CRC for
Water Sensitive Cities

Liveability and the Water Sensitive City

Science-Policy Partnership for Water Sensitive Cities

Phillip Johnstone, Rachelle Adamowicz, Fjalar J. de Haan, Briony Ferguson and Tony Wong

Monash University Water for Liveability &
Victorian Government Department of Sustainability and Environment

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The further development of the societal needs framework for liveability and its application to the transition towards a Water Sensitive City has been greatly assisted by:

- many informal discussions with colleagues from CWSC, DSE and the Industry Partners of the Centre's *Cities as Water Supply Catchments* research program,
- a Science-Policy Workshop (8 February 2012) with participants from CWSC and DSE that explored the relationships between integrated urban water management, societal urban water needs and liveability,
- feedback from Rachelle Adamowicz's presentation – *Creating the Liveable City* – to the WSUD 2012 conference in Melbourne (February 2012), and
- numerous discussions and feedback from Prof. Rebekah Brown and Dr Meredith Dobbie.
- an expert panel workshop (7 May 2012) with participants from CWSC that tested the application of the societal urban water needs framework to the assessment of the liveability value of integrated urban water management projects.

The contributions made by all that were involved in these discussions and workshops are greatly appreciated.

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Executive Summary

The role of the city and its relationship to societies has changed over time; it is increasingly recognised that the form and structure of cities have a major impact on individuals and communities.

The Victorian Government's *Living Melbourne, Living Victoria* policy focuses on improving liveability through urban water reform.

Liveability is subjective and normative, the various definitions and applications of liveability can be valid and legitimate if the context and the particular needs that are addressed are transparent. The liveability of a city then, needs to be explored within a defined frame or context, for as long as the niche is clearly defined, then the parameters of liveability can be appropriately applied.

Needs and Liveability

We adopt a 'societal needs' approach to liveability. Humans require that their basic needs be satisfied in order to ensure their continued survival – from both the physiological (the needs of the body: breathing, food, water) and security stances (the basic need for a perception of safety: of the body, health security and the continuity of necessary resources). In addition, humans also have 'wants' that are thought to enhance their quality of life.

In determining the liveability of a city, it is necessary to uncover both the needs and wants of its citizens. To a large extent the physical and material needs for survival are common to all communities – food, water, shelter etc, however, the needs and wants beyond mere survival, those that effectively enhance one's quality of life, are likely to reflect the particular values and ambitions of the communities. Borrowing from a well-established sustainability narrative, we espouse that a liveable city should be a city that meets the needs and wants of its present inhabitants without compromising the ability of its future inhabitants to meet their needs.

Alderfer's E.R.G. theory (1969) is a development of Maslow's five tier hierarchy of needs and contracts the tiers into three levels – Existence, Relatedness and Growth (E.R.G). Maslow's lower layer needs, safety and physiological are merged into Existence (providing the physical and material needs for survival); love and esteem (esteem external to self) into Relatedness (the need for interpersonal relationships), and self-actualisation and self-esteem into Growth (the intrinsic desire for personal development)

We follow De Haan *et al.'s* (2011) use of Alderfer's E.R.G. Theory as a framework for considering societal urban water needs, and our further development of the framework is presented in Table A. This approach considers that systems such as water supply and drainage systems are technological responses to the needs of humans, such as the need for drinking water and flood protection.

Table A: Societal Needs in Urban Water Systems (adapted from de Haan *et al.* 2011)

Needs category		Urban-water societal need	Description
Existence	Physical and material needs	Drinking Water	Safe, secure and accessible supply of water for direct human consumption
		Non-drinking Water	Safe, secure and accessible supply of water available for other uses
		Public Health	Protection from polluted wastewater and stormwater; tolerable microclimates; public places that promote physical and mental health.
		Public Safety	Protection of people from the hazards of water, e.g. during floods or storm events
		Property Protection	Protection of property and infrastructure from water, e.g. during floods or storm events
		Economic Activity	Industries and jobs that rely on water and/or water systems and services
Relatedness	Social interaction and inter-personal relationships	Recreation	Places for play, sport and leisure
		Social Cohesion	Safe and secure places for social interaction and human connectedness with people and nature
	Societal-environmental inter-relationships	Beauty	Aesthetic urban environments
		Comfort	A pleasant micro-climate and landscape for human thermal comfort
		Ecological health	Clean and healthy ecosystems with no negative impact on other ecosystems
Growth	Societal self-esteem and self-actualisation	Identity	Harmony with culture and tradition, to feel belonging. Proud association with urban water systems and environments.
		Purpose and Ambition	Progress towards a shared vision of a water sensitive future.
		Control and Independence	Choice and influence on decision-making about water infrastructure and services
		Equity and Social justice	Equal opportunity to access the benefits of the urban water system
		Intergenerational equity	Preserve the ability of future generations to meet their water-related needs.

Integrated Urban Water Management and Water Sensitive Urban Design

Integrated Urban Water Management (IUWM) represents the managed hydrological cycles and systems of a Water Sensitive City. As described by Barton *et al.* (2009), IUWM seeks to change the impact of urban development on the natural water cycle based on the premise that by managing the urban water cycle as a whole, a more efficient use of resources can be achieved providing not only economic benefits but also improved social and environmental outcomes. IUWM builds on existing water supply and sanitation considerations within urban areas by incorporating water resources, and their uses, that lie outside of the piped supply and wastewater systems.

'Green infrastructure' aims to mimic natural biophysical and ecological processes and provides a means for re-introducing or maintaining 'nature' in urban environments. The 'nature' provided by green infrastructure can contribute to satisfying a range of societal urban water needs such as physical and mental health and relatedness needs. The US-EPA specifically links 'green infrastructure' with stormwater management *Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.*[1]

Water Sensitive Urban Design (WSUD) is defined by the Council of Australian Governments (COAG) as '*the integration of urban planning with the management, protection and conservation of the urban water cycle that ensures that urban water management is sensitive to natural hydrological and ecological processes'.* WSUD, extend the principles of IUWM to include additional urban design considerations such as urban amenity, public health, urban microclimates and heat mitigation, biodiversity and the ecological health of natural environments and receiving waters.

IUWM can be achieved entirely by pipes and underground structures, while it is only through WSUD that we get to attain the additional benefits that are associated with green infrastructure.

WSUD can improve the quality of life, and hence the liveability, of urban areas by:

- Expanding the direct and indirect beneficial uses of water in urban areas and ensuring that the uses are resilient to climate variability
- Reducing the adverse impacts by control and treatment of wastewaters and stormwater, and their subsequent discharge to the environment
- Utilisation of a range of alternative sources of water, particularly to substitute for potable water, to meet demands for non-potable water, including additional demands for enhancing 'nature' in urban environments that delivers a range of health and wellbeing benefits.

Societal Urban Water Needs

This section outlines the ways in which WSUD can contribute to societal urban water needs and, in particular, the additional value that can be gained over conventional urban water systems based on external water sources, centralised water and wastewater services, stormwater drainage and disposal of untreated stormwater and treated wastewater to the environment.

Existence

Alderfer's **'Existence'** relates to a person's physical and material needs such as food, clothing and shelter. In many cases there are threshold needs that are essential for survival. There is usually a minimum amount of clean water that a person needs for drinking and consumption. Having more than the minimum amount of water available, not only reduces the mental stress that may come from being on the edge of survival, but also opens up the opportunity for more discretionary uses of

[1] United States Environment Protection Agency *Green Infrastructure* http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm#tabs-1 accessed 27 April 2012.

water. Extending beyond the critical survival needs, many 'discretionary' uses of water, for example bathing and cleansing, can be considered as essential cultural needs based on cultural norms.

Water services and systems and uses of water are also part of the economy and, therefore, play an important role in supporting people's ability to access other (non-water) existence needs.

Relatedness

Alderfer's '**Relatedness'** relates to a person's interpersonal needs within his personal as well as professional settings, also described as social and external esteem needs. De Haan *et al.* (2011) consider a person's interactions with their environment as part of this suite of interpersonal needs. Two subcategories of Relatedness can be distinguished that are related to the role of water in:

1. Supporting or facilitating social interactions, and hence interpersonal relationships, and
2. Contributing to societal-environmental interrelationships.

Growth

Alderfer's '**Growth' r**elates to a person's needs for personal development, also described as self-actualisation and internal esteem needs. Societal growth needs reflect the engagement of society in the processes that shape cities and urban water systems. Overall, growth is achieved when the intellect and resources of society are applied to deliver 'State of the Art', or 'best practice', services (societal self esteem) and these actions are on a pathway towards some societal vision for the future (societal self actualisation).

A hydro-social contract can define the expectations for direct community engagement and the responsibilities that are effectively delegated to institutions that, together, underpin societies' ability to satisfy their Growth needs.

City States, Water Sensitive Cities and Societal Urban Water Needs

The contributions of each of Brown *et al.'s* city states to societal urban water needs provides a basis for establishing a relationship between the city states and Alderfer's Existence, Relatedness and Growth needs categories (see Figure A). As with the city states, the needs categories can be considered as being nested. For example, the more existence needs are met the more relatedness needs are desired.

The relationships between the city states and the needs categories are not exclusive and the illustration highlights the predominant, or key, relationships. Transition from a Waterways City to a Water Cycle City, for example, can contribute to Growth needs by providing progress (towards a Waterways City) and purpose (by establishing a trajectory towards a Water Cycle City).

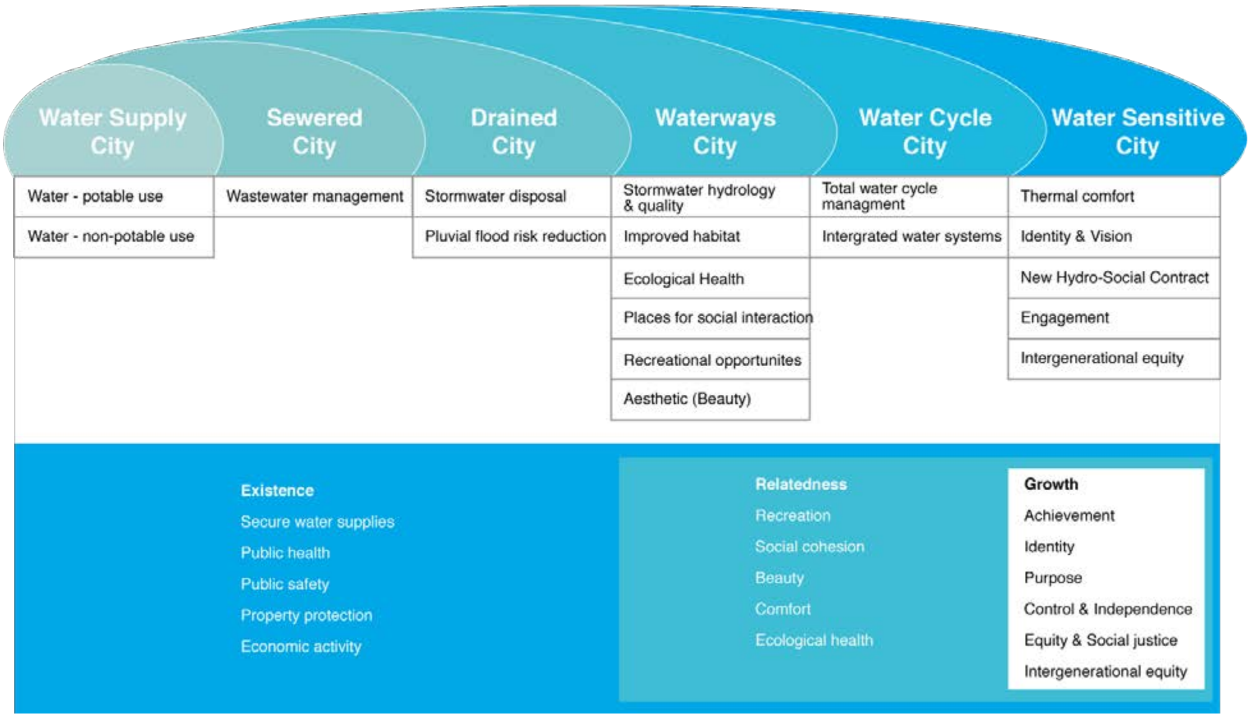

Figure A: Illustration of the relationships between City States and Societal Urban Water Needs

The City States analysis shows that there is scope for further development of Melbourne's water systems towards the Water Sensitive City and for the relationship between the city, its residents and water. Further application of green infrastructure, to both new and existing urban areas, can continue the city's progression towards a water sensitive city and hence towards greater fulfillment of the relatedness and growth needs that underpin liveability.

Assessing and Measuring Liveability

This paper focuses on the contribution that water systems and services can make to the liveability of a city. It is in this context that questions of the assessment and measurement of liveability can be considered.

The societal urban water needs presented in this paper provide a framework for assessing the role of IUWM and WSUD in liveability. The actual data or information required is context specific – for example the information to describe and compare the social cohesion outcomes of local-scaled projects would be quite different to that required to make inter-city comparisons. While the general types of information can be identified, there have been no systematic analyses of the satisfaction of each of the societal urban water needs. It is likely that a specific data and/or information collection process will need to be designed and undertaken for each need to produce the data needed for analysis.

Applying the framework for assessing the contribution of contemporary urban water management to liveability in any situation requires a bespoke project to be designed and undertaken to generate and analyse the data and information required to assess the status of societal urban water needs.

The urban water liveability of a proposed development or project could be assessed by a semi-quantitative scoring of the projected changes in the satisfaction of societal urban water needs of various options, benchmarked against either the starting conditions or a 'business as usual' development. This assessment has the potential to yield negative scores for societal urban water needs if the initiative produces lesser outcomes than the benchmark starting condition or business as usual case.

The assessment of the urban water niche of liveability for a place, such as a suburb, would need to seek information that is applicable at that geographic scale and the particular circumstances. The outcome of such an analysis could be a ranking with, possibly, a semi-quantitative rating.

Conclusions

Liveability remains a complex and highly subjective aspect of cities. Accepting this view allows us to define a particular niche within the broader family of liveability – *the role and contribution of water, its management, use and interactions with the environment, to the liveability of our cities*. It is important to remember that there are many other niches and influences on the 'liveability' experienced in a city. While pursuing a water sensitive city would contribute to the city's liveability, it is unlikely that a focus on water alone would transform, or secure, the overall liveability of a city.

Consideration of societal urban water needs provides a framework for assessing the water niche of liveability. In terms of liveability, the relationship between city states and societal urban water needs illustrates that basic water supply, sewerage and drainage systems meet existence needs. Melbourne, like most developed cities meets these existence needs. However, Melbourne is progressively moving towards the Waterways City and Water Cycle City states, which, by addressing relatedness needs and more efficiently/sustainably addressing Existence needs, can be considered to be enhancing the city's liveability. Alderfer's sixth proposition, that *the more relatedness needs are satisfied then the more that growth needs will be desired*, becomes particularly pertinent. The desire to satisfy growth needs is apparent in the Victorian Government's Living Melbourne, Living Victoria policy, further reflecting Melbourne's position as progressing on the city states associated with relatedness.

