Professional Perceptions on Institutional Drivers and Barriers to Advancing Diverse Water Options in Australia

M.A. Farrelly[1*] and R.R. Brown[1]

National Urban Water Governance Program,
School of Geography and Environmental Science, Monash University
Victoria 3800 Australia

* *corresponding author, email* Megan.Farrelly@arts.monash.edu.au

ABSTRACT
The adoption of a diverse water supply approach in Australia is a high policy priority; however, the rhetoric is often not translated into effective implementation. Although commentators have long pointed to the social and institutional aspects of urban water management as major constraints, many have failed to collect empirical, experience-based evidence to substantiate and reliably scope such constraints. Over 1000 urban water professionals in three Australian capital cities responded to an online questionnaire survey in late 2006. Framed through the concept of receptivity, the perceived importance of diverse water sources, uses and technologies were tested alongside a range of influencing factors thought to enable and/or constrain technology adoption. The analysis revealed professionals exhibited high association with diverse water sources and technologies within a fit-for-purpose context, yet professionals are also highly concerned about potential public risks in relation to more decentralised approaches. Further, a range of governance factors including regulatory conditions, management systems, and institutional arrangements were all revealed as highly constraining new practices, despite the differing institutional contexts of the three case study cities. Institutional capacity building focused on addressing institutional learning, risk sharing and adaptive experimentation will be essential for the realisation of diverse water supplies across Australian cities.

KEY WORDS
receptivity; social and institutional; barriers and drivers; diverse water sources; technology adoption

INTRODUCTION
Sustainable urban water management (SUWM) is both a philosophical and ideological approach requiring integrated and innovative approaches. While urban water policies are beginning to reflect this understanding, the rhetoric is often not translated to implementation; indeed, many demonstration projects are not replicated and remain isolated (Harremoes, 2002; The Barton Group, 2005; Mitchell, 2006). Despite the new philosophy, urban water management remains complex and fragmented, relying on traditional, technical management approaches. The difficulty involves shifting deeply embedded and well-understood practices that operate predominantly at centralised scales, towards more diverse and reflexive approaches at multiple scales. For example, a recent report to the Australian Government entitled *Water for Cities: building resilience in a climate of uncertainty* (PMSEIC, 2007:11), calls for a 'share portfolio' of diverse water source options supported by centralised and

decentralised water infrastructure. Similarly, Mitchell (2006) considers integrated urban water management requires a suite of 'new' approaches including demand management, non-traditional water resources, fit-for-purpose use and decentralised systems.

Contemporary research has identified the most significant barriers to transitioning towards more sustainable urban water management practices as social and institutional, rather than purely technological (Maksimović and Tejada-Guibert, 2001; Brown, 2005; Schäfer *et al*., 2006). Indeed, Brown and Farrelly (2007) determined, following an extensive literature review, that many of the barriers identified are systemic and embedded within the broader institutional framework and reflect issues related to community, resources, responsibility, knowledge, vision, commitment and coordination. In addition, their review identified very few meaningful strategies for overcoming the barriers highlighted. Drivers for sustainable urban water management, on the other hand, are more obvious due to increasing demand for potable water by growing populations, aging and degraded infrastructure, and increasing climate variability (Birrell *et al*., 2005; Engineers Australia, 2005; IPCC, 2007). However, when examining the direct drivers for pursuing diverse water supplies and associated technologies, the situation is less clear.

National and international urban water industry commentators suggest that to overcome implementation inaction a range of institutional barriers must be addressed (Rauch *et al*., 2005; Brown *et al*., 2006). Yet in Australian cities, like others around the world, significant national reform efforts have largely targeted efficiency, regulation and the delivery of services (McKay, 2005). With ongoing reforms planned, it is vital that the knowledge and experience of professionals currently working within the urban water sector are drawn upon to inform the design of more effective reform efforts. Yet there is limited research that draws on the insights from urban water professionals who encounter these drivers and barriers in their strategic and/or operational experiences (Brown and Farrelly, 2007). Therefore, this paper seeks to address this deficit by presenting the outcomes of a social science research project undertaken to examine professional perceptions of the drivers and barriers to advancing diverse water sources and technologies in Australia.

