Institutions and decentralised urban water management

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Institutions and Decentralised Urban Water Management

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of the requirements for the degree of
Doctor of Philosophy

School of Civil and Environmental Engineering
University of New South Wales

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Abstract

Physically decentralised water management systems may contribute to improving the sustainability of urban water management. Any shift toward decentralised systems needs to consider not just physical system design but also social values, knowledge frames, and organisations, and their interconnections to the physical technology.

Four cases of recent Australian urban water management improvement projects were researched using qualitative methods. Three cases were of decentralised water management innovation. The other was of a centralised system, although decentralised options had been considered. These cases were studied to identify institutional barriers and enablers for the uptake of decentralised systems, and to better understand how emerging environmental engineering knowledge might be applied to overcome an implementation gap for decentralised urban water technologies.

Analysis of each case focused on the institutional elements of urban water management, namely: the values, knowledge frames and organisational structures. These elements were identified through in-depth interviews, document review, and an on-line survey. The alignment of these elements was identified as being a significant contributor to the stability of centralised systems, or to change toward decentralised systems.

A new organisational home for innovative knowledge was found to be common to each case where decentralised innovation occurred. 'Institutional entrepreneurs', strong stakeholder engagement, and inter-organisational networks were all found to be linked to the creation of shared meaning and legitimacy for organisational and technological change.

Existing planning frameworks focus on expert justification for change rather than institutional support for change. Institutional factors include shared understandings, values and organisational frameworks, and the alignment of each factor. Principles for, and examples of, appropriate organisational design for enabling and managing decentralised technological innovation for urban water management are proposed.

This research contributes to the understanding of the institutional basis and dynamics of urban water management, particularly in relation to physical centralisation and decentralisation of urban water management technologies and, to a lesser extent, in relation to user involvement in urban water management. Understanding of factors that contribute to enabling and constraining decentralised technologies is extended to include institutional and organisational factors. New and practical pathways for change for the implementation of decentralised urban water systems are provided.

Thesis Publications

Some of the work presented in this thesis is also presented in the following publications:

Livingston, D. (2002), Developing a Sustainable Water Management Paradigm for Remote, Rural and Developing Communities, In, *Proceedings, Third Postgraduate Student Conference, 16-19 October*, CRC for Water Quality and Treatment, Adelaide.

Livingston, D. and Schäfer, A. (2002), Decentralised water management paradigms for sustainability, In, Lamborn, J., *Conference Proceedings, Environmental Engineering Research Event, December 3-6*, Blackheath.

Livingston, D. (2004a), Decentralised urban water management for sustainability: frames and change pathways for a socio-technical problem, In, *Proceedings, Fourth Postgraduate Student Conference, 14-16 April*, CRC for Water Quality and Treatment, Noosa, pp. 71-76.

Livingston, D. (2004b), Developing a Sustainable Water Management Paradigm for Remote and Developing Communities, In, Ho, G. and Mathew, K., *Sustainability of Water Resources: International Conference, Western Australia, November 2002*, IWA Publishing, London.

Livingston, D., Ashbolt, N. J. and Colebatch, H. K. (2004a), Urban water management as a changing socio-technical system: participation, decentralisation and sustainability, In, *Proceedings, 6th IWA Specialist Conference on Small Water & Wastewater Systems; and 1st International Conference on Onsite Wastewater Treatment & Recycling, February 11-13*, Murdoch University, Fremantle.

Livingston, D., Stenekes, N., Colebatch, H. K., Ashbolt, N. J. and Waite, T. D. (2004b), Water management planning in local government: organisational factors impacting effective policy for sustainability, In, *Conference Proceedings, Sewage Management: Risk Assessment and Triple Bottom Line, April 4-6*, Queensland EPA, Cairns.

Livingston, D., Stenekes, N., Colebatch, H. K., Ashbolt, N. J. and Waite, T. D. (2004c), Water Recycling and Decentralised Management: The Policy and Organisational Challenges for Innovative Approaches, In, Daniell, T., *Proceedings,*

International Conference on Water Sensitive Urban Design: Cities as Catchments, November 21-25, Adelaide, pp. 581-592.

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Livingston, D., Colebatch, H. K. and Ashbolt, N. J. (2006a), Querying institutional support for decentralised urban water: four Australian cases, In, *Proceedings, 1st Australian Young Water Professionals Conference, February 15-17, IWA (Australia)*, UNSW, Sydney.

Livingston, D. J., Ashbolt, N. J. and Colebatch, H. K. (2006b), Institutional Barriers to Decentralised Systems, *Water, Journal of the Australian Water Association*, 33(3), 75-77.

Livingston, D., Colebatch, H. K. and Ashbolt, N. J. (in preparation), Institutionalisation and innovation in urban water management: lessons from four Australian case studies of decentralisation, *Water Resources Management*.

Livingston, D., Colebatch, H. K. and Ashbolt, N. J. (in preparation), Institutionalisation and innovation in urban water management: reflection on historical development, current challenges and opportunities, *Water Resources Management*.

Kärrman, E., Söderberg, H., Lundie, S., Ashbolt, N., Kazaglis, A., Lai, E., Livingston, D. and Anderson, J. (2005), *Literature Review: Methodology for Evaluating the Overall Sustainability of Urban Water Systems*, Centre for Water and Waste Technology, University of New South Wales, Sydney (commercial report for WSAA).

Lundie, S., Ashbolt, N., Livingston, D., Lai, E., Kärrman, E., Blaikie, J. and Anderson, J. (2005), *Sustainability Framework: Methodology for Evaluating the Overall Sustainability of Urban Water Systems*, Centre for Water and Waste Technology, University of New South Wales, Sydney (commercial report for WSAA).

Stenekes, N., Livingston, D., Colebatch, H. K., Waite, T. D. and Ashbolt, N. J. (2004), Sustainable water management in Australia: an institutional analysis, In,

Proceedings, Good Water Governance for People and Nature: Water Roles for Law, Institutions & Finance August 29-September 2, 2004, Dundee, Scotland.

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List of Abbreviations and Acronyms

ANT	Actor Network Theory
AUD	Australian dollar
BCC	Brisbane City Council
BOO	Build-own-operate
BOOT	Build-own-operate-transfer
BW	Brisbane Water
COD	Chemical oxygen demand
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DLGP	Department of Local Government and Planning
Ecosan	Ecological sanitation
EIS	Environmental Impact Statement
EPA	Environment(al) Protection Agency/Authority (varies by location)
GCCC	Gold Coast City Council
GCW	Gold Coast Water
GL	Gigalitre(s)
IUWM	Integrated urban water management
LTS	Large technical system
MCA	Multi-criteria Assessment

MCDA	Multi-criteria Decision Aiding
MDG	Millennium Development Goals
MISTRA	(Swedish for) The Foundation for Strategic Environmental Research
MP	Member of Parliament
NIMBY	'Not in my backyard'
NP	National Park
NRM	Department of Natural Resources and Mines (Queensland)
NSW	New South Wales
PHPS	Port Hacking Protection Society
PPP	Public private partnership
Qld	Queensland
SSC	Sutherland Shire Council
STP	Sewage treatment plant
STS	Sociotechnical system
SWC	Sydney Water Corporation
USD	United States dollar
WSAA	Water Services Association of Australia
WSUD	Water sensitive urban design

Glossary

Action	Societal events, processes and change (e.g., communication and decision-making)
Actor	Participant in social action (e.g., communication and decision-making)
Black water	(Sewage containing) faecal matter
Brownfield	Characterised by existing residential/industrial development
Centralised	In the context of water management, water services infrastructure designed to service entire towns, cities, or large/multiple communities/suburbs
Cognitive	Of the mind – thoughts, ideas, knowledge
Decentralised	In the context of water management, water services infrastructure designed to service individual sites, neighbourhoods or small communities
Discourse / discursive	Identifiable pattern of speech / pertaining to such
Dual reticulation	Two separate pipe networks for potable and recycled water (in addition to the sewer pipe network)
Eco-village	Community with small population (e.g., 100 or similar order of magnitude), intended to be socially, economically and ecologically sustainable
Fit-for-purpose	(Water quality) appropriate for the intended use
Frame / framing	The perspective taken on something / the process of constructing such a perspective

Governance	Governing through self-organising, inter-organisational networks as opposed to governing by authoritative direction
Greenfield	Characterised by no existing residential/industrial development
Greywater	Household water emanating from household use such as showering, hand-washing and laundry-washing, but not toilet or kitchen waste
Indirect potable reuse	Water reuse where recycled effluent is released into a raw water supply for further treatment before distribution as potable water
Institution	Established pattern of social order or practice
Institutional entrepreneur	Organisational actor with sufficient resources who sees and acts on an opportunity for change
Isomorphism	Having the same form
Normative	Value-oriented – what 'ought to be'
Organisational silo	Distinct or separated department or division within an organisation, with emphasis on hierarchical command
Reflexive	Having self-analysis leading to constitutive change
Regulative	Rule and structure oriented
Social construction	The cognitive process of building meaning around an entity
Sociotechnical system	System of interconnected social and technical components

Stakeholder	Anyone with an interest in a process or issue
Structuration	Process whereby action determines structure as well as structure determining action
Technocrat	Technical bureaucrat
Triangulation	(Social science method for) multiple cross-checking of sources
Yellow water	Urine

1 Introduction

> The realization that institutional problems in water resources development and management are more prominent, persistent, and perplexing than technical, physical, or even economic problems has fostered as much frustration as insight among analysts and planners in water resource agencies (Ingram *et al.*, 1984, p. 323).

This thesis is about the institutionalisation of new environmental engineering knowledge pertaining to the physical scale and format of systems for urban water management, within the overall pursuit of more sustainable water management practice. It examines institutional factors that constrain and enable change toward decentralised practice. The importance of the study is that it identifies general and specific approaches to implementing change toward enabling decentralised urban water management, highlighting the importance of understanding the social context for the application of engineering knowledge.

The roles of planning and decision-making for water management have traditionally fallen within the engineering discipline. Moreover, questions of water management policy are usually addressed using engineering knowledge. Therefore this study is located in the discipline of (environmental) engineering, but crosses into social sciences for theory and methods considered appropriate for dealing with the research problem at hand.

1.1 Research Problem

The problem that was the subject of this research was the apparent existence of institutional barriers to adoption of decentralised urban water technologies. The aim was to analyse the governing of the urban water cycle, from an institutional perspective, to identify better ways to apply environmental engineering knowledge concerning decentralised urban water management within social and institutional contexts.

This research is motivated by the need perceived by the Australian (and global) urban water industry for innovative approaches to overcome the physical constraints of limited and shrinking urban water supplies against continued increase in demand, along with other compounding environmental problems surrounding urban water management. Water scarcity is an increasing problem for both rural and urban water users (i.e., all inhabitants) of Australia and many other countries (de Fraiture *et al.*, 2001; Seckler *et al.*, 1999), especially the rapidly growing regions of the world. The focus of this thesis is total water cycle management in Australian urban centres, many of which face a difficult and growing problem for achieving sustainable water management (Australian Senate, 2002; Radcliffe, 2004a; Rathjen *et al.*, 2003).

Traditional supply augmentation methods are becoming increasingly less favourable, from environmental, political and social perspectives (Australian Senate, 2002; World Commission on Dams, 2000). Likewise, ocean outfalls are also becoming less favourable (Beder, 1991). However, water services provision and use has been institutionalised in a particular centralised 'pipe-bound' course that, while considered unsustainable against a number of criteria, is continuing to persist and in some cases be replicated to the exclusion of other more innovative and potentially useful management options (Drangert *et al.*, 2002; Hallström, 2002).

