Transitioning to Water Sensitive Cities: Historical, Current and Future Transition States

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ABSTRACT
Drawing from three phases of a social research program between 2002 and 2008, this paper proposes a framework for underpinning the development of urban water transitions policy and city-scale benchmarking at the macro scale. Through detailed historical, contemporary and futures research involving Australian cities, a transitions framework is proposed, presenting a typology of six city states, namely the 'Water Supply City', the 'Sewered City', the 'Drained City', the 'Waterways City', the 'Water Cycle City', and the 'Water Sensitive City'. This framework recognises the temporal ideological and technological contexts that cities transition through when moving towards sustainable urban water conditions. The aim of this research is to assist urban water managers with understanding the scope of the hydro-social contracts currently operating across cities in order to determine the capacity development and cultural reform initiatives needed to effectively expedite the transition to more sustainable water management and ultimately to Water Sensitive Cities. One of the values of this framework is that it can be used by strategists and policy makers as a heuristic devise and/or the basis for a future city state benchmarking tool. From a research perspective it can be an underpinning framework for future work on transitions policy research.

KEY WORDS
Social research; sustainability; transitions theory; urban water

INTRODUCTION
Across Australia and internationally a growing body of urban water professionals are focussed on transitioning to more sustainable urban water management (SUWM) as they respond to the challenges associated with environmental degradation, rapidly growing urban populations and the impacts from climate change. The 21st century marks the first point in recorded history when the proportion of the world's population living in urban environments has surpassed those living in the rural environment, making cities a critical focal point for realising sustainable practices. As growing urban communities seek to minimise their impact on already stressed water resources, an emerging challenge is to design for resilience to the impact of climate change, particularly in regards to ensuring secure water supplies and the protection of water environments.

While there has been significant progress towards SUWM in many cities, particularly related to the innovation of more sustainable technologies and shifts in community values around the environment and waterways, numerous commentators argue that current progress towards

SUWM is too slow (see Brown *et al*, 2007b). Gleik (2003) suggests that a critical barrier to progress is the lack of a benchmarking tool or heuristic device for informing the development of long-term policy for SUWM. In the absence of such a tool, it is currently very difficult for researchers and practitioners to communicate and learn around inter-city SUWM developments. Additionally, while concepts such as integrated urban water management and water sensitive urban design offer alternative philosophical approaches to the traditional urban water paradigm, urban water strategists still lack a clear vision or goal for the attributes of a sustainable water city.

In an attempt to address this crucial gap, this paper presents a proposed 'urban water transitions framework', designed to act as a conceptual tool to inform the development of urban water transitions policy and city-scale benchmarking at the macro scale. This framework recognises the temporal, ideological and technological contexts that cities transition through when moving between different management paradigms and is sensitive to other influencing contextual variables such as city specific histories, ecologies, geographies and socio-political dynamics. This has been characterised by some as the concept of the 'hydro-social contract' (Lundqvist, 2001), which is a term used to describe the pervading values and often implicit agreements between communities, governments and business on how water should be managed. This contract is shaped by the dominant cultural perspective and historically embedded urban water values, expressed through institutional arrangements and regulatory frameworks, and physically represented through water systems infrastructure.

Through an historical analysis of the changing institutional and technological arrangements supporting Australia's urban water management practices over the last 200 years, the proposed transitions framework attempts to provide a typology of the attributes of past and present hydro-social contracts in Australian cities as well as to propose potential future hydro-social contracts underpinned by sustainability principles. It is hoped that the proposed transitions framework, will provide a useful benchmarking tool for urban water strategists and national governments for assessing cities' trajectories to SUWM in relation to other cities. Being able to assess progress towards SUWM will facilitate inter-city learning, as understanding city-specific differences will assist with identifying the change strategies that can be most usefully adapted and applied in different temporal, bio-physical and institutional contexts. It is also envisaged that the framework could act as a constructive heuristic tool to stimulate discussion and debate on the potential attributes of future city states. Facilitating a clear and agreed vision for a more sustainable future city state will assist with identifying the capacity development and institutional reform needs for expediting the transition to SUWM.