The paper documents one component of a larger research project aimed at providing a credible knowledge base in support of advancing sustainable urban water management in Australia through the National Urban Water Governance Program at Monash University. The full details of this research project are presented in an industry report by Brown *et al*. (2007), and available at www.urbanwatergovernment.com.

METHODS

A quantitative, comparative case study approach was undertaken and involved three metropolitan regions of Australia: Brisbane, Melbourne and Perth. These capital cities share similar drivers for re-examining their water management options and collectively, represent three distinct governance structures, reflecting the breadth of institutional arrangements across Australian cities. An online questionnaire was available to urban water professionals in November 2006. The questionnaire aimed to test the level of professional receptivity to 1) augmenting conventional potable water supplies with diverse water sources, 2) using diverse water sources in a fit-for-purpose context, 3) adopting appropriate technologies to supply diverse water sources, and 4) the level of influence eleven social and institutional factors have on constraining or enabling technology adoption. Finally, questions were asked about the effectiveness of their institutional arrangements, levels of perceived stakeholder commitment to total water cycle management and projected timeframes for the development of diverse water supply options.

The preliminary qualitative research revealed that professional language for sustainable urban water management practices varies significantly across Australian cities; to achieve consistency amongst the case study cities, 'total water cycle management' was adopted and defined in the questionnaire as:

- total water cycle management recognises that our water services – including water supply, sewerage and stormwater management – are interrelated and linked to the well-being of our catchments and receiving waterway environments (including surface and sub-surface). It involves making the most appropriate use of water from all stages of the water cycle that best deliver social, ecological and economic sustainability.

The urban water variables tested are listed in Table 1. The social and institutional factors tested in the survey are listed in Figure 1. The technologies tested were rainwater tanks, onsite greywater systems, third-pipe systems in greenfield and existing developments, and indirect and direct potable reuse schemes. Demographic data were analysed using chi-square tests to identify significant differences amongst respondents within a range of categories: professional background, level of experience in urban water management, level in organisation, government status, major versus minor role in urban water management, and stakeholder group.

Table 1. Urban Water Variables Tested in the Survey.

WATER SOURCES						
Rainwater	Stormwater	Sewage	Greywater	Seawater	New Dams	Water Trading
WATER USES						
Drinking	Indoor Household Use	Outdoor Household Use	Public Open Space	Industry	Environmental Flows	
WATER SOURCE TECHNOLOGIES						
Rainwater Tanks	On-site Greywater Systems	Third-pipe in Existing Areas	Third-pipe in Greenfield Areas	Centralised Indirect Potable Reuse	Centralised Direct Potable Reuse	

The concept of *receptivity*, drawn from 'innovation and technology transfer policy' studies (Jeffrey and Seaton, 2003/2004), was applied as the analytical framework for assessing the professional community's readiness to develop a diverse water source approach. The philosophy behind receptivity considers that for a new technology or initiative to be successfully implemented, any reform approach must be designed from the end-user or recipient's point of view. The value of the receptivity concept is that it assists with locating the types of policy mechanisms needed to improve practice. Receptivity comprises four important attributes that policy makers and strategists should be knowledgeable of from the recipient's perspective, these are:

1) **Awareness** - individual or organisation is aware of a problem and need for a solution.
2) **Association** - individual or organisation relates to the potential benefits, enough to expend effort to apply solution(s).
3) **Acquisition** – individual or organisation has requisite skills, capacities and support to implement solution(s).

4) **Application** - incentives are available to encourage the individual or organisation to implement solution(s).

The social and institutional variables tested in the on-line survey that were assessed in relation to the four receptivity attributes are listed in Figure 1. The online survey was structured so that each question would provide data on one or more of the receptivity attributes. A high level of awareness of the need for more sustainable urban water management practices amongst the professional community was assumed.