One such alternative, which may enhance the future sustainability of urban water systems, and is starting to receive increased attention, is decentralisation (Lens *et al.*, 2001) of water service provision infrastructure. There are currently few decentralised urban water systems worldwide or in Australia. While not a simple panacea for solving the water management problem, this possible option is the subject of this research. Table 1-1 provides some characteristics and examples of decentralised water systems in contrast to centralised water systems, as well as working definitions.

Table 1-1: Characteristics, examples and definitions of centralised and decentralised water systems

	Centralised Water Systems	**Decentralised Water Systems**
Selected characteristics (typical and generalised)	Locations of source, treatment, use and discharge geographically removed Inter-catchment transfer Less adaptive capacity Less likely to involve reuse Less likely to involve users Less likely to fail, but high consequence of failure High intensity of resource use Comprehensive coverage Used water, pollutant and nutrient streams tend to be combined	Locations of source, treatment, use and discharge geographically proximate No inter-catchment transfer More adaptive capacity More likely to involve reuse More likely to involve users More likely to fail, but low consequence of failure Low intensity of resource use Incremental coverage Used water, pollutant and nutrient streams tend to be kept separate
Examples	Municipal water and wastewater treatment plants and distribution systems	Rainwater tanks Greywater recycling Source separating / composting toilets Stormwater harvesting & reuse
Definitions (for this research)	Water services infrastructure designed to service entire towns, cities, or large/multiple communities/suburbs	Water services infrastructure designed to service individual sites, neighbourhoods or small communities
Notes	There is a continuum between centralised and decentralised systems, and some systems may have characteristics of both.	

Decentralised water services provision may provide more sustainable[1] options than many of the centralised systems that are the established norm. Decentralised systems may be designed to use fewer resources (although this is not always the case) and may also have greater adaptive potential than centralised systems.

Decentralised systems that currently exist are more likely to require user involvement in managing the provision of water than centralised systems. But decentralisation of physical infrastructure need not necessarily require decentralisation of organisational management structures. Increased user involvement may be perceived as advantageous for sustainable behaviour change because members of the community are obliged to become more engaged with management of water (PHPS, 1997; Pinkham *et al.*, 2004; Schertenleib, 2005). On the other hand, it may be perceived as a source of risk of

[1] There are a variety of definitions and perspectives of sustainability, reviewed in part in Chapter 2. The focus of this research is limited to institutions and decentralisation. Links to and measures of sustainability are also important in this broad area of enquiry, but are left for other researchers to investigate.

system failure (Beal *et al.*, 2005a; Beal *et al.*, 2005b; Charles *et al.*, 2004; Gardner, 2005).

Decentralised systems, by nature, integrate different parts of the water cycle on a more local scale. This is likely to result in more closely mimicking the natural water cycle due to reduced inter-catchment transfer. In contrast, typical present centralised systems take large quantities of water from one location, mix a variety of nutrients and pollutants with it during once-only use, and finally deposit the resulting waste streams at point locations relatively far removed from the source locations. The typical result is that receiving waters become more polluted and fresh water sources become more scarce (Berndtsson and Hyvönen, 2002; Kärrman, 2001; Lens *et al.*, 2001).

Beyond overcoming supply shortages and finding cleaner or alternative ways of disposing or reusing wastewater, there are also other unresolved aspects of achieving a sustainable urban water system, including: extending coverage to the significant numbers of urban poor who (in many cities) lack adequate water and sanitation (United Nations, 1992a); the challenge of good governance (Ohlsson and Lundqvist, 2000, p. 58-60; Stenekes *et al.*, 2006); maintaining or enhancing surface and ground water quality (Huang and Xia, 2001); and managing nutrients such that they do not pollute receiving waters but are (ideally) returned to agriculture where they are needed (Berndtsson and Hyvönen, 2002; Lampert, 2003). Therefore, to alleviate the accumulated stresses, urban water managers are currently pursuing a variety of innovative approaches – both improving technology (Asano, 1998; UNEP IETC, 2002) and modifying social practice (European Environment Agency, 2001). The emerging knowledge on what sustainable urban water management might be is thus diverse and complex, and the pursuit of decentralised systems is only one of many current or emerging innovations.

While there is significant emerging knowledge of what might be more sustainable urban water management, it may be readily observed (often to the frustration of technical experts, as in this case with emerging knowledge of decentralised water systems) that knowledge does not implement itself. It is used by participants in the context of

organisations and underlying values, which are integral parts of the framework for action.

Comparison with other large technical systems (e.g., cf. Hughes, 1983) suggests that a change toward decentralised water management must tackle not only technological systems for overcoming physical limits on available water supplies, but must also tackle institutional dimensions of the sociotechnical[2] system (cf. Hofman *et al.*, 2004).

Part of the problem is that the constitutive elements of a sociotechnical system are tightly woven together, such that change in one element affects or is constrained by other elements. This tends to create stable patterns of water management systems (Hofman *et al.*, 2004), or institutions. Technological systems are closely tied to patterns of water use behaviour and values. These both link to the organisations established to provide water services. The Swedish Urban Water program characterises the urban water system as being composed of technology, users and organisations (MISTRA, 2001, p. 9). There are a number of other elements of the sociotechnical system of water management (depending on how it is modelled). Figure 1-1 shows several interlinked components for the sociotechnical system of water services provision and use.

[2] Large technical systems, such as water management systems, are 'sociotechnical' (Hughes, 1983, p. 465) in that they are the product of social and technical interconnections (Guy and Marvin, 2001, pp. 27,28). According to Hughes, technical knowledge and artefacts arise within a social context, and do not persist unless their social context is adapted to the innovation.

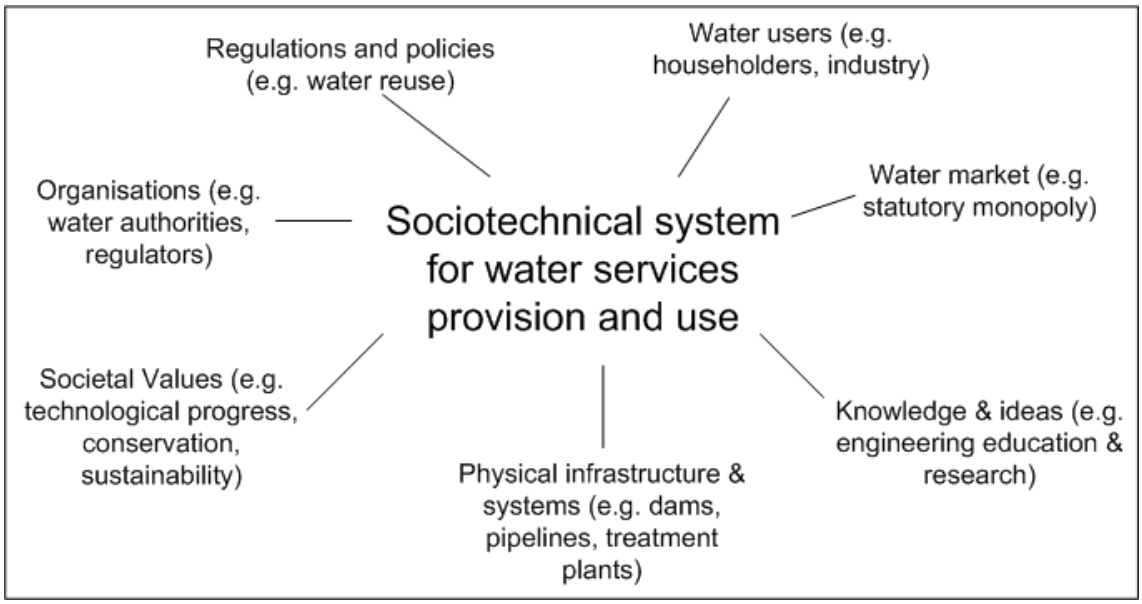

Figure 1-1: Sociotechnical system of water service provision and use (adapted from Hofman *et al.*, 2004)

The observed low uptake of decentralised systems, along with the deeply embedded nature of centralised systems, has given further support to the suggestion that institutional barriers[3] operate to marginalise decentralised systems, and this has led to the choice of an institutional perspective for this research.

CSIRO Land and Water (2007) conducted interviews with 170 people from 100 organisations in the Australian water industry (and related research organisations) to identify research needs. The following quotes support the need for this research:

> A number of interviewees noted that institutional changes would be needed to facilitate the most effective planning and management for land and water resources. They noted that research was needed to identify these barriers and recommend better governance models (CSIRO Land and Water, 2007, pp. 21,22).

And:

> Several organisations noted that urban water and wastewater authorities are currently set up to manage centralised systems; institutional changes or new

[3] 'Institutional barriers' here does not mean that organisations are acting as barriers (see Table 1-2).

business approaches may be needed if there is a move to a more localised service provision (CSIRO Land and Water, 2007, p. 22).

1.2 Theoretical Frameworks

Studies of urban water management are faced with problems that are increasingly complex and interdisciplinary (Jeffrey *et al.*, 2000; Loucks *et al.*, 2000; Maksimovic and Tejada-Guibert, 2001). Traditionally, water management has been built on the disciplines of engineering and science. This research started from questions arising at the leading edge of this knowledge base – i.e., the implementation of new technology for decentralised urban water management.

Several other authors have identified a lack of attention to institutional and social factors leading to implementation problems (Brown, 2003; Lundqvist *et al.*, 2001; Pahl-Wostl, 2002). Having proposed a likely social, or, more specifically, institutional, barrier to uptake of decentralised urban water systems, theoretical frameworks for policy, governance and institutions were reviewed for applicability to the problem at hand. Many organisational analysts have adopted an 'institutional' perspective on their subject matter, focusing on the practices and contextual factors which create and sustain organisation (March and Olsen, 1989; Powell and DiMaggio, 1991; Scott, 1995). This perspective is useful in explaining how institutions can both constrain technological change, as well as enable it. According to Scott, "Institutions consist of cognitive, normative, and regulative structures and activities that provide stability and meaning to social behavior" (Scott, 1995, p. 33). These three elements (cognitive, normative and regulative) are referred to as (Scott's) institutional 'pillars'. (See Figure 1-2 for a diagram of the three 'pillars', and also Table 1-2 for summary of what is meant by 'institution' in this thesis.) The study of water management practice was analysed for characteristics such as stability in and between each of these 'pillars' for understanding of constraints to, and dynamics of, change.

Table 1-2: Definition and usage of 'institution' in this thesis

Definition of 'Institution'	Established pattern of social order or practice
What an 'institution' is not	An institution, therefore, is not (merely) an organisation. An organisation may provide rules and regulations and harbour knowledge and values that together constitute an institution. An organisation may be thought of as an outcome of (and also a contributor to) a process of institutionalisation.
Example of usage: 'Institutional barrier'	In existing water management literature, an 'institutional barrier' may be an organisation or organisational arrangement that actively or passively prevents change, typically because of regulations. But in this thesis, an 'institutional barrier' does not mean that an organisation is blocking action. 'Institutional barrier' means, rather, that the interplay of established norms, knowledge and rules (rather than specific organisations) serve to constrain what is and what is not considered to be appropriate activity for managing urban water.