NEW INSTITUTIONALISM: AN ANALYTICAL APPROACH

New institutionalism is an active field of social research, concerned with understanding the processes involved in institutional change. As discussed by Healey (1997), institutions are expressed through both 'hard' and 'soft' infrastructure, where the 'hard' represents formal organisational structures, departments, formal committees, laws, taxes and subsidies, and the 'soft' institutional infrastructure includes the social relations, informal networks, administrative routines, professional cultures and social worlds. Institutions are defined by Scott (1995) as comprising three mutually reinforcing pillars that collectively shape patterns of practice: i) *Cognitive* - dominant knowledge, thinking and skills. An example of changing cognition in the water sector is the growing dialogue and thinking around Water Sensitive Urban Design (WSUD) which conceptually challenges traditional notions of water management; ii) *Normative* - values and leadership. An example of changes to values in the urban water sector is the growing focus upon the importance of environmental protection and

the remediation of waterways; iii) *Regulative* – administration, rules and systems. Rules and systems are designed to protect dominant values (normative) and thinking (cognitive). The growing focus upon environmental protection and sustainability has seen the gradual introduction of legislation and regulation aimed at protecting natural water environments.

New Institutionalism reveals that the defining characteristic of institutions is their capacity for stability and to withstand attempts at being significantly changed over short periods (see Scott, 1995). For institutional change to successfully occur there must be a mutually reinforcing shift within each of the pillars of institutional practice. However, very often, change interventions aimed at fostering SUWM focus upon institutional reform through only one of the pillars. For example, change interventions are often focussed solely on education programs dealing with the cognitive aspect of institutional change but are not backed up by changes to how people value water (normative) or changes to the rules by which they must operate (regulative). In a similar fashion, sometimes regulation is introduced without adequate changes to thinking (cognition) and values (norms) and the regulation fails (see Brown and Keath, 2007). Usually, changes to thinking and values will occur prior to changes in regulation; however, regulation is largely determined by those stakeholders with the most formal institutional power. Overall, New Institutionalism provides a useful analytical tool for understanding Australia's evolving urban water hydro-social contract.

METHODS

Reported here is a synthesis of the results from three research activities, conducted between 2002 and 2008, broadly investigating the institutionalisation of SUWM across Australian cities. The transitions framework involved researching and identifying the times in history when distinct changes in urban water technology and practice occurred as well as anticipating social and institutional factors that are likely to influence future change. Past research strongly indicates that there are a range of significant institutional barriers to advancing SUWM (Brown and Farrelly, 2007) suggesting that the cognitive, normative and regulative underpinnings of urban water management are not well aligned with the delivery of SUWM, and most likely privilege past institutional underpinnings. The first two phases of the research evolved from this perspective.

Research Phase 1 (2002-2006). The key research question for phase one was - *What have been the major cognitive, normative and regulative developments in Australian urban water management history since the early 1800s?* This phase involved an embedded multiple-case analysis following the principles of Yin (1994). The historical development of urban water management across Australia's four largest cities (Sydney, Melbourne, Perth and Brisbane) were mapped and contrasted up until the 21st century. Multiple sources of evidence were drawn upon including oral histories (n=74) with leading practitioners and researchers that had been involved in urban water management in the cities for at least 25 years. In addition to a systemic review of the historical scientific literature on the development of modern urban water systems, a documentation analysis of archived and available policy, organisational and media documentation was conducted. In some instances, field inspections of historical urban water infrastructure were undertaken. A data collection plan was developed for systematically collecting multiple sources of evidence for each case study to seek both converging and contradictory evidence within and between each case study.

Research Phase 2 (2006-2008). This phase was focused on clearly identifying the current barriers and drivers to advancing SUWM across Australian cities. This was based on the well recognised issue that despite the development of innovative technologies and processes over the last 20 years to support more SUWM, implementation remains slow. Drawing from a new

institutionalism perspective, this suggests that while there may be cognitive changes (best practice thinking such as WSUD) there has not been sufficient normative and regulative change to support new practice. Therefore, the key research question was - *What are the major institutional drivers and barriers to sustainable urban water management practice in Australian cities?* The phase also involved an embedded comparative case analysis of three cities (Melbourne, Perth and Brisbane), which were selected because they represent one of the widest diversity in structural institutional arrangements for urban water management across Australia, and therefore offer a suitable research control given that structure and fragmentation have been highlighted in the literature as key issues (Blomquist, 2004; Mitchell, 2005). The protocol for data collection was based on the findings of a pilot case study providing feedback on document content analysis, respondent selection and interview processes. A case-based data collection plan was developed for systematically collecting multiple sources of evidence for each case study to seek both converging and contradictory evidence within and between each case. Both quantitative and qualitative data were gathered from urban water professionals representing state and local government agencies, water utilities, regulators, consultants, developers, research institutions and non-government organisations. The data collection included on-line questionnaires (n=1041), in-depth and semi-structured interviews (n=250), focus groups (n=8), document content analysis of policy, organisational and media literature, and field inspections of demonstration projects. A case study database was established for each case containing all interview transcripts, documentation, notes and observations made.