Liveability and the Water Sensitive City

Introduction

Cities are the nodes of human society; they contain the highest densities of human settlement. While today the number of urban dwellers exceeds 50% of the world's population (Grimm, Faeth *et al.* 2008), it is expected that by 2060 this figure will escalate to 70% (UN Population Division 2008). As cities continue to develop into more significant and influential places for the living of human populations, the idea of 'the liveable city' is becoming increasingly influential in city-shaping policies.

The role of the city and its relationship to societies has changed over time; it is increasingly recognised that the form and structure of cities have a major impact on individuals and communities. As the upsurge in cities' populations continues, so have the demands and expectations of its residents. Developed nations have rapidly become accustomed to a particular quality and standard of living as yet unparalleled in human history.

The Victorian Government's *Living Melbourne, Living Victoria* policy focuses on improving liveability through urban water reform. The policy's objectives are to:

- Establish Victoria as a world leader in liveable cities and integrated water cycle management.
- Drive generational change in how Melbourne uses rainwater, stormwater and recycled water.
- Drive integrated projects and developments in Melbourne and regional cities to use stormwater, rainwater and recycled water to provide Victoria's next major water augmentation.

'But what is liveability, anyway?', Marshall (2011) asks in an article published in Melbourne's *The Age* newspaper. It is clear that the growing use of the term 'liveability' parallels the growing importance of cities and while the term invokes various ideas pertaining to quality of life or human wellbeing, it is often perceived as a complex and ambiguous concept. Indeed, while the *Living Melbourne Living Victoria* roadmap argues that superior water management will contribute to the liveability of cities, it is acknowledged that further research is required to identify 'the linkages between liveability and integrated water cycle management'. If we are to move toward this transition in enhancing Melbourne's liveability, and establish Melbourne as a 'world leader' in liveable cities, a vital step will be to understand what policymakers, researchers and the public are envisioning when employing the term.

This paper explores the role that Integrated Urban Water Management (IUWM) and Water Sensitive Urban Design (WSUD) can play in enhancing the liveability of cities. The key steps of this exploration are:

1. development of a concept of 'liveability' through a literature review of relevant journals and government policy documents in the urban planning domain
2. establishing the role of urban water management in contributing to liveability by considering societal urban water needs
3. an analysis of the potential for IUWM and WSUD to further contribute to societal urban water needs and, consequently, to enhance the liveability of Melbourne.


NO SMOKING ZONE

What is Liveability?

While the origin of the term 'liveability' is fairly simple, in that it is the amalgamation of the verb 'live' with the suffix 'ability', its meaning and usage are far more complex than simply 'one's ability to live'. The *Oxford Dictionary* defines liveability as the 'suitability for habitation; capacity to offer comfortable living. Also of a region, environment, planet, etc.: capacity to sustain life'. This definition falls short of the current policy focus on liveability which focuses on 'quality of life' and, while it may reflect the origins of liveability concepts, is inadequate as a basis for city-shaping policy initiatives.

The liveability of a city is often associated with factors that improve the 'quality of life' or 'wellbeing' of its inhabitants. Exploring liveability as a method of city comparison is no new undertaking; studies performed by various researchers from the 1970s such as Smith's (1973) or Liu's (1976) reports, attempted to rank U.S. cities based on the quality of life they provided. According to Tremblay *et al.* (2008), attempts at city ranking based on their quality of life was borne out of the neoliberal era where restlessness with the locations of people's living and working lives prevailed. However in 1981, the ranking of cities reached new heights in prominence, when the first popularised effort at statistical ranking of metropolitan areas was published by Boyer and Savageau (1981). Their publication of the *Places Rated Almanac*, although it held less statistical rigour than either Smith's or Liu's studies (Rogerson 1999), achieved far greater public acclaim and impact, attracting an audience of public, media and professionals interested in the property, promotion and construction of cities.

Geographically, these regional rankings soon broadened from being US-centric, as international comparisons of the city with the highest quality of life were increasingly generated. Rankings such as *Fortune Magazine's* cities comparison; *Mercer's* *Quality of Living Survey* or *The Economist's* *World's Most Livable Cities* - the intention of each to ultimately inform the relative benefits and disadvantages of the various locations - were regularly used by employers to understand the kind of allowance that should be afforded to employees undertaking job relocations, it is also used by multi-national companies to decide on potential places to open new offices or organisations. There is therefore significant economic value that is associated with liveability and the city comparison rankings, since liveable cities attract both social and economic capital.

> *Liveability encompasses the wellbeing of a community and comprises the many characteristics that make a location a place where people want to live. The concept of liveability encapsulates the Government's entire portfolio of responsibilities.*
>
> Victorian Government Response (2008) to Victorian Competition and Efficiency Commission's Final Report. A State of Liveability: An Inquiry into Enhancing Victoria's Liveability

These uses of 'liveability' and, in particular, the international rankings, have created a patriotic mindset in Melbourne. In August 2011, Melbourne was, again, awarded the title of the 'World's

Most Liveable City' by The Economist Intelligence Unit, a title that Melbournians were only too willing to adopt. *The Age* newspaper published an article a few days after the release of the results, entitled 'Welcome to the World's Most Liveable Delusion', arguing that querying Melbourne's ranking is considered almost 'un-Australian' (Nelson, 2011). For months after, any social or business occasion seemed to provoke discussion on how rewarding and fortunate we are to live in 'our' city. Marshall (2011) asserts in another recent article in The Age, 'When we talk about our town we seem to lean back with folded arms, chin out, as if beaming at some imaginary trophy cabinet'.

This enthusiastic embracing of a particular definition and measure of liveability creates a strong bias and distortion of the overall concept of liveability as it emphasises a particular niche of the more generic concept. A literature review was undertaken in order to establish an understanding of the broader dimensions of liveability. Appendix 1 provides an example of the different definitions of liveability from various sources. These various definitions and descriptions are elaborated on by the identification of factors and parameters of the environment that affect each particular definition of liveability. Appendix 2 tabulates fourteen differing perspectives taken from the literature of the characteristics, factors and dimensions that are argued to be either necessary or sufficient conditions for attaining the liveable city.

A review of a number of common measures of liveability and sustainability by the Victorian Competition and Efficiency Commission (VCEC) concluded that: *The subjective nature of the inclusion of factors relating to liveability, the weighting of these factors, and the vastly different indicators being included, results in different measures providing different rankings of the liveability of cities. There is a lack of theoretical underpinning for these measures, particularly for composite measures. It is questionable whether any of the above composite measures would be directly relevant for informing public policy* (VCEC 2008).

It is apparent that liveability is so inherently subjective, that its definitions and classifying its attributes, do little to determine its meaning. This is because the dimensions and definitions of liveability must vary depending on the culture, value, disciplines and the objectives of the researchers (*van Kamp et al*., 2003; Leby and Hashim, 2010; Pacione, 2003). It is the varying values, cultures, disciplines and perspectives however that pave the pathway to liveability, because in essence, liveability is dependent on the needs of the people for whom liveability is being sought. However, while liveability is clearly subjective and normative, the various definitions and applications of liveability can be valid and legitimate if the context and the particular needs that are addressed are transparent.

The liveability of a city then, needs to be explored within a defined frame or context, for as long as the niche is clearly defined, then the parameters of liveability can be appropriately applied.

Societal Needs and Liveability

Humans require that their basic needs be satisfied to ensure their continued survival – from both the physiological (the needs of the body: breathing, food, water) and security stances (the basic need for a perception of safety: of the body, health security and the continuity of necessary resources). In addition, humans also have 'wants' that are thought to enhance their quality of life. While dividing needs and wants is a highly contested endeavour, for this purpose it is merely to establish the distinction between what humans require for survival on a basal level, and what they have come to expect and desire as key contributors to quality of life.

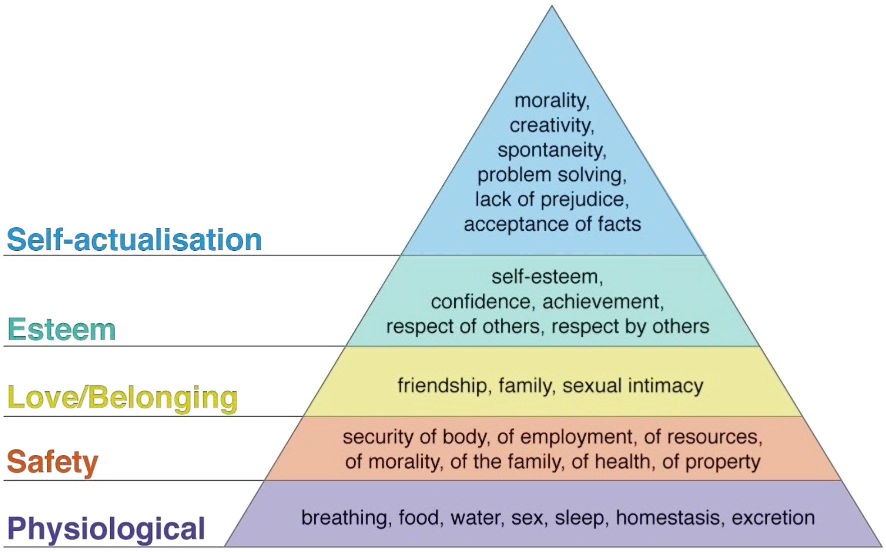

Figure 1. Maslow's hierarchy of human needs (Finkelstein 2006)

Maslow's hierarchy of needs (Figure 1) is perhaps the most popular conceptualisation of human needs; often portrayed in a pyramid, it aims to demonstrate human needs in five layers, with the most fundamental at the bottom (physiological) such as breathing, food and water, and the highest attainment of being at the top (self-actualisation), such as creativity, morality and lack of prejudice. It can be shown that there are clear parallels between Maslow's hierarchy of needs and the level, or quality, of liveability.

A city must meet the fundamental needs of its citizens if they are to survive. However, the extent to which the 'higher' needs are met reflects the quality of life, or wellbeing that a city can provide, and hence its 'liveability'.

While this report does not seek to determine the role of the city in enabling humans to attain their highest level of being, there does however need to be recognition within the definition of liveability, that humans are striving toward *something,* and that it is the role of the city to, at the very least, allow this pursuit. Aristotle named this endeavour *Eudaimonia*, often translated to mean human flourishing, Maslow called it *Self-actualisation*[2], described by Carl Rogers (1961) as '…man's tendency to actualize himself, to become his potentialities', for the purpose of this report however, this pursuit will simply be labeled 'Growth', as put forward by Alderfer (1969).

In determining the liveability of a city, it is necessary to uncover both the needs and wants of its citizens. To a large extent the physical and material needs for survival are common to all communities – food, water, shelter etc, however, the needs and wants beyond mere survival, those that effectively enhance one's quality of life, are likely to reflect the particular values and ambitions of the communities. For a large complex city such as Melbourne, this means that there are a mosaic of different 'liveability profiles' that reflect the cultural, demographic and socio-economic characteristics of local communities and the bio-physical characteristics of their local environments. This endless assortment of varying liveability profiles presents a further challenge in that there are apparent inequalities that befall certain parts of society within a city, and this needs to be recognised in the transition toward liveability.

The quality of life that a city offers its residents differs greatly amongst social groups (Herington *et al.* 2006). Within an urban environment, individuals and social groups are disaggregated along many divisions and according to Pacione (2001), some of these factors include gender, ethnicity, class and age, but also, the way that people choose to use a city differs (eg. consider the different transport preferences of cyclists, drivers or public transporters). Further, geographical location and different parts of urban centres are also a strong determinant in how a resident is able to use and perceive their city. Lynch (1981) showed that people's quality of life in a city centre does not permeate to the same liveability and quality of life to that in the suburbs.

To emphasise this point, a recent study performed by Tract featured in The Age entitled 'Our Liveable City', rates the liveability of 314 suburbs of Melbourne. However, while endeavouring to show that liveability within a city differs depending on one's geographical location, the design of the assessment and choice of parameters in this study introduced a significant geographical bias into the results. Melbourne can be described as a 'radial city' with primary transport services (road, rail, tram and bus) as spokes from the Central Business District (CBD) hub. Consequently, transport services are denser close to the CBD and hence the average distance to access services is much shorter closer to the hub than further out. The Tract study considered a total of 14 parameters as indicators of liveability. Of these, four are highly influenced by the distance from the CBD (proximity to CBD, train, tram and bus services). This loading of the analysis by CBD centric parameters is countered to some extent by parameters such as traffic congestion, tree cover and open space, all of which tend to be associated with middle and outer suburban areas. While the geographic bias diminishes the value of the overall ratings, examination of the data for non-geographic based parameters collected in the study does illustrate the intrinsic variations in liveability factors between different suburbs and parts of Melbourne. These include the design and infrastructure of the biophysical environment, such as 'open space' and 'tree cover', and local societal and business communities' development, such as

[2] Although Kurt Goldstein is argued to have coined the term in 1934 in his book *The Organism: A Holistic Approach to Biology Derived from Pathological Data in Man*

'culture', 'shopping' and 'cafes and restaurants'. The interplay between people and their biophysical environment results in differing local characteristics that are reflected in their liveability assessment.

UNEP (2007) argues that sustainable urban development must be the key attribute to a liveable city, that sustainable development is no longer the choice of a city, but a fundamental necessity. The World Commission on Environment and Development (WCED 1987), also known as the 'Brundtland Commission', defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. While sustainable urban development is a key attribute of a liveable city, it needs to be acknowledged that other factors associated with people's interactions with each other and with their bio-physical environment are also necessary to achieve the 'quality of life' implied by liveability. The principles of inter-generational equity of sustainable development also underpin other aspects of liveability.

The concepts of 'sustainability' are often intertwined with 'liveability' and like liveability, there are many different interpretations and definitions of sustainability. Broadly, sustainability is generally considered to encompass the long term maintenance of environmental, economic and social dimensions of society, although since the Brundtland Commission, 'sustainability' has taken on a stronger environmental or ecological focus. Nonetheless, liveability generally has connotations of going 'beyond sustainability' in that the 'quality of life' aspect of liveability is more than maintaining or sustaining values or performance. 'Liveability' also has far more of a human or self interest focus. Whereas 'sustainability' generally refers to an individual's external factors – environment, economy and social systems – 'liveability' conveys the idea that it is the benefits gained by individuals or society that are most important.

Societal Needs

A liveable city should be a city that meets the needs of its present inhabitants without compromising the ability of its future inhabitants to meet their needs.

It should be noted that needs and wants have not been differentiated. While physiological needs (within Existence) are shared needs amongst humans and are necessary for survival, Alderfer's conceptualization of human needs go further than physiological and mere bodily needs, and further recognizes the subjectivity of needs.

Water is undoubtedly an essential ingredient for living in a city. McGregor *et al.* (2009) investigated the necessity of certain items that contribute positively to quality of life and the only item considered 'necessary' to 'very necessary' by everyone, was indeed, water. The *Living Melbourne Living Victoria* roadmap argues that superior water management will go beyond meeting a city's essential needs and can contribute to the liveability of cities. However, the roadmap acknowledges that further research is required to identify 'the linkages between liveability and integrated water cycle management'.