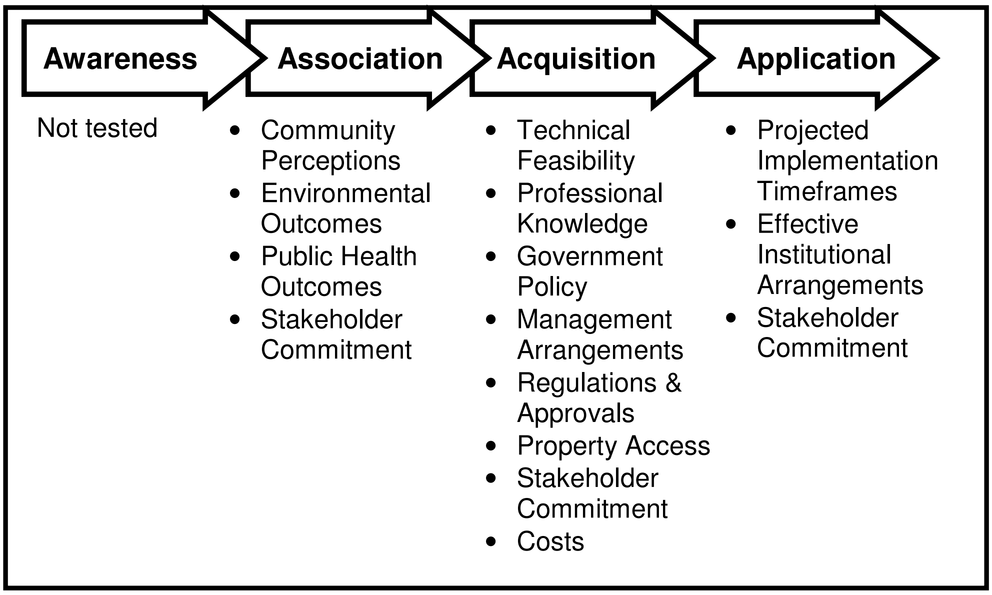

Figure 1. Social and Institutional Variables that Underpinned the Receptivity Assessment

RESULTS

Over 1000 urban water professionals completed the survey: 307 in Brisbane, 424 in Melbourne, and 310 in Perth. A good representation of respondents from each of the stakeholder organisations involved in urban water management in each city was achieved. The majority of respondents had more than 11 years experience in the sector with 22% of respondents having less than 2 years experience and 19% with more than 20 years experience. The majority of respondents had professional training in engineering and/or science while the remaining respondents had professional training in business and/or economics followed by planning. A similar distribution of respondents in each city indicated that they worked in the specialty fields of water supply, stormwater/waterways and sewerage. Of note, 12% of respondents in each city indicated they worked in the area of 'total water cycle management' that encompasses each of the traditionally separate water streams. Over 40% of respondents in each city indicated they worked in design/technical/operations and over 30% in strategy/policy. Overall, this is relatively representative of the Australian urban water sector.

The survey was designed to test differences based on experience, professional background, stakeholder representation and city. However, there were very limited statistically significant differences from the correlation testing, with the exception of some minor differences in perspectives between respondents with professional backgrounds in planning and engineering. Overall, there were very few differences amongst respondents within each city. Therefore, the overall results suggest that the 1041 respondents of the urban water profession are largely a cohesive professional community with limited differences in receptivity to diverse water sources. City specific results are detailed in Brown *et al.* (2007).

Association & Acquisition

On average, across the three cities, urban water professionals rated rainwater, greywater, stormwater and sewage as the most important diverse water supply options for supplementing conventional supplies. On the other hand, as demonstrated in Table 2, new dams, seawater and groundwater received low levels of support. Table 2 presents the combined distribution of responses to 'very high' and 'high' importance ratings for diverse water source options.

Table 2. Perceived Importance of Developing Diverse Water Sources.