Research Phase 3 (2007-2008). The third phase of the research focused on anticipating and projecting the future institutionalisation of SUWM across Australia. Therefore, the key research question was - *What are the future socio-technical factors that will need to underpin the institutional practice of SUWM for Australian cities?* The research involved two major activities including a meta-analysis of the futurist and sustainability orientated literature and the facilitation of informal visioning processes (as reported in Brown *et al*, 2007a) of future attributes that need to underpin SUWM.

Research Validation Processes. At the end of each research phase a number of large-scale and rigorous stakeholder (including representatives of regional organisations of Councils, key environmental NGO's and a number of state agency officers) validation activities were undertaken to test and ensure both internal and external validity of the qualitative data. The proposed transitions framework, as presented in the next section, is still a tentative hypothesis but has been tested and refined via a validation process involving presentations of the framework to approximately 300 urban water professionals (researchers and practitioners) across Australia, England and the Netherlands. While the findings relate specifically to Australia, the validation workshops indicate that the framework has potential applicability in the European context, which also reflects the commonality with Australia's early urban water history of importing cultural norms and management practices from Europe.

KEY TRANSITION STATES: HISTORICAL, CURRENT AND FUTURE

Upon completion of the three research phases it was possible to infer six distinct, yet cumulative, transitional stages in the development of urban water management across Australian cities. As shown in Figure 1 on the following page, this transitions framework presents a typology of different states that cities transition through when pursuing change towards more sustainable futures. The 'Cumulative Socio-Political Drivers' reflect shifts in the normative and regulative dimensions of the hydro-social contract and the 'Service Delivery Functions' represent the cognitive response.

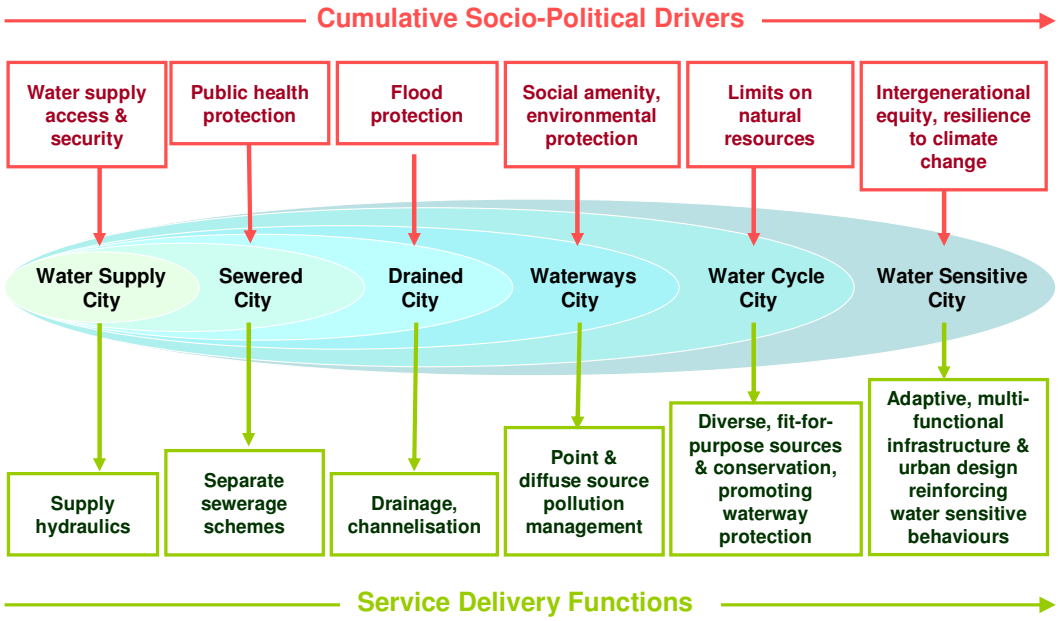

Figure 1: Urban Water Management Transitions Framework

The first three transition states, the 'Water Supply City', 'Sewered City' and 'Drained City', all evolved from the historical research phase, the 'Waterways City' and part of the 'Water Cycle City' evolved from the second research phase. The remainder of the 'Water Cycle City' and 'Water Sensitive City' transitions states evolved from the futures research. While micro changes between transition states were not reliably observed (and more difficult to substantiate) the major historical, contemporary and future transition states clearly emerged throughout the meta-analysis across the three research phases.