In order to identify these linkages, it is essential to determine the urban water needs of a society; and to do this by distinguishing higher order needs (such as aesthetics) from basic needs (such as potable water). While Maslow's hierarchy of needs is undoubtedly the most well-known conceptualisation of human needs, further developments have been made to assist in the analysis of social drivers such as satisfaction/progression, frustration/regression and motivation. Alderfer's E.R.G. theory (1969) is a development of Maslow's five tier hierarchy and contracts the tiers into three levels – Existence, Relatedness and Growth (E.R.G). Maslow's lower layer needs, safety and physiological are merged into Existence (providing the physical and material needs for survival); love and esteem (esteem external to self) into Relatedness (the need for interpersonal relationships), and self-actualisation and self-esteem into Growth (the intrinsic desire for personal development) (see Figure 2).

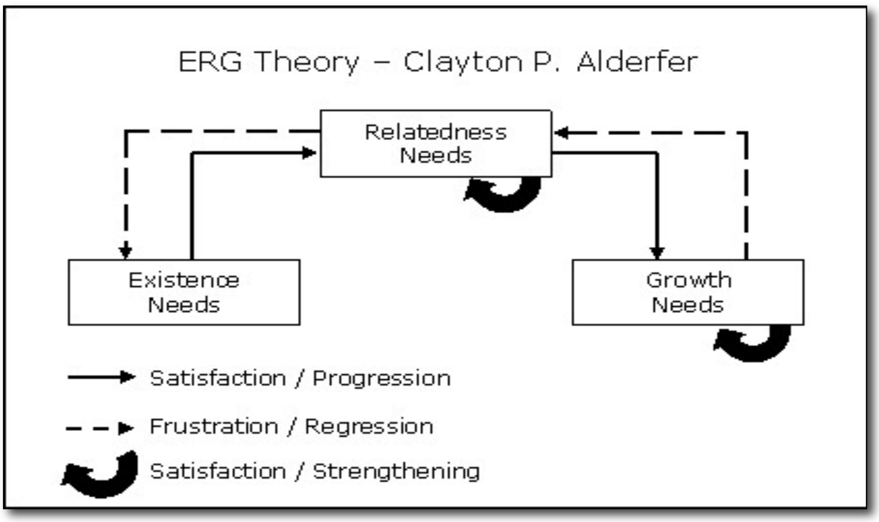

Figure 2. Alderfer's E.R.G. Theory (Scribbles website 2011)

Alderfer examines the relationship between the satisfaction of needs and their impact on desires, and emphasises that the satisfaction of lower level needs are not a prerequisite for the satisfaction of higher level needs. While E.R.G.is hierarchical in a sense, in that it distinguishes needs that are necessary for human survival from needs that allow the pursuit of human growth, it also recognises that the order of importance can vary from individual to individual and further postulates that any level of need can be operational at any given time. Therefore, individuals can meet higher level needs, even if the needs of the lower levels remain unsatisfied. Alderfer gives the example of a starving artist who can attempt to meet her/his growth (personal development) needs, even if s/he is hungry.

Alderfer also considered the interactions between 'needs' and 'desires'. He proposes that a particular need in any category that remains unsatisfied enhances the desire for that particular need and, if a higher order need remains unfulfilled, the individual is likely to regress to an easily accessible lower level need in order to compensate. These interactions lead to seven propositions about the relationships between human needs and desires (Table 1).

Table 1. The relationships between human needs and desires (Alderfer 1969)

Needs Satisfaction		Impact on Desire
i. The less existence needs are satisfied	→	the more they will be desired.
ii. The less relatedness needs are satisfied	→	the more existence needs will be desired.
iii. The more existence needs are satisfied	→	the more relatedness needs will be desired.
iv. The less relatedness needs are satisfied	→	the more they will be desired.
v. The less growth needs are satisfied	→	the more relatedness needs will be desired.
vi. The more relatedness needs are satisfied	→	the more growth needs will be desired.
vii. The more growth needs are satisfied	→	the more they will be desired.

The last of these (number vii) has significant implications for liveability as it suggests that there is no definitive end point and that a society that enjoys a comparatively high quality of life will have a perpetual desire to go further. This reflects the strength of vision and self-actualisation as a driver of growth needs.

The relationships between needs and desires also suggests that the needs categories could be considered as being nested. For example, the more Existence needs are met, the more Relatedness needs will be desired. These relationship dynamics are not absolute – needs within a category do not need to be completely satisfied before progressing to the next category. However, higher order needs are unlikely to be desired if lower needs are not satisfied (eg propositions i and iv essentially impede progression).

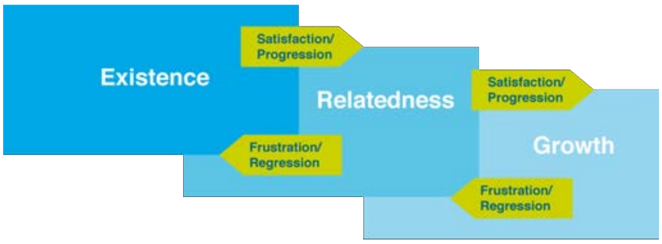

Figure 3. Nesting of Needs Categories

De Haan *et al.* (2011) use Alderfer's E.R.G. Theory as a framework for considering societal urban water needs as a driver of socio-technical transitions in urban water. This use of E.R.G. Theory applies the model at a societal scale rather than the individual and asserts that since urban water management is a societal system, it is one that has manifested to meet certain societal needs. Therefore, systems such as water supply and drainage are technological responses to the needs of humans, such as the need for drinking water and flood protection.

An important consequence of this application of E.R.G. Theory is that the Relatedness needs category extends beyond inter-personal relationships to consider inter-relationships between people and their bio-physical environment.

Dunlap and Rosa (2000) identify three functions of the environment from a societal-environmental interaction perspective:

- The environment provides the resources necessary for life, ranging from air and water to food and materials needed for shelter, transportation, and the vast range of economic goods that are produced.
- The environment also serves as a sink or waste depository for the waste products of human activity. While many waste materials are reincorporated into the environment and ecological processes, some remain effectively 'in storage'.
- The third function of the environment is to provide a 'living space' or habitat for human populations.

The first two functions are directly linked to Existence needs for the consumption of physical and material goods. Societal needs for 'living space', or habitat, are not so much consumptive but how the bio-physical environment provides comfort and aesthetic beauty with a sense of integral security (such as ecological health).

The physical and material Existence needs span from 'survival' needs through to desires that enhance quality of life. For example, there is a minimum amount of clean, safe water that is needed for direct consumption. While the availability of additional water may lessen concern over its future availability, it also opens up a broader range of uses that enhances quality of life.

The Relatedness needs of Societal Urban Water Needs fall into two subcategories related to the role of water in:

- Supporting or facilitating social interactions and, hence, inter-personal relationships, and
- Contributing to societal-environmental inter-relationships.

At an individual scale Growth needs reflect the need for achievement that develops self-esteem and personal development. Scaled up to a societal level, Growth is reflected by the ability to overcome potential challenges and, in doing so, not only improve 'performance' but also prepare and be adaptive to future challenges. For a society as a whole, to contribute to self-esteem and self-actualisation, its individuals need to be engaged in societal processes. Engagement can be very indirect through some form of delegation and is dependent on the 'hydro-social contract' (Turton and Ohlsson 1999) that exists between communities, governments and businesses on water management. Growth also depends upon alignment with social values and principles, such as intra- and inter-generational equity, for acceptable progress.

The framework of societal urban water needs presented by de Haan *et al.* (2011) has been further developed to reflect these subcategories of relatedness needs (Table 2). While extensive, the urban-water related societal needs identified in Table 2 are not exhaustive. There may be other societal needs that water systems and services also contribute to.

Table 2. Societal Needs in Urban Water Systems (adapted from de Haan *et al.* 2011)

Needs category		**Urban-water societal need**	**Description**
Existence	Physical and material needs	Drinking Water	Safe, secure and accessible supply of water for direct human consumption
		Non-drinking Water	Safe, secure and accessible supply of water available for uses other than direct human consumption
		Public Health	Protection from polluted wastewater and stormwater; tolerable microclimates; public places that promote physical and mental health
		Public Safety	Protection of people from the hazards of water, e.g. during floods or storm events
		Property Protection	Protection of property and infrastructure from the hazards of water, e.g. during floods or storm events
		Economic Activity	Industries and jobs that rely on water servicing
Relatedness	Social interaction and inter-personal relationships	Recreation	Places for play, sport and leisure
		Social Cohesion	Safe and secure places for social interaction and human connectedness with people
	Societal-environmental inter-relationships	Beauty	Aesthetic urban environments promoting interaction with nature
		Comfort	A pleasant micro-climate and landscape for human thermal comfort
		Ecological health	Clean and healthy ecosystems with no negative impact on other ecosystems
Growth	Societal self-esteem and self-actualisation	Identity	Harmony with culture and tradition, to feel belonging. Proud association with urban water systems and environments
		Purpose and Ambition	Progress towards a shared vision of a water sensitive future
		Control and Independence	Choice and influence on decision-making about water infrastructure and services
		Equity and Social justice	Equal opportunity to access the benefits of the urban water system
		Intergenerational equity	Preserve the ability of future generations to meet their water-related needs

While it is convenient to assign various aspects of urban water systems to needs, such classifications are not necessarily absolute. Some attributes and needs may transcend the boundaries that we have constructed. For example, a use of water can be to support lush vegetated environments, which in turn can affect perceptions of personal safety. This can be analysed to reveal a complex set of interactions between physical/material inputs (water), societal-environmental interrelationships (people's perception of the safety risks in a vegetated environment) and inter-personal relationships (people's perceptions/expectations of anti-social behavior of people that may conceal themselves in urban parks and forest). Needs for inter-personal safety could legitimately be allocated to several needs categories.

Integrated Urban Water Management and Water Sensitive Urban Design

Integrated Urban Water Management (IUWM) represents the managed hydrological cycles and systems of a Water Sensitive City. As described by Barton *et al.* (2009), IUWM seeks to change the impact of urban development on the natural water cycle based on the premise that by managing the urban water cycle as a whole, a more efficient use of resources can be achieved by providing not only economic benefits but also improved social and environmental outcomes. IUWM builds on existing water supply and sanitation considerations within urban areas by incorporating water resources, and their uses, that lie outside of the conventional centralised water supply and wastewater systems. The scope of water resources is expanded to include decentralised recycled treated wastewater and stormwater while the range of water uses is extended to consider the pre-development water pathways of infiltration, evapotranspiration and groundwater recharge.

Table 3. Generalised Elements of Integrated Urban Water Management

Sources of water for urban use	Urban Water Infrastructure for storage, treatment, transport	Beneficial Use	Disposal (return to environment)
External • Catchment/ diversion to Dams • Seawater (desalination ***Internal*** • Stormwater (precinct) • Rainwater (roof) • Recovered from wastewater (recycled)	***Water Supply*** • Service basins • Distribution networks • Water treatment and disinfection ***Wastewater*** • Reticulated sewerage • Local wastewater treatment ***Stormwater***	***Indoor*** • Direct consumption (drinking, food preparation) • Hygiene (bathing, showering, cleaning) • Waste disposal (toilet flushing) ***Outdoor***	Treated wastewater discharge Stormwater drainage discharge Septic tanks Evaporation/ evapotranspiration/ infiltration Leakage

	• Piped drainage • Overland flow paths • Bioretention • Wetlands • Ponds • Detention basins and flow control structures • Aquifer storage and recovery	• Gardens – ornamental & productive • Swimming pools & spas ***Commercial/Industrial*** • Process water etc • Cooling • Cleaning ***Community*** • Open space/ parklands irrigation • Sportsgrounds • Community gardens • Water features (ponds/ fountains) • Aquatic centres/facilities	**Adverse Impacts** Flood – surface flows Flood – inundation Water supply – health risks Wastewater (sewage & stormwater) • Health risks • Environmental risks (pollution and physical)
	Multipurpose stormwater infrastructure-use-disposal ○ Green roofs ○ Infiltration systems ○ Permeable paving ○ Swale drainage ○ Street trees (bioretention pits)		

The elements of IUWM are illustrated in Table 3. These include sources of water, infrastructure used to store, treat and transport water in urban areas, beneficial uses made of water, potential adverse impacts of water in urban areas and pathways by which water returns to the environment from urban areas (disposal). While most elements can be ascribed to a primary purpose, there are several that are specifically multi-purpose and hence are represented as a separate category.

'Green infrastructure' aims to mimic natural biophysical and ecological processes and provides a means for re-introducing or maintaining 'nature' in urban environments. The 'nature' provided by green infrastructure can contribute to satisfying a range of societal urban water needs such as physical and mental health and relatedness needs. The US-EPA specifically links 'green infrastructure' with stormwater management. *Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.*[3]

[3] United States Environment Protection Agency *Green Infrastructure* http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm#tabs-1 accessed 27 April 2012.

Green Infrastructure is a concept originating in the United States in the mid-1990s that highlights the importance of the natural environment in decisions about land-use planning. In particular there is an emphasis on the 'life support' functions provided by a network of natural ecosystems, with an emphasis on interconnectivity to support long-term sustainability. Examples include clean water and healthy soils, as well as the more anthropocentric functions such as recreation and providing shade and shelter in and around towns and cities.

The United States Environmental Protection Agency (EPA) has extended the concept to apply to the management of stormwater runoff at the local level through the use of natural systems, or engineered systems that mimic natural systems, to treat polluted runoff. This use of the term 'green infrastructure' to refer to urban 'green' best management practices (BMPs), although not central to the larger concept, does contribute to the overall health of natural ecosystems.

From Wikipedia http://en.wikipedia.org/wiki/Green_infrastructure (accessed 29 Dec 2011)

Water Sensitive Urban Design (WSUD) is defined by the Council of Australian Governments (COAG) as '*the integration of urban planning with the management, protection and conservation of the urban water cycle that ensures that urban water management is sensitive to natural hydrological and ecological processes'.* WSUD, extend the principles of IUWM to include additional urban design considerations such as urban amenity, public health, urban microclimates and heat mitigation, biodiversity and the ecological health of natural environments and receiving waters.

IUWM can be achieved entirely by pipes and underground structures, while it is only through WSUD that we get to attain the additional benefits that are associated with green infrastructure.

Maller *et al.* (2005) define 'nature' in urban environments as extending from single elements of the natural environment (eg plants, animals, soil, water or air), including domestic animals and cultivated plants, through to fully functional complex ecosystems (as would be expected in wilderness areas). Their review of physiological and psychological health benefits of nature in urban environments found that there is evidence that just viewing nature can markedly improve many aspects of human health and development. Further, 'being in' nature can deliver theraputic benefits. They make nine assertions about health and wellbeing benefits of contact with nature that are demonstrated with certainty through anecdotal, theoretical and empirical evidence (Maller *et al.* 2005).

What the Research Demonstrates With Certainty - Assertions that contact with nature promotes health and well-being

- There are some known beneficial physiological effects that occur when humans encounter, observe or otherwise positively interact with animals, plants, landscapes or wilderness
- There are established methods of nature-based therapy (including wilderness, horticultural and animal-assisted therapy among others) that have success healing patients who previously had not responded to treatment
- When given a choice people prefer natural environments (particularly those with water features, large old trees, intact vegetation or minimal human influence) to urban ones, regardless of nationality or culture
- The majority of places that people consider favourite or restorative are natural places, and being in these places is recuperative
- People have a more positive outlook on life and higher life satisfaction when in proximity to nature (particularly in urban areas)
- Exposure to natural environments enhances the ability to cope with and recover from stress, cope with subsequent stress and recover from illness and injury
- Observing nature can restore concentration and improve productivity
- Having nature in close proximity, or just knowing it exists, is important to people regardless of whether they are regular 'users' of it

(Maller *et al.* 2005).