0-19%	20-39%	40-59%	60-79%	80-100%
New Dams	Seawater Groundwater	Water Trading	Greywater Stormwater Sewage	Rainwater

Professionals supported the concept of fit-for-purpose use. For example, respondents supported using rainwater and groundwater for drinking, but indicated low support for using greywater, stormwater, sewage and seawater as drinking sources (Table 3). Yet, for use in public open spaces, respondents considered stormwater and sewage were of high importance, greywater, rainwater and groundwater were of average importance and seawater was of low importance.

Table 3. Professional Receptivity to Diverse Water Source Uses.

	VERY LOW n = 0-19%	LOW n = 20-39%	AVERAGE n = 40-59%	HIGH n = 60-79%	VERY HIGH n = 80-100%
DRINKING	Greywater Stormwater	Sewage Seawater	Rainwater Groundwater		
INDOOR HOUSEHOLD USE		Greywater Stormwater Sewage Seawater Groundwater		Rainwater	
OUTDOOR HOUSEHOLD USE		Seawater	Sewage Groundwater Stormwater	Rainwater Greywater	
PUBLIC OPEN SPACE		Seawater	Rainwater Greywater Groundwater	Stormwater Sewage	
ENVIRONMENTAL FLOWS		Greywater Seawater Groundwater	Rainwater Sewage	Stormwater	
INDUSTRY			Rainwater Greywater Seawater Groundwater Stormwater	Sewage	

As shown in Table 4, urban water professionals identified public health as a common association barrier and numerous other acquisition barriers to advancing the adoption of diverse water source technologies. The only driver was that environmental outcomes (association factor) were perceived as an important influencing factor for the uptake of on-site and third-pipe technologies. Community perceptions, while identified as an encouraging factor in the adoption of rainwater tanks in all three cities, were also considered a barrier to the implementation of on-site greywater systems, and indirect and direct potable reuse schemes. Public health outcomes were considered an outright barrier in all three cities for all six technologies types (with the exception of rainwater tanks in Brisbane and Melbourne where this factor was considered a neutral influence).

Table 4. Drivers and Barriers to Diverse Water Supply Technologies.

TECHNOLOGY TYPE	BARRIERS	DRIVERS
Rainwater Tanks & Greywater Systems (onsite)	- Public health outcomes - Management arrangements & responsibilities - Regulation & approval processes - Capital & maintenance costs	- Environmental Outcomes
Third-pipe Systems (greenfield and existing)	- Public health outcomes - Management arrangements & responsibilities - Regulation & approval processes - Capital & maintenance costs - Property access rights	- Environmental Outcomes
Indirect & Direct Potable Reuse Schemes (centralised)	- Community perceptions - Public health outcomes - Management arrangements & responsibilities - Regulation & approval processes - Capital & maintenance costs	- Nil

There were no outright acquisition drivers identified for technology adoption, with management arrangements and responsibilities (except for rainwater tanks), regulations and approvals processes, capital costs and, maintenance costs identified as consistent barriers.

The majority of urban water professionals in each case study city considered the other influencing factors: a) technical feasibility and performance, b) professional knowledge and expertise, and c) government policy, acted as barriers to the adoption of on-site greywater systems and third-pipe systems in existing areas. In Perth, urban water professionals also perceived these three influencing factors acted as barriers to third-pipe greenfield, indirect potable reuse and direct potable reuse schemes. On the other hand, Melbourne and Brisbane respondents were ‘mixed’ (equally distributed between encouraging and preventing) regarding the influence of these three factors.

Application

Current institutional arrangements for supporting total water cycle management were considered to be ineffective by respondents in each of the three capital cities. Figure 2 reveals over 45% of professionals in Melbourne, over 50% in Brisbane, and over 60% in Perth, consider that their institutional arrangements constrain total water cycle management practices.