The transitions framework emerged largely as a result of the difficulty associated with analysing the data from the second research phase, where some of the barriers and drivers identified in each city (see Brown *et al*, 2007b) were disparate and difficult to interpret when the differences in institutional structure could not explain this result. It became apparent that the cities could not be directly compared because they were in different states of transition in relation to achieving SUWM, and many of the reasons were due to differing socio-political and bio-physical conditions some of which is beyond the scope of this paper. Developing the transitions framework was not only essential for understanding and analysing the research data but it also became evident that such a tool would be essential to enable much needed intercity learning and comparison.

Each of the six city states is marked by a distinct shift in the dominant pillars of institutional practice (cognitive, regulative and normative). The six transitions states are a nested continuum, so the hydro-social contract in previous city states influences and shapes the hydro-social contract in subsequent transition states. As a city progresses through the transition states it accommodates additional, and sometimes competing, objectives. While the different transition states have been simply represented as a model of linear progression, there is no evidence to suggest that cities could not move in both directions across the continuum as well as jumping and/or straddling phases based on changing circumstances (see Keath and Brown, 2008). In the absence of comparative detailed research from other countries for verification or otherwise, this transitions framework remains a hypothesis. Nonetheless, this does not detract from the intent for the framework to inform the design of transitions policy and change management strategies. Each transition state is characterised below.

Water Supply City

The Water Supply City represents the first modern urban water city state in Australia, reflecting the colonisation of Australia by Europeans in the early 1800s. The normative underpinning at the time was the effective provision of safe and secure water supplies for a growing urban population, and centralised provision particularly for the elite where the social movement of cleanliness was strongly linked with social status. Much of the cognitive faculties used to address these norms, were imported from the British hydraulic engineering profession, with key engineers brought to Australia from the UK. This informed the planning, construction and management of centralised city water supply schemes including the extraction of large quantities of water (from what was considered a benign environment) through building dams and pipe systems to supply large quantities of water. Once the capacity for such systems was secured, there was a strong normative development that the perceived 'limitless fresh water' should be a public right and delivered by governments (like those in the UK) at a very low cost to ensure that the poor and other disadvantaged groups could have equitable access. This marks the start of the first formal hydro-social contract in Australian cities, which was established with the formation of regional governments (often local governments and eventually metropolitan water boards) raising a centralised taxing system to pay for water infrastructure and delivery. This was sometimes in the form of charging residents a flat property rate, and in other cities charging a specific water tax. The hydro-social contract implicitly promised the delivery of a safe, cheap and largely limitless volume of water from a benign environment to the rapidly growing urban population.

Sewered City

The Sewered City state emerged between the mid to late 1800s depending on the particular city within Australia. By this time there are well established cognitive 'engineering' communities between the UK and Australia, and public health concerns around epidemic outbreaks of cholera and typhoid across European cities was at the top of the political agenda in the UK. There were also outbreaks across Australia, but not at the same scale. With the discovery that people were becoming ill through pathogen infection of water supplies from wastes, sewage and industrial effluents, the combined sewerage system was innovated in London. This involved the design and construction of a reticulated sewerage system to dispose of waste effluent outside of cities, and often to receiving waterways that were perceived as environmentally benign. This development influenced the cognitive processes in Australia with Sydney starting the construction of a combined sewerage and stormwater drainage system in 1850. By 1890, it was clear that the Australian rainfall conditions were more intense and stochastic than the British and the larger infrastructure required was deemed too costly. So, in concert with some of the newly developing American cities, from the late 1800s Australian cities invested in separate sewerage systems. Many cities also invested in on-site septic systems due to the perceived prohibitive cost of providing this infrastructure. The new regulative regime often involved the evolution of new water boards that were responsible for water supply and sewage through raising a levy in addition to property taxes. The hydro-social contract implicitly promised public health protection to the rapidly growing urban population, through the delivery of sewerage services directing waste flows to an environmentally benign receiving waterway environment. The overall structure of the hydro-social contract remained unchanged as it was a logical expansion for sewerage services to be added to the water supply services of the previous city state.

