOL2, BUFFER	13.3 km	EACT, ACT Forests, Rural lessees
Hurdle Creek	ECOL1, BUFFER	4.8 km	EACT
Larrys Creek	ECOL1, ECOL2, BUFFER	7.9 km	EACT, Rural lessees

Name	Riparian zone values	Stream length (km) or pond area (ha)	Management responsibility
Paddys Catchment (continued)			
Mountain Creek	ECOL1, BUFFER	4.4 km	EACT
Punchbowl Creek	ECOL1, ECOL2, BUFFER	7.6 km	EACT, ACT Forests, Rural lessees
Paddys River	ECOL1, ECOL2, BUFFER	28.4 km	EACT, ACT Forests, Rural lessees
Tidbinbilla River	ECOL1, ECOL2, BUFFER	13.4 km	EACT, ACT Forests, Rural lessees
Tanners Flat Creek	ECOL1, ECOL2, BUFFER	7.6 km	EACT, ACT Forests, Rural lessees
Unnamed8	ECOL1, BUFFER	2.6 km	EACT
Murrumbidgee Catchment			
Bulgar Creek	ECOL1, ECOL2, BUFFER	5.2 km	EACT, ACT Forests, Rural lessees
Murrumbidgee River	ECOL1, ECOL2, BUFFER, REC1	58.7 km	EACT, Rural lessees
Reedy Creek2	ECOL1, ECOL2, BUFFER	3.1 km	EACT, ACT Forests
Sawyers Gully	ECOL1, ECOL2, BUFFER	7.0 km	EACT, Rural lessees
Swamp Creek	ECOL2, BUFFER	1.8 km	Rural lessees
Stony Creek	ECOL1, BUFFER	4.3 km	EACT
Uriarra Creek	ECOL1, ECOL2, BUFFER	13.9 km	ACT Forests, Rural lessees
Unnamed4	ECOL1, ECOL2, BUFFER	1.1 km	EACT, Rural lessees
Unnamed7	ECOL1, ECOL2, BUFFER	3.2 km	EACT, ACT Forests
Lower Stranger Pond Creek	ECOL1, ECOL2, ECOL3, BUFFER, REC1	3.3 km	CUPP, EACT
Point Hut Pond Creek	ECOL1, ECOL2, ECOL3, BUFFER, REC1	5.4 km	CUPP, EACT
Molonglo Catchment			
Glenburn Creek	ECOL2, BUFFER	5.3 km	Rural lessees, ACT Forests
Jerrabomberra Creek	ECOL2, BUFFER	10.8 km	EACT, Rural lessees, CUPP
Molonglo River	ECOL2, BUFFER	58.0 km	EACT, Rural lessees, CUPP, ACT Forests
Queanbeyan River	ECOL2, BUFFER	0.6 km	Rural lessees
Reedy Creek3	ECOL2, BUFFER	8.3 km	EACT, Rural lessees, ACT Forests

Name	Riparian zone values	Stream length (km) or pond area (ha)	Management responsibility
Molonglo Catchment (continued)			
Unnamed11 ACT Forests	ECOL2, BUFFER	3.4 km	Rural lessees,
Weber Creek	ECOL2, BUFFER	5.3 km	Rural lessees, ACT Forests
Weston Creek	ECOL2, ECOL3, BUFFER, REC1	5.2 km	CUPP, ACT Forests, Rural lessees
Ginninderra Catchment			
Gooromon Ponds Creek	ECOL2, BUFFER	2.9 km	Rural lessees
Ginninderra Creek	ECOL2, ECOL3, BUFFER, REC1	23.4 km	EACT, Rural lessees, CUPP
Hall Creek	ECOL2, BUFFER, REC1	7.3 km	Rural lessees
Unnamed12	ECOL2, ECOL3, BUFFER, REC1	8.7 km	Rural lessees
Unnamed13	ECOL2, ECOL3, BUFFER, REC1	3.4 km	Rural lessees
Unnamed14	ECOL2, ECOL3, BUFFER, REC1	2.9 km	Rural lessees
Unnamed15	ECOL2, ECOL3, BUFFER, REC1	2.6 km	Rural lessees
Tuggeranong Catchment			
Tuggeranong Creek	ECOL2, ECOL3, BUFFER, REC1	12.7 km	Rural lessees, CUPP
Village Creek	ECOL2, ECOL3, BUFFER, REC1	4.6 km	CUPP
Other Catchments			
Guises Creek	ECOL2, BUFFER	9.4 km	Rural lessees
Sullivans Creek	ECOL2, ECOL3, BUFFER, REC1	15.2 km	CUPP, ANU, Rural lessees
Woolshed Creek	ECOL2, BUFFER	12.3 km	Rural lessees, ACTPLA, CUPP EACT
Yarralumla Creek	ECOL2, ECOL3, BUFFER, REC1	8.1 km	Rural lessees, CUPP
Gungaderra Creek	ECOL2, ECOL3, BUFFER, REC1		Rural lessees, CUPP