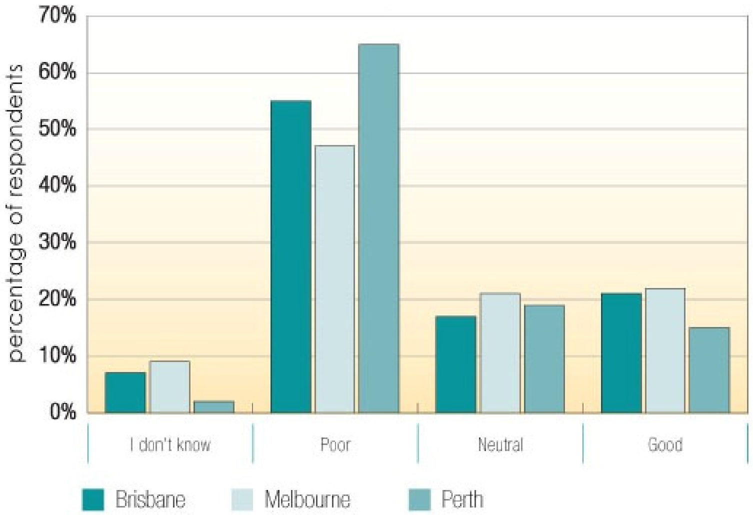

Figure 2. Perceived Effectiveness of Institutional Arrangements for Supporting Total Water Cycle Management.

Respondents were asked to identify when, over the next five to 30 years, would diverse water source options be developed to supplement conventional supplies. Over 40% of respondents considered rainwater as already integral to supply, and a similar percentage of respondents in Perth considered seawater as already integral. In each case study city, the majority of respondents identified the next five years would be characterised by development in the areas of greywater, stormwater, sewage, rainwater and water trading. Interestingly, in Melbourne, less than 10% of respondents considered seawater would be developed over the next five years and 36% not for at least 16 years. Yet, within six months of the survey being completed, the Victorian government announced the construction of a 150GL desalination plant to supplement conventional supplies.

Stakeholder Commitment

Organisational commitment to advancing total water cycle management was perceived as variable within each city. Only three organisations across all three case studies received just over a 50% perceived commitment rating. The only organisations considered to have high levels of perceived commitment were those with primary responsibility for urban water management, as compared to those with a minor role. Indeed, in each of the three cities, the state economic and health regulators each received high ‘I don’t know’ responses. Another trend across the three cities suggested professionals perceive local governments (with the exception of Brisbane City Council), consultants and land developers as only having ‘some individuals in Organisation/Sector committed’ to total water cycle management.

DISCUSSION & RECOMMENDATIONS

The empirical evidence collected from urban water professionals in Australia further supports and expands on the commentary of contemporary international literature on the many social and institutional barriers limiting the adoption of sustainable urban water management practices. In particular, this work expands on the literature meta-analysis of Brown and Farrelly (2007), and prioritises industry receptivity issues based on key barriers in the areas of community (public health risks), resources (capital and maintenance), management arrangements, responsibilities, technical knowledge, stakeholder commitment and institutional arrangements.

While the online survey results revealed that urban water professionals in Brisbane, Melbourne and Perth place high importance on the need for pursuing a diverse water supply approach (particularly for sewage, stormwater and greywater for non-consumptive purposes), there are significant association and acquisition constraints. The concern around public health risks is the most important association issue to be addressed. As explained in an accompanying paper in this conference, by Brown *et al.* (2008), the provision of centralised public health protection has been instrumental to the Australian urban water hydro-social contract since the mid 1800s. An independent scientific review into the known and perceived public health risks in relation to the range of diverse water source technologies is required, and should be conducted in a way that examines and compares risks with other relevant social activities.

To support sustainable urban water management practices, the suite of acquisition barriers identified in this research needs to be addressed. Capital and maintenance costs are perennial limitations, yet the trade-off with not adopting new technologies now, may create greater financial resourcing difficulties into the future. Also, by continuing with traditional, centralised management practices and not encouraging the hybrid decentralised and centralised approach (PMSEIC, 2007), we risk locking our growing cities into permanent, inflexible infrastructure, making financing future sustainable urban water management practices more challenging. The current urban water reform efforts that are focused on enabling a diverse water supply approach need to systematically address the low levels of acquisition identified around the technical feasibility and performance of all technologies (with the exception of rainwater tanks). Of note, the low public health association is likely to underpin the low acquisition capabilities.