In considering the contribution of public land to Melbourne's liveability, West and Jones (2009) identify a number of areas of direct contribution. While using a different framework than ours for considering liveability, the range of attributes and their interaction with liveability has some common themes.

Public land contributes to:

- **healthy, safe and inclusive communities**
  - physical health
  - mental health
  - community's social capital
  - community safety
  - sense of pride and attachment to place
- **dynamic, resilient local economies**
  - stimulates the economy
- **culturally rich and vibrant communities**
  - venues for artistic expression and cultural diversity
  - local, metropolitan and international sporting events
  - heritage sites and knowledge
- **sustainable built and natural environments**
  - water quality and food security
  - absorb greenhouse gases and other atmospheric pollutants
  - alleviate heat stress
  - sustain biodiversity
  - phyto-remediation
  - environmentally sustainable urban areas
- **democratic and engaged communities**
  - consultation and engagement
  - forum for community action

West and Jones (2009)

Societal Urban Water Needs

This section outlines the ways in which IUWM and WSUD, can contribute to societal urban water needs and, in particular, the additional value that can be gained over conventional urban water systems based on external water sources, centralised water and wastewater services, stormwater drainage and disposal of untreated stormwater and treated wastewater to the environment.

Existence

Alderfer's **'Existence'** category relates to a person's physical and material needs such as food, clothing and shelter. In many cases there are threshold needs that are essential for survival. For example, there is a minimum amount of clean water that a person needs for drinking and consumption. Having more than the minimum amount of water available, not only reduces the mental stress that may come from being on the edge of survival, but also opens up the opportunity for more discretionary uses of water. Extending beyond the critical survival needs, many 'discretionary' uses of water, for example bathing and cleansing, can be considered as essential cultural needs based on cultural norms.

Drinking water and non-drinking water

Conventional urban water systems meet the needs for both drinking and non-drinking water from water sourced externally to urban areas and stored in large reservoirs prior to distribution through piped reticulation. There is no differentiation between water for direct human consumption and other uses. Security of supply, which ensures that existence needs for water are satisfied, is provided by ensuring that the sources and storage provide sufficient reserves of water to satisfy demand across seasons and years with variable rainfalls.

The Millennium Drought caused Melbourne's security of supply to be challenged. The responses, to ensure that the existence needs could be met, included demand management (eg water use restrictions) and supply augmentations (eg pipelines to expand the water grid and construction of a desalination plant). While Melbourne did not reach a point where survival needs for water were directly threatened, the public profile of water resource management and the need for supply and demand initiatives created some community anxiety (as reflected by substantial public commentary in the media), indicating the frustration and regression associated with the perception that future existence needs may not be fully satisfied.

IUWM provides an opportunity to expand the sources of water available to a city by tapping into the 'internal' sources such as rainwater, stormwater and recycled water. The beneficial uses of water in urban areas include some that are highly sensitive to water quality, such as drinking and food preparation, through to those that are reasonably tolerant of poor water quality. Conventional water supply relies on assessing water sources external to the city and a centralised distribution system that is treated to a quality that is suitable for the most sensitive uses. IUWM provides an opportunity for multiple sources and hybrid centralised and decentralised system such that lower quality water sourced and supplied locally and used on a 'fit for purpose' basis.

By accessing a broader range of water sources, that can have different weather/climate responses, IUWM systems within the urban environment, can increase the security of water systems and strengthen community confidence that these needs are being satisfied.

Public Health

Society needs to be protected from public health risks from water and water-related practices. The key risks are:

1. Exposure to pathogens and/or contaminants via drinking water supplies
2. Exposure to pathogens in wastewater (sewage etc)
3. Exposure to pathogens and/or contaminants from other sources of water (eg non-potable distribution, drainage systems, water bodies etc)

The risks of exposure to pathogens have been major drivers for the development and operation of water supply and sewerage systems. While water supply systems protect water resources from contamination, sewerage systems have developed to prevent contact with wastewater, protecting people from the polluted waters.

Further, water also plays a key role in the promotion of good physical and mental health. The role of water, and more particularly the practices Water Sensitive Urban Design, create environments in which people can undertake activities that promote their physical and mental health. Research on the human-environment relationship shows that the presence of nature and green spaces encourages recreation and physical activity (Humpel *et al.* 2002, Van den Berg *et al.* 2007), promotes social cohesion (Van den Berg *et al.* 2007, Kweon 1998) and can provide an 'ecological aesthetic', traditionally referred to as 'scenic beauty' (Gobster *et al.* 2007). There has been significant research in the environmental psychology and ecohealth fields that show a positive link between the quantity of green spaces and human health – both physical and emotional (Ulrich 1984, Hartig *et al.* 2003, Pretty *et al.* 2005, Kaplan & Kaplan 1989). It is further shown that natural environments are restorative and promote recovery from mental fatigue (Kaplan & Kaplan 1989, Hartig *et al.* 2003); enhances the ability to recover from illness or injury (Ulrich *et al.* 1991); provides people with a positive outlook and higher life satisfaction Kaplan & Kaplan 1989, Kuo 2001) and restores concentration and improves productivity (Taylor *et al.* 2001).

Conventional urban water systems have been particularly successful in providing safe water supply and protecting people from exposure to wastewater. Except in times of water scarcity, they have also been able to supply water for the irrigation of sporting grounds and public spaces. Conventional stormwater drainage, with its emphasis on rapid disposal of stormwater, has also played an important flood protection role and preventing the pooling of contaminated stormwater in urban environments. However, the disposal of untreated stormwater and treated wastewater from conventional systems to the environment creates health risks. For example, the Victorian Environment Protection Authority routinely advises that marine waters in the vicinity of stormwater drain outfalls, are not suitable for human swimming following rainfall.

IUWM and WSUD can improve the protection of public health by:

1. Increasing the opportunity for irrigation (both active and passive) of sportsgrounds and public spaces, in a way that does not compromise potable water needs in times of water scarcity.
2. Reducing the generation of stormwater which reduces the mobilization and distribution of pollutants and, hence, reduces the hazard posed by polluted stormwater

3. Providing treatment of stormwater, removing contaminants and further lowering the risk of exposure to contaminants in the receiving environments.

Public Safety and Property Protection

Flooding, particularly fast moving overland flow, is a key risk to public safety and property damage in urban environments. Measures that reduce such risks, by either reducing the source of floodwaters or ensuring that it is conveyed in a way that reduces risks to people, can improve safety and reduce the damage to property.

Conventional urban water systems include a reliance on hydraulically efficient and cost-effective drainage to remove water and alleviate flooding. This is based on a major/minor drainage system that includes piped drainage (generally designed to convey 1 in 5 year storm events) and overland flow paths, floodways, floodplains and retarding basins that combined provide a 1-in-100 year flood capacity without affecting public safety, or increasing flood levels on upstream or downstream properties. Changes to catchment imperviousness through infill development and additional hard surfacing (paving and roofing) and/or changes to rainfall patterns as a consequence of climate change can compromise the design performance of drainage systems.

Green infrastructure measures that detain and/or retain stormwater can offer alternative methods of stormwater drainage in new greenfield developments and as supplementary to the conventional piped system to mitigate the effects of urban densification on stormwater runoff. Initiatives that retain stormwater close to source for use or treatment (eg infiltration or biofiltration) can counter the effects of catchment development and/or climate change and either recover or improve the design performance of the drainage system.

Economic Activity

Societies need healthy economies to maintain the cash flow that is necessary to ensure that all individuals can access resources, goods and services to meet their needs. 'Jobs' are commonly used as a key indicator economic activity and health. Water and water services and systems can support a range of economic activities. The design, construction and operation of water systems can directly contribute through the provision of jobs. Water can also be a key input for 'downstream' economic activity – for example water dependent industries require a secure source of water to meet their economic (and jobs) potential. IUWM provides opportunities to expand the portfolio of water resources that are available to support economic activity without compromising, and indeed improve, the security of existing potable water supplies.

Relatedness

Alderfer's '**Relatedness**' category relates to a person's interpersonal needs within his personal as well as professional settings, also described as social and external esteem needs. De Haan *et al.* (2011) consider a person's interactions with their environment as part of this suite of interpersonal needs. As discussed above, two subcategories of Relatedness can be distinguished that are related to the role of water in:

1. Supporting or facilitating social interactions, and hence interpersonal relationships, and
2. Contributing to societal-environmental interrelationships.

Social Interactions and Inter-Personal Relationships

Recreation

Sporting grounds are a key focal point for active recreation. Research on the human-environment relationship shows that the presence of nature and green spaces encourages recreation and physical activity (Humpel *et al.* 2002, Van den Berg *et al.* 2007). In addition to the physical health benefits, they provide opportunities for social interactions and the development of interpersonal relationships that can be based on the sporting or other common interests of spectators. Sporting grounds range in profile from the major centres (such as premier football and cricket grounds) to local sporting fields used by junior sporting clubs. The quality of playing surfaces, particularly grassed surfaces, depends on the availability of water and can be a key factor in the desire to use or visit a facility.

Recreation extends far beyond organized team sports. Other, more individual, pursuits such as golf also attract large numbers of participants. Green spaces, such as parks, gardens and waterway corridors, support a broad range of structured and informal recreation. As with sporting grounds, the quality of green spaces that make them appealing for recreational use are dependent upon the availability of water.

The Millennium Drought has highlighted both the value of sporting grounds and open space as community assets and also their vulnerability to water scarcity. Irrigation of open space and sporting grounds from conventional water supply systems is often considered as a low priority in times of water scarcity and irrigation is limited from the early stages of water restrictions. Nevertheless, many local governments resorted to purchasing recycled water trucked to sport grounds at significant costs.

IUWM offers opportunities for obtaining water suitable for sporting ground irrigation through stormwater harvesting and/or wastewater recycling. The adoption of green infrastructure, WSUD approaches for localised stormwater treatment and harvesting adjoining these sporting grounds can improve their resilience to water scarcity and ensure their endurance and sustainability.

Social Cohesion

Van den Berg *et al.* (2007) and, Kweon (1998) demonstrate that the presence of nature and green spaces promotes social cohesion. Attractive open spaces and public places will encourage visitation and use that foster social interaction. In many cases, the role and dependency on water may not seem apparent as other factors have a higher public profile. For example, many local parks are popular arenas for people walking dogs with informal peak periods that result in higher levels of social encounters and interactions (involving both the dogs and their walkers).

As with recreation (above), conventional urban water systems can supply water for irrigation of open spaces and public places. However, in times of water scarcity these uses are particularly vulnerable and are generally a lower priority than sporting or recreation areas. IUWM offers opportunities for sustaining these places through such times by sourcing water by stormwater harvesting or recycled wastewater or by design that retains rainwater on site in the landscape.

Social interactions are not always positive. Offences against the person, which encompass crimes such as assault (physical and sexual) and robbery, are an unfortunate feature of urban living. The attraction of a public place as a place of social interaction can be tempered by concerns that it harbors anti-social behaviors and that there is a risk of becoming a victim of crime. Kuo and Sullivan (2001) explore the relationship between urban parks, wetands and forested areas and crime. They found that although vegetated areas have been positively linked to fear of crime and crime in a number of settings, residents living in "greener" surroundings report lower levels of fear, fewer incivilities, and less aggressive and violent behavior. They conclude that landscape design, such as the density and form of vegetation, is an important determinant of both the perception of safety and the actual incidence of criminal activity. This has important implications for the use of vegetation and irrigation in the management of stormwater and water sensitive urban design.

Societal-Environmental Inter-Relationships

Comfort

Water can play a key role in moderating urban microclimates. The evaporation of water from ponds and other water bodies, together with vegetation evapotranspiration, provide an evaporative cooling effect. In addition, vegetation (dependent upon water) can provide shading, which reduces heating effects. Wong and Yu (2003) show that urban heat island effects can be mitigated through the presence of green spaces.

Conventional urban water systems can support evaporation and evapotranspiration through the irrigation of gardens, lawns and other vegetation with potable water. However, this is generally regarded as a low value use of treated and managed water. This means that, if optimised, irrigation seeks to use the minimum amount of water necessary to maintain plant growth and health. This may not correspond with maximizing the evaporative cooling effects.

WSUD utilises infiltration, evaporation and evapotranspiration, and stormwater harvesting as means of managing stormwater and minimising the impacts of urbanization on the supporting hydrology of natural waterway and thereby protect its ecosystems.

An outcome of a well designed WSUD approach to stormwater management is that it optimises the opportunities for protection and enhancement of the ecological health of urban waterways, securing alternative water sources to support a greener cityscape which in turn promotes urban cooling, enhances biodiversity and amenity in urban spaces for both active and passive recreational uses.

Beauty

The aesthetic attractiveness and beauty of an urban landscape is fundamental to the relationship that people form with their surroundings. An urban area can be fully functional, meeting all needs from a physical perspective, but if it is unattractive then it may well be viewed as a cold and inhospitable place.

While beauty and aesthetic attractiveness may be considered subjective, there are methodologies for determining community preferences and values. For example Dobbie (2012) surveyed 241 individuals to rate and rank aesthetic preferences for wetlands. Dobbie found that particular wetland attributes are preferred, including the presence of trees, open water and (perceived) wetland health.

Creating beauty and attractiveness in the built environment can be challenging. While vegetation and water can soften an otherwise harsh environment the context created by the built form can be the dominant influence.

Conventional urban water systems dispose of stormwater and use imported potable water to maintain vegetation and water features (eg ponds and fountains). As with other outdoor uses of water, these are generally considered to be of low value in times of water scarcity (as reflected by water restrictions).

Water Sensitive Urban Design (WSUD) explicitly incorporates the pathways of water through vegetated and water features that are an integral part of the urban landscape. The beneficial outcomes of WSUD, including beauty and attractiveness, are sustained by water sourced and retained within the urban environment (rainwater and stormwater in particular).

Ecological Health

The ecological health of the natural environment can be significantly influenced by the impacts of urban development and urban living. Symptomatic of the effects of urban development on ecological health of the natural environment include the lost or degradation of habitat conditions associated with reduced air and water quality, invasion of exotic flora and fauna, land and waterway erosion. Consequential impacts include reduction in the biodiversity of the natural environment and increased pollution of urban waterways. As such, maintaining the ecological health of the natural environment within, and adjoining, urban environments is a key urban liveability aspiration.

With conventional urban water systems, wastewater management has been the primary focus in protecting public health and indirectly, the protection of ecological health of waterways within urban environments since many of these waterways were previously used as conduits for disposal of untreated wastewater. The separation of wastewater from the environment through the sewerage system and the treatment of wastewater to produce an effluent suitable for disposal to the environment has minimised the impact on natural environments and improved public health. Nevertheless, the continued discharge of treated effluent into waterways has resulted in significant changes to these ecosystems through changed hydrology and water quality. Most of Melbourne's treated wastewater is discharged from Western Treatment Plant to Port Phillip Bay and from the Eastern Treatment Plant to Bass Strait. In addition, several local treatment plants discharge to waterways within the Port Phillip and Westernport catchments and there are some localised discharges of sullage in unsewered catchments and sewer overflow events.