Name	Riparian zone values	Stream length (km) or pond area (ha)	Management responsibility
Lakes And Ponds			
Lake Ginninderra	ECOL 3, BUFFER, REC1, REC2	105 ha	CUPP
Lake Tuggeranong	ECOL 3, BUFFER, REC1, REC2	57.1 ha	CUPP
Upper Stranger Pond	ECOL 3, BUFFER, REC1	4.4 ha	CUPP
Lower Stranger Pond	ECOL 3, BUFFER, REC1	4.1 ha	CUPP
Isabella Pond	ECOL 3, BUFFER, REC1	5.7 ha	CUPP
Tuggeranong Weir Pond	ECOL 3, BUFFER, REC1	7.5 ha	CUPP
Gungahlin Pond	ECOL 3, BUFFER, REC1	23.8 ha	CUPP
Yerrabi Pond	ECOL 3, BUFFER, REC1	26.4 ha	CUPP
Dunlop Pond 1	ECOL 3, BUFFER, REC1	0.7 ha	CUPP
Dunlop Pond 2	ECOL 3, BUFFER, REC1	0.7 ha	CUPP
West Belconnen Pond	ECOL 3, BUFFER, REC1	9.9 ha	CUPP
Point Hut Pond	ECOL 3, BUFFER, REC1	16.7 ha	CUPP
Gordon Pond	ECOL 3, BUFFER, REC1	0.1 ha	CUPP
Eddison Park Pond	ECOL 3, BUFFER, REC1	1.15ha	CUPP
Conder Wetland	ECOL 3, BUFFER, REC1	0.5 ha	CUPP
O'Connor Wetland	ECOL 3, BUFFER, REC1	0.29 ha	CUPP
McKellar Wetland	ECOL 3, BUFFER, REC1	0.9 ha	CUPP
Barr Smith Pond	ECOL 3, BUFFER, REC1	0.32 ha	CUPP
Fern Hill Park Ponds	ECOL 3, BUFFER, REC1	1.2 ha	CUPP

7 Glossary

50th percentile flow	The flow that is exceeded 50% of the time.
80thpercentile flow	The flow that is exceeded 80% of the time.
Basin	An area drained by a given stream and its tributaries.
Catchment	An area of land draining rainfall into a river or reservoir.
Catchment yield	The annual average volume of run-off from a catchment.
COAG	Council of Australian Governments.
CSIRO	Commonwealth Scientific and Industrial Research Organisation.
Demand management	An approach that is used to reduce the consumption of water (also called water conservation).
Environmental flow	The streamflow required downstream of a water storage to maintain appropriate environmental conditions in a waterway.
ESD	Ecologically Sustainable Development
Flow rate	Volume of water per unit of time (for example kilolitres or megalitres per day).
Gigalitre (GL)	1,000,000,000 Litres or 1,000 Megalitres.
Greenfield development	New urban development areas.
Greywater	Water from the laundry, bathroom and kitchen that does not contain faecal matter.
Kilolitre (kL)	1,000 Litres or 1 cubic metre.
Mains water	Water supplied by ACTEW through the urban water supply system.
Megalitre (ML)	1,000,000 Litres or 1,000 Kilolitres.
Per capita	Per person.
Reclaimed water	Effluent that has passed through a treatment process and has been reticulated to users, or domestic greywater used for garden irrigation or other purposes.
Regulation	A rule set by government requiring or prohibiting a specific action or outcome (for example, installation of dual flush toilets, restriction on water uses during drought periods).
Retrofitting	Installation of fittings or appliances on existing buildings (for example, dual flush toilets).
Run-off	That part of precipitation that flows from a catchment area into streams, lakes, rivers or reservoirs.
Sewage	The waterborne wastes from our homes, workplaces and other buildings.

Sewerage system	The pipes and plant for the collection, removal and treatment of sewage.
Streamflow	The flow in a stream or river.
Sub-catchment	The management unit used by the ACT for water resource management. Catchments in which ACT has an interest are divided into 32 sub-catchments.
Treated effluent	The treated water discharged from a sewage treatment plant.
Urban stormwater	Rainfall run-off from urban areas.
Volume	Kilolitre (kL) = 1,000 Litres or 1 cubic metre. Megalitre (ML) = 1,000,000 Litres or 1,000 Kilolitres. Gigalitre (GL) = 1,000,000,000 Litres or 1,000 Megalitres.
Water ACT	ACT's draft policy for sustainable water resource management released in July 2003 by the ACT Government.
Water cap	Cap on water diversions from the Murray–Darling River system set by the Murray–Darling Basin Ministerial Council to stop further deterioration of river health by limiting water use to 1994 levels of development.
Water conservation	See Demand management.
Water use efficiency	A measure of whether activities are being undertaken with the minimum amount of water needed and/or whether the water used is more pristine for the purpose than needed.
WSUD	Water sensitive urban design