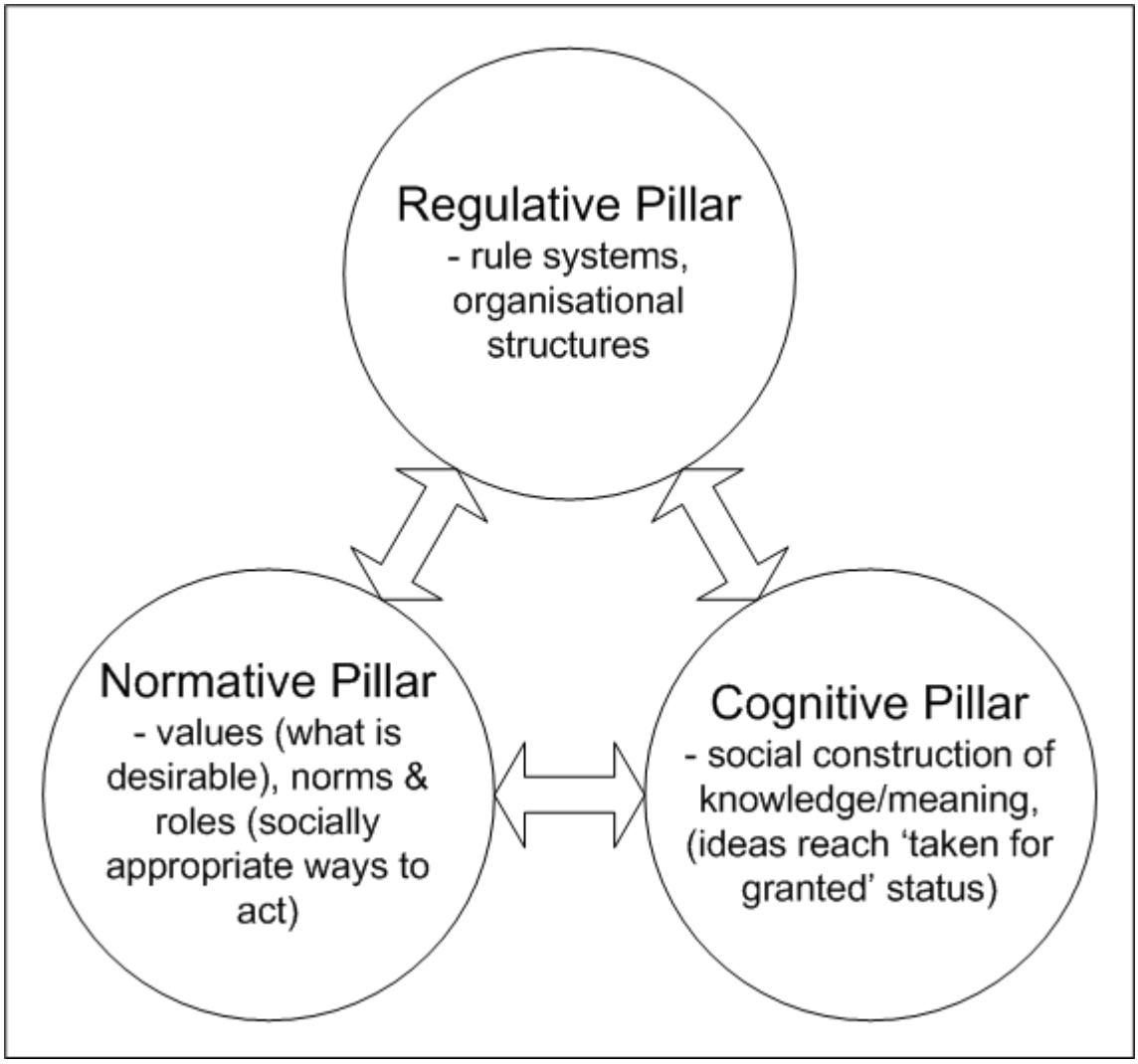

Figure 1-2: Scott's framework of institutional pillars (Scott, 1995) used throughout this thesis

Another important theoretical construct employed in this thesis is the social construction of knowledge (Berger and Luckman, 1971). This theory is important because it allows for, and provides understanding of, the multiple perspectives and problem frames for what the important problems for water management may be, as well as what the appropriate solutions may be. With increasing physical and social complexities in water management (Lundqvist *et al.*, 2001; Vlachos and Braga, 2001), water managers are now required to use a greater variety of skills. It is now not sufficient to use scientific models alone for predicting 'safe yield' and then to build infrastructure to supply demand. Management of water under competing and complex pressures has turned to questions of the practices of using water, which involves the understandings, values and practices of multiple and often disparate stakeholders. Water managers therefore require more knowledge and skills than just answering the question of which technologies to employ to solve the problem of unsustainable water management. A central problem for the water management professionals of today is to integrate their scientific expertise into the collective discourse so that the competing value structures and problem frames, and their scientific expertise, are recognised and reflected in the outcome.

1.3 Research Questions

Two research questions were formulated to address the research problem:

1. To what extent do institutional factors operate to include or exclude decentralised technologies in urban water management?
2. To what extent do institutional factors operate to include or exclude user involvement in urban water management?

In answering these questions, important institutional factors for enabling decentralised urban water management were identified through testing a series of hypotheses put forward. The hypotheses were built progressively in correlation to the development of the theoretical framework, methodology and availability of data. The complete set of hypotheses is listed in Table 1-3, together with references to where data informing, and conclusions regarding, each hypothesis are located. Table 6-1, in the Conclusion, summarises the answers to these questions and the outcomes of testing each hypothesis.

Table 1-3: Hypotheses with references to where they are developed and answered

Hypotheses (Grouped by Research Question)	**Where Developed**[4]	**Where Answered**
Research Question 1: To what extent do institutional factors operate to include or exclude decentralised technologies in urban water management?		
Hypothesis 1.1: Innovative decentralised technologies are excluded from urban water management because of entrenched or otherwise misaligned institutional factors: knowledge, values and organisational structure/regulations.	§ 2.5.1, § 3.5	§ 4.1.5, § 4.5.1.2, § 4.5.2.1
Hypothesis 1.2: Successful uptake of decentralised technologies in urban water management requires a combination of shifts or innovation in all of three institutional factors so that they are aligned: knowledge, values, and organisational structure/regulations.	§ 2.5.1, § 3.5	§ 4.2.5, § 4.3.5, § 4.4.5, § 4.5.2.2, § 4.5.3.1
Hypothesis 1.3: Alignment of institutional factors to support decentralised technologies for urban water management (i.e., the condition of Hypothesis 1.2) is improved by an organisational home where new ideas and values are part of accepted discourse.	§ 2.5.1, § 3.5, § 4.1.5	§ 4.2.5, § 4.3.5, § 4.4.5, § 4.5.1.2, § 4.5.2.2
Hypothesis 1.4: Alignment of institutional factors to support decentralised technologies for urban water management (i.e., the condition of Hypothesis 1.2) is improved by an organisational structure that includes a broad network of stakeholders with diverse discourses.	§ 2.5.1, § 3.5, § 4.1.5	§ 4.2.5, § 4.3.5, § 4.4.5, § 4.5.1.1, § 4.5.3.2
Research Question 2: To what extent do institutional factors operate to include or exclude user involvement in urban water management?		
Hypothesis 2.1: User involvement in urban water management is excluded because of entrenched or otherwise misaligned institutional factors: knowledge, values and organisational structure/regulations.	§ 2.5.1	§ 4.1.5, § 4.2.5, § 4.3.5, § 4.5.4
Hypothesis 2.2: Successful uptake of user involvement in urban water management requires a combination of shifts or innovation in all of three institutional factors so that they are aligned: knowledge, values, and organisational structure/regulations.	§ 2.5.1	§ 4.3.5, § 4.4.5, § 4.5.2.2, § 4.5.4
Hypothesis 2.3[5]: The acceptance of user involvement is a helpful (but not necessary) condition for enabling or enhancing uptake of decentralised technologies.	§ 2.5.1, § 4.1.5	§ 4.2.5, § 4.3.5, § 4.4.5, § 4.5.4

The primary focus of the research was on the first of the above research questions. The case studies chosen did not allow much investigation of user involvement. But the two

[4] The logic of the hypothesis testing approach (but not the hypotheses themselves) is also developed in the introductory paragraphs of Chapter 4.

[5] The sequence of hypotheses for Research Question 2 could have followed the sequence for Research Question 1, with further hypotheses to explore the nature of institutional factors that could enable user involvement. But insufficient evidence was found to continue to build and test further hypotheses under this question. Instead, Hypothesis 2.3 was formed to loosely test the importance of a relationship between findings in the first and second research questions. It is only a loose test because there are many variables that may come into play, such as the type or configuration of specific decentralised technologies.

questions are related in that, as described above, decentralised technology is often linked (either in perception or reality) with user involvement.

1.4 Scope

This thesis does not seek to further the argument for the sustainability of decentralised urban water management nor does it assume that decentralised water management is necessarily the only or best answer to sustainable water services provision.

The study focused on major Australian cities, with case studies in Brisbane, the Gold Coast and Sydney. While data collection was limited to the Australian context, the findings are argued to be relevant to urban water management situations in other developed countries.

Focus was also primarily restricted to urban domestic water management. Other sectors such as industry and agriculture are also important; however, domestic use is typically a significant majority of total urban water use, and is the focus of demand management strategies in times of water shortage. For example, in Sydney, domestic water use accounts for about 70% of total water use (not including system leakage and losses) (Sydney Water, 2003); and demand management during the current drought has reduced consumption to 526 GL/y from an estimated use of 620 GL/y without the influence of water restrictions (Sydney Water, 2005).

1.5 Outline of Thesis

Chapter 2 reviews the literature from the various disciplines on which this research draws. Stages in the development of decentralised water management are reviewed. A diverse field of literature around the theme of 'decentralisation' is outlined, with parallels drawn to the research problem at hand where relevant. Institutional dynamics and theories are then reviewed; and other institutional analyses of environmental and water management are compared with the approach of this thesis. Environmental sustainability literature is reviewed before reviewing principles for and approaches to sustainable urban water management, including an analysis of decentralised systems in the current mix of possible physical options for urban water services provision.

Chapter 3 presents the research methods, predominately based in social sciences. Case study analysis is defended as the most appropriate practical research method for investigation of institutionalisation of water services management, and the social construction of the water management problem. Supporting methods, including document review, in-depth interviews and an on-line survey, are also outlined.

Chapter 4 reports the data gathered from, and analysis of, four Australian case studies. The first case, the Bundeena Maianbar Priority Sewerage Project, in Sydney, is considered as an 'unsuccessful' example of implementation of decentralised systems because decentralised innovation was considered before a conventional centralised system was implemented. The other three cases are considered as 'successful' cases of implementation of decentralised systems. They are the Gold Coast Pimpama Coomera Waterfuture project, a subdivision development at 599 Payne Rd, The Gap, Brisbane, and another subdivision development called the Currumbin Ecovillage in the Gold Coast hinterland. The chapter ends with a cross-case comparison. This chapter tests the hypotheses listed in Table 1-3.

Chapter 5 identifies implications of this work for engineering practice. A proposed planning framework for water management projects, and organisational options for their implementation, are speculatively put forward as possible pathways for enabling institutionalisation of technological change toward decentralised water management.

Chapter 6 concludes with a summary of research findings, their significance and limitations, and recommendations for future work.

1.6 Research Contribution and Outcome

This research significantly contributes to the understanding of the institutional basis and dynamics of urban water management. Institutional theory and explanations have been applied by others to urban water management (Brown, 2003; Stenekes, 2006), but this is the first study to use this theoretical and methodological approach for questions of decentralisation of urban water management. This work extends the understanding of

factors that contribute to centralisation and decentralisation to include institutional and organisational factors, and provides new and practical pathways for change for the implementation of decentralised urban water systems.

2 Literature Review

As introduced in the previous chapter, limited success of decentralised initiatives in the pursuit of sustainable urban water management raises questions as to whether sociological, or, more specifically, institutional factors are important in determining the degree of success in implementation of such initiatives. This chapter reviews literature associated with decentralised urban water management to establish the existing knowledge relating to, and the gaps filled by, this thesis. The review draws from current and historical literature in a mix of fields including engineering and physical sciences relating to the pursuit of appropriate water management. It also examines social science literature to identify an appropriate framework for explaining the substance and importance of institutional dimensions of decentralising urban water.