Drained City

While drainage at a more micro scale has always formed part of land development in one way or another, the Drained City state largely emerged after the second-world-war in the mid 1900s. With Australian cities coming out of a major economic depression, government

spending on infrastructure and welfare substantially increased. At the same time, the global social value-set of materialism became normatively embedded in Australian society reflected in a new Australian dream of everyone having their own house, large backyard and a family car. With the advent of the automobile, people were prepared to live further away from city centres, accommodated through the rapid expansion of medium to low density housing. However, the consequences for flooding and property damage were also substantially increased. Australian engineers began to develop local cognitive capital with the establishment of local rainfall records and drainage design standards. The new discipline of urban hydrology emerged internationally during the 1960s, and Australia was a strong innovator in the professional community – focused on developing techniques and models that enabled the rapid and efficient conveyance of stormwater out of cities to receiving waterway environments. This substantially impacted the development patterns of Australian cities with numerous waterways piped and located underground, and river systems channelised to allow for more urban development in floodplain areas. Many houses at this time were constructed facing away from waterways which were often perceived as waste dumping grounds, and were therefore not a socially valued part of the urban landscape. Overall, from a community perspective stormwater was largely viewed as a nuisance, therefore the hydro-social contract implicitly promised cost-effective flood protection services through the efficient conveyance of stormwater to a benign waterway environment to facilitate the rapid urban expansion of cities. Services were delivered by the centralised water supply and sewerage authorities and over time also by local authorities. The structure of the hydro-social contract remain initially unchanged with the expansion in the service delivery functions of centralised authorities but this progressively involved local governments as new urban areas were established leading to a steady transition to a more complex hydro-social contract involving multiple (and fragmented) urban water services providers.

Waterways City

While each of the previous city states expanded the boundaries of the hydro-social contract, the Waterways City marks a departure from this progression by fundamentally challenging the service delivery functions adopted under the previous city states. While much progress has been made, the waterways city cannot be considered to be mainstreamed in any Australian city today. Historically, the hydro-social contract had been subsidised by the common practice of not accounting for environmental services, leading to the over extraction and pollution of water resources. These reflected the old, normative perspective that the environment is benign and of much lower priority than the economy. However, the late 1960s saw the emergence of a global social movement, 'environmentalism' that challenged this assumption and advanced a new normative value set around environmental protection. Since the 1970s, Australian communities had been raising concerns about the state of local waterways, which were becoming increasingly degraded with visible pollution (eg. litter, gross pollutants, hydrocarbons), and algal blooms and beach closures. At the same time, the massive urban expansion of previous decades was prompting communities to demand greater levels of amenity and access to green open space. Cognitively, water began to be integrated into planning functions as important visual and recreational features for communities and measures were taken to reduce pollutant inputs into waterways, which involved regulating environmental discharges from wastewater treatment plants and industrial processes as well as replacing septic tanks with centralised sewerage systems. Science revealed the impact on waterways from diffuse-source stormwater pollution prompting researchers and practitioners to develop new technologies such as wetlands and bio-filtration systems to protect receiving waterways. Cognitive tools such as industry guidelines and capacity building programs featured strongly in raising the profile of this city state.

Despite progress towards Waterways Cities, there remain significant barriers to widespread stormwater quality management, as reported in Brown and Farrelly (2008) and Morison (2008). At the cognitive and regulative levels, stormwater pollution is a diffuse problem that cannot be solved by the centralised technologies and government control mechanisms that have been adopted under the previous hydro-social contract. Despite the development of promising decentralised technologies, there is still poor understanding about their ongoing management and operation under dispersed accountabilities. The lack of an adequate dedicated funding stream (modelled after the hydro-social contract of the Drained City) added to current challenges. The distributions of functions and responsibilities has been radically altered with new stakeholders such as community and environment groups playing an active role. Normatively, this creates tension between those professionals and politicians concerned with traditional values around water supply, sewerage and drainage and those who are seeking to adopt new practices associated with environmental protection. An historical analysis of Melbourne's transition to the Waterway City by Brown and Clarke (2007) reveals that despite partial institutionalisation of this city state, the field of stormwater management remains primarily driven by advocates championing change.