To tackle the low levels of acquisition identified, further emphasis on building professional capacities around the different diverse water source technologies is required. Well-designed demonstration projects around individual or multiple diverse water source technologies could help build greater technical confidence, professional knowledge and improve inter-organisational cooperation. Such initiatives would provide exposure to the best available science and relevant data related to construction, implementation and monitoring of such technologies, and each demonstration project should have links to capacity building programs. Importantly, multiple stakeholders will need to be involved; their involvement and contributions must be mapped so future requirements of similar organisations, involved in the design, construction and implementation stages of similar systems, are well understood. This allows not only for technical learning but a deeper understanding of the role that individuals and organisations have in the sector. However, it should also be recognised that, while demonstration projects are an important mechanism for supporting changes in urban water management practices, they are but one 'enabling context factor' (Brown and Clarke, 2007).

Each case study city was selected based on the diversity of structural arrangements to test how important institutional structure is for advancing sustainable urban water management. Interestingly, although each city is structured differently, the majority of professionals within each city considered their institutional arrangements to be ineffective; thus suggesting at present, there is no optimal structural arrangement for advancing sustainable urban water management in Australia. This is an important issue considering the current emphasis of urban water reform efforts and scholarship highlighting the issue of structure and fragmentation in Australia and internationally. Recent international commentary has also suggested that while institutional structure remains an important consideration, we need to focus efforts on fostering institutional change through intra- and inter-organisational relationships (Briassoulis, 2004; Mitchell, 2005).

The results of the highly variable, and overall quite low, levels of stakeholder commitment, suggests that while there may be individual organisations advancing sustainable urban water management practices, this effort is often undermined by the broader city context and hence the social, economic and ecological sustainability of cities. The urban water sectors of Brisbane, Melbourne and Perth, and other cities across Australia, need to begin a dialogue around what a sustainable urban water future looks like, and how all organisations can contribute towards achieving this future. Key policy makers and strategists need to find incentive structures that capture all key stakeholders in the water cycle across cities. One of the most referred to mechanisms in the sustainability literature is the undertaking of a visioning process, and also providing opportunities for individual stakeholder leverage and competition (where necessary) to galvanise such incentives and commitment. Such processes are also essential investments in institutional learning and provide a critical point of reference for the sector to work towards, with the by-product of strengthening intra- and inter-organisational relationships.

CONCLUSIONS

This paper provides a snapshot of the perceived social and institutional drivers and barriers to implementing sustainable urban water management in Australian cities. Professionals operating in the urban water sector provided empirical evidence regarding how the drivers and barriers that they face either encourage and/or impede the development and implementation of diverse water sources and technologies. Framed using the concept of receptivity, this paper documents how urban water professionals associate with the need to augment conventional potable water supplies with diverse water sources in a fit-for-purpose (water use) context. However, there remains a tension between best practice thinking for sustainable urban water management and current practice, with numerous barriers identified in the uptake of diverse water source technologies. Public health implications in using certain diverse water source options (e.g. greywater and sewage) need to be reviewed. The urban water industry also needs to foster the development of professional capacity building initiatives to help address the limitations identified in terms of skills and capacities (acquisition), particularly in Perth. Furthermore, with current institutional frameworks in each city considered a limiting factor, perhaps the current focus of urban water reforms in Australia (and internationally) needs to be reviewed. Building professional capacity within the sector is suggested through the implementation of demonstration projects that have defined learning programs to build sectoral awareness and knowledge. Finally, a visioning process is suggested as a policy mechanism to help lead the urban water sector towards achieving sustainable urban water management in Australia. Such policy interventions may assist in creating and strengthening intra-organisational and inter-organisational relationships which could deliver the institutional change required to advance sustainable urban water management practices in Australia.

ACKNOWLEDGEMENTS

Thank you to the urban water professionals who completed the questionnaire. Thanks also to the National Urban Water Governance Program industry funding partners, including the Australian Research Council, for generously support our research.

REFERENCES

Birrell, B., Rapson, V. & Smith, T.F. (2005), *Impact of Demographic Change and Urban Consolidation on Domestic Water Use*. Water Services Association of Australia, Melbourne, Australia, 24.

Briassoulis, H. (2004), The institutional complexity of environmental policy and planning: the example of Mediterranean desertification. *Journal of Environmental Planning and Management*, **47**(1), 115-135.

Brown, R. (2005), Impediments to Integrated Urban Stormwater Management: The Need for Institutional Reform. *Environmental Management*, **36**(3), 455-468.

Brown, R.R & Clarke, J. (2007), *Transitioning to Water Sensitive Urban Design: The Story of Melbourne, Australia.* Facility for Advancing Water Biofiltration, Monash University, Melbourne, Australia, 62.

Brown, R.R & Farrelly, M.A. (2007), *Advancing the Adoption of Diverse Water Supplies in Australia: A Survey of Stakeholder Perceptions of Institutional Drivers and Barriers.* Report No. 07/05, National Urban Water Governance Program, Monash University, September 2007, ISBN 978-0-9804298-0-0.

Brown, R.R., Sharp, L. & Ashley, R.M. (2006), Implementation impediments to institutionalising the practice of sustainable urban water management, *Wat. Sci. Tech.,***54**(6-7), 415-422.

Brown, R.R., Farrelly, M.A. & Keath, N. (2007), *Summary Report: Perceptions of Institutional Drivers and Barriers to Sustainable Urban Water Management in Australia*. Report NO. 07/06, National Urban Water Governance Program, Monash University, December 2007, ISBN: 978-0-9804298-2-4, p35.

Brown, R.R., Keath, N. & Wong, T. (2008), Transitioning to the Water Sensitive City: Historical, Current and Future Transition States, Paper submitted to the *11th Int. Conf. on Urban Drainage*, August 2008, Edinburgh, Scotland.

Engineers Australia (2005), *Australian Infrastructure Report Card*. August 2005, Engineers Australia, Canberra.

Harremöes, P. (2002), Integrated urban drainage, status and perspectives. *Wat. Sci. & Tech*., **45**(3), 1-10.

Intergovernmental Panel on Climate Change (2007), 'Summary for Policymakers'. In: M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden & C.E Hanson (Eds.). *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 7-22.

Jeffrey, P., Seaton, R.A.F. (2003/04), A Conceptual Model of 'Receptivity' Applied to the Design and Deployment of Water Policy Mechanisms. *Environmental Sciences*, **1**(3), 277-300.

Maksimović, C. & Tejada-Guibert, J.A. (2001), *Frontiers in Urban Water Management: Deadlock of Hope?* IWA Publishing, Cornwall, United Kingdom, 416.

McKay, J. (2005), Water Institutional Reforms in Australia. *Water Policy*, **7**, 35-52.

Mitchell, B. (2005), Integrated water resource management, institutional arrangements, and land-use planning. *Environment and Planning A*, **37**(8), 1335-1352.

Mitchell, V.G. (2006), Applying integrated urban water management concepts: A review of Australian experience. *Environmental Management*, **37**(5), 589-605.

Prime Minister's Science Engineering & Innovation Council, 2007: *Water for Our Cities: building resilience in a climate of uncertainty*. A report of the PMSEIC working group for the Australian Government, Canberra, 57.

Rauch, W., Seggelke, K., Brown R. & Krebs, P. (2005), Integrated approaches in urban storm drainage: Where do we stand? *Environmental Management*, **35**(4), 396-409.

Schafer, A., Khan, S. & Muston, M. (2006), Integrated Concepts in Water Recycling 2005 Conference Summary from the Organising Committee. *Desalination*, **187**, ix-xv.

The Barton Group (2005), *Australian Water Industry Roadmap: A Strategic Blueprint for Sustainable Water Industry Development*. Report of The Barton Group, Coalition of Australian Environment Industry Leaders, May 2005, Visited www.bartongroup.org.au 10 November 2005.