The literature review is structured as follows. It begins by looking at how predominately local water management systems became centralised since the beginning of the industrial revolution. The alternative of local systems (or decentralisation) is then examined from a number of different perspectives. Because the research questions seek to identify institutional factors that may be important in any move toward decentralised systems (Research Question 1) and/or user involvement (Research Question 2), the next section reviews theories and frameworks for analysis of institutional dynamics. The final section reviews current knowledge and practice in sustainable water management, establishing the place and relevance of decentralised systems in the current mix of possible physical options for urban water services provision. The conclusion pulls the review together, demonstrating how the institutional framework may help to explain water management practice.

2.1 Centralisation of Water Systems

This first section of the literature review traces the growth and development of current typical centralised urban water management sociotechnical systems. This background is important for a study of the social and institutional dimensions of urban water management. According to Harremoës (1999), any suggestion of change to well-established practices and systems should include an understanding of the reasons and

basis for the current situation. There is significant capital investment in established infrastructure, suggesting the inertia associated with path dependence (Melosi, 2000). Thus an understanding of the origins of the present sociotechnical system facilitates finding arguments for change (Harremoës, 1999). This historical review does not attempt to portray any overriding reason for centralised water services provision. There are many and varied significant factors. The review of such factors is done from an institutional perspective (as introduced in the introductory chapter, with more details to come in Section 2.3).

Water and wastewater management systems in developed urban environments have been, over the last 150 to 200 years, based mainly on 'big pipe', centralised systems. In most parts of the world, water supply prior to the industrial revolution was primarily sourced directly from surface (river) water or groundwater (through wells), on an individual or local basis. Sanitation was likewise an individual or local responsibility (Melosi, 2000). Roman aqueducts are an important exception (Wikander, 2000).

Urban water management in Australia has local (or decentralised)[6] origins. Sydney's first water source was the 'tank stream', a natural stream running through what is now the central business district. This relatively unregulated and decentralised water source had to be abandoned as it was quickly overcome by pollution as the city grew (Aird, 1961; Beder, 1998; Henry, 1939). Throughout urban and rural Australia, rainwater tanks have been relied upon quite heavily throughout the past two centuries (Cunliffe, 1998). Rainwater tanks are now receiving renewed attention and support, particularly as a supplementary source to limited mains water supplies (enHealth, 2004).

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[6] Note that 'decentralised origins' is oxymoronic in a strict interpretation of *decentralised*, because the *ised* suffix suggests that a process of decentralising has already taken place. This interpretation is not intended. The *ised* suffix, as applied to *(de)central* throughout this thesis, is not intended to connote any process, but rather intends only to characterise scale as is. Alternate words such as 'local' and 'central' could have been used to avoid this, but doing so would have introduced the confusion of using different words than what are used by other writers in this field. The *isation* suffix as used for the heading of this section does, however, intend to connote the process of a change in scale.

Rainwater tanks demonstrate that some forms of decentralised physical systems for urban water management have persisted through the industrialised era, to some extent, at least in Australia. There were also a number of decentralised physical forms that were considered but deemed not to be the most appropriate approaches for urban water management at the time. These will be returned to later (Section 2.2.1), after the development of centralised systems for urban water management is reviewed.

2.1.1 Factors in the Development of Centralised Systems

Developing a complete understanding of why urban water sociotechnical systems are predominately centralised in nature would be advantageous but was beyond the scope of this work. This section traces key technical factors, rather than the wider range of sociotechnical factors, in the development of centralised physical systems of pipes and treatment works. Contributing factors related to administrative structures have largely been left out of this review. Together with the physical systems and water users (see Figure 1-1) administrative structures make up the sociotechnical system of water management. Administrative structures are influenced by a number of different factors which are not necessarily uniform across all jurisdictions. Barraqué (2004) contrasts the administrative structures of water management in various European countries, noting quite significant differences. For example, in the United Kingdom, while water management was in the domain of municipalities 100 years ago, it has now become centralised to the point that municipalities are not involved at all. Other European countries have more subsidiary approaches (see also Juuti and Katko, 2005, p. 30)[7]. In contrast, the physical systems of urban water management have generally followed similar centralised patterns. The degree of uniformity in centralisation of physical systems is probably more consistent than that of the administrative structures pursued over time and throughout the world's developed urban centres.

It is the centralisation and decentralisation of physical systems that is of primary interest in this review. But administrative centralisation (or alternatives) is of secondary significance, considering the interest of the research questions in institutional factors associated with moves toward decentralised physical systems and/or user involvement.

[7] Schumacher (1973) advocates the "principal of subsidiarity" favouring administrative decentralisation.

Edwin Chadwick, a leading sanitation pioneer of the mid-19th century, was an influential figure in early water and sanitation system design. Melosi (2000) states that the elaborate 'hydraulic system' of sewage removal planned by Chadwick required a strong central authority[8]. Undoubtedly this cannot be relied upon as an explanation for all cases and aspects of centralised administration for water management. The nature of any causal relationship between physical systems and administrative structure would be very interesting and relevant to trace through history. But this was beyond the scope of this study.[9]

Following is a brief review of literature tracing broad technological change in urban water management physical systems, and the way that such change became institutionalised. Figure 2-1 provides an illustrated summary of the imperatives driving innovation in physical structures for water services over time. Each phase was guided by the imperatives listed across the top of the diagram. The focus here is on capturing and reviewing those institutional factors that have contributed to technical change – i.e., the way that ideas, values and organisational form have interacted to form established patterns of social practice.

It is interesting to note that the labelling of the water professional has varied from civil engineer, sanitary engineer to environmental engineer. Indeed, there are yet to be many schools of 'sustainable engineering', although the Centre for Sustainable Engineering hosted by Carnegie Mellon University, the University of Texas at Austin, and Arizona State University, is one example.

The implied decision-point in Figure 2-1, with a choice of either centralised or decentralised water management, is only one of many significant questions for future sustainable water management, but is at the heart of this thesis.

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[8] Karl Wittfogel's account of Chinese "oriental despotism" based on "hydraulic bureaucracies" demonstrates similar arguments for strong centralised control (Wittfogel, 1970).

[9] The research questions guiding this study restricted analysis to present-day organisational enabling and disabling of physical decentralisation.

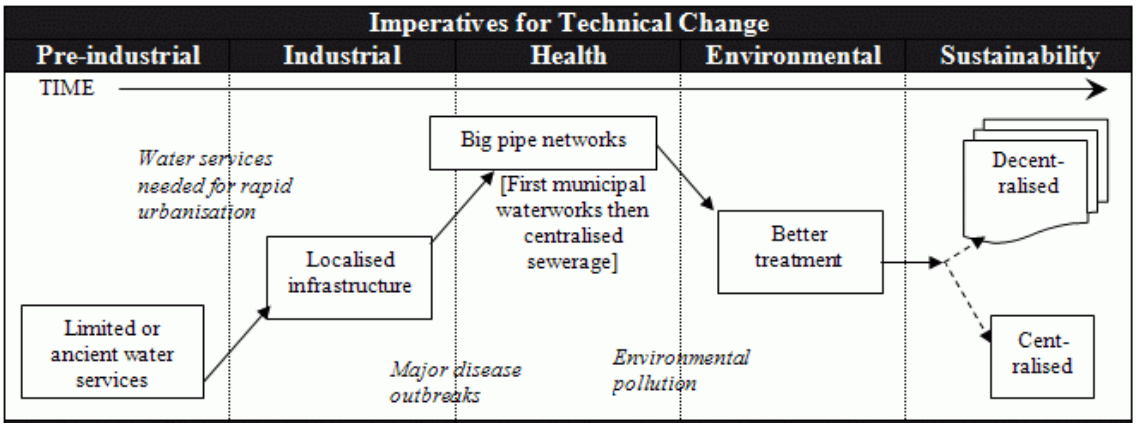

Figure 2-1: Eras of technological change in urban water management

2.1.1.1 Industrialisation

The advent of industrialism coincided with an increase in scientific knowledge in both natural systems and technology; and values centred on progress, material welfare, economic growth, and urban living. Provision of water in some form of collective, organised manner became essential to allow and promote high-density urban living with supplies adequate for domestic use and also fire protection. Public works engineers provided the technical knowledge, establishing water boards (or similar authorities) focused on the problem of providing functionally and technically adequate water supplies for growing cities. The primary basis for urban water supply was construction of large gravity water mains and sewers, and dams, with expertise in this area often being the determining factor for career advancement (Bob Wilson, pers. comm., 2004).

Collective organisations of water management had existed prior to industrialisation – both informal and formal.[10] But the beginnings of the existing institutional form of today's urban water authorities can be largely traced back to the early stages of industrialisation in the 19th century (Henry, 1939; Melosi, 2000). Table 2-1 summarises and generalises[11] this early stage of institutionalisation.

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[10] Dutch Water Boards dating back to the Middle Ages (Havekes *et al.*, 2004) are an example of early water management collectives; though these were primarily concerned with drainage and flood control. There were aqueducts and sewerage networks in place prior to this time, even in ancient civilisations (Wikander, 2000); however, ancient sewers primarily handled stormwater drainage.

[11] Table 2-1 through Table 2-5 are similarly generalised.

Table 2-1: Industrialisation of urban water: the problem, response, and its institutionalisation

Stage of institutionalisation	Industrialisation
Problem to be solved	Water supply for growing cities – both domestic & fire protection
Technical solution	Centralised water supplies (often municipal)
Knowledge base	Engineering/health[12]/scientific (public works & sanitary engineers)
Values	Progress, growth, urban living, material welfare
Organisation(s) formed	Water boards and similar

2.1.1.2 Sanitisation

The provision of centralised supply of significant quantities of water for domestic urban use created a complementary need for the used water to be disposed. The reason for this was twofold. The first was functional: the effectiveness of cesspits in England was vastly reduced after the introduction of water closets around 1810 (Melosi, 2000). Secondly, but more significantly, widespread and catastrophic outbreaks of cholera and dysentery necessitated effective management of wastewater. While the earlier introduction of municipal water supply also helped improve public health, the epidemics were not abated until wastewater removal systems were also introduced. Based on prevailing engineering knowledge and industrial values, 19th century sanitation pioneer Edwin Chadwick planned an elaborate 'hydraulic system' for sewage removal. He originally planned that the nutrient-rich wastewater would be returned to agriculture (valuing the used water as a potential resource rather than conceiving it as waste), but the closed loop reuse part of his plan was not fully realised[13] (Melosi, 2000). Despite other dissident voices from those who wanted to conserve water and nutrients using other means such as dry conservancy (Beder, 1998; Hallström, 2002), public health problems were much more pressing than environmental or sustainability concerns, so the water closet was almost universally adopted.

John Snow conclusively identified the link between contaminated water and cholera, when in 1854 he removed the handle of the Broad Street pump in London, bringing an end to an epidemic (Gleeson and Gray, 1997, pp. 4,5). Robert Koch identified the bacteria that caused cholera in the late 19th century (Morris, 2003, pp. 177,178), thus

[12] For example, London's sewers were built to remove 'bad air' (miasma) thought to cause disease (Melosi, 2000).

[13] However, sewage farms were used to return sewage to agriculture. See Section 2.2.1.

establishing germ theory (Gleeson and Gray, 1997, p. 5). The implementation and institutionalisation of water filtration and chlorination is regarded as one of the most important public health interventions ever, if not the most important (Farland and Gibb, 1993; Guerra de Macedo, 1993; Okun, 1993).

