Australian Water Conservation and Reuse Research Program – Outcomes of Reviews and a New National Portfolio of Innovative Projects

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ABSTRACT

The first stage of the Australian Water Conservation and Reuse Research Program, consisting of twelve reviews of knowledge gaps and other factors considered to impede improved urban water management have been completed and will be summarised. Reviews of current practice, including water recycling, water sensitive urban design and integrated water system design, factors affecting social acceptance of reuse, health and risk assessment to support new national guidelines, environmental issues, safety of food crops irrigated with reclaimed water, economics including externalities, policy and institutional barriers, new technologies, plumbing regulations, and supplier-user contracts are all addressed. A series of state workshops conducted in May 2004 provide a basis for establishing a national portfolio of innovative demonstration projects that will produce direct local benefits and provide field laboratories for research on the identified priority issues. These icon projects will include harvesting of rain falling on urban areas and stormwater passing through urban areas using a variety of technologies, at a range of scales, and integrated in different ways with water supply, sanitation and groundwater systems. This paper gives a summary of progress of the program and assesses its contribution to coordination of national and international research efforts for the advancement of management of urban water resources of all types.

INTRODUCTION

In September 1999 the Australian Water Association established the Water Recycling Forum, a Special Interest Group, leading to the first national conference on Water Recycling in October 2000. Reviews to assess the volume and proportion of Australian sewage reclaimed and reused, (7% in 1998 and rising), the research activity in this field in 2000 ($2.9M pa and fragmented), and the perceived research needs as expressed by members of the Water Recycling Forum's state representatives were reported (Dillon, 2000). A plenary at that conference resolved to establish a national water reuse research program and provided its charter (Dillon, 2001). A Steering Committee was formed to oversee its development, chaired by John Anderson, Chair of AWA WRF and representatives of AWA, CSIRO and the CRC for Water Quality and Treatment.

A main driver for water reclamation and reuse was environmental considerations, and the Clean Seas Program (Natural Heritage Trust) was a significant factor in this (Reynolds, 2000). (At the 2001 level of treatment and reuse there is still 1,400 GL with 36,000 Tonnes of Nitrogen discharged to sea from STPs of major cities.) Radcliffe (2004) showed that projects that largely allow reuse in new peri-urban horticulture are not commercially viable without a subsidy or land revaluation. Furthermore they do little to increase the security of urban supplies.

The volume of stormwater discharged from urban areas is considerably larger, and less than 5% of this is harvested and reused. Radcliffe (2004) suggests that ownership rights to stormwater and recycled water should be established to provide increased security for investors in water harvesting. Furthermore he recommended greater use of urban wetlands and a commitment to their maintenance for water quality remediation.

Water conservation measures have reduced per capita consumption and associated energy costs in major cities, but with increasing urban populations, increased variability in rainfall, capped catchments, and continuing deterioration of coastal waters in some populated areas, there is no option but to increase water conservation and reuse. At least three cities have set targets for 20% reuse within the next decade (Melbourne, Perth and Canberra). Managing health, environmental, economic, social and legal issues, will require development and implementation of new knowledge, technologies, policies, regulations and in some cases institutional reform.

AWCRRP STAGE 1

Recognising this need for knowledge and a common scientific foundation for conservation and reuse, the specific reviews to be included in AWCRRP stage 1 were defined by the steering committee and a prospectus released to major water utilities, state government departments, local government, regional authorities and others likely to be interested in the water industry. Subscribers became stakeholders in the program and we gratefully acknowledge the 19 stakeholding organisations (see acknowledgements) without whom AWCRRP would not have been able to deliver Stage 1 outcomes.

Table 1. Australian Water Conservation and Reuse Research Program timetable

Oct 00	AWA resolution commissioning reuse research program
Oct 01	Urban water conservation included in program objectives
Sep 02	Steering Committee consensus on research activities in stage 1
Oct 02	First stakeholders invest in program
Jan 03	ATSE Water recycling in Australia review commences (John Radcliffe)
Jun 03	10 more Stage 1 reviews commissioned
Sep 03	Quantitative microbial risk assessment Workshop, Brisbane
Sep 03	AWCRRP designated as an AWA Project of National Significance
Oct 03	Final stage 1 activity commissioned
Dec 03	Draft reports completed and sent to two independent reviewers
Feb 04	Reviews returned to authors
Apr 04	Final reports revised, edited and accepted
May 04	8 workshops run to release stage 1 reports, and identify candidates for national portfolio of innovative demonstration projects & research required
Jul 04	Finalise case for national investment

Table 2. Australian Water Conservation and Reuse Research Program – Stage 1 research activities and international research links

The big picture
Water recycling in Australia.
John Radcliffe, Project Director, Australian Academy of Technological Sciences and Engineering.
A review of stormwater sensitive urban design in Australia.
Tim Fletcher, Ana Deletic, Belinda Hatt, CRC for Catchment Hydrology, Monash University
Integrated urban water management: A review of current Australian practice.
Grace Mitchell, CSIRO

Social acceptance
Factors affecting public perceptions of water reuse.
Murni Po, Juliane Kaercher, Blair Nancarrow, CSIRO

Health and risk assessment

The fate of viruses and other pathogens: health risks in non-potable reuse of stormwater and reclaimed water. *Simon Toze, CSIRO*
Quantitative microbial risk assessment in water recycling (2 day national workshop, Sept 03)
Ted Gardner (Convenor), Qld Department of Natural Resources and Mines

Implementing new technology
Innovation in on-site domestic water management systems in Australia: A review of rainwater, greywater, stormwater and wastewater utilisation techniques
Clare Diaper, CSIRO
Review of national & state plumbing codes to facilitate domestic water reuse
Ray Herbert, Gary Workman, Greg Tink, GreenPlumbers, MPMSA and RMIT University

Agricultural and Environmental Issues
Endocrine disrupting chemicals, pharmaceuticals and personal care products in reclaimed water in Australia.
Guang-Guo Ying & Rai Kookana, CSIRO & David Waite, University of NSW
Impacts on crop quality from irrigation with reclaimed water. *Daryl Stevens, Murray Unkovich, Guang-Guo Ying & Jim Kelly, CSIRO, Adelaide Univ, & ARRIS Pty Ltd*
Impacts on soil, groundwater and surface water from continued irrigation of food and turf crops with reclaimed water. *Daryl Stevens, Murray Unkovich, Jim Kelly and Guang-Guo Ying, CSIRO, Adelaide Univ, & ARRIS Pty Ltd*

Economics and contractual arrangements
The economics of water: Taking full account of first use, reuse and return to the environment
Darla Hatton MacDonald, CSIRO
Exploring the institutional impediments to water reuse
Darla Hatton MacDonald & Brenda Dyack, CSIRO
The reclaimed water agreement manual
Andrew Sherman & Astrid Di Carlo, Russell Kennedy Solicitors

International Links
American Water Works Association Research Foundation, Water Reuse Foundation, Global Research Alliance, European Commission (via Oz-Aquarec), UNESCO, WHO, Global Water Research Coalition

STAGE ONE RESEARCH OUTCOMES

Each of the 11 activity reports below provide a literature review and discuss the research issues at depth. The reports can be downloaded from the AWCRRP web site. The brief summaries below focus on the information gaps that impinge on policy formation, project selection and implementation of innovative demonstration projects, as well as underpinning current water conservation and reuse projects.

Water Recycling in Australia

Radcliffe's (2004) AATSE report comprehensively documents the locations, amounts and types of sources, treatments and uses of reclaimed water and stormwater in Australia and gives prominent examples from overseas. It also summarises current Australian guidelines and distils the drivers, issues and successes associated with recycling of water from sewage treatment plants, rainwater and stormwater. In spite of progress in recent years, only 9.1% of STP effluent was reused in 2001-02 and only about 3% of capital city STP effluent was reused. Much of reuse was to peri-urban horticulture and very little was used to reduce the cities demands on water supply catchments and aquifers, with some notable exceptions for industrial reuse in Brisbane, Newcastle and Perth.

Radcliffe found a number of policy inhibitions to water reuse, including water pricing policies that are inconsistent with increasing the water security of cities and the rural industries in their catchments, and decreasing discharge of pollutants into urban coastal waters. Other issues such as rights of ownership of stormwater, reclaimed water and water banked in aquifers also need to be addressed to facilitate private investment. In some cases fragmentation of management of different urban water sources discouraged integrated water management and water and energy use efficiencies. New guidelines are in development but most states are under-manned and under-skilled to expeditiously deal with innovative ways of managing urban water and thereby throttle the rate of uptake. Radcliffe listed 3 pages of summary recommendations including policy adjustments, investment in demonstration projects, research and public participation in decision-making.

Australian Water-Sensitive Urban Design

The review by Fletcher, Delectic and Hatt (2004) illustrates six case studies for improved management of stormwater in new subdivisions and infill developments, and provides information on the performance of WSUD techniques at these sites. National and state guidelines are reported along with policy, economic and institutional issues effecting adoption of SWSUDs in Australia.

They found several principal weaknesses in current guidance documents:

- lack of attention to non-structural measures to achieve WSUD objectives
- lack of detailed design guidance on WSUD for 'non-specialists'
- WSUD has evolved in isolation from water re-use, and guidelines reflect this
- lack of reliable lifecycle cost-benefit data creates uncertainty for project proponents

Fletcher *et al* concluded that long-term monitoring of performance and maintenance of WSUD techniques is critical to adoption and improvement of designs. For WSUD to become widespread in Australia, research and policy to support the integration of the various components of the urban water cycle are needed.

Integrated Urban Water Management: Australian Case Studies

This report by Mitchell (2004) draws on both preceding studies and focuses on a number of additional projects where water uses from multiple sources are planned. Integrated Urban Water Management (IUWM) considers all parts of the water cycle as an integrated system, all requirements for water, both anthropogenic and ecological and takes account of the environmental, social, cultural and economic perspectives and involves representation of all stakeholders.

The barriers to IUWM combine those of Water Recycling and WSUD and are compounded by the consultation required between different authorities. Knowledge gaps and research needs identified in the review include the following:

- Current guidelines, standards and regulations need to be more flexible to allow innovation whilst protecting public health and the environment.
- Few people have all the required skills and appropriate design tools and there are few decentralised maintenance services
- Water authorities avoid enlarging buried infrastructure and need reliable data for investment decisions;
- Integration of leading edge technologies into existing infrastructure systems needs to be addressed;
- Source control measures, particularly those that require behavioural change of individuals are poorly understood;
- There is a need for risk assessment frameworks for use within IUWM design.

Mitchell proposes research strategies to address these knowledge gaps.

Public Perceptions of Water Reuse

The importance of community acceptance of water reuse is fundamental but a review of research (Po, Kaercher & Nancarrow, 2004) found a conspicuous lack of social research in understanding the basis of public perceptions of water reuse and the psychological factors governing individual decision making processes. However they identified some basic principles for engaging the community in water reuse projects. Firstly offering early and genuine involvement so that the community has the opportunity to shape the project, and consider the full range of options. Where developers or utilities endeavour to convince a community of the value of a reuse project after these decisions have been will have a high probability that the issue will become political and the chances of acceptance are more random.

Areas recommended by Po *et al* for research include developing an understanding of the effect of the following factors in influencing people's decisions to accept or reject use of recycled water:

- Understanding judgment strategies
- Identifying the factors that influence people's risk perceptions
- Investigating the role of trust in the authorities and the limits of scientific knowledge
- Examining the different ways and situations where factors such as health,
- Environment, treatment, distribution and conservation issues can have an impact
- Examining people's sensitivity in regard to the disgust emotion
- Understanding why different sources and uses of recycled water can have influence
- Understanding how perceived economic advantages can facilitate decisions
- Identifying possible environmental justice issues
- Examining the effectiveness of models of planned behavior in predicting decisions

Pathogens and Health Risk Assessment

A review by Toze (2004) identified from a large body of literature, rates of inactivation of pathogens (viruses, bacteria, protozoa, and helminthes) under various environmental conditions. One log removal times (time for a population to reduce to 10% of its initial size) were generally longer for viruses and protozoa than for commonly used indicator bacteria. Detection methods are improving with advances in genetic techniques (such as PCR) and recoveries can be reliably quantified using new labeling methods. Under some identified conditions, regrowth of pathogenic bacteria may also occur.

Toze recommended that research and further information is needed on

- development of data for use in risk assessment, such as Hazard Analysis and Critical Control Points (HACCP) protocols
- rapid and reliable detection of microbial pathogens in effluent streams,
- improving the understanding of effectiveness of engineered treatment processes for removal of pathogens
- understanding the effectiveness of natural treatment processes for pathogen removal and incorporating these in risk assessments
- epidemiological studies on individual and community resistance to infection
- better integration of research on pathogens with sociological research on community decision making processes.

A workshop on **Quantitative Microbial Health Risk Assessment in Water Recycling** was held in Brisbane on 3-4 September 2003, convened by Ted Gardner, Qld Department of Natural Resources and Mines, and sponsored by AWCRRP, Water Services Association of Australia, Gold Coast Water and the CRC for Water Quality and Treatment, and attended by 50 delegates and included five international speakers. The clear message from the workshop was that quantitative microbial risk assessment has advanced to the extent that it can be relied on for reuse project approval decisions by regulators. Detection methods are improving, for many pathogens there is adequate data on ingested dose responses and for evaluating the effectiveness of removal in treatment systems, and statistical packages designed to provide risk assessment and uncertainty analysis are well advanced. In the face of uncertainty this can be a useful tool to identify which information to collect to most efficiently reduce uncertainty to acceptable levels, and to assist in developing HACCP operational plans.

The principles and numerous applications were presented and exercises given to help increase understanding of the material. Feedback from attendees indicated that the information presented in the workshop was valuable. Regulators were likely to adopt the methods described in licensing water reuse operations, and researchers welcomed a common framework to integrate and interpret experimental results and give better focus to future work.

Innovative Domestic-Scale Water Management

Diaper (2004) reviewed innovative technologies commercially available in Australia for improved management of household rainwater, stormwater, greywater and in-situ reclaimed water. She considered components such as harvesting, storage, treatment, monitoring and control, and maintenance, and documented their reported performance with respect to potable water savings, end uses of saved water, operational and maintenance requirements, and water cycle and other environmental impacts. Rainwater detention innovation has been spurred by recent changes in regulations in some suburban areas which now permit or mandate this for building approvals in catchments where stormwater flood risk is increasing due to urban infill development. In-house uses such as in hot water services, toilets and laundry of water from multi-purpose storages, such as modular fence and wall panels that store water, or flexible bladder tanks and eaves storages allow detention where space is unavailable for conventional cylindrical tanks. Storage size and overflow position depends on the volumes required for flood detention and water supply. Decentralised wastewater collection, treatment and distribution systems are also proliferating and in some areas STED (septic tank effluent disposal) schemes have proved economic. Grey water and stormwater treatment technologies are also emerging but uptake is limited by cost to niche markets.

Specific areas recommended for research by Diaper include assessment of;

- social, economic, and environmental aspects of domestic water technologies

- economic scales of application of grey water and sewage technologies
- effect of rainwater treatment methods on water quality
- health and environmental impacts of large scale uptake of grey/waste water for irrigation
- options for reducing salinity, sodicity, phosphorus and boron content of greywater
- public perception of alternative sanitary appliances
- emerging innovative technologies including monitoring and control systems

Plumbing regulations affecting domestic-scale water conservation and reuse

A review of plumbing regulation related to domestic-scale rainwater harvesting and use, sewage treatment and greywater (sullage) was undertaken by Herbert, Workman and Tink (2004). They found that the plumbing industry regulations were excessively complex, in part due to the absence of a single national regulatory body and the large number of regulatory stakeholders in each state, with different regulations applying even between adjacent local government areas. Recent amendments to the National Plumbing and Drainage Code of Aust AS/NZS 3500 have included; pipe identification/ labelling for water recycling, water uses other than potable water (non drinking water services)- materials, products and installation, and testing, commissioning, and backflow control. A new Plumbing Code of Australia (expected June 2004) will help facilitate national product approval and define plumbing standards to be used. These need to be embraced by each state and supported with continual professional development for plumbers, for example through programs such as *GreenPlumbers*. The current code caters for recycled water treated off-site and returned for domestic use in toilet flushing and garden irrigation as long as the plumbing system meets the current back flow and cross-contamination requirements and is identified (lilac coloured) with signage in place and child-proof tapware. However some health and environmental authorities are currently restricting the possible use of such supplies.

Current Standards were considered too prescriptive in some aspects and inclusion of a range of viable options would be valuable for plumbers, considering the wide range of requirements between new developments, existing homes, and apartments, and the variety of climate conditions, topographic relief, soils, and sizes of sites.

Current gaps and deficiencies that need to be addressed in future codes include;

- rainwater for hot water heating for domestic use
- rainwater tanks connected for multiple purposes that include toilet flushing
- greywater regulations are particularly fragmented and unclear, and a firm common basis is urgently needed.
- there is no provision for separation of sewage and sullage pipes until they reach the outside of a building to enable future opportunity for reuse
- there is no provision to merge greywater and rainwater systems for irrigation purposes
- Although guidance on on-site wastewater treatment is clear, the sustainability of reuse of wastewater treated on-site does is not addressed.
- Improved risk assessment would open opportunities for new housing and renovations to have much more flexible and efficient water management that would need to be reflected in changes to the national Code.

Endocrine disrupting chemicals, pharmaceuticals and personal care products

Ying, Kookana and Waite (2004) undertook a literature review on trace organic constituents in recycled water in Australia. The literature is clear that there are many chemicals and naturally produced hormones contained in sewage that have been detected at very low concentrations. There is evidence of their effects on populations of shellfish, fish, frogs and alligators where partially treated sewage is discharged directly into surface waters. There is also a growing body of evidence for the degree of effectiveness of removal of these

substances in various wastewater treatment and water reclamation processes, and for their rates of environmental biodegradation and inactivation. There is no evidence to date that reclaimed water appropriately treated and exposed to natural processes in catchments and aquifers have any impact on human health, and standard risk assessment procedures accounting for exposure pathways support this. However, recognising the importance of environmental and health considerations, vigilance in risk management demands research to fill current knowledge gaps. These are recorded under the categories; sources, fate, receptors and risk assessment.

Sources

- Identify abundance of selected groups of endocrine disrupting chemicals (EDCs) and pharmaceutically active compounds (PhACs) and personal care products (PCPs) in Australian wastewater. Priorities for these groups have already been produced on the basis of potency and degradability.
- Adapt and develop standard and appropriate monitoring protocols and sensitive analytical techniques.
- Assess removal efficiencies of the current treatment technologies and develop technologies that are more effective and targeted at removing these compounds.
- Understand the key sources of these substances in Australian wastewater, and develop intervention/mitigation strategies to manage sources.

Environmental Fate

- Establish rates of breakdown of the compounds under Australian environment conditions, especially covering the scenarios of wastewater reuse, e.g. aquifer storage and recovery; irrigation of crops and other uses.
- Sorption, release and mobility in soil, sediment and water need to be established
- Bioavailability, bioconcentration/bioaccumulation aspects need to be better understood
- Determine the characteristics and stability of breakdown products

Receptors

- Adapt international testing protocols to Australian fauna and flora
- Bioassay and biosensors based on the native organisms (e.g. fish species) need to be developed
- The combined effect of various xenoestrogens on endocrine disruption needs to be properly understood
- Validation of laboratory testing under field environments

Risk assessment

- A first tier risk assessment relevant to water reuse be undertaken. It is recognised that the uncertainties are larger than for microbial risk assessment, but these tools may help to focus research where it is most needed.
- A communication strategy is needed to deal with “alarmist media” sensationalising this issue.

Effects of Reclaimed Water Irrigation on Soils, Groundwater and Surface Water

Stevens, Unkovich, Ying and Kelly (2004) reviewed impacts on soil, groundwater and surface water from sustained irrigation of food and turf crops with reclaimed water. They found that the short term perceived issues have been manageable at the large number of reclaimed water irrigation schemes operating successfully in the world. Long-term environmental issues were identified and this suggests the following research will be valuable;

- A comparison of the quality of reclaimed water and other irrigation waters
- Improved risk assessment for trace organic substances in reclaimed water

- Better tools to predict the potential for leaching of nitrate, and developing strategies to mitigate this
- Developing practical tools for irrigators to monitor leaching of nitrate and soil sodicity
- Identification of appropriate thresholds for inorganic contaminants in soils particularly heavy metals and metalloids
- Better assessment of the relative boron tolerance of crop species
- Improved strategies to manage salt.

Reclaimed Water Irrigation Effects on Crop Quality

Stevens, Kelly, Unkovich and Ying (2004) reviewed impacts on crop quality from irrigation with reclaimed water. In brief they found that many studies have been performed but none have found any evidence of adverse impacts on the health of humans consuming food grown with reclaimed water. In the cases studied there were guidelines for use of reclaimed water and withholding periods before harvest for crops eaten raw. However growers required additional knowledge and skills when using reclaimed water because of nutrients, salt, metals and pathogens present in the water that require some modification of conventional farming practices. Acceptance of produce by markets and market chains was found to require only the sanctioning of produce by regulatory bodies. Provision of factual information was generally sufficient for wholesaler and consumer acceptance. The quality assurance given to reclaimed water may in fact be an advantage, given the lack of QA of other irrigation waters. A watching brief is required on emerging chemicals of concern, for food and human health quality and crop yield. Salt management is seen to be the biggest concern in the long term for irrigation of recycled water on food crops and turf.

Economics of Water Conservation and Reuse

Hatton-MacDonald (CSIRO) reviewed the economic framework for decision making and pricing of water and reclaimed water (see AWCRRP web site) in a report entitled ”The Economics of Water: Taking Full Account of First Use, Reuse and the Return to the Environment’. Part of taking account of the full price of water under National Competition Policy is including externalities. Noting that there are fixed and variable costs in the supply of water, sewerage and recycled water, Hatton-MacDonald provides a unified pricing framework that applies to these three water management functions, taking account of the fixed and variable externalities associated with each. For example there is a fixed environmental cost associated with having a dam on a stream, in addition to the environmental flow cost that may be related to volume of use. Similarly there may be fixed and volumetric costs associated with discharge of treated STP effluent into coastal waters where the volumetric cost may be inversely related to the level of treatment for constituents which are not environmentally benign.

Replacing mains water with recycled water has the effect of reducing the volume of mains water taken from catchments and of sewage discharge to receiving waters so taking variable externalities into account, along with the cost of production, may give quite different price structures than currently apply. Currently only Canberra explicitly includes a resource charge in abstracting water from its catchment (20c/KL). The report recognises the difficulties in quantifying externalities particularly where there are multiple users or dischargers, and recommends that further research is required on pricing externalities and addressing the consequences and expectations of changes in relative prices of water utility services.

Institutional Impediments to Reuse

In a review by Dyack and Hatton-MacDonald (CSIRO) of institutional impediments to water conservation and reuse, the main impediment identified was a lack of coordination of policies and regulations that govern water conservation and reuse. The basis may relate to uncertainty in government agencies attempting to manage health and environmental protection with efficiency of water resource use. A range of specific problems and knowledge gaps were identified for which solutions need to be found. These include:

- How to facilitate flows of information to ensure that policy, regulation and practice change with an evolving state of knowledge,
- Legislative and licensing systems used to define water access are often far from perfect with rights being incompletely specified.
- Most reuse projects are subsidised where the costs of production are markedly higher than return revenue from direct supply charges to consumers. This is due to a perception that the reclaimed water is of inferior quality and there is unwillingness to pay 'higher charges'. There is also a lack of full cost pricing in a way that reflects the value of externalities associated with water use (as detailed in the previous report).
- Price is a management tool, and avoidance of perverse outcomes, such as addressed by Chapman (2003) in reconciling water conservation with consumer charges, utility revenue and dividends to state governments who are attracted to both high profits and water conservation.
- Stormwater management has tended to focus on disposal at minimum cost. Viewed from a local council perspective, stormwater management has historically been a flood management problem not an opportunity to make money through harvesting and use.
- When water is injected lawfully into an aquifer, the rules are not clear on who owns the injected water. Without the rules being clearly set out, risk and uncertainty may limit private sector and local government investment.
- At the state level, uneven or excessive application of the precautionary principle by state environmental protection authorities (EPAs) has the potential effect of inhibiting innovation in development proposals. There are a number of situations where exemptions to regulations and rules are commonly sought and approved, suggesting that the regulatory system is inefficient or that current policies need to be revised.
- For greywater, state authorities and local councils are reluctant to deal with permanent greywater interception and reuse in anything other than a case-by-case basis. Health and environmental affects, nuisance and potential adverse affects on sewage treatment plants create uncertainties that are large barriers.
- Inescapable fixed headwork charges for developers present a disincentive to water reuse. While providing a revenue stream to cover costs for utilities, the charges represent a barrier to innovative design.
- Rainwater tanks, stormwater reuse, ASR projects and third pipe systems require on going maintenance and investment which may have uncertain costs and may require servicing from companies that do not yet exist.
- Reuse projects are evaluated at the project level without accounting for benefits and costs across cities and catchments.

Legislation, regulations, and agreements for supply and use of reclaimed water

A manual on supplier-user contractual arrangements has been prepared by Andrew Sherman and Astrid Di Carlo of Russell Kennedy & Partners (solicitors). The manual establishes the basis for reclaimed water agreements, predominantly for reclaimed water from Sewage Treatment Plants. It sets out the nature of the relationship between suppliers and purchasers of reclaimed water and the principles establishing their responsibilities; the legislation and regulations in relation to the supply and use of reclaimed water as this affects suppliers, purchasers and owners of land; it identifies a range of factors and circumstances to be covered in reclaimed water agreements and the preferred procedures for addressing

them; provides four examples of supplier-purchaser agreements that can serve as models or templates for agreements; advises how laws affecting such agreements may differ between jurisdictions and therefore any different or additional provisions that may be required in any Australian state or territory to achieve the same ends; provides a summary of training programs and resources available to assist suppliers and purchasers.

Factors accounted for in regulations include public health protection, animal health, agricultural production, and environmental protection. In all instances, Environmental Management Plans must be produced and agreements for reclaimed water must refer to these. Monitoring and auditing of the reuse scheme must be undertaken to prevent any contamination or illegal use that might lead to health and environmental concerns. The manual is intended to be a comprehensive document that provides detailed and reference information on a broad range of legal responsibilities and requirements of Australian suppliers and users of reclaimed water, and aims to assist in addressing this issue more expeditiously in future.

Other Related Reviews and Research

The National Water Quality Management Strategy is currently developing guidelines for use of a range of sources of water including rainwater, stormwater greywater and reclaimed water for non-potable purposes. This is intended to be in draft form by end of 2004. The Water Engineering Committee of The Institution of Engineers, Australia (2003) has orchestrated development draft Australian Runoff Quality guidelines that address water sensitive urban design and stormwater detention and use. Horticulture Australia has appointed a national coordinator for Water Reuse in Horticulture with a view to providing guidance for horticulturalists and their advisors. A related Land and Water Australia project on potential impediments to water reuse in horticulture is also underway. Furthermore the Cooperative Research Centre on Irrigation Futures has an urban irrigation program which intends to include urban irrigation with recycled water within its research agenda. The Cooperative Research Centre for Water Quality and Treatment current also has projects in its Sustainable Sources program to initiate an evaluation of rainwater quality and to develop a data base on urban uses of water, and treatment processes for water recycling and their reliability. The partners of that CRC also support a Wastewater Management program, and two of its four proposed research projects relate to biofilms in reclaimed water pipes and potential effects on water reuse of chemicals used in wastewater treatment. There are a number of other projects underway and programs of a larger scale addressing urban water management in Victoria, Western Australia and Queensland. The Sydney Water program 'Every Drop Counts' for urban water conservation in industry, also has huge potential at a national scale.

International Coordination of Research

AWCRRP has Memoranda of Understanding with American Water Works Association Research Foundation, WateReuse Foundation, World Health Organization and UNESCO and has collaborative arrangements with Global Research Alliance, Global Coalition for Water Research and via Oz-Aquarec with the European Commission. At a meeting convened in Sydney and subsequently ratified by the above collaborators, it was agreed that all Australian public domain research outcomes on water conservation and reuse will be posted on or linked to the AWCRRP web site and the relevant web pages of other international organisations will also be linked. Furthermore as new research reports are produced we will post information on the AWA Water Recycling Forum's newsletter and also to the newsletter of the IWA Special Interest Group on Water Recycling and Reuse. AQUAREC, centred at University of Aarchan, Germany, will act as a repository or hub for European research, and WateReuse Foundation intends fulfilling this role for United States and other GCWR research.

NATIONAL PORTFOLIO OF INNOVATIVE DEMONSTRATION PROJECTS

Eight workshops were run in each Australian state and mainland territory during May 2004 to present the results of AWCRRP Stage 1 and to seek nominations of projects for a national portfolio of innovative demonstration projects on water conservation and reuse (Figure 1). More than 400 people attended and at least 140 potential projects were suggested. This initiative emerged in response to recommendations of an independent working group of the Prime Minister's Science Engineering and Innovation Council in its report 'Recycling Water for Our Cities', prepared for PMSEIC's 11th Meeting, 28 Nov 2003, and to the National Water Initiative's concept proposal to renew efforts for urban water policy reform and encouragement of more efficient and sustainable water use in cities.

Two types of projects emerged from the AWCRRP workshops and these are broadly classified as on-the-ground projects and non-structural projects that will enable improved policies. On-the-ground projects included specific examples of industrial water recycling, stormwater conservation and reuse, rainwater management for hot water services, greywater treatment and use for domestic irrigation, and reclaimed water projects including for saline intrusion barriers, landscape and horticultural irrigation and 3rd pipe recycling ranging up to $45M per project were proposed and spanned every city. In each case the research essential to achieve projects success was identified. Examples of non-structural projects included developing further information to support human health and environmental protection policies, mapping of aquifer systems for storage potential, defining rights to rainwater, stormwater, and sewage effluent, quantifying externalities for pricing reform and institutional strengthening to address the range of interconnected issues, expanding training available to plumbers concerning preventing cross-connections and backflow prevention and nationalising implementation of plumbing codes.

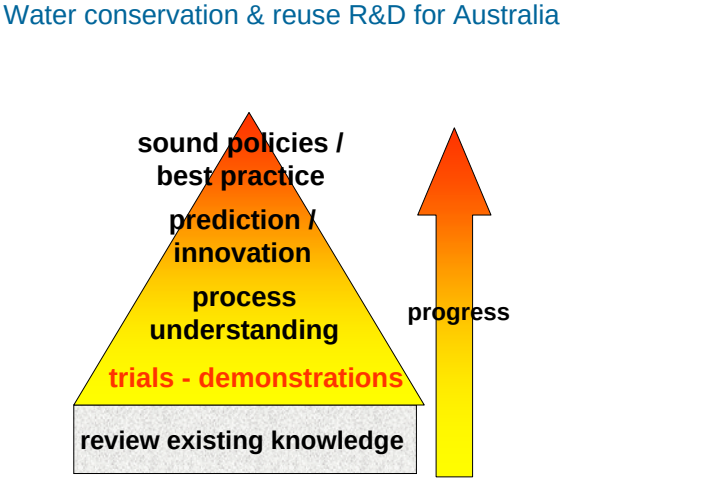

Figure 1. AWCRRP transition from Stage 1, laying common national scientific, technical and economic foundations for water conservation and reuse to forming a national program of innovative demonstration projects and the research required to support these, including reasearch to support enabling policy changes.

The objective is to ensure that innovative projects are implemented with the necessary research base to get full value from each investment and enabling use of results elsewhere in Australia and overseas. An expanded stakeholder network, including utilities, technology providers, and government at all levels will be sought to successfully complete the demonstration program and the underpinning research according to the agreed priorities.

CONCLUSIONS

Water conservation and urban reuse will be essential if Australian cities are to continue to grow without imposing unacceptable stresses on the water environment and efficient food production. Because of the significance of the changes to institutions, regulations, pricing, technologies, social attitudes, planning and capital investment in order to benefit from this new frontier of water management, a coordinated research program has commenced, and will need to be continued. There is much to be learned to give confidence that new systems for water management are commercially responsible, protect public and environmental health, and are socially acceptable. A few areas of research need go no further for the present, as the information gap no longer constitutes a barrier to progress.

However it would be irresponsible to make commitments to new water systems and infrastructure without a sufficient level of confidence that a relatively small research program can achieve. Of the Australian major water utilities revenue of $4.7Billion (WSAA 2001), the annual capital investment of $1.8Billion ($0.3Billion from subdivider/developers) demonstrates a substantial investment in long-term assets of urban water systems. Dividends returned by these utilities to governments amount to $0.8Billion. A comprehensive research program is affordable, especially if Australia focuses its research resources wisely. A plan for a national portfolio of iconic demonstration projects is in preparation and will assist in further focusing and integrating the research. Australian utilities, government at all levels, technology providers and researchers will need to move on from targeted investigations that produce locally applicable benefits and embrace a broader view of generating knowledge and skills that can be widely applied. Uniting as a nation on this and linking effectively into international research programs we will multiply the benefits of research investments, increase exports, and take a leading role in the achievement of UN millennium goals for water supply and sanitation.

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