Water Cycle City

The Water Cycle City is a response to the recognition of the current 'limits' to traditional water sources for supplying ever growing populations and urban development, as well as the limits to waterways being able to assimilate pollution. It also reflects the growing normative acceptance of the need for social, economic and environmental sustainability. While this city state remains largely at the level of academic and sometimes policy rhetoric, it is in part a cognitive attempt to address the tensions that have arisen between the Waterways City and the preceding city states. Researchers and practitioners are involved in dialogue and experimentation around taking an integrated or total water cycle approach (see Keath and Brown, 2008) which involves water conservation and finding fit-for-purpose diverse water supplies (from sources of varying quality – rainwater, stormwater, sewage, seawater - matched to the most appropriate uses – potable, irrigation, industry, household) at a range of scales that are also sensitive to the energy and nutrient cycles and ultimately contingent on protecting waterway health.

While such an approach complements the objectives of supply security and waterway protection in a context where water resources are reaching the limits of sustainable exploitation, it challenges the implicit promise of governments of previous hydro-social contracts to deliver risk free water supply services. Instead, the regulative dimension of the Water Cycle City would involve co-management of the water cycle between business, communities and the government with risk shared and diversified via private and public instruments. Cognitively, practitioners would be involved in interdisciplinary, multi-stakeholder learning to deliver diverse and flexible solutions. This presents many challenges the Australian governance context with the institutional context identified as a significant barrier to advancing the total water cycle management approach (Farrelly and Brown 2008).

While the proposed attributes of a Water Cycle City are supported by many at a level of rhetoric, there remains a passionate debate about the relative role of centralised and decentralised delivery of recycled water. This may be seen as a reflection of the unstable hydro-social contract of the Waterways City which undermines current government responses to natural resource limits (ie vulnerable supplies and degraded receiving water environments). The dominant government responses to the current extended drought conditions largely involves expanding centralised systems, with the implicit controls and promises to communities of the old hydro-social contract, rather than to support the co-existence of

centralised and decentralised systems and new forms of co-management with the community and private sectors. There are contemporary views that the provision of recycled water should be based on the same hydro-social contracts that have worked well in the past during the era of the Water Supply City and the Sewered City. This is contrasted by other arguments for the provision of alternative water sources through decentralised and diffuse technologies, along the same principles advocated for managing diffuse pollution sources in the Waterways City.

It may be possible that if the Waterways City is given sufficient time to stabilise, the hydro-social contract may allow for a smoother transition to a Water Cycle City. On the other hand, the way in which the Water Cycle City links environmental protection with the other well established normative values around supply security, public health protection and flood control may enable the principles underpinning the Waterways City to be adopted more readily.

Water Sensitive City

Today, there is not an example of a Water Sensitive City anywhere in the world although the concept is attracting attention from scientists and practitioners interested in envisaging potential sustainable water futures. Contemporary futurist research highlights that the hydro-social contract for a Water Sensitive City would be significantly different to that underpinning conventional urban water approaches requiring a major socio-technical overhaul. Work by Brown *et al* (2007a) highlights that the hydro-social contract for a Water Sensitive City would integrate the normative values of environmental repair and protection, supply security, flood control, public health, amenity, liveability and economic sustainability, amongst others. Communities would be driven by the normative values of protecting intergenerational equity with regards to natural resources and ecological integrity, as well as by concern that communities and environments are resilient to climate change.

This social capital would be likely to reflect a sophisticated and engaged community supportive of a sustainable lifestyle and would extend to the professionals and practitioners in the water sector, in relation to their capacity for innovation and sustainable management of the city's water resources. Technologies, infrastructure and urban form would be diverse and flexible, designed to reinforce sustainable practices and social capital, recognising the implicit link between society and technology. The hydro-social contract in a Water Sensitive City would be adaptive and continually evolving underpinned by a flexible institutional regime. A demonstration this framework for transiting to the Water Sensitive City is presented in an accompanying paper in this conference series by Wong and Brown (2008) *'Transitioning to Water Sensitive Cities: Ensuring Resilience through a new Hydro-Social Contract'*.

CONCLUSION

The research presented here reveals that as cities develop, urban water managers are being confronted with increasingly complex and multi-faceted challenges as societal expectations grow and natural resources reach the limits of sustainable exploitation. Given the significant climate change and population growth challenges facing cities, there is a critical need for strategic investment in solutions that will deliver long-term sustainable outcomes. The proposed urban water transitions framework is offered as a tool for assisting urban water strategists with the challenging task of identifying the attributes of more sustainable city states and the capacity development and institutional reform required to deliver SUWM. It is hoped that the framework will be used not only to facilitate dialogue and debate around the attributes of a future Water Sensitive City, but also as a benchmarking tool to assist strategists to identify those cities engaged in progressive transition strategies that can be learned from by other cities.

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