

Future directions for water recycling in Australia

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Abstract

Although the scope for water recycling was examined in two reports in 1977–1978, it was not until the Environment Protection Authorities had been established in most of the states in the early 1990s that water authorities began making substantial use of treated wastewater, using recycled water on land as a component of meeting newly imposed discharge limits from sewage treatment plants. The period of nation-wide drought in 2001–2003 led to increased interest in the use of recycled water as a means of substituting it for drinking quality water where that standard was not required. The Australian Academy of Technological Sciences and Engineering published an extensive review of water recycling in Australia in March 2004, outlining progress to 2003 and identifying 24 issues that needed to be addressed. Developments since then are discussed, including an intergovernmental agreement between the Australian Government and most of the States and Territories on a National Water Initiative, and the generation by the mainland States of new strategies which aim to reduce per capita demand for water and increase the use of recycled water, stormwater and rainwater in Australia's capital cities.

Keywords: Wastewater; Water recycling; Stormwater; Australia

1. Introduction

Within Australia, constitutional responsibility for water management, including recycling, rests with the States. At the time of drafting the Australian Constitution at the beginning of the 20th century, there was no perception that the Federal (Australian) Government had any role in the management of Australia's water resources. That position is changing.

Detailed consideration was given to the potential for recycled water use in Australia in a report entitled "Strategies towards the use of reclaimed water in Australia" prepared in 1977 [1], and was followed up in the following year by a further report specifically oriented to Victoria [2], but neither report appears to have had any major impact on water resource management at the time.

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Water recycling was given an impetus from the early 1990s as the States established Environment Protection Authorities which imposed compositional standards on the discharge of treated effluents from sewage treatment plants (STPs), resulting in increased interest in recycling for productive purposes on land as an alternative to installing expensive biological nutrient removal plants.

Following widespread drought in 2001–2003 and the recognition that water catchment volumes in cities were being reduced, a further impetus arose for recycling. This was driven by recognising the need for more effective conservation of drinking water supplies by using recycled water for purposes for which drinking water standards were unnecessary.

2. Australia's current water recycling

A review was undertaken in 2003–2004 under the aegis of the Australian Academy of Technological Sciences and Engineering, one of Australia's four learned academies, based around an evaluation of recycling data then available for 2001–2002 [3]. The review described water recycling schemes across Australia extant as at the end of 2003. It established that over 500 Australian STPs recycled some or all of their effluent. However, water recycling was greater in the rural and regional areas than in the capital cities, and greater in inland cities than coastal cities, many of which continue to discharge to ocean. This was well illustrated by figures from rural New South Wales showing there was 50% reuse from plants west of the Great Dividing Range, 20% reuse from inland plants east of the Great Dividing Range, but only 2.5% reuse from coastal STPs.

The review identified a range of issues to be addressed if an increase in recycling is to be facilitated in Australia, including:

- an attitudinal change with recycled effluent, rainwater and stormwater being regarded as additional resources rather than disposal problems and recognised as complementary to water harvested from catchments;
- policymakers, developers and the entire community developing a wider appreciation of the entire hydrologic cycle;
- “drinking water” adopted as the term to describe potable water;
- wider use made of recycled water where water of drinking water quality is not required, with its use having to be mandating in some areas;
- titles to water extended to cover recycled water;
- revision of the National Water Quality Management Strategy Guidelines with completion of the new Water Recycling Guidelines as soon as possible, new Stormwater Guidelines to encompass water harvesting, and Use of Rainwater brought within the NWQMS Guidelines;
- harmonisation of States and Territories plumbing and drainage regulations to achieve standardised outcomes;
- generation of greater awareness in the plumbing industry and consumers of the need to maintain complete separation of drinking water and recycled water supply systems;
- planning approval mechanisms streamlined for water supply and effluent treatment provisions in new developments;
- achieving more equitable water authority “headworks” charges to reflect recognition of drinking water savings achieved where recycled water is included in developments;
- greater attention being given to possible cost savings and benefits from locating small STPs close to new developments rather than using long supply lines to older centralised treatment systems;
- recycled water providers given legislative or regulatory provisions to be able to lay appropriate infrastructure on equal terms with other service providers;