While securing a baseline level of protection of ecological health in waterways through the provision of sewerage services, conventional stormwater systems can also have significant impacts on receiving environments. Attaining a higher level of ecological health in waterways requires a focus to be placed on stormwater management. The surge of polluted stormwater generated by rain falling on efficiently drained impervious urban surfaces has a range of ecological and environmental impacts that are summarized as the 'urban stream syndrome' (Walsh *et al.* 2005).

Conventional urban planning and design approaches can often miss opportunities for incorporating urban water infrastructure whilst maintaining/enhancing ecosystems in urban environments. The drainage and disposal of stormwater deprives urban landscapes and ecosystems of their essential water needs. In addition, ephemeral and small scaled aquatic ecosystems are often lost through lack of integration in the urban planning and design development phase.

WSUD can overcome some of the limitations of conventional urban planning and design approaches. Retaining and managing stormwater in the urban landscape using green infrastructure employs natural systems, or engineered systems that mimic natural systems, to treat and manage stormwater. As such, ecosystem functioning and health is a critical success factor for green infrastructure systems and ecological health is an intrinsic part these systems.

Growth

Alderfer's '**Growth'** category relates to a person's needs for personal development, also described as self-actualisation and internal esteem needs. de Haan *et al.* (2011) nominate the attributes of independence, control, social justice, identity and intergenerational equity as representing the societal needs for water to meet growth needs. In considering the application of societal urban water needs to liveability we have revised de Haan *et al.'s* list of growth needs to include identity, purpose and ambition, control and independence, equity and social justice and intergenerational equity.

Societal growth needs reflect the engagement of society in the processes that shape cities and urban water systems. Overall, growth is achieved when the intellect and resources of society are applied to deliver 'State of the Art', or 'best practice', services (societal self esteem) and these actions are on a pathway towards some societal vision for the future (societal self actualisation).

Hydro-Social Contract

The 'hydro-social contract' (Turton and Meissner, 2002) is a mechanism that can connect individual growth needs to societal systems. As described by Brown *et al.* (2008), the hydro-social contract comprises 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.

An example of the role of the hydro-social contract can be seen in Keremane *et al. (2011)* which surveyed residents over the internet to determine their attitude towards using treated stormwater for several non-potable uses. While there was agreement or support from respondents, this was conditional on having a trustworthy well-funded organisation managing the system.

A failure to achieve societal growth from major water system initiatives can indicate a failure in the hydro-social contract. For example, Victoria's 2007 Water Plan which announced major initiatives, such as the desalination plant and North-South pipelines to create an expanded water grid, was not warmly embraced by significant sections of the broader community and reflected a societal 'regression' rather than a progression toward growth. This can be attributed to the process and timing of the development of the plan which was rapid and lacked community engagement and consultation. Some opponents to the Water Plan[4] claim that the Government's mandate at the time ruled out the construction of a desalination plant. They argue that the public was not expecting that a desalination plant would be central to the Water Plan and that, in effect, the government operated outside of the hydro-social contract by pursing significant initiatives outside of the expectations of the community.

In order to use the hydro-social contract to progress liveability it is necessary to understand the prevailing 'terms and conditions'. However, as it is an informal contract, there is no formal structure

[4] For example, http://candobetter.net/node/2528 *Victoria's Wonthaggi Desal Plant - public demand for Royal Commission*

or documentation. A social research program that explores the needs, wants and expectations of society, could help to reveal the mandate and authority that society has delegated to government and its agencies to act on its behalf. Submissions and evidence given to processes such as the Victorian Parliament's Environment and Natural Resources Committee's Inquiry into Melbourne's Future Water Supply[5] may be a useful source of information that could be analysed to reveal aspects of the hydro-social contract.

Identity

Identity is described as 'harmony with culture and tradition, to feel belonging'. The planning and development of most cities is fundamentally linked to water, for example the site for the initial settlement of Melbourne was chosen because of the fresh water provided by the Yarra River. The city's growth is also linked with water. The higher rainfall to the east of the emerging city, combined with a topography suitable for large dam construction nearby, provided a reliable source of water making it a desirable area for development. Taking advantage of the opportunity to keep water supply catchments closed from public access has resulted in a high quality water supply which is a source of pride and identity for Melbournians.

Features, such as the Yarra River, Port Phillip Bay and other waterways, are iconic elements that help to define Melbourne's identity. This identity extends into a spiritual connectedness between individuals, communities and societies with places, through historic and cultural heritage. Whether as a substance, as a water body or as a meteorological phenomenon, water is a clear aspect of indigenous spiritualties' and of many western religions (Altman 2002). However there are also clear societal, community (shared) and individual (personal) connections with water. For example, Melbourne residents' connections with the Yarra River, Port Phillip Bay and other local water features, forms part of a shared identity that is fostered through recreational engagement, artistic impressions and personal memories of water in their neighbourhoods and city. For example, the 'Heidelberg School' of artists, a late nineteenth century plein-air impressionist art movement, were inspired by the landscapes of the Yarra and helped to make these scenes a part of Melbourne's identity. Beyond particular landscape features, the physical form of water itself creates a sense of identity through people's unique or shared experiences with water; for example, memories associated with children playing under sprinklers, splashing in waves, or the ability of water to impress a mood or sentiment from watching water flow or listening to rain fall on a roof or stomping in puddles.

Water is a focal point for a wide range of celebrations varying in scale, formality and spirituality, providing the central focus for spiritual ceremonies, days at the beach, picnics by the lake, and many other parts of a community's festivities. For example, Moomba is a key event on Melbourne's contemporary social/cultural calendar. The Melbourne Moomba Waterfest is Australia's largest free community festivals and has been celebrated annually since 1955.

Identity also recognises the spiritual connections with water and acknowledges the strong link that individuals and communities have with their surrounds.

[5] See http://www.parliament.vic.gov.au/enrc/inquiries/inquiry/246 - Victorian Parliament - Environment and Natural Resources Committee (accessed 2 April 2012).

WSUD has the potential to create urban places that have their own particular identity – places where the management and use of water (eg for supporting green corridors, parklands, urban forest and water features) creates a local environment that communities identify with and have a particular sense of belonging. Places like the Lynbrook Estate, for example, has its identity as Australia's first WSUD precinct and remains an important showcase for many practitioners across multiple disciplines on the WSUD approach in land development. Presland (2004) notes that while Melbourne's growth has been lopsided towards the east and south east, influenced by topographical and natural history interest in the landscapes, the balance is being redressed by new developments to the west, such as Caroline Springs, where artificial lakes are created to give residents some aquatic scenery. In addition to contributing to the Relatedness needs for Beauty, Comfort and Ecological Health, it is apparent that WSUD can create an identity for local and broader communities.

Purpose and Ambition

Societal growth reflects a dynamic society that is working with a sense of purpose towards a common goal. Purpose and ambition guide self actualisation. A strong vision shared by society can provide a sense of purpose for the development of cities and their communities.

The contemporary urban water services of water supply, sewerage and drainage are mature and fulfill their purpose – the provision of safe and secure water supply, safe and effective wastewater services, drainage and flood protection. This presents an interesting challenge as they do not instill a sense of purpose or ambition to progress towards some further goal. While population growth and climate change may make maintaining the level of service challenging, an aim of maintaining *status quo* service performance does not translate into a societal ambition, particularly if there is not an appreciation by the community of the significance of the changing influences on their water services. The challenges of maintaining 'mature' services needs to be understood and appreciated by communities if they are to contribute to societal growth needs.

It is also necessary to note that slow paced developments and transitions are also challenging to recognise as contributors to Societal Growth. For example, while new Greenfield urban development can be designed and built in various ways to incorporate WSUD and contribute to a host of societal urban water needs, urban redevelopment and renewal presents a different set of challenges. Brownfield redevelopment projects and activity centres can use masterplanning processes to gain good integrated solutions. However, an advantage of WSUD is that it is scaleable and even single-lot scale redevelopment can produce more liveable outcomes that progressively improve neighbourhoods. In terms of Societal Growth, it is important to ensure that the slow, gradual transformation is acknowledged as progress towards a societal vision.

WSUD and the ideas of water sensitive cities create a vision for future cities that are distinctly different from today's cities. Actions that help to strengthen and share the vision across society can contribute to the societal needs for purpose and ambition. The hydro-social contract can help to set the vision and ambition for urban water systems and clarify the expectations of the community in the key dimensions and rate of progress of the transformational pathway.

Control and Independence

Societal growth is a product of engagement in activities that strengthen self esteem and self actualisation. While much of the direct engagement in decision making is effectively delegated to government and water utilities, through the hydro-social contract, there is an important role for individuals to have an appropriate level of control and choice over their services. This can be scale-based so that the large scale decisions of governments and water utilities are complemented by the local decisions of municipal councils and the decisions of individual households.

Conventional urban water systems are large scale and generally rely on centralised systems for water supply (eg large dams or desalination plants) and wastewater treatment (eg major sewage treatment plants). While these systems have developed to take advantage of the economies of scale that existed, they were developed in a different economic context to that which exists today. Further expansion of centralised systems to meet all of the needs of new users in a 'user pays' environment may disenfranchise local communities and individuals by disconnecting them from decision making processes that can have significant effects on their finances. The disconnection between local communities and centralised water systems can be softened to some extent through consultative processes that allow interested members of the community to participate in decision making processes.

By creating a role for local systems to supply water and to manage stormwater, WSUD provides opportunities for individuals to make decisions and have control and independence over various elements of their water services and environments. Household rainwater tanks provide an opportunity for a degree of independence, self sufficiency and control for meeting non-drinking water supply needs. Likewise green roofs, infiltration systems, permeable paving, bioretention systems, greywater treatment systems and private gardens give households control over the management and use of stormwater and some wastewater.

Equity and Social justice

Principles of social justice and equity are key tenets that underpin human cultural values. It is generally agreed that fairness and equity are culturally universal goals and various researchers contend that notions of equity and social justice are a human survival mechanism and part of the mind's 'architecture'. These values are evident in the philosophical basis of most religions and social justice movements. Development of water sensitive city systems have the capability to contribute to societal growth by improving equity and ensuring that entire communities are beneficiaries of the advantages of IUWM, or they could compromise equity by creating a regime of favor and exclusion. In order to assure equity and social justice, there needs to be an even geographical distribution of benefits and access to them across society, in order to avoid the marginalisation or the exclusion of the benefits of societal systems.

Socio-economic factors can have a major influence on equity if one's ability to pay, or affordability, make it difficult for sectors of the community to access the benefits of IUWM and WSUD. In addition geographic characteristics can cause some parts of a city to be more vulnerable to poor performance or system failures – for example, elevated areas may be more dependent on pumping for water supply while low-lying areas may present challenges to effective drainage.

Conventional urban water systems have had a strong focus on ensuring that minimum standards for water supply, sewerage and drainage are met across service areas. Water pricing has been based on common service and consumptive charges regardless of the actual cost differences arising from local geography.

However, conventional systems provide only a portion of the services and benefits expected from IUWM and WSUD. A challenge for application and development of IUWM and WSUD is to ensure that the benefits are available to the broader community and that barriers are not created that effectively exclude sectors of the community from accessing things that can contribute to their liveability. For example, how can equitable access to amenity opportunities be ensured, irrespective of people's socio-economic status? While the quality of greenspace may vary across Melbourne, can the system be planned and designed to ensure everyone has access to parks and gardens, healthy waterways and beaches? An important advantage of WSUD over conventional systems is that it brings amenity and other ways of meeting Relatedness needs into the urban environment. For example, while conventional drainage systems are underground, many WSUD options keep stormwater on the surface in green infrastructure which provides comfort, ecological health and beauty benefits. WSUD ensures that green infrastructure and their benefits are distributed across urban areas improving the availability and accessibility to local communities.

In the broadest sense, equity could also be considered to refer to equity amongst different species, implying that the ecosystem services provided by water should not be unduly compromised for the sake of humans. By creating habitat and healthy ecological systems, WSUD strengthens biodiversity improving the equity of non-human species.

Intergenerational equity

Intergenerational equity can be a key driver for societal self-actualisation. It provides a challenge for communities and societies to account for the needs and interests of future generations in making decisions relating to services and- systems that meet current needs.

Conventional urban water systems are developed on the basis that societies' future physical and material needs for water (their Existence needs) are not dissimilar to today's needs. Accounting for projections in population, development and climate, infrastructure systems are planned and developed to ensure that service standards are maintained into the future. Intergenerational equity demands that these infrastructure and service developments do not compromise other societal values and needs. For example, meeting future urban drainage needs by the destruction of waterway ecosystems could compromise the liveability of future generations.

Societal Relatedness Urban Water Needs are satisfied through the design of substantial, long-lasting, community infrastructure and assets such as sporting grounds, parks and open space, and green infrastructure. Successful delivery of these needs should deliver infrastructure and assets that will serve successive generations.

IUWM and WSUD provide opportunities for enhancing liveability in ways that are enduring and sustainable such that the benefits enjoyed by today's generation can be available and enjoyed by future generations.

City States, Water Sensitive Cities and Societal Urban Water Needs

Brown *et al* (2009) describe the development of water systems in urban environments as an embedded city states continuum of Water Supply, Sewered, Drained and Waterway cities and suggest a forward trajectory to the Water Cycle and Water Sensitive Cities (see Figure 4).

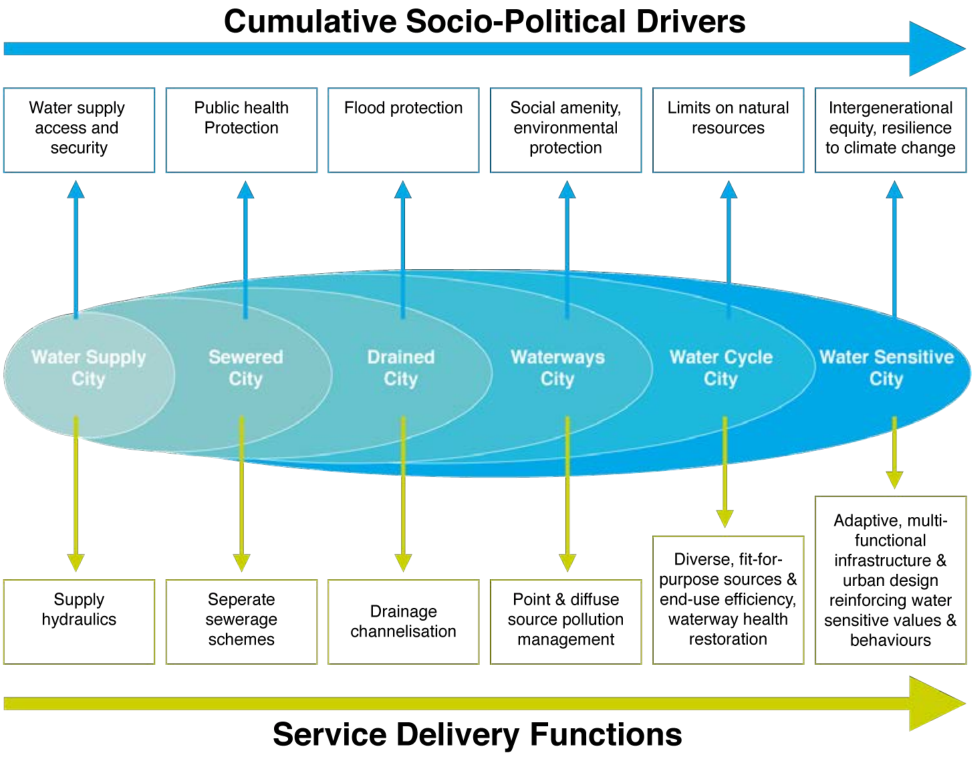

Figure 4: Urban water city states, their socio-political drivers and their service delivery functions (Brown *et al.* 2009)

The Water Supply City is characterised by supply hydraulics to establish safe and secure water supply. The Sewered City protects public health through the provision of a separate sewerage system. Flood protection through drainage systems characterises the Drained City. The infrastructure associated with these three city-states is almost universally recognised in developed(??) cities around the world (i.e. the drinking water reservoirs, the sewer and sewage treatment plants, the storm drains etc.). In contrast, the Waterways City values the social and environmental amenity provided by urban waterways and the infrastructure associated with the evolution of cities to this state reflects local biophysical conditions and local community aspirations. The infrastructure is often associated with pollution control and environmental management to protect and enhance these values.