In most developed regions, 'big pipe' networks have become the norm for both sewerage and water (see Table 2-2). The centralised, technical, bureaucratic management of water and wastewater became the prevailing physical and also organisational form for water management throughout the industrialised world[14].[15]

Table 2-2: Sanitisation of urban water: the problem, response, and its institutionalisation

Stage of institutionalisation	**Sanitation**
Problem to be solved	Water-borne disease epidemics
Technical solution	Centralised water treatment and wastewater removal: big pipes in and out
Knowledge base	Microbiological/technical/scientific (sanitary engineers)
Values	Urban living, human welfare (health)
Organisation(s) formed	Addition of public health to responsibility of water authorities; eventually separated to regulation by external health agencies

2.1.1.3 Environmental Awareness

Water management then moved into broader questions of environmental quality and resource management. While there were early examples of cleaning up polluted rivers in the late 19th century (Johnstone and Horan, 1996), environmental values (see Table 2-3) came to pre-eminence during the 1960s and 1970s with several influential publications (including Carson, 1963; Hardin, 1968; Meadows *et al.*, 1972). Air, land and water pollution, deforestation, loss of biodiversity and other unintended by-products of technological and economic progress, became visible, public and political issues. The emphasis on the value of nature for its own sake, or at least to support human life, along with scientific understanding of the delicate balance of ecological systems, were

[14] Rather than having followed alternate infrastructural approaches, many cities in developing nations still do not have any organised wastewater collection and treatment (Lens *et al.*, 2001).

[15] As stated earlier, this brief historical review does not propose that centralised physical form always caused organisationally centralised management, but leaves this question unanswered. The trends of historical phenomena are generalised and summarised in this review. No attempt is made to establish causality. Further, there have been many variations in organisational characteristics between specific times and places.

together brought to bear in tightened wastewater management regulations and improved remediation technologies (Schertenleib, 2005), administered by new government bureaucracies (manifest as environment protection agencies).

Table 2-3: Environmental awareness in urban water: the problem, response, and its institutionalisation

Stage of institutionalisation	Environmental awareness
Problem to be solved	Polluted waterways: fish kills, stench, loss of amenity
Technical solution	Deeper ocean outfalls & improved wastewater treatment
Knowledge base	Ecological/scientific (now environmental engineering)
Values	Nature, aesthetics, recreation, (later) sustainability
Organisation(s) formed	Environment protection agencies (also natural resources departments)

Environmentalism, while modifying the institutional form of the water sociotechnical system by adding another technocratic agency and a new broad criterion for good water management practice, generally allowed the water sociotechnical system to continue its focus on technical expertise administered by a growing centralised technical bureaucracy. In this context of environmentalism, natural resource departments could also be included in the increasingly complex array of government organisations holding a stake in water management.

2.1.1.4 Economic Rationalisation

In contrast to the other four headings (three above and one below), the economic rationalisation stage did not bring innovations or solutions in terms of the physical technologies and systems used for water management. This stage only has relevance to the organisational make-up of the water management sociotechnical system. Therefore in some senses this section does not belong in the discussion, and was also not included in Figure 2-1. But because the detailed discussion in the text for the other stages includes significant organisational developments, it has been included.

In contrast to the theme of an ever-increasing technical bureaucracy, this next stage (see Table 2-4) of the institutionalisation of water management focused on downsizing of the technocracy in the pursuit of economic rationalism driven by competition (e.g., Hilmer Committee, 1993). This phase could also be placed somewhat in parallel (chronologically) to environmental reform, but has generally followed the political ideology of Margaret Thatcher and Ronald Reagan. These leaders were most influential

regarding such economic rationalism at least a decade after environmental reforms began. Against the value of profit maximisation, social values such as pricing equity were upheld by yet a further addition to the array of regulatory organisations: pricing regulators. The water authorities themselves have typically downsized as a result of privatisation/corporatisation (Johnson and Paddon, 1995), with outsourcing of operations and public-private partnerships coming into vogue.

Table 2-4: Economic rationalisation of urban water: the problem, response, and its institutionalisation

Stage of institutionalisation	**Economic rationalism**
Problem to be solved	Commercial viability/competitiveness of government businesses[16]
Technical solution	No new technologies, but privatisation, corporatisation and/or partnerships were deemed to increase economic efficiency
Knowledge base	Financial, economic (e.g., cost-benefit analysis)
Values	Progress, growth, material welfare, profit maximisation vs social equity, de-monopolisation, & competition
Organisation(s) formed	Water authorities remain but corporatised/privatised; independent pricing regulators established to ensure social equity

2.1.1.5 Sustainability Awareness

The current phase of institutionalisation of the water sociotechnical system is the embracing of the goal of sustainability to cope with water scarcity (see Table 2-5). The 'big picture' idea of sustainability seeks to harness all of the (somewhat competing) values and knowledge that have become institutionalised into the water sociotechnical system: health, economic, environmental, etc. The knowledge and value base is thus more multi-disciplinary, and the problem less easy to solve with technocratic expertise alone – and less easy to define. The relevant issues now are very broad – including population growth, climate change, economic rationalisation, governance, etc. Being able to integrate such broad questions and objectives is becoming quite difficult. For example, conserving water seems to contradict corporatised water agencies' core business goal of profitability through selling water (various Australian water industry professionals interviewed for this research, 2004-2005, as discussed in Section 3.3).

[16] In 1993 the Independent Committee of Inquiry into Competition Policy in Australia released a report (widely known as the 'Hilmer Report') recommending greater competition to enhance competitiveness of Australian industry and business.

The emerging organisational arrangement is also not yet clear. For example, in Australia, State Government departments have undergone a variety of restructures and name changes associated with incorporating 'sustainability'[17]; however, the basic arrangement of a centralised urban water authority regulated by health, environmental and pricing agencies generally remains unchanged (ACIL Tasman, 2005). What is clear is that water is moving from a technical supply focus to questions of how people use and manage a scarce resource. Whether the focus on sustainability will be a centralising or decentralising force on the deployment of physical technologies of water management is also unclear, although there appears to have been elements of both.

Table 2-5: Sustainability in urban water: the problem, response, and its institutionalisation

Stage of institutionalisation	**Sustainability overcoming water scarcity (current stage)**
Problem to be solved	Continuation of secure water supplies in face of population growth, climate change, and limited sustainable yields
Technical solutions	Demand management, recycling, alternate sources, closing loops (nutrients back to agriculture, treated water returned to households)
Knowledge base	Engineering, scientific, social (more multi-disciplinary)
Values	Varied, including: progress, growth, urban living, material welfare, nature, social equity, future generations, etc.
Organisation(s) formed	Name changes, restructures, sometimes no change. Sustainability has not yet been fully institutionalised; however, early indications are that a variety of stakeholders will be involved for integrated solutions – governance rather than (or in addition to) government (see glossary).

2.1.2 Centralisation: A 'Historical Accident'

The predominant centralised, linear system for water supply and wastewater disposal was developed through decision-making and problem-solving that was logical and successful for the apparent problems. However, if health had not been the first driving problem or discourse – but rather sustainability or environmental protection – quite a different physical (and thus sociotechnical) system would probably have eventuated. Because of the early emphasis on health, however, the centralised infrastructure became a 'historical inevitability' (Gandy, 2004), or alternatively, a 'historical accident'.

[17] Name changes of Victorian State Government agencies responsible for regulating water management provide a good example. The Department of Water Supply (c1940-1975) was followed by the Ministry of Water Resources and Water Supply (1975-1984), then the Department of Water Resources (1984-1990), the Department of Conservation and Environment (1990-1992), the Department of Conservation and Natural Resources (1992-1996), the Department of Natural Resources and Environment (1996-2002), and now the Department of Sustainability and Environment (2002-).

Further, even though sanitary problems and subsequent successes drove the initial direction of the water management sociotechnical system, engineering developments in water services provision have tended to precede not only understanding of environmental impacts, but also a complementary understanding of health impacts (Harremoës, 1999). The transition from local, user-managed systems to organised, centralised systems was primarily in response to disease outbreaks that were not fully understood. The contemporary understanding of disease aetiology could not properly explain why such centralised systems proved favourable to public health until the microbiological breakthroughs of Robert Koch and others, who, during the 1890s, identified the bacteria causing massive water-borne outbreaks of cholera and typhoid (Melosi, 2000).

2.1.3 Growth and Bureaucratisation of the Sociotechnical System

In part due to the successes of the sanitary movement, urban water management organisations focused their attention, knowledge-generation and skill-base on providing clean drinking water and removing waste as quickly and as far from the household as possible. The resulting industrial paradigm focuses on the supply of drinking quality water for all urban demand, with used water requiring disposal, along with any rainwater and stormwater that happens to enter the urban environment (Gleick, 2000).

The dominant logic became ‘expand and upgrade’, with service providers having territorial monopoly and top-down one-way interaction with constituents (Moss, 2001c, pp. 5,6). Paralleling the provision of electricity in Western society (Hughes, 1983), ‘system builders’ (typically engineers, managers and investors) have had interest in developing large technical systems for water management. Economic rationalism has countered this trend (as explained in Section 2.1.1.4), but a technocratic and growth mentality has persisted in most urban water management organisations.

2.2 The Alternative of Local or Decentralised Water Systems

The decentralisation that this thesis is concerned with is physical decentralisation of water management infrastructure. While interest is in organisational and institutional

characteristics of successful physically decentralised water management, it is not assumed that organisational decentralisation is a necessary corollary. Nevertheless, various other aspects of decentralisation are reviewed here, including organisational or administrative decentralisation.

This section first reviews some forgotten ideas for decentralised water systems during early stages of industrialisation. Then the section diverges to briefly examine three other broad cases of decentralisation: first, administrative decentralisation in general; second, decentralisation in the developing world, including the case of water management; and third, decentralisation in the energy sector. The purpose is to develop a broad basis for analysis of institutional dynamics (Section 2.3). It is also necessary to review principles and practice for sustainable urban water management, but this does not come until Section 2.4, where options for physically decentralised urban water management are examined in detail.

2.2.1 Lost Ideas for Decentralised Water Systems during Industrialisation

The presence of voices disputing the centralised 'big pipe' networks is not an entirely recent phenomenon. Dissident voices were particularly apparent during the early stages of industrialisation, and also in recent times. As early as the end of the 19th century there were concerns that with a centralised system: valuable fertiliser would be wasted; too much water would be consumed; and that receiving waters would be contaminated (Beder, 1998; Hallström, 2002).

Sanitation pioneer Edwin Chadwick initially planned for a hydraulic system for depositing liquid sewage to sewage farms, which had been in limited use for some three centuries (Asano and Levine, 1996; Melosi, 2000). In Sydney, a sewage farm at Botany was also employed for a few decades, and the treatment ponds for the Werribee sewage farm (created for Melbourne in 1897) are today the world's largest. The grand scheme of Chadwick, where "we complete the circle" (Melosi, 2000) of the nutrient cycle, was never realised, as it was seen to be too impractical.

The realisation of the resource which human waste provides was not lost on a number of proponents, not just of sewage farming, but even dry conservancy. The debate between centralised water-carriage disposal of sewage and nightsoil occurred in many industrialising cities (Beder, 1998; Hallström, 2002; Harremoës, 1997). Source separation of urine even featured in some multi-story dwellings in Sweden in the 1860s (Drangert, 2004). However, the nutrient-rich urine was merely emptied into the sink for discharge into waterways rather than reused, reducing the number of trips required for emptying the pan. The adoption of the water closet was cautious in some parts, e.g. Sweden (Drangert *et al.*, 2002; Hallström, 2002). Nevertheless, in most developed regions, centralised 'big pipe' networks became the norm for both sewage and water.