- “in-house” recycling systems encouraged in new high-rise office and apartment buildings, with concomitant development of a service industry able to contractually manage such facilities;
- developing a national approach to the costing and pricing of drinking water and recycled water;
- ensuring recycling projects carefully define their markets before commencement to avoid the risks of making over-optimistic assumptions;
- any residual liabilities within the Trade Practices Act 1974 (Cwlth) being clarified with respect to residual liabilities that might otherwise accrue to water authorities operating in compliance with current Australian and State legislation in a similar manner to that proposed in a bill to the 108th US Congress to amend the Safe Drinking Water Act (US) to provide for claims relating to drinking water;
- industry attraction programs recognising the benefits of locating large non-drinking water quality industrial water users close to sewage treatment plants;
- greater use of wetlands for water quality remediation, particularly stormwater, but with provision of adequate operational and maintenance strategies;
- potential role of effluent treatment facilities in biodiversity conservation being recognised;
- further research encouraged into water and wastewater treatment processes,;
- stimulating investment in innovative community-scale water recycling projects;
- unification of policy responsibilities for the management of water and wastewater resources;
- governments resolving at whole-of-government level the conflicts of interest evident between portfolio agencies in environmental management, water resource provision, revenue generation and pricing determinations as they affect water policy, and
- recognising that ensuring public participating in decision making, and gaining public confidence and trust in future water-recycling initiatives is absolutely essential to the greater use of water recycling in Australia.

A prolonged drought in much of Australia in 2001–2003, together with release of outcomes from the Academy’s recycling review, resulted in water recycling being more widely identified as a valuable contributor to the conservation of drinking water. New recycling research opportunities were presented to and discussed by the Prime Minister’s Science, Engineering and Innovation Council in November 2003. Recycling was incorporated as an aspect of the policies for urban water reform.

The Natural Resource Management Standing Committee (comprising the heads of natural resources agencies including water resources agencies of the Australian and States/Territories governments, together with the Bureau of Meteorology and CSIRO) considered the recommendations of the Academy’s recycling review as a specific agenda issue in September 2004, and referred the report to the working group to be formed by the Standing Committee’s Natural Resource Policies and Programs Committee to assist in implementing the National Water Initiative. The ATSE report is being scoped with other papers and research proposals for presentation as reports to the Standing Committee and subsequently to the Natural Resources Management Ministerial Council.

Water recycling is now firmly on the policy agenda of the Australian Government and those of the individual Australian States and Territories, most of which have established specific strategies and targets. Developments since the publication of the Academy’s report in March 2004 are outlined below.

3. Planning for the future

3.1. National approach

In June 2004, all of the Australian States and Territories except Western Australia and Tasmania signed the 108 clauses of the Intergovernmental Agreement on the National Water Initiative with the Australian Government [4]. The parties agreed to the establishment of a National Water Commission (NWC) to assist with the effective implementation of the agreement. The NWC accredits implementation plans to ensure consistency with an agreed implementation timetable.

The agreement included the achievement of outcomes for urban water reform including to: (1) provide healthy, safe and reliable water supplies; (2) increase water use efficiency in domestic and commercial settings; (3) encourage the re-use and recycling of wastewater where cost effective; (4) facilitate water trading between and within the urban and rural sectors; (5) encourage innovation in water supply sourcing, treatment, storage and discharge; and (6) achieve improved pricing for metropolitan water.

Parties to the agreement undertook to perform the following actions in regard to innovation: (1) develop national health and environmental guidelines for priority elements of water sensitive urban designs (initially recycled water and stormwater) by 2005; (2) develop national guidelines for evaluating options for water sensitive urban developments, both in new urban sub-divisions and high rise buildings by 2006; (3) evaluate existing “icon water-sensitive urban developments” to identify knowledge gaps and lessons for future strategically located developments by 2005; (4) review the institutional and regulatory models for achieving integrated urban water cycle planning and management, followed by preparation of best practice guidelines by 2006; and (5) review incentives to stimulate innovation by 2006.

Parties to the agreement agreed that an important outcome is to engage water users and other stakeholders in achieving the objectives of this agreement by: (1) improving certainty and building confidence in reform processes; (2) transparency in decision making; and (3) ensuring sound information is available to all sectors at key decision points.

The agreement identifies a number of areas where there are significant knowledge and capacity building needs for its ongoing implementation. These include: regional water accounts and assessment of availability through time and across catchments; changes to water availability from climate and land use change; interaction between surface and groundwater components of the water cycle; demonstrating ecological outcomes from environmental flow management; improvements in farm, irrigation system and catchment water use efficiency; catchment processes that have an impact on water quality; improvements in urban water use efficiency; and independent reviews of the knowledge base. It recognises that there are significant national investments in knowledge and capacity building in water, including through the Cooperative Research Centres programme; the CSIRO Water for a Healthy Country Flagship; Land and Water Australia, State agencies; local government and higher education institutions. The needs for scientific, technical and social aspects of water management are seen as multi-disciplinary and extend beyond the capacity of any single research institution.

Since March 2004, most states have released new water strategies encompassing recycling, affecting Australia’s major cities.

3.2. New South Wales

The New South Wales Metropolitan Water Plan issued in October 2004 [6] explored Sydney’s future water supplies and noted that over

the next 5 years, Sydney Water expects to save additional 8 GL through several business and residential recycled water projects, including at BlueScope Steel, Liverpool Golf Course, Hoxton Park, Rouse Hill Stage Two new release areas and North Head and Malabar STPs. Other recycling projects currently being investigated include:

- providing recycled water, through separate pipes for outdoor or toilet flushing uses in new release areas, saving as much as 24 GL/y of water;
- using recycled water to irrigate farms, saving up to 32 GL/y of river water;
- releasing up to 40 GL/y of high-grade recycled water to rivers in a natural flow pattern, for environmental benefit;

Development of contingency plans for desalination is also proposed.

Options outlined in the NSW Water Plan for future growth centres in the Sydney region, incorporating recycled water, are shown in Fig. 1. However, the issue by the National Competition Council in August 2004 of a draft recommendation on the application by Services Sydney Pty Ltd for a declaration of sewage transmission and interconnection services provided by Sydney Water [7], and its subsequent recommendation to NSW Premier Carr who must “declare” the services within 60 days or choose to do nothing, has introduced a completely new aspect into the potential for water recycling in Australia. This could open sewage services to retail competition in a similar way to that in which electricity, water, railway and urban public transport services have been opened up to competition in recent years. The Services Sydney proposal envisages accessing part of the sewage effluent stream currently managed by Sydney Water through the North Head, Bondi and Malabar STPs, and remediating it at a new facility with the aim of generating recycled water that, among other uses,

might be used to supplement diminished environmental flows within existing catchments.

3.3. *Victoria*

A Victorian Government white paper, *Securing our Water Future Together* [5], issued in June 2004, encompasses a most comprehensive integrated water strategy for Victoria and could be considered the most explicit of those thus far developed by the various states. It recognises that urban water supplies comprise all available water resources including recycled water, stormwater rainwater and greywater, and that water should be “fit for purpose”, with not all of it needing to be drinking water. Placing treated water in the drinking water system is not acceptable at present, though technical development and implementation elsewhere will be monitored. Eight committed recycling projects in Melbourne (pastures at the Werribee STP, horticulture from the Western and Eastern STPs at Werribee and Carrum, golf courses at Sandhurst from the Carrum STP, a new course from Yarra Valley’s Whittlesea STP, golf courses at Koorngal and Sanctuary Lakes from the City West’s Altona STP and a dual-urban reticulation scheme in the developing suburb of Aurora) are outlined. A further six are listed as under investigation along with several rural irrigation proposals.

3.4. *Queensland*

The EPA Queensland issued a draft document entitled *Queensland Guidelines for the Safe Use of Recycled Water* [8] in April 2004, designed to encourage and support water recycling that is safe, environmentally sustainable, cost-effective and has the support of local communities. A draft water strategy released by the Brisbane City Council [9] launched in late 2004 and open for public comment until December 15, 2004, proposed:

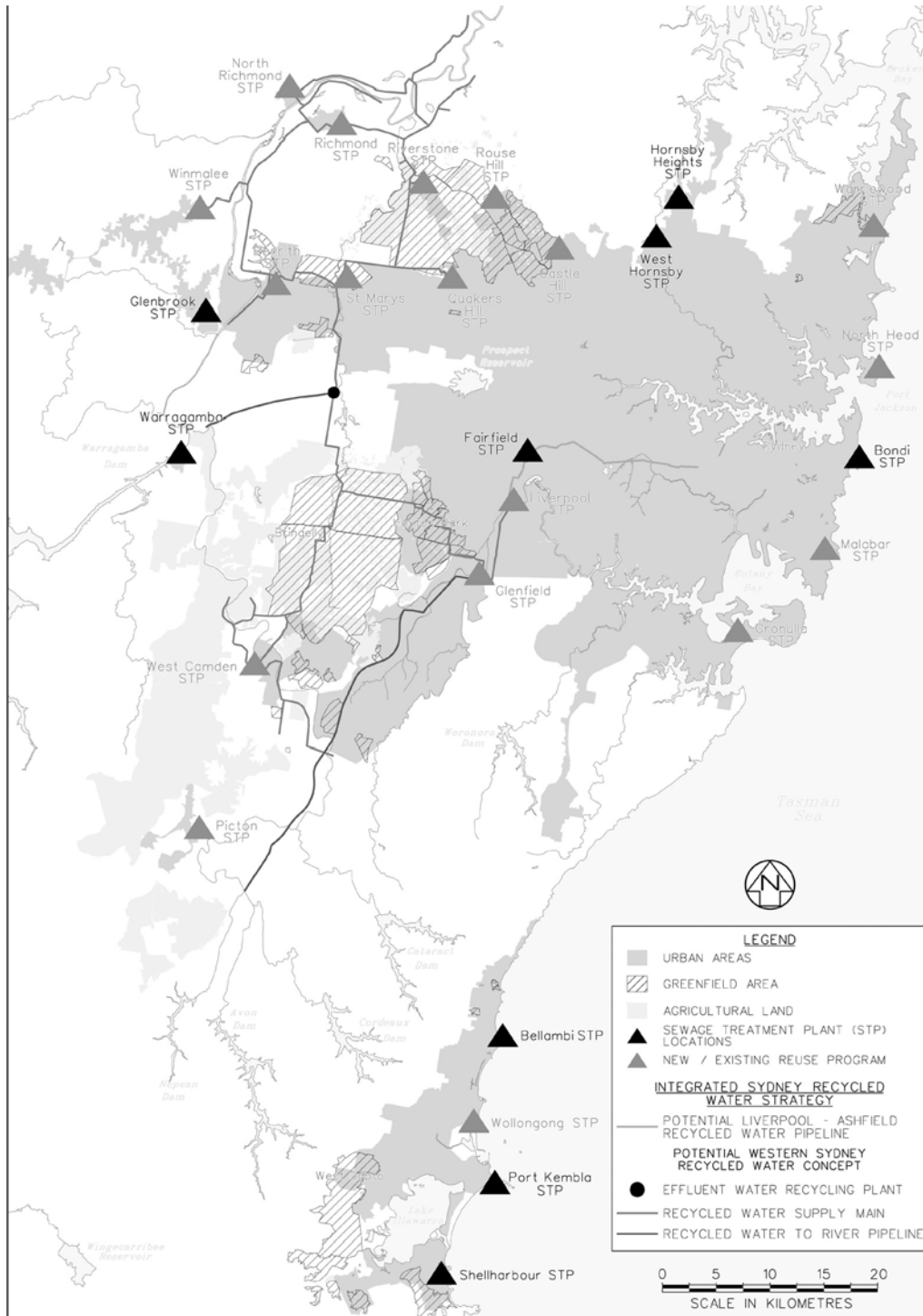


Fig. 1. Sydney’s existing sewage treatment plants and potential sewage effluent recycling schemes to be considered in its Metropolitan Strategy: Recycled Water [6].

- support planning and implementation of one integrated regional water recycling scheme;
- ensuring that all new regional greenfield developments include water sensitive urban design and recycling provisions;
- establishing a water policy and regulatory framework for City plan and developer contributions including provisions for recycled water, greywater, rainwater tanks, stormwater harvesting, groundwater and potable water;
- 20% substitution of urban potable water supply by alternative water supplies
- extensive local area and citywide use of alternate water supply schemes;
- zero wastewater discharge into Moreton Bay;
- 100% of all recycled water to be used sustainably;
- stormwater systems to be capable of harvesting stormwater and improving natural water cycle conditions.

3.5. *South Australia*

The South Australian Government released a draft strategy for “water proofing” Adelaide [10], open for comment until 31 January 2005. The draft identified that there are potentially viable opportunities to provide additional water and benefit the environment. In particular, stormwater and wastewater discharges to Gulf St Vincent contain nutrients and other pollutants that are harmful to the marine environment. It suggests that it is possible to utilise some of these resources and at the same time reduce environmental impact. By 2025 discharges to Gulf St Vincent could be reduced from 2002 levels by as much as 34,000 ML each year. Schemes to substitute mains water use with alternative sources could contribute to this. If the costs were shared amongst all water users, the report estimates them to be equivalent to \$0.05/kL.

On average about 160,000 ML of stormwater, combined with surface water from the Adelaide Hills, flows through watercourses into Gulf St

Vincent. Actual annual stormwater run-off varies significantly depending on weather patterns and may be much higher in a wet year, or as low as 50,000 ML in a drought year. With current technology and opportunities for use of stormwater, it is estimated that by 2025 rainwater and stormwater use could be increased to about 20,000 ML per annum. About 90,000 ML of treated wastewater is generated in Adelaide each year, of which around 70,000 ML is discharged into Gulf St Vincent. It is estimated that wastewater reuse can grow from 14,000 ML in 2002 to more than 30,000 ML per annum by 2025. The reduction in groundwater availability in the Northern Adelaide Plains, where resources have been over-allocated, will be managed through ongoing improvements in irrigation techniques and through the provision of recycled wastewater piped to the region from the Bolivar STP. Localised reuse of wastewater, including sewer mining and greywater recycling will be encouraged. The SA Government will ensure that its long-term water infrastructure plans remain flexible enough to enable the integration of desalination plants in the future.

3.6. *Western Australia*

The Economic Regulation Authority of WA published an issues paper inquiring into urban water and wastewater pricing in July 2004 [11], followed by a draft report by March 2005. The paper contains a wealth of comparative data about Australian water and wastewater systems, noting that the combined household cost of water and wastewater services in Perth is higher than all other capital cities, and that the level of complaints about the water supply is the nation’s highest. Although the WA Water Corporation is installing a 5 ML/d recycling plant at the Woodman Point STP for supplying industrial consumers at Kwinana, and the installation of a 45GL/y desalination plant at Kwinana is noted, the issues paper does not address the topic of pricing of recycled water separately from that of

conventional reticulated mains water. Nevertheless, the Water Symposium held in September 2004 was advised of the commitment to 20% recycling by 2012, with a Water Reuse Steering Committee established, and both a Recycling Strategy having been submitted to Government and an assessment completed of further recycling opportunities for water recycling on the Swan coastal plain. It recognised the issues remaining to be resolved included pricing of recycled water to many consumers, water allocation for aquifer replenishment, aboriginal heritage issues relating to aquifer recharge, environmental impact and consumer perceptions [12]. The strategy involves a progression from industrial recycling and agricultural use, to recycled water replacing urban water where drinking water is not required and ultimately indirect use of recycled water for all forms of urban supply.

3.7. Future targets

Each of the State Governments has announced targets for reduced per capita water consumption and/or increased water recycling for their capital cities. These, together with recent changes in recycling percentages, are given in Table 1. Although recycling in some capitals remains relatively low, there has been some increase in the past 2 years.

Melbourne and Adelaide have shown significant increases in their water recycling percentages since 2002, in Melbourne's case due to class C water from newly installed lagoon systems at the Western treatment plant (Werribee) being used to irrigate cattle pastures in place of the raw sewage previously used from the former land and grass filtration system; and in Adelaide due to continued development of the Water Reticulation Services Virginia scheme based on the Bolivar STP, and the development of the Willunga Basin Water Company scheme derived from the Christies Beach STP.

3.8. National water quality management strategy guidelines

With the recognition that some of the guidelines developed in the 1990s under the National Water Quality Management Strategy are no longer adequate, revisions have been instituted. The Natural Resource Management Ministerial Council was asked to endorse the publication and release of *Guidelines for Sewerage Systems — Sewerage System Overflows*, *Guidelines for Sewerage Systems — Biosolids Management*, and the *Australian Drinking Water Guidelines* at its meeting on 3 December 2004. The latter is especially important, as this HACCP-based guideline will underpin the development of the new high-profile guideline *National Guidelines for Water Recycling — Managing Health and Environmental Risks*.

The recycling guidelines have been developed by three working parties under the joint aegis of the Natural Resource Management and the Environment Protection and Heritage Standing Committees, and managed by a Steering Committee coordinated by the National Environment Protection Council Service Corporation. Components include the Risk Management Framework, the Health Risk Guidelines and the Environmental Risk Guidelines. Progress was reviewed by the Project Steering Committee on 30 January 2005, followed soon afterwards by a Stakeholder Workshop. It was intended that final drafts of the Risk Management Framework, the Health Risk Guidelines and the Environmental Risk Guidelines were available for clearance by the National Resource Management Ministerial Council as a basis for public consultation in April 2005, that public consultation on the complete guideline package including any National Health and Medical Research Council requirements was to occur in mid-2005, with final endorsement of the guidelines by the National Resource Management Ministerial Council in October 2005.

Table 1

Recycled water use as a percentage of sewage effluent treated, and future water consumption and recycling targets of capital cities

State capital	Percent of recycled water use 2001–2002 [3]	Percent of recycled water use 2004 [13]	Future recycling targets [3, 10, 13]
Sydney	2.3	2.6	35% reduction in per capita consumption by 2011
Melbourne	2.0	14	15% reduction in water consumption, 20% wastewater recycling by 2010
Brisbane	6.0	3.5	Increase recycling to 17% by 2010
Adelaide	11.1	19.2	30,000 ML/y (33%) recycling, 2025
Perth	3.3	4.1	20% recycling by 2012
Hobart	0.1	Negligible	10% reduction in water consumption

A revised edition of *Guidelines for the Use of Rainwater Tanks* [14] was released in July 2004 by the enHealth Council, a subcommittee of the National Public Health Partnership, which brings together top environmental health officials at the federal and state/territory level along with representation from the Australian Institute of Environmental Health, the environment and public health sectors, the indigenous community and the wider community.

4. Discussion

Despite the rate of change in management of water resources, much remains to be done. Current water pricing regimes vary between the states, and some send perverse market signals. There are conflicts to be resolved between objectives in water resource conservation, commercial efficiencies, maximisation of capital resources and meeting community social expectations.

Mechanisms must be established to ensure that recycling just does not become an end in itself, and that recycled water actually is used in the most appropriate and cost-effective way. The setting of arbitrary targets and meeting them without regard to other issues may not necessarily

be in Australia's best interest. The National Land and Water Resources Audit [15] showed that returns for water used in 1996/1997 for beef production generated \$14/ML of water applied compared to \$1295/ML for vegetables, \$1276/ML for fruit crops and \$600/ML for grape production. Table 1 indicates that Melbourne's water recycling has increased from 2% to 14% between 2001 and 2004, a seemingly impressive change. If this trend is examined closely, it is found that that in 2003–2004, Melbourne Water recycled 32,968 ML of effluent from its western and eastern STPs, yet used 31,073 ML within those plants and only supplied 1,895 ML to consumers spread between the Werribee Tourist Precinct, the Eastern Irrigation Scheme and those on its south-eastern outfall [16]. Whilst the use of some of the recycled water as process water in STPs is not unusual and makes good economic sense, the throughput from this process still finds its way ultimately to the marine outfalls. Much of the remainder was used to irrigate beef pastures on the Werribee plant site, one of the lowest value uses for irrigation water, and since it was substituted for the raw sewage that was used previously in the former land and grass filtration system that in recent years could not be counted

as “recycling”, would not have generated significantly increased returns. Whilst the pasture production facility also serves as an emergency overflow capacity for the plant, and the Victorian government and Melbourne Water have many innovative new recycling projects being developed, Melbourne’s 2003–2004 figures highlighted the need to develop mechanisms that ensure that recycled water, like catchment irrigation water, is managed with policies that facilitate movement to the highest value uses. The issue of title to recycled water remains to be addressed, and appears to have been skirted around in the Intergovernmental Agreement on the National Water Initiative.

However, the Agreement does provide for many other issues previously raised to be addressed and sets timelines for their achievement. Pricing policies for recycled water and stormwater are to be developed, institutional and regulatory models for integrating urban water cycle planning and management and best practice guidelines are to be prepared, innovative solutions for urban water reform are to be stimulated and environmental water accounting is to be introduced, all to be completed by the end of 2006. Though the states vary in their individual approaches to water resource management and the extent to which water recycling is being encompassed, nevertheless, all have established additional policies and programs that are now being pursued.

5. Conclusions

Australia has made considerable progress in recent years in the use of recycled water and in the development of policies to ensure its safe and effective management. The water shortages and consequent severe water restrictions in the Gold Coast, Sydney, Canberra, Melbourne and Perth at various times during 2001–2004 due to drought have reinforced community interest in making

better use of Australia’s water resources. Interests in water salinity, wastewater and stormwater recycling, use of rainwater tanks and desalination have risen in quick succession over the past 5 y. The scene has been set for greater collaboration among governments and among water supply agencies to learn from each other in the development of innovative policy and technical approaches to best managing our fragile water resources.

Yet the public’s memory of natural resources problems such as droughts and bushfires and its commitment to changes can dissipate after about 5 y. Australia must continue to maintain the pressure for rapid and continuing progress in water reform to ensure that the most effective use of its water resources, including wastewater, stormwater and rainwater, is achieved.

In so doing, water policy agencies must ensure that local and regional communities have a voice in the decision-making processes that lead to finalisation of future water recycling developments and thereby “own” the consequent outcomes. It is not adequate for them just to be presented with communications programs advising them of the decisions that have already been made in their interest. Likewise, water authorities must ensure that recycling and drinking water supplies are managed to the highest possible standards so that there is no risk of the hard-earned community trust being lost by a single incident that will be long remembered and not readily forgiven.

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