The water supply and demand constraints from managing limited natural resources leads to the integration of different sources of water (with different 'fit for purpose' potential uses) into a Water Cycle City through the adoption of IUWM. This city state embeds the infrastructure of the Water Supply City, the Sewered City and the Drained City, but not necessarily that of the Waterways City. The infrastructure of a Water Cycle City is also influenced by local biophysical and social context and there are significant opportunities for the infrastructure of a Water Cycle City to be integrated with that of a Waterways City. In addition to strengthening the capacity to manage water supply and demand, the expanded scope of water sources and uses allows the benefits associated with the Waterways City (e.g. the amenity, aesthetics, comfort etc of vegetated waterway environments, and environmental protection) to be enjoyed away from waterways in parks and gardens and other private and public spaces.

A Water Sensitive City takes the integration of water cycles further to link with other environmental aspects (for example, urban microclimates) and social dimensions (for example, the benefits of alternative urban design for stormwater systems contributing to the higher order societal needs for water).

As illustrated in Figure 5, Melbourne's journey through the city states is reflected in the pattern of development of the city. While almost all parts of Melbourne have the characteristics of a Water Supply City and Sewered City, progressively fewer parts of the city reflect the more advanced city states of the Waterways and Water Cycle characteristics.

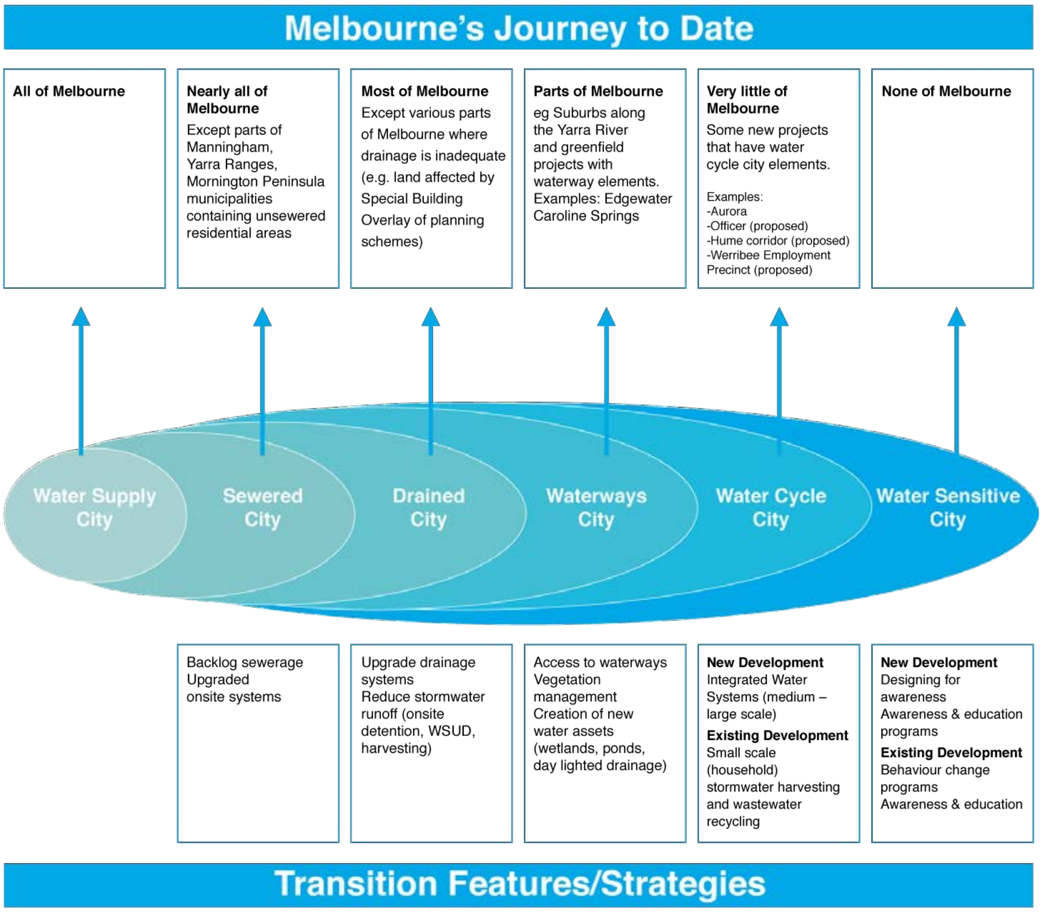

Figure 5: The status of various parts of Melbourne mapped against the city states of Brown *et al.* (2009) and the programs and activities that are associated with each transition.

The contributions of each of Brown *et al.'s* city states to societal urban water needs provides a basis for establishing a relationship between the city states and Alderfer's Existence, Relatedness and Growth needs categories (see Figure 6). However, these relationships are not exclusive and the illustration highlights the predominant, or key, relationships. Transition from a Waterways City to a Water Cycle City, for example, can contribute to Growth needs by providing progress (towards a

Waterways City) and purpose (by establishing a trajectory towards a Water Cycle City). Furthermore, progression from one city state to another does not need to be linear and more often, there are opportunity to progress across the Waterway City and Water Cycle City states concurrently.

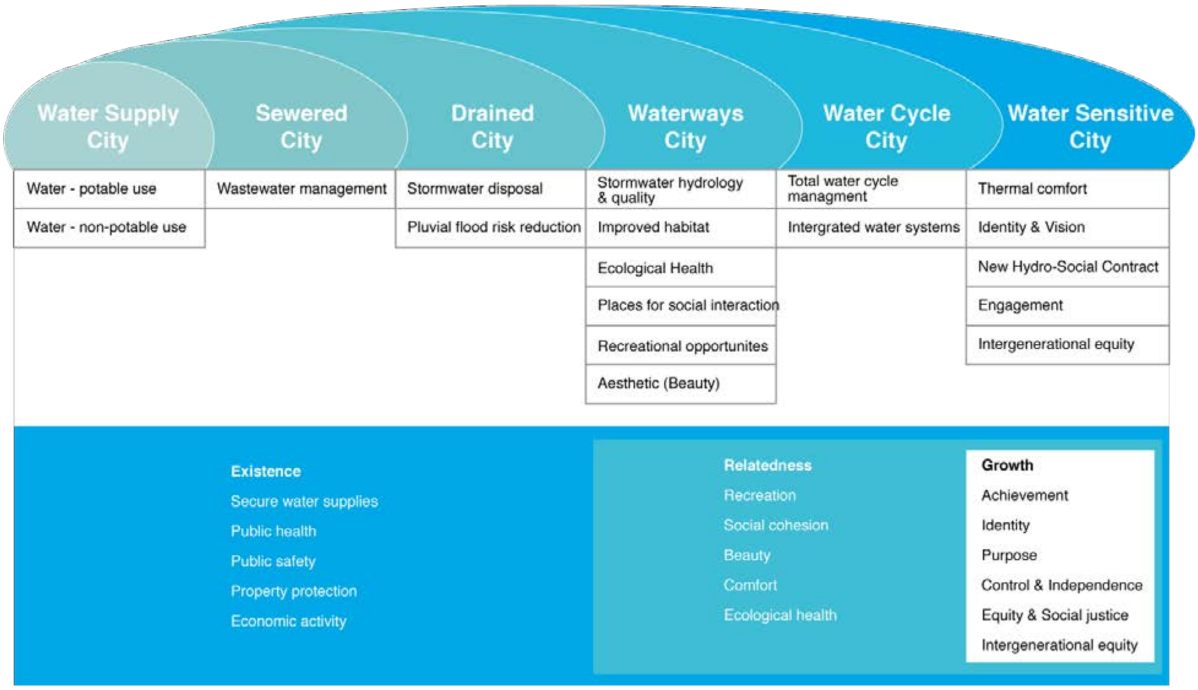

Figure 6: Illustration of the relationships between City States and Societal Urban Water Needs

Conventional urban water systems reflect the Water Supply, Sewered and Drained city states and are essential for meeting societal existence needs. As illustrated in Figure 4, these services are in a mature state with all of Melbourne having a water supply, nearly all of Melbourne being sewered and most of Melbourne having adequate drainage. Without societal aspirations to move to further city states there is a risk that these systems will not contribute to societal growth needs as achievement needs have been long satisfied and there is no sense of purpose or ambition to progress.

The Waterways and Water Cycle city states contribute to societal relatedness needs. The aesthetic development of waterway environments provides a place for recreation and social interaction in addition to strengthening the habitat and ecological health of the natural environment. These features facilitate inter-personal inter-relationships and socio-environmental inter-relationships.

The Water Cycle City allows the expansion of the benefits of Waterways Cities away from the waterways and into other parts of the city. In addition to distributing the societal benefits further, this expansion also removes inequities imposed by distance from waterways.

As Melbourne is still progressing towards Waterways and Water Cycle city states, they can provide a sense of achievement, and of purpose, and therefore contribute to societal growth needs.

The Water Sensitive City has a strong focus on societal self-esteem and self-actualisation which, even as a vision, makes it a strong contributor to societal growth needs.

This City States analysis shows that there is scope for further development of Melbourne's water systems and for the relationship between the city, its residents and water. Further application of green infrastructure, to both new and existing urban areas, can continue the city's progression towards a water sensitive city and hence towards greater fulfillment of the relatedness and growth needs that underpin liveability.

Assessing and Measuring Liveability

As outlined above, this paper has focused on the contribution that water systems and services can make to the liveability of a city. It is in this context that questions of the assessment and measurement of liveability can be considered. It must be acknowledged, however, that there are many other dimensions to liveability such as transport and mobility, crime and public safety and economic characteristics. A comprehensive assessment of the liveability of a city, or of parts of a city, would need to account for the full spectrum of societal needs.

The Victorian Government provides a mandate for a focus on water's role in liveability in its *Living Melbourne: Living Victoria* policy. The challenge now, having explored the role of water in liveability, is to create a framework for the assessment and measurement of liveability. As the saying goes '*if you can't measure it, you can't manage it'.* As liveability is a key objective of the Government's policy it becomes important to be able to monitor the liveability status of the city and to predict the benefits, or liveability gains, that different urban development strategies, projects and initiatives can yield.

The Victorian Competition and Efficiency Commission (VCEC) considered the measurement of liveability in its inquiry into enhancing Victoria's liveability (VCEC 2008). VCEC concluded that while composite measures of liveability (such as the Economic Intelligence Unit's Quality of Life City Ranking) are signposts for the public and policymakers, they do not substitute for the complex analysis required to underpin sound public policy. While VCEC's primary interests are the economic impacts of regulatory structures and governance architecture, they determined that the main drivers of liveability are: communities; economic strength and markets; governments and decision making; and human rights. These qualities resonate with the societal needs that we have adopted as a framework for describing liveability.

Assessing Liveability

The societal urban water needs presented in this paper provide a framework for assessing the role of IUWM and WSUD in liveability. Table 4 outlines the type of information that is required to assess the extent to which each societal urban water need is satisfied. These can be further developed to provide context-specific indicators. The actual data or information required is context specific – for example the information to describe and compare the social cohesion outcomes of local-scaled projects would be quite different to that required to make inter-city comparisons. While the general types of information can be identified, there have been no systematic analyses of the satisfaction of each of the societal urban water needs. It is likely that a specific data and/or information collection process will need to be designed and undertaken for each need to produce the data needed for analysis.

Table 4: Examples of the information required to assess societal urban water needs and liveability.

Needs category		**Urban-water societal need**	**Type of information (potential indicators)**
Existence	Physical and material needs	Drinking Water	• Potable water demand, supply, variability, security of supply
		Non-drinking Water	• Non-potable water demand, supply, variability, security of supply
		Public Health	• Wastewater and stormwater hazards and risks • Non-potable water quality – hazards and risks • Heat vulnerability, microclimate profiles • Environmental parameters of physical and mental wellbeing
		Public Safety	• Storm and flood flow risks • Environmental parameters of personal safety
		Property Protection	• Storm and flood flow modelling
		Economic Activity	• Investment and job creation in industries and activities that benefit from, or are dependent on, water and/or water systems and services.
Relatedness	Social interaction and inter-personal relationships	Recreation	• Behavioural analysis of environmental parameters and recreational needs • Supply and demand for recreational facilities (needs study)
		Social Cohesion	• Behavioural analysis of environmental parameters and visitation attractiveness and needs • Supply and demand for social interaction (needs study)
	Societal-environmental inter-relationships	Beauty	• Aesthetic preferences and needs for urban landscapes
		Comfort	• Urban microclimate and human thermal comfort information.
		Ecological health	• Biodiversity and ecological processes within urban catchment. • External ecological impacts – consequences of urban water practices (extraction and disposal of urban water)
Growth	Societal self-esteem and self-actualisation	Identity	• Community values and expectations • Community receptivity
		Purpose and Ambition	• Community values and expectations • Hydro-social contract
		Control and Independence	• Hydro-social contract • Governance and decision making systems
		Equity and Social justice	• Socio-economic and/or cultural impediments and barriers to adoption and delivery. • Motivation and drivers for adoption and delivery.
		Intergenerational equity	• Timeframes and legacy – implications on the opportunities for future generations.

As with other complex situations, it is not possible to construct an algorithm to process empirical data to produce an ‘answer’. With appropriate guiding rules and principles, tacit knowledge and expertise can be called upon to provide expert opinion and judgment to draw out an assessment of the status of societal urban water needs from the information identified in Table 4. This 'expert panel' approach is often employed to provide a determination of complex issues in Victoria (for example, environmental water requirements are determined by an expert panel guided by the FLOWS methodology[6], strategic land use planning recommendations are made by Planning Panels[7]).

Each societal urban water need represents a separate dimension in this assessment. A consolidated assessment that combines these different dimensions requires subjective judgment to scale and weight each of the separate variables. The subjectivity and potential loss of detail that a consolidation would introduce would need to be weighed against the benefits of a simpler 'liveability metric'.