2.2.2 Administrative Decentralisation in General

Outside of the context of water management, *decentralisation* refers to the spreading of power (rather than physical artefacts) away from the centre to local branches or governments[18] such that responsibilities can be transferred from central government to lower levels of government (political or administrative decentralisation) or the private sector (market decentralisation) (Faguet, 1997). This section considers the background literature concerning such decentralisation – stemming from economics and political science.

Faguet (1997) argues that decentralisation often occurs in response to failures of Weberian (see, e.g., Weber, 1978) central bureaucratic administration (see also Bardhan, 2002), justified by an *a priori* assertion that decisions made closer to the people are better (compare the subsidiarity principle, see footnotes 7 and 34). The impetus for decentralisation may be provided by a deliberate policy decision, or an anarchic erosion of central control typical in developing countries (Bardhan, 2002).

[18] See definitions (e.g., at www.dictionary.com and www.wordreference.com); see also the literature on fiscal federalism, particularly pertaining to the United States (Inman and Rubinfeld, 1997; Oates, 1991; Rabe, 2000). Federalism or devolution in general – its implications, patterns and consequences – is analysed for developed countries in Greer (2006) and OECD (2001).

Those supporting administrative decentralisation may be from a wide variety of backgrounds and perspectives; they may be free market economists, structural reformers, or 'anarcho-communitarians'[19] – i.e., a mix of postmodernists, environmentalists, and supporters of indigenous groups and multiculturalism, etc. (Bardhan, 2002)[20].

2.2.3 Decentralisation and Decentralised Water in Developing Countries

Administrative decentralisation is an increasing trend in developing countries as democracy spreads and citizens demand input into the process of government (Larson and Ribot, 2004; World Bank, 2000). There is a growing body of literature investigating the effectiveness of decentralised *governance* of water management in developing countries (Brannstrom *et al.*, 2004; Garande and Dagg, 2005; Jackson and Gariba, 2002; Parkinson and Tayler, 2003; Pearce-Oroz, 2003; Reynoso, 2000).

Pahl-Wostl (2002) argues that there are strong arguments for decentralised *technologies* in developing countries, as well as increased householder involvement, due to failures of centralised government to deliver and maintain adequate service provision.

Many of the objectives and activities set out in the *Agenda 21* document (United Nations, 1992a) call for local participation and decentralisation of the functions of government – including in the area of water management (Chapter 18 of *Agenda 21*), particularly for developing countries. The set of objectives and actions recommended in Chapter 28 of *Agenda 21* is often referred to as 'Local Agenda 21' and emphasises the importance of citizen engagement at local levels for achieving sustainability (compare the subsidiarity principle of sustainability, footnote 34, and the literature on public participation, reviewed in Section 2.4.3.3).

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[19] See also the 'communitarian' concept proposed by Etzioni (1993) and Ostrom's (1990) recommendations for community-based management.

[20] Comparison may be drawn to the three logics of action of Colebatch and Larmour (1993): market, bureaucracy and community.

Partly in response to Local Agenda 21 imperatives, there is emerging interest and research into sustainable local communities in developed countries also, including the decentralisation of natural resources management (Armitage, 2005), infrastructure networks and service provision (Barton, 2000; Guy and Marvin, 2001).

2.2.4 Decentralisation in the Energy Sector

Significant attention is now being given to decentralisation of physical systems in the energy sector. Centralised networks were widely developed and accepted as the most appropriate solution, but have since been questioned because of improvements in technology and changes in understanding of, for example, climate change (WADE, 2003, p. i):

> To speed electrification, governments everywhere passed laws granting central generation protection from competition, creating monopolies. Over the past 20 to 40 years, numerous factors have combined to make decentralized generation – at or near users – the optimal method of heat and power generation. However, as is often the case, yesterday's laws remain in place, protecting yesterday's optimal approaches, to the detriment of today's citizens.

The particular technical innovations and how they relate to their legal, organisational, and institutional contexts differs between the water and energy sectors. Of greater concern in the energy sector are the legal framework and permissibility of competition, but regulatory barriers are also significant for the development of decentralised water technologies (Berndtsson and Hyvönen, 2002; Hatton MacDonald and Dyack, 2004)[21].

[21] In the United States, the National Decentralized Water Resources Capacity Development Project (NDWRCDP) was established in 1996, funded by the USEPA, in order to break down barriers to greater acceptance and uptake of decentralised water services provision (see http://www.ndwrcdp.org/, accessed 6/6/2006). This can be compared with the World Alliance for Decentralized Energy (WADE), which was formed in 1997 in response to the Kyoto meetings of the United Nations Framework Convention on Climate Change (see http://www.localpower.org/, accessed 24/4/2006).

Amory Lovins of the Rocky Mountain Institute developed ideas for decentralised energy systems as part of his general idea of a 'soft path' for energy (Lovins, 1976, 1977). This soft path entailed both technological and social change for anticipated improved environmental and international peace and equality outcomes. The original essay and its associated literature is of significance to this study, because of the recognition of the institutionalisation of the centralised system and associated path dependence (cf. Hughes, 1983, and the idea of large technical systems). Further, the Rocky Mountain Institute has also applied the idea of a soft path to water (Pinkham, 1999), with others following (Gleick, 2003).

Despite considerable initial opposition to the idea (Nash, 1979), decentralisation of energy supply has happened to a significant extent around the world (WADE, 2005) and promises to be an increasing trend (Vaitheeswaran, 2003). This is due both to advances in technology (WADE, 2003) but also to market forces associated with the diseconomies of scale of large power grids (Lovins *et al.*, 2002). For example, Finland's energy supply strategy emphasises sustainability through small-scale generation plants with a variety of fuels (Finergy, 2006).

Hughes (1983; 1987) has examined the evolution of large technical systems (LTS) or sociotechnical systems (STS) (Hughes, 1983, p. 465) in the history of electricity network systems in developed nations. This study contributes understanding to the social construction of technical systems (Bijker *et al.*, 1987) and also to the understanding of the strong stability and entrenchment of interwoven institutional factors that hinder innovation for regime change (Hofman *et al.*, 2004). Hofman *et al.* use an analytic construct developed by Geels (2004) that combines several approaches and theories, including Scott's three pillars framework of new institutional theory, in examining dynamics and change of LTS and STS. While such concepts and approaches have not penetrated so deeply into the study of water management and regime change, the concepts are readily applicable. For example, the Swedish Urban Water project understanding of the water management system (see Section 2.4.2.2.2) easily fits this understanding of sociotechnical systems.

2.3 Institutional Dynamics

The starting point for this research was an interest in the role of institutional factors in enabling or preventing uptake of decentralised water management technologies. The presence of 'institutional barriers' has widely, and for some time, been claimed as a significant obstacle to positive change in water management practice (Hatton MacDonald and Dyack, 2004; Ingram *et al.*, 1984). Such 'barriers' may simply mean that institutional dynamics are operating such that the response to a situation or input is not the outcome that is desired. The research questions were framed with the desire that an appropriate understanding of institutional dynamics may be developed in order to identify particular institutional factors that can *enable* decentralised alternatives for water management systems.

In existing water management literature, what is meant and understood by 'institutional barriers' is not always consistent. It appears that it can mean any of the following:

- Laws and regulations (Berndtsson and Hyvönen, 2002; Hatton MacDonald and Dyack, 2004);
- The organisational arrangement (or simply existence) of administrative and regulatory agencies (Hatton MacDonald and Dyack, 2004);
- Market incentives and disincentives (Ward and King, 1998);
- Inappropriate separation of policy and planning roles and processes between different levels of (American) government such that it leads to antagonistic federalism (Hrezo and Hrezo, 1985);
- Knowledge (or its lack), attitudes and values held by management staff and used in management techniques (Berndtsson and Hyvönen, 2002; Elliott, 2005);
- Lack of suitable integration in organisational arrangements (ACIL Tasman, 2005; CSIRO Land and Water, 2007); and
- A mix of several components, e.g., "organizations, laws, and system operating procedures that act as institutional barriers" (Ward *et al.*, 2007).

Therefore when the need for further research of 'institutional barriers' to water management reform is highlighted (CSIRO Land and Water, 2007; Hatton MacDonald and Dyack, 2004; Means, 2004), it is not altogether clear which disciplinary skills,

methods and theories are being, or should be, called upon. There could be ample justification to draw from the disciplinary fields of law, economics, management, policy analysis, and various other fields. The common thread in understanding seems to be that obstacles exist beyond the sphere of traditional technical expertise, and that social phenomena are at work that may be difficult to overcome in any reform endeavour.[22] This is consistent with the idea already introduced that water management may be thought of as a sociotechnical system. Therefore a full explanation of change (and of the possibility of alternative trajectories) calls for an investigation of the social as well as the technical dimensions of water management systems, hence the attractiveness of giving attention to the way that the management and use of water is institutionalised.

In identifying what is the most appropriate analytical framework to apply to the research problem at hand, several possibilities are reviewed. The fact that institutional or 'new institutional' social theory exists does not automatically make it the right choice to study all 'institutional' problems. Naturally, it is germane to weigh the advantages and disadvantages of a number of explanatory frameworks. For a framework to be useful it needs to be simple enough to apply yet complete enough to include all the relevant elements of the system and therefore be able to give valuable insight. The important elements (as reviewed above) are commonly regarded as both social and technical, if not primarily social. That is why the urban water management system is regarded as a 'sociotechnical system' in this work. As a starting point, then, a suitable framework is likely to be able to include elements such as: the physical system; the organisations; the rules; the people; and discourse (values and beliefs). The interest is not so much to characterise specific elements (e.g., actors) and their actions, intentions or relationships within observed cases, but to observe and understand how modes of operating become institutionalised.

[22] Such social phenomena may be in any or all of the domains of market, bureaucracy and community (Colebatch and Larmour, 1993), thus enabling the inclusion of even the market-based understanding of institutional barriers listed above.

2.3.1 Approaches to Institutional Analysis

It would be difficult to exhaustively list all of the available analytical frameworks possible for examining (broadly defined) institutional factors in water management. Part of the problem of being transparent, systematic, and exhaustive, in choosing an analytical approach is that the choice of framework is, in part, biased by the way the problem is understood, framed and interpreted.[23]

There are many different varieties of 'institutional' theory. A dominant critique of the water institutional arrangement in the recent past has been market reform (see also Section 2.1.1.4). For many years users had not been asked to pay the full price for the provision of their water services. Dr John Paterson, an economist by training, was the president of the Hunter District Water Board in Newcastle, when in 1982 the Board resolved to solve a crisis of increasing demand by introducing pricing reforms instead of by supplementing supply. The reforms were based primarily on volumetric pricing rather than flat charges. The success of these reforms in reducing demand was a significant catalyst for similar subsequent pricing reforms throughout most Australian urban water authorities (Musgrave, 2000). The full cost pricing debate continues with regard to externalities (Hatton MacDonald, 2004). Thus, the market-oriented institutional critique suggests that many of the problems in water management are most appropriately addressed through optimising pricing signals.

A market orientated institutional analysis could certainly provide a useful framework for analysis for the first research question (see Section 1.3 and Table 1-3). Other work has demonstrated this (Fane, 2005; Fane and Mitchell, 2006; Mitchell *et al.*, 2007). But market factors are not the only factors considered as possibly important in developing a more complete understanding of institutional factors enabling and constraining the implementation of decentralised urban water systems (see introduction to Section 2.3). Social factors and theories have also been considered as a significant possible source of a deepened understanding.

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[23] As in Section 1.2, this work is carried out with an understanding of social construction within the phenomena observed as well as in the process of observing, analysing, and reporting phenomena.