Assessments made with the societal needs framework, either multi-dimensional or consolidated, are relative as there is no absolute scale of each of the dimensions or of liveability as a whole. As the application of this framework to a particular situation is context specific, it also means that an assessment of liveability can't be transferred to another situation. For example, an assessment of the liveability outcomes of a particular project that has been made as a comparative study of project options or alternative projects, cannot be directly transferred to a different ranking or rating of projects.

Application of liveability assessment

The urban water liveability of a proposed development or project could be assessed by a semi-quantitative scoring of the projected changes in the satisfaction of societal urban water needs of various options, benchmarked against either the starting conditions or a 'business as usual' development. This assessment has the potential to yield negative scores for societal urban water needs if the initiative produces lesser outcomes than the benchmark starting condition or business as usual case.

A project assessment scheme for urban water liveability is presented in Appendix 3. This scheme is geared towards precinct scaled Water Sensitive City projects and could be applied to consider options for the development of a precinct or to rank project proposals for separate precincts that are competing for government grant funding.

The assessment of the urban water niche of liveability for a place, such as a suburb, would need to seek information that is applicable at that geographic scale and the particular circumstances. Primary data, gained by observation, can be used to assess the current liveability status of a place, which should provide greater confidence in the assessment outcome than the projected, or estimated, liveability outcomes for project proposals. Data from a place could be compared to the data obtained by the same process from other places and/or hypothetical benchmarks. The outcome of such an analysis could be a ranking with, possibly, a semi-quantitative rating.

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[6] Environmental Flow Assessment - http://www.water.vic.gov.au/environment/rivers/flows/assessment accessed 2 April 2012.

[7] Planning Panels Victoria - http://www.dpcd.vic.gov.au/planning/panelsandcommittees/planningpanelsvictoria accessed 2 April 2012

Applying the framework for assessing water's contribution to liveability in any situation requires a bespoke project to be designed and undertaken to generate and analyse the data and information required to assess the status of societal urban water needs. It is possible, at some time in the future when many liveability assessments have been undertaken, that a generic methodology can be developed.

The application of this framework was trialed with an expert workshop to explore the potential and key requirements of this approach. Key learnings from this workshop include:

- The fulfillment and requirement of different needs will need to be assessed in different ways.
  - Existence needs can generally be quantified as they have a physical and material basis. The challenge is determining what is required to be measured or estimated.
  - Relatedness needs are aggregations of measures of individual perceptions and preferences (eg. 'beauty' can be assessed through surveys of landscape preferences). While these can be determined at an individual level, their determination and/or aggregation at a community and societal level, presents challenges for ensuring adequate representation and recognition of the diversity of views/positions.
  - While current knowledge and understanding is inadequate for a quantitative assessment of societal Growth, qualitative estimates of the likely strength of outcomes should be achievable.
- The assessment, or estimation, of the satisfaction of societal urban water needs requires a context specific reference framework that, for example, establishes bounds of the 'best' and 'worst' outcomes that could be achieved. These bounds then define the '-3' and '+3' extremes of the Likert scales.
- The particular societal urban water needs are dependent on the 'community of interest'. Initiatives may have more than one identifiable community of interest – for example, there may a local community that are primarily focused on Relatedness needs while a broader, regional, community may have a stronger interest the contribution to Existence needs. It is essential that the various communities of interest and their particular needs are identified.

Further development of liveability assessments

The methodologies for assessing urban water's contribution to liveability are at an early stage of development. While the approach described in Appendix 3 show promise, it also has gaps and weaknesses that could be addressed through further research and model development. Some possibilities include:

1. The application of multivariate pattern analysis techniques to explore the interrelationship between the societal urban water needs and to investigate natural groupings or distributions of entities. This work could help to better characterize the component needs of liveability and facilitate the development of an indicator set to assist further assessments.

2. The development of criteria and protocols for identifying communities of interest and engaging with them to identify their particular urban water needs in the context of liveability assessments.

3. The development of reference data sets of societal urban water needs for selected communities of interest that can serve as both a benchmark for comparisons (eg temporal, spatial and between communities) and as a model for establishing comparable reference data for other circumstances.

Conclusions

Liveability remains a complex and highly subjective aspect of cities. Accepting this view allows us to define a particular niche within the broader family of liveability – *the role and contribution of water, its management, use and interactions with the environment, to the liveability of our cities*. It is important to remember that there are many other niches and influences on the 'liveability' experienced in a city. While pursuing a water sensitive city would contribute to the city's liveability, it is unlikely that a focus on water alone would transform, or secure, the overall liveability of a city.

Consideration of societal urban water needs provides a framework for assessing the water niche of liveability. In terms of liveability, the relationship between city states and societal urban water needs illustrates that basic water supply, sewerage and drainage systems meet existence needs. Melbourne, like most developed cities meets these existence needs. However, Melbourne is progressively and simultaneously moving towards the Waterways City and Water Cycle City states, which, by addressing relatedness needs and more efficiently/sustainably addressing Existence needs, can be considered to be enhancing the city's liveability. Alderfer's sixth proposition, that *the more relatedness needs are satisfied then the more that growth needs will be desired*, becomes particularly pertinent. The desire to satisfy growth needs is apparent in the Victorian Government's Living Melbourne, Living Victoria policy, further reflecting Melbourne's position as progressing on the city states associated with relatedness.

This paper establishes a liveability framework that connects Integrated Urban Water Management and Water Sensitive Urban Design(?) practices through to societal urban water needs and a transitions framework for water sensitive cities. This framework can serve as a basis for the assessment of urban water liveability of projects and initiatives and for the development of performance measures that can be used to assess the 'urban water liveability status' of urban areas.

The framework also provides a platform for further research to better understand the prevailing hydro-social contract and how this can be renewed to facilitate the transition towards a water sensitive city.

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Appendix 1: Examples of lexical definitions of liveability

Liveability

Balsas (2004): The ability of a centre to maintain and improve its viability (perpetual ability to attract investment) and vitality (to remain alive)

Newman (1996): The human requirement for social amenity, health and well-being and includes both the individual and community well-being

Lynch (1981): is the form of a good city or a 'good settlement' – for a city to be liveable, it must be responsive to the human situation and further determines the connection between human values, their actions and the physical form of cities.

Hortulanus (1996): the degree to which the individual is capable of creating his or her daily living situation

Veenhoven (1996): Quality of life in the nation - the degree to which its provisions and requirements fit with the needs and capacities of its citizens

Hahlweg (1997): The City as a Family - the liveable city must be a city for all people

Salzano (1997): A city that satisfies the needs of the present inhabitants without reducing the capacity of the future generation to satisfy their needs...'

Vuchic (1999): liveability as a series of elements that make a city liveable: 'generally understood to encompass those elements of home, neighbourhood, and metropolitan area that contribute to safety, economic opportunities and welfare, health, convenience, mobility and recreation'.

Pacione (2003): liveability is a relative term and its meaning depends on the place, time and purpose. It is a behaviour-related function, it is dependent on the interaction between environmental characteristics and person characteristics.

cities$^{\text{PLUS}}$ (2003): refers to an urban environment that must contribute positively to the social, physical and the mental wellbeing and personal development of all its residents.

The World Urban Forum in Vancouver (2006) : The quality of life as experienced by the residents within a city or region

Appendix 2: Fourteen Perspectives on the Attributes of Liveability

Attribute	Smith 1973	Liu 1976	Boyer and Savageau 1981	Lynch 1981	Rogerson et al. 1988	Burnley 1988	Hart et al. 1989	Population Crisis Committee 1990	Hahlweg 1997	Wheeler 2001	Salzano 1997	Balsas 2004	Throsby 2005	Economist Intelligence Unit 2011
Access to high quality education	✓		✓		✓		✓	✓					✓	✓
Accessible (residents can access what the city has to offer)				✓						✓		✓		
Arts/Cultural Diversity	✓		✓		✓		✓			✓		✓		✓
Atmosphere/Peace and Quiet						✓	✓	✓						
Beautiful/attractive									✓	✓		✓		
Clean									✓	✓		✓		
Clean air													✓	
Climate			✓		✓	✓								✓
Commercial space							✓							
Control (residents have a say)				✓						✓		✓		
Convenient schools, shops and services									✓					
Cost of living (affordable)			✓		✓				✓	✓		✓		
Crime/Public Safety	✓		✓	✓	✓			✓	✓	✓		✓		✓
Economy/Business Climate	✓	✓					✓			✓		✓		
Employment –					✓	✓						✓		
Environment/Pollution		✓	✓		✓	✓		✓						
Fit (city provides spaces, buildings, infrastructure that is necessary)				✓						✓		✓		
Functional infrastructure										✓		✓		
Health/healthcare													✓	✓
Housing Costs and Access	✓	✓	✓		✓		✓	✓	✓					✓
Intergenerational equity									✓		✓			
Intra-generational equity									✓		✓			
Lifestyle Opportunities						✓								
Parks and green spaces									✓	✓		✓		
Pedestrian/bike-oriented									✓		✓			
Places that emphasise local culture, history and ecology									✓		✓			

	Smith	Liu	Boyer and Savageau	Lynch	Rogerson et al.	Burnley	Hart et al.	Population Crisis Committee	Hahlweg	Wheeler	Salzano	Balsas	Throsby	Economist Intelligence Unit
Pleasant													✓	
Political involvement/community governance	✓	✓												
Proximity to suppliers/market							✓							
Public spaces											✓		✓	
Recreation			✓		✓									✓
Retirement						✓								
Salary/Wages					✓		✓							
Sensible (the city makes sense, is 'intuitive')				✓						✓		✓		
State taxes/Development Aid							✓							
Support a sense of community									✓	✓		✓		
Sustainable									✓		✓			
Tangible													✓	
Transport/Traffic Flow					✓		✓	✓	✓	✓		✓	✓	✓
Viability (ability to maintain and improve)										✓		✓		
Vitality (allows maximum scope for activity)				✓						✓		✓		
Water disposal system													✓	
Water sanitation													✓	

Appendix 3: Project Liveability Assessment

Purpose

To describe a process for assessing the contribution of Integrated Urban Water Management (IUWM) projects to liveability.

Process

This liveability assessment protocol is intended to be applied to proposed IUWM projects that are seeking funding assistance from Government or its agencies.

1. These IUWM projects are assumed to be local-precinct scaled initiatives such as the treatment, harvesting and/or use of stormwater.
2. Green infrastructure elements of the project (may include end use through irrigation etc) are assumed to be in the public domain or the benefits are directly accessible to local communities. Private benefits would need to be assessed separately and accounted for against private investment.
3. The liveability assessment is provided by the project proponent as part of their funding application (this is to ensure that the liveability outcomes are considered in the design of projects).
4. Responding to the questions requires an understanding of the particular needs of the communities involved (the community of interest) (eg directly involved local communities and indirectly involved citywide or statewide communities) and an understanding of how the proposal would affect these various needs. This may require social research investigations to provide the necessary understanding, as well as explicit engagement with the communities of interest to support them in identifying their own urban water needs for their particular local context.
5. The assessment of liveability is qualitative. Uncertainty around each of the parameters is unknown which does not allow confidence in quantitative measures. In addition, the contribution of each element to liveability is complex – non-independent, non-linear and affected by interaction between elements – making it difficult to construct a weighted quantitative index.

The following table provides a framework for assessing and rating liveability. Each element has a key question that is rated on a seven point Likert[8] scale. A +3 rating implies that the proposed initiative will fully deliver the particular societal urban water need. Negative ratings imply that existing meeting of needs will be compromised by the proposal. These bounds should be determined for each need from the understanding of community needs and of the technical capability to satisfy the need (+3) or to deliver the worst possible outcome for that need (-3).

[8] Likert Scale – *Wikipedia* http://en.wikipedia.org/wiki/Likert_scale - accessed 140312

Needs category		**Urban-water societal need**	**Objective**	**Liveability assessment question and Rating** (see below for rating scale) **To what extent will the project ……**	**Key parameters**
Existence	Physical and material needs	Drinking Water	Safe, secure and accessible supply of water for direct human consumption	contribute or impact on the drinking water needs of the community? -3 -2 -1 0 1 2 3	• Potable water demand • Potable water production • Potable water substitution • Affect on security of potable water supply
		Non-drinking Water	Safe, secure and accessible supply of water available for other uses	contribute or impact on the non-drinking water needs of the community? -3 -2 -1 0 1 2 3	• Potential non-potable water demand • Non-potable water production • Security of non-potable sources and supplies
		Public Health	Safe supply of drinking water and safe and hygienic disposal of wastewater, tolerable microclimates	contribute or impact on public health? -3 -2 -1 0 1 2 3	• Health risk profiles for additional water sources • Effect, if any, on health risks of current sources
		Public Safety	Protection of people from water, e.g. during floods or storm events	contribute or impact on public safety? -3 -2 -1 0 1 2 3	Changes to surface flow characteristics • Flow • Depth • Velocity • volume • frequency
		Property Protection	Protection of property and infrastructure from water, e.g. during floods or storm events	Contribute or impact the protection of property and infrastructure from water -3 -2 -1 0 1 2 3	Changes to inundation risks (flood frequency/ probability)

		Economic Activity	Industries and jobs that rely on water and/or water systems and services	Investment and job creation in industries and activities that benefit from, or are dependent on, water and/or water systems and services.
				-3 -2 -1 0 1 2 3
					• Value of investments
					  ○ direct (water systems and services)
					  ○ indirect (water dependent industries)
					• Number of jobs created
					  ○ direct (water systems and services)
					  ○ indirect (water dependent industries)
					• Value of water dependent industry

Relatedness	Social interaction and inter-	Recreation	Places for play, sport and leisure	Increase or decrease accessible places for formal (structured) and informal sport and recreation -3 -2 -1 0 1 2 3	• New places developed • Net new area • Areas improved • Uses of areas • Anticipated participation (number of people and Duration) • Volume of water to establish and maintain • Source of water
		Social Cohesion	Places for social interaction and human connectedness with people and nature	Increase or decrease opportunities for interactions with other people and with the bio-physical environment -3 -2 -1 0 1 2 3	• Identify factors contributing to social cohesion • Water sources and volumes needed to establish and maintain

	Societal-environmental inter-relationships	Beauty	Aesthetic urban environments	Contribute or detract from the aesthetic values of the urban landscape
				-3 -2 -1 0 1 2 3
					• Greenness
					  ○ trees
					  ○ shrubs
					  ○ grass/ground cover
					• Water features
					• Water sources and volumes to establish and maintain

		Comfort	A pleasant micro-climate and landscape for human thermal comfort	Improve or decrease human thermal comfort -3 -2 -1 0 1 2 3	• Modelled urban thermal comfort • Vegetation involved in contributing to urban thermal comfort • Water sources and volume to establish and maintain vegetation (and any other cooling effects)
		Ecological health	Clean and healthy ecosystems with no negative impact on other ecosystems	Increase or decrease measures of ecological health (aquatic and terrestrial ecosystems) -3 -2 -1 0 1 2 3	• Current and projected aquatic ecosystem health assessment scores • Terrestrial biodiversity changes • Projected change to weed and pest species

Growth	Societal self-esteem and self-actualisation	Identity	Harmony with culture and tradition, to feel belonging. Proud association with urban water systems and environments.	Create or lose elements (places, infrastructure, services, institutions) that communities identify with. -3 -2 -1 0 1 2 3	• Identification and characterization of elements that potentially contribute to identity
		Purpose and Ambition	Progress towards a shared vision of a water sensitive future.	Contribute or detract from shared societal visions for a water sensitive future -3 -2 -1 0 1 2 3	• Understanding of community's vision for water sensitive cities • Measure of strength of the vision as a driver for proposed project. • Projection of how project will strengthen vision for water sensitive cities.
		Control and Independence	Choice and influence on decision-making about water infrastructure and services	Progress or conflict with the hydro-social contract for urban water systems -3 -2 -1 0 1 2 3	• Community recognition that key system decisions are made under their authority • Individuals choice for water sources and management options at the household scale
		Equity and Social justice	Equal opportunity to access the benefits of the urban water system	Improve or decrease equitable access to the benefits of urban water systems -3 -2 -1 0 1 2 3	• Analysis of access to urban water system benefits across the community (to identify any barriers to access and understand the parameters of access)
		Intergenerational equity	Preserve the ability of future generations to meet their water-related needs.	Improve or decrease the opportunity of future generations to meet their societal urban water needs -3 -2 -1 0 1 2 3	• Projection of future societal urban water needs • Identification of barriers to future generations created by project.

Rating:

-3 complete loss of existing meeting of needs

-2 has a substantial impact on existing meeting of needs

-1 has a minor impact on existing meeting of needs

0 Neutral – no effect on meeting this need

+3 ensure that all needs are met

+2 makes a substantial contribution to meeting needs

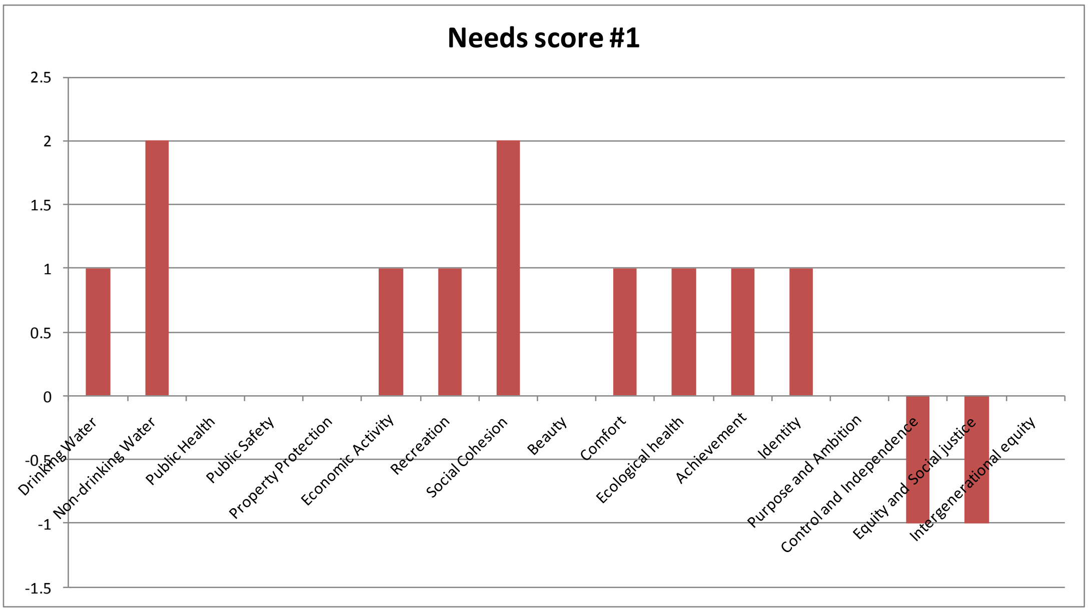
+ 1 makes a minor contribution towards meeting needs

Validation of self-assessment

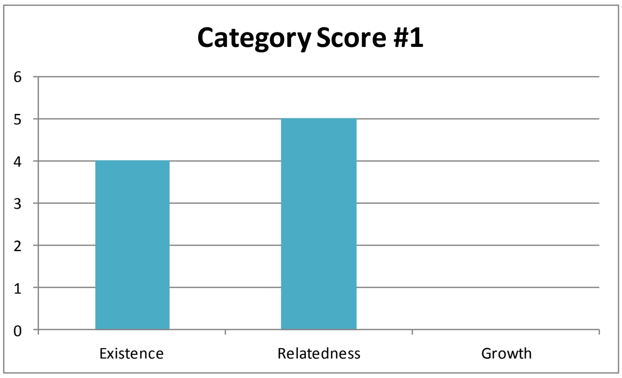
Self assessment data should be validated through a technical expert panel process. This would involve individuals with acknowledged expertise in IUWM, urban design and planning, social sciences etc reviewing project proposals, including the Liveability Self-Assessment, and conferring to establish agreed ratings for each of the societal urban water needs. There may also be a role for a community reference group to be part of a process for validating how well a project is likely to meet their urban water needs.

Project Ratings – example

The following is a hypothetical illustration of the liveability rating of a project. Non-zero scores for each societal urban water need appear as a bar on the chart.



The ratings can be combined for each needs category. The following chart shows a simple, unweighted, consolidation.



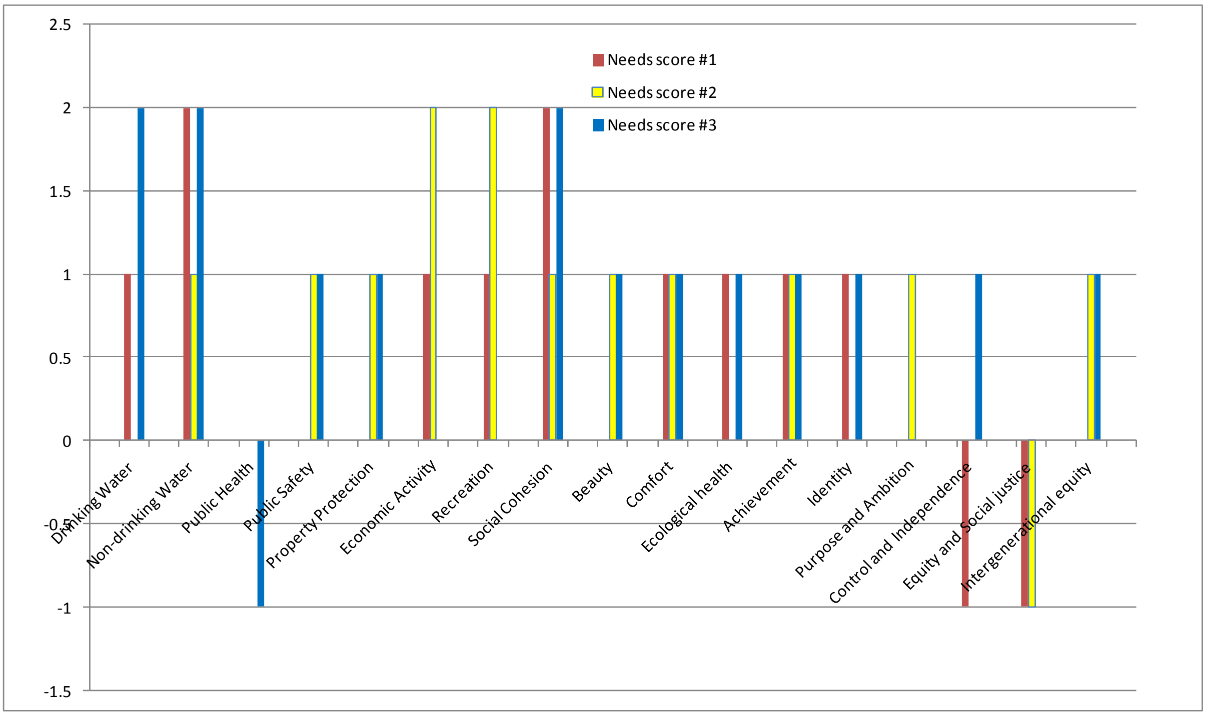
While this consolidation simplifies the presentation, it does mask potentially important detail. In this case 'Growth' has both positive and negative elements that effectively cancel each other out to give an overall zero score. An assessment process may need to establish its tolerance for negative scores as a primary filter for projects. For example, in this illustration is it acceptable to proceed with the project if it is going to provide some loss of independence and control and loss of equity and social justice.

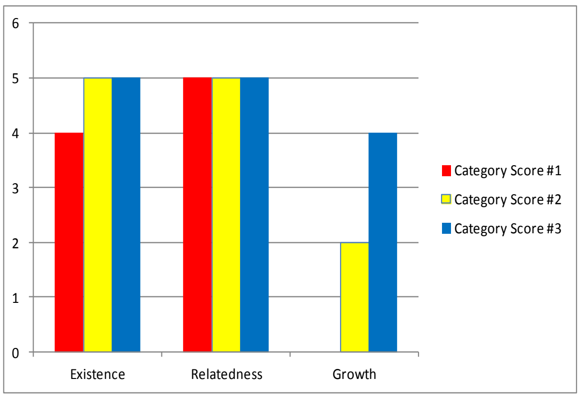
Multiple projects/options

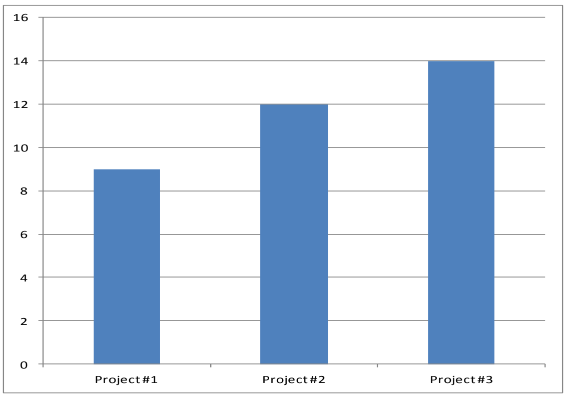
Qualitative ratings, by themselves, are of limited value. The illustration above allows the strengths and weaknesses of the proposal to be identified and gives an overall impression that the benefits outweigh the impacts.

The assessment of multiple projects allows various rankings of projects to be made. Such rankings may be useful to prioritise project proposals where funding may be limited or to better understand the merits and weaknesses of individual projects.

The following set of hypothetical project scores illustrate the assessment of three separate projects (#1, #2 and #3).







While the scores for the individual societal urban water needs present a complex picture, they do allow the differences in projects to be appreciated. The consolidation into the needs categories, or to a single project score, allows the overall relativities of the projects to be appreciated.

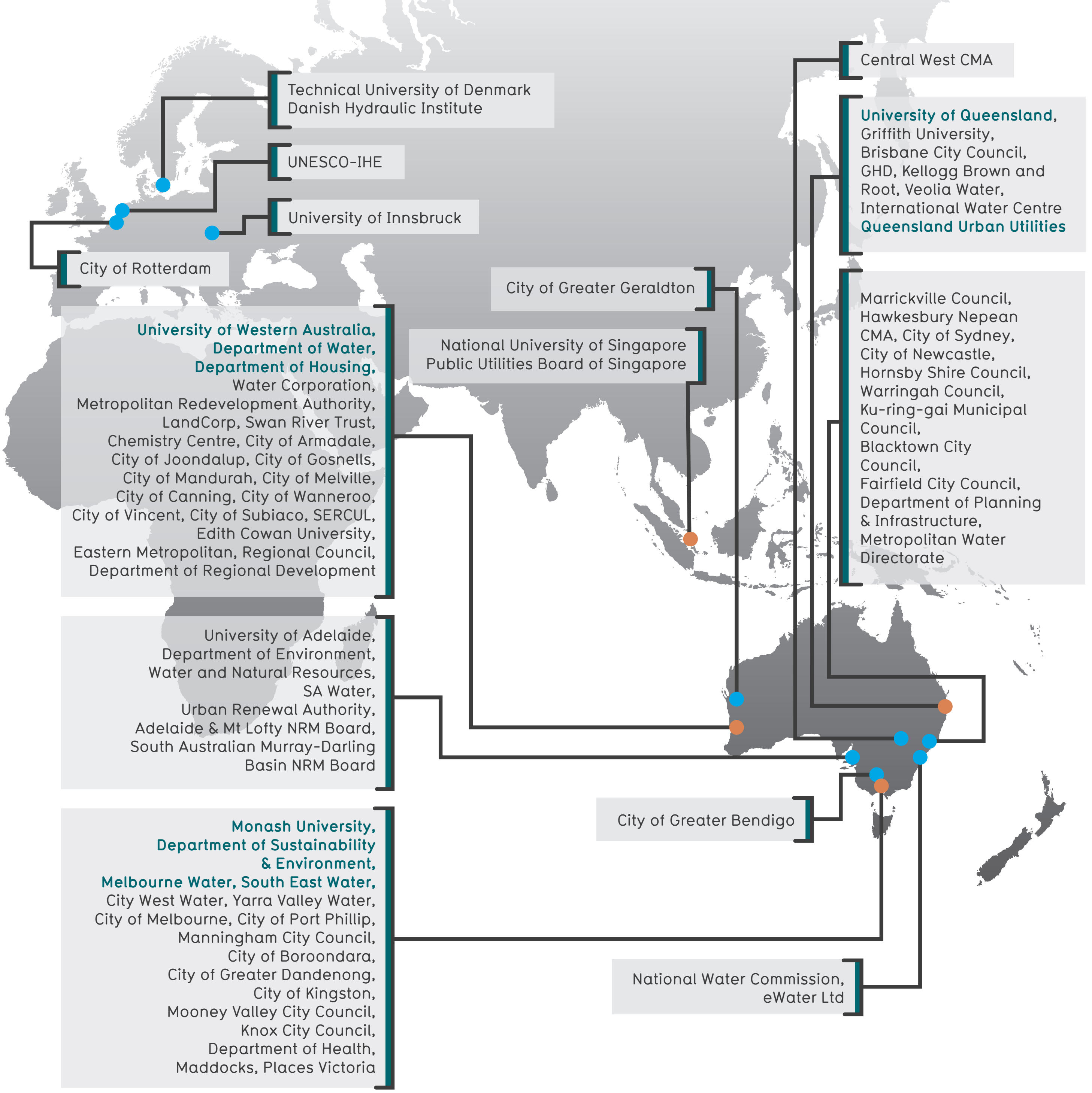
Conclusion

A wide range of information needs to be considered to assess the contribution of an IUWM project to a city's liveability. Community involvement in defining the liveability needs for their local context, as well as being part of a validation process for assessing how well a particular project is expected to meet their needs, is critical. Expert assessment and judgment can support assessments to be made on qualitative and incomplete data with little effect on ratings or rankings of projects.

While assessments can be aggregated to needs categories or to a single rating, the consolidated scores do not convey important and useful information contained in the overall profile of societal needs. An alternative strategy to consolidate information could be developed employing multivariate pattern analysis techniques to substantially reduce the number of valid dimensions and eliminate correlation between variables.

CRC for Water Sensitive Cities: Partner Organisations

30 Local Governments
14 State Government Departments/Agencies **(3 Essential Participants)**
12 Research Organisations **(3 Essential Participants)**
8 Water Utilities **(3 Essential Participants)**
4 Land Development Organisations
4 Private Companies
1 Federal Government Agency
1 Community Group
1 Training/Capacity Building Organisations



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