Goodin (1996) outlines the broad base of institutional theory and the various alternatives, including the new institutionalism of sociology. There are also social science and policy theories that place little weight on the role of institutions and question the causative capacity of anything other than the individual agent (e.g., see Powell and DiMaggio, 1991, p. 8-16). There are various ways of categorising social science theoretical frameworks for understanding public policy and institutions, such that locating one particular approach within a sub-discipline and discipline, and relating it to the alternatives, is not as straightforward as, for example, biological taxonomy.

An increasingly popular approach to Science and Technology Studies (and beyond) is actor-network theory (ANT). ANT was pioneered by Bruno Latour, Michel Callon and John Law in the 1980s. It has received significant criticism (e.g., Amsterdamska, 1990) but also developed beyond its early forms and has strong support (Law and Hassard, 1999). ANT contributes an emphasis on including non-human actors as equal players with humans in heterogeneous networks where all actors are equally capable of acting and influencing outcomes. ANT has been used in work related to this research: to analyse and account for the development of centralised water and sewerage systems in two European cities (Hallström, 2002). ANT allows for inclusion of social, technical and natural actors, thereby allowing inclusion of most of the elements considered of interest to this study, and would provide interesting and useful explanations of the outcomes of case study phenomena (Chapter 4). But the research questions (Section 1.3) emphasise the quest to understand institutional factors as a higher priority than unearthing all explanatory insight into actors and their actions within networks. Further, the granting of equal status to human and non-human elements in ANT has often been criticised as limiting the contribution of an otherwise useful perspective (Beveridge, 2007). Because of this 'principle of generalised symmetry' and its tension with social constructivism, reality can only be understood in the performance of actor-networks, such that prior existence of social structures (institutions) as influencers of behaviour does not fit an ANT perspective (Beveridge, 2007).[24] Thus the research questions would

[24] Note that Beveridge (2007) was specifically looking at the application of ANT to water management and policy.

have to be written differently (or at least understood differently to the introductory remarks of Chapter 1 and Section 1.2 in particular) for ANT to be selected as the most appropriate analytical framework.

2.3.2 New Institutional Theory

New institutional theory was chosen as the most suitable framework for analysis with which to approach the problem. The problem was initially framed from an institutional perspective; therefore the approach to analysing the problem naturally also fits this mould. There is both sufficient match to what is loosely meant by the 'institutional problem' or 'institutional barriers' regarding water management, as well as valuable insight offered, that this choice is argued to be appropriate and worthwhile. It is not argued to be the only appropriate approach, and not necessarily the best approach that will ever be possible.

This research also fits into a stream of research at the University of New South Wales in which new institutionalism has been found useful in understanding stability and change in water management practice (Brown, 2003, 2005; Colebatch, 2006; Stenekes, 2006; Stenekes *et al.*, 2006).

The institutional approach to the analysis and understanding of urban water management used in this thesis draws comes from 'new' institutional theory (Powell and DiMaggio, 1991; Scott, 1987, 1995). New institutional theory revives interest in the study of institutions – and not just rational individuals – as being important to social policy and action. Institutional theory holds that "institutions matter" to social processes (Scott, 2006) such as the organisation of society around water. W. Richard Scott characterises institutions thus:

> Institutions consist of cognitive, normative, and regulative structures and activities that provide stability and meaning to social behavior. Institutions are transported by various carriers—cultures, structures, and routines—and they operate at multiple levels of jurisdiction (Scott, 1995, p. 33).

Institutions and institutionalisation are relatively diverse but also re-emerging concepts across different disciplines, including political science, sociology and economics (Goodin, 1996; Powell and DiMaggio, 1991; Scott, 1995; Zucker, 1987). At its basic level in these disciplines, an institution is "an organized, established, procedure" or "social order or pattern" in society (Jepperson, 1991, pp. 143-145). This goes beyond the traditional focus on institutions as organisations (e.g., parliament or the family), not to mention the 'common-sense' understanding of an institution as a place for education or care of disabled people.

New institutionalism is distinguished from previous understandings by an expanding theoretical base, though this has led to a diverse range of approaches to studying institutions within and among social science disciplines (Scott, 2006). Scott (2006) categorises the variation of institutional theory into three strands: rational choice theory, normative theory, and cultural-cognitive theory. These strands of theory form the basis of Scott's theoretical framework for understanding institutions. Scott's (1995, pp. 34-45) framework comprises emphasis on all three pillars taken from these separate strands: the regulative, normative and cognitive pillars. Scott's specific 'three pillars' formulation of new institutionalism is used as an analytical construct throughout this thesis (see Figure 1-2).

While regulations or rules are recognised by all institutional theories, rational choice theorists (e.g., Ostrom, 1999) see social action as the result of the choices of individuals. Thus the establishment of rules and institutions is considered the result of individual behaviour (see March and Olsen, 1989, pp. 8-16).

Normative theory introduces a prescriptive and obligatory basis for social action, being concerned with what 'ought to be' rather than 'what is'. Normative theorists suggest that institutions have a primarily normative foundation (Scott, 2006). Selznick developed an early and influential version of institutional theory where organisations become "infused with value" over time (Selznick, 1957, pp. 17-22). Normative theorists emphasise the role for values and norms to determine behaviour through a "logic of appropriateness" rather than a "logic of utility" or "logic of consequentiality" (March

and Olsen, 1989, p. 23; Scott, 2006). Thus, according to March and Olsen, an actor assesses the nature of a situation plus the nature of their own role or identity, and acts accordingly (rather than acting according to rational choice ideas of utility, for example).

'Cultural-cognitive theory' as identified by Scott (2006) draws from both cultural theory and cognitive theory (see, e.g., DiMaggio, 1997), and could be simplified to saying that people's actions are influenced by their internalised semiotic representations of reality. Cultural-cognitive theory recognises the socially constructed nature of knowledge (Berger and Luckman, 1971) and the importance of shared meaning to establishing and maintaining institutions (Scott, 1995, pp. 40-45). Such shared meaning may be maintained or transformed through ongoing interaction and sense-making. It is the emphasis of this cognitive dimension in new institutionalism that is the most significant factor distinguishing it from old institutionalism (Powell and DiMaggio, 1991, pp. 14-15; Scott, 1995, p. 40).

2.3.2.1 Justification and Features of a New Institutional Framework

While all features of new institutional theory cannot be recounted here, there are some characteristics of Scott's three-pillar framework for new institutionalism that make it a useful framework for the research questions at hand.

2.3.2.1.1 Three Pillars Match Elements Considered Important in Water Management

The three pillars of Scott's framework can be matched reasonably closely with the elements considered important, as reviewed in the introduction to Section 2.3.

2.3.2.1.2 Focus on Informal as well as Formal Institutions

Having departed from a purely organisational understanding of institutions by adding cognitive theory (or the cognitive pillar), new institutionalism recognises informal institutions and informal organisational structure as being a carrier and determiner of social practice and order.

2.3.2.1.3 The Reflexive Nature of Structure: Institutions Enable as well as Constrain

Giddens' (1984) theory of structuration provided an answer to the question of whether action determines structure, or structure determines action, by linking the two: structure indicates appropriate action, and, when this action is done, it recreates structure. New institutionalism incorporates this theory – thus institutions not only constrain action, but also allow enterprising action or reform behaviour to modify existing structure. Herein lies the relevance of applying this framework of policy and organisational analysis to the field of water management, with its emerging new paradigm of sustainable water management. Transitioning to a more sustainable water management sociotechnical system is therefore possible when new ideas become part of policy and practice, and the resulting action (re)produces modified institutional arrangements which become the framework for action in a future more sustainable urban water sociotechnical system. However, because institutions give credence to established (cognitive) constructions of problems, solutions to present and future problems are often 'path dependent' – i.e., "prior institutional choices limit available future options" (Krasner, 1988).

2.3.2.1.4 Organisational Fields and Isomorphism

While some of the more rational and reductionist approaches to institutions take as the unit of analysis an 'action arena' (Imperial, 1999; Ostrom, 1999; Ostrom *et al.*, 1993), Scott's version of new institutionalism allows for study of organisational fields and the associated isomorphism (DiMaggio and Powell, 2002). The organisational field level is a level of analysis[25] where similar organisations share cognitive, normative or regulative frameworks and thus interact more frequently (Scott, 1995, p. 56). Institutional isomorphism is the tendency for organisational structure to be patterned after institutionalised (cognitive) myths that have been socially constructed in the organisational field, tending to work against the practical activity of such organisations. In water management, the socially constructed 'myths' about what constitutes good water management are strong driving forces toward institutional isomorphism, as the case studies of Chapter 4 illustrate.

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[25] Levels of analysis are, in order of increasing size: organisational subsystem, organisation, organisational population, organisational field, societal, world system (Scott, 1995, p. 57).

2.3.2.1.5 Transformation of Intent

Unlike rational choice theories, new institutionalism allows for preferences and goals to change in response to social action (March and Olsen, 1989, p. 66). This phenomenon is evident in the case studies.

2.3.2.1.6 Socially Constructed Nature of Facts and Artefacts

The socially constructed nature of problems and solutions is an important complementary analytical construct. The cognitive-cultural theory of new institutionalism regards meaning in symbols, signs, facts and artefacts as constructed by actors rather than being inherent (Berger and Luckman, 1971). This creates significant scope for both discursive conflict and agreement, as was found extensively in the case studies researched (Chapter 4). In this dissertation there is an awareness of a distinction between 'brute facts' (the physical reality of the world) that exist independent of human institutions, and 'institutional facts' (the social reality of the world). But the distinction is blurred somewhat in that the institution of language is required to perform this differentiation and to describe what are otherwise 'brute facts' (Searle, 1995, pp. 2-29). An example is that the total quantity of freshwater is a brute fact (even if not precisely known); however, water shortage is an institutional fact. Many times it has not been deemed necessary to explicitly differentiate between aspects of problems that are physical realities and those that are socially constructed in this thesis. Regardless of whether 'facts' are 'institutional facts' or 'brute facts', where any perspective on those 'facts' is held by stakeholder(s), it is necessary to take this cognition into consideration.

2.3.2.1.7 Institutionalisation of New Ideas

Post-empiricist policy theorists maintain that, for an idea to impact on the policy process and eventually be institutionalised[26], that idea needs to be (socially) constructed or framed such that it fits into the policy discourse which persuades or justifies action for a particular problem (Colebatch, 2002, p. 108; cf. Majone, 1989, pp. 42-52). Environmental policy is one of the more contested discursive fields, with a number of plausible accounts brought to bear (Dryzek, 1997; Hajer, 1995). Hence it is not only an

[26] Tarlock (2001) also wrote about ideas needing institutions in the context of sustainability, but from a legal incentives and institutions point of view.

understanding of the technical aspects of the debate that is important, but also the discursive process of policy-making and, over a longer time horizon, institutionalisation of those ideas. Fischer argues that environmental policy making in practice entails skilled and selective use of facts and values to shape policy and action: "In this view, emphasis is placed as much on the role of credibility, acceptability, and trust as on empirical evidence in the explanations of policy change" (Fischer, 2003, p. 114). Thus, clearly, the institutionalisation of sustainability requires more than just rational scientific models and calculations, but also persuasive rhetorical discourse (Throgmorton, 1991). So not only is the institutional form of the existing sociotechnical water system of interest, but also the interrelation between established institutions and dissident or alternate discourse.

2.3.2.2 Discourse – 'the Software of Institutions'

The cognitive pillar of institutions is revealed in language and discourse – the 'software' of institutions (Dryzek, 1997, p. 19)[27]. Dryzek employs discourse analysis to map out dominant environmental discourses, contending that "language matters" (Dryzek, 1997, p. 9). Table 2-6 reviews these environmental discourses, with an extra column to illustrate the impact of these discourses on water management policy approaches. (This forms important background for the analysis of case study discourse of Chapter 4.)

[27] Dryzek equates formal rules to institutional 'hardware'. Cf. Connor and Dovers (2004) who emphasise organisation and discourse as the elements comprising institutions.

Table 2-6: Environmental discourses (Dryzek, 1997) with examples from water management

Discourse	Explanation	Illustration from water
1. Industrialism: Commitment to Growing Supply[28]	Dominant in much of the world since the industrial revolution. Most political systems are committed to industrialism and the pursuit of growth in the production and consumption of goods and services.	Also the dominant focus for water management. General trend of construction of bigger and better dams, with discharge to oceans (Aird, 1961; Henry, 1939; Melosi, 2000; Tarr, 1996).
2. Survivalism: Global Limits	Key publications include Hardin (1968) and Meadows *et al.* (1972). Limits to global economic and population (Smail, 2002) growth are imposed by the limited resources and carrying capacity of Earth. Corrective measure proposed: authoritative control to halt growth.	Global limits to nutrients recognised by the ecological sanitation movement (Lampert, 2003). Global phosphorous reserves may last 100-150 years (Otterpohl and Grottker, 1996) or even less (Runge-Metzger, 1995).
3. Promethean[29] Response to Survivalism: No Limits	Similar to industrialism, but defends human ingenuity to maximise benefit from scarce resources, dominating nature (Simon and Kahn, 1984).	Desalination has long been pursued as a means of tapping a relatively limitless supply of seawater (e.g., see journal *Desalination*).
4. a)[30] Administrative Rationalism: Tighter Regulation	Emphasis on scientific expertise guiding public policy to solve environmental problems. Dominant administrative forms include natural resource management bureaucracies and pollution control agencies, utilising processes such as environmental impact assessment and policy tools such as cost-benefit analysis.	Administrative rationalism has been largely responsible for tightened sewage effluent quality requirements, typically administered via environmental protection agencies. The idea that recycled water will solve the water scarcity problem has also been generally driven by this scientific, administrative problem-solving discourse.
4. b) Democratic Pragmatism: Public Consultation and Participation	Public consultation and involvement is possible at a wide range of levels (Arnstein, 1969). Problems are solved by citizens rather than, or working with, bureaucracies (Fischer, 2000; Kasemir *et al.*, 2003; Lafferty and Meadowcroft, 1996).	A recent and somewhat limited phenomenon in Australian water management (Brown *et al.*, 1999; NWQMS, 1994; Ryan *et al.*, 2001). Institutional arrangements or technical approaches have not been greatly impacted by this approach (Stenekes *et al.*, 2006).

[28] Industrialism is considered only briefly by Dryzek (1997, p. 12), and not listed as one of his environmental discourses. Further, the final discourse listed here (green radicalism) is actually split into two by Dryzek: green romanticism and green rationalism. The slight differences made in this table are intended for the sake of clarity in drawing parallels to the case of water management.

[29] Prometheus, in Greek mythology, stole fire from Zeus, thereby increasing human power to control nature. This name is thus suitable for such an anthropocentric discourse, where human ingenuity overcomes obstacles to the furtherance of progress. (Known elsewhere as 'Cornucopian'.)

[30] Dryzek (1997) groups the following three discourses (4.a, 4.b & 4.c) as reactionary approaches to environmental problem-solving policy. They correspond to the logics of action set out by Colebatch & Larmour (1993) in *Market, Bureaucracy and Community*.

Discourse	Explanation	Illustration from water
4. c) Economic Rationalism: Pricing, Trading and Privatisation	Free markets with private ownership of resources and infrastructure ideally allocate resources efficiently. Where market fails, taxes, quotas or tradeable allocations may be used.	Tradeable water rights (COAG, 2004); privatisation and competition (Johnson and Rix, 1993; Johnson and Paddon, 1995; NCC, 2004a; Sheil, 2000); and full cost pricing (Braden and van Ierland, 1999; COAG, 1994; Hatton MacDonald, 2004).
5. Sustainable Development: Global Environmental and Economic Welfare	Commitment to improving living standards of the world's poor: supports continued growth rather than limits. Such apparent limits may be overcome through careful planning.	Integrated water management and various other related terms and approaches are relevant to this discourse.
6. Ecological Modernisation: Precautionary, Green Technology	Developed nations can progress further by embracing environmental goods and services, along with the precautionary principle (Hajer, 1995). Green capitalism.	The proliferation of cleaner water and wastewater treatment technologies, such as membranes and biological nutrient reduction, fits the discourse of ecological modernisation.
7. Green Radicalism: Nature not Capitalism	Inherent value of nature independent of humans. Rejection of industrialism and consumer capitalism. Proposed means of achieving such a society are disparate and mostly untried.	Fringe and radical ideas (Trainer, 1995). Eco-villages in Sweden (Fittschen and Niemczynowicz, 1997; Hanaeus *et al.*, 1997) and Germany (Otterpohl and Grottker, 1996; Otterpohl *et al.*, 1997)

2.3.2.3 Water Management through the Three Institutional Pillars

Water institutions regulate behaviour based on the sedimentation[31] of knowledge and values relating to water, generally enacted in a formal way through regulatory provisions. Thus consumers are served with predictable, uniform access to water services. The nature of the water services provision is determined by interplay between all three institutional pillars (see introductory paragraphs of Section 2.3.2 and Figure 1-2). Technical knowledge determines the means of water supply, transmission and disposal or reuse. Societal norms determine in large part what role water plays in the routine of daily life, while also providing a limit on some options for water management made available by technical knowledge (e.g., potable reuse). Regulations create uniformity of action, giving power and legitimacy to society's knowledge of, and value for, water management. Thus these three pillars create institutions – a stable, predictable framework for, in this case, the provision of water services. Table 2-7 outlines Scott's three pillars framework with illustrations applying to water.

[31] 'Sedimentation' is used throughout as a descriptor of the process of, and synonym for, 'institutionalisation'.

Table 2-7: The three pillars of institutions (Scott, 1995) illustrated by the case of water management

Pillar	Explanation	Application to water
Regulative	Regulations, or rules, are the explicit processes constraining or institutionalising behaviour. Activities that support this pillar of institutions include rule-setting, monitoring and sanctioning (Scott, 1995, p. 35-37). Under this view of institutions, actors follow and obey rules on the basis of expediency without necessarily believing in or valuing the process or outcome.	In the water industry, an example of a regulatory pillar is the Australian Drinking Water Guidelines (NH&MRC, 1996, 2004) which set the performance guidelines (used by various states in licences for water authorities) for most water treatment plants. The management of water in Sydney is shaped significantly by the regulatory environment created for Sydney Water by the *NSW Water Management Act (2000)*, the *Sydney Water Act (1994)*, the Department of Environment and Conservation (DEC), Utilities and Sustainability (DEUS), the Department of Natural Resources (DNR), Department of Planning, NSW Health, the Sydney Catchment Authority (SCA), Sydney Metro Catchment Management Authority (CMA), local governments (for stormwater), and the Independent Pricing and Regulatory Tribunal (IPART).
Normative	Values and norms stabilise and constrain behaviour in social life (Scott, 1995, p. 37-40). The normative pillar emphasises values (what is desirable) and norms (the appropriate ways of achieving those values). Applied to a specific actor in a given position, those values and norms shape the role or expected behaviour for such a person to fulfil. The normative pillar not only restricts behaviour but also enables it through rights, responsibilities and professional licences and accreditation.	In the case of water management, the normative institutional pillar is reflected in (amongst other things) values held by the public community of water users including safety, purity, availability, etc. Associated with these values is the perspective that such health and related issues are best left to competent professionals. Professional organisations, such as the Institute of Engineers and the Australian Water Association, espouse values such as public health, technical competence, environmental protection, and social accountability.
Cognitive	The cognitive pillar emphasises the importance of symbols and meanings (Scott, 1995, p. 40-45). The cognitive view of institutions highlights the social construction of meaning. Such meaning is formed, transformed and shared through social interaction and the cognitive response of the individual. Institutionalisation occurs when an idea reaches 'taken for granted' status, and propagates through mimetic processes, as evidenced by the number of similar organisations performing a similar practice.	In the water industry, the concepts of water supply and pathogen removal, and, more recently, demand management, represent fundamental (or 'taken for granted') knowledge as far as any competent practitioner is concerned. However, the cognitive frames available to the water industry professional are not all complementary and are in many cases actually competing (Bouwen and Taillieu, 2004). Different frames occur both in terms of problem definition (Pahl-Wostl, 2002) and also in the construction of an account to justify a certain solution or policy (Colebatch, 2002, p. 108; Fischer, 2003, pp. 113, 114).

2.3.3 Institutional Theory and Environmental Studies

There are recent empirical and theoretical works where questions of environmental sustainability are analysed using an institutional framework related to the new institutional theory outlined above.

Jennings and Zandbergen (1995) use new institutional theory to help build understanding of how ideas of sustainability are socially constructed and then accepted and embedded into organisational life and, in turn, organisational fields. Hoffman and Ventresca (1999) use an institutional approach (and in particular Scott's three pillars) to frame a policy debate between the environment and economics. The theory has been applied more specifically to, for example: questions of stakeholder action in organisational environmental management (Delmas and Toffel, 2004), environmentalism in the United States wine industry (Marshall *et al.*, 2005), and adoption and implementation of environmental policies in Bangladesh (Alam, 2003).

Various other institutional frameworks are also used in environmental studies, such as the work of Ostrom *et al.* (1993), which uses institutional economics and the institutional analysis and development framework, developed further by others such as Imperial (1999). This framework, however, focuses on rules and actors tied to specific decisions and outcomes (an action arena); whereas the new institutionalism of sociology provides a better framework for understanding institutional isomorphism through mimetics within an organisational field (DiMaggio and Powell, 2002). Isomorphism within the organisational field of water management is an important aspect of this research.

2.3.4 Institutional Analyses of Water Management

Many studies note or highlight institutional and social dimensions of water management problems or approaches (Lundqvist *et al.*, 2001; Moss, 2004; Ohlsson and Lundqvist, 2000). Fewer actually analyse institutional aspects of water management, and those that do are of varying depth and orientation. Many are not, or do not aim to be, fundamental and/or rigorous (e.g., Lesouef, 1996). Others seek only to outline existing

institutional/regulatory arrangements (ACIL Tasman, 2005; Gardner, 1999), or historical development of institutions (Johnstone and Horan, 1996; Powell, 2002).

Engineering (or physical sciences) literature concerning urban water management has often identified 'institutional issues' as significant factors (and possibly obstacles) to innovation and change toward more sustainable urban water management (Berndtsson and Hyvönen, 2002; Hatton MacDonald and Dyack, 2004). Cameron (2005) asserts that institutional and regulatory hurdles for decentralised wastewater management in the United States were removed twenty years ago, but that barriers are still strong in Australia[32].

Grigg (2005) argues that there is a shortage of training for engineers that would be necessary to equip them to deal with institutional issues. He proposes a simple framework for institutional analysis that is more akin to engineering systems analysis than the sort of institutional analysis proposed by economists, political scientists or sociologists.

There have been several economic institutional analyses of national water management policies and systems (Livingston, 2005; McKay, 2005; Saleth and Dinar, 2005) with a transaction cost approach (Ostrom *et al.*, 1993). Bressers and Kuks (2002) studied regime change for integrated water basin management under the European Water Framework Directive, innovating an institutional regime theory that combined property rights theory and rational choice theories. Guy and Marvin (2001, pp. 22, 23) lament the 'dual vision' given to technocratic innovation on the one hand and social barriers requiring education and mobilisation on the other. They argue the need for a sociotechnical view that realises the links between production and consumption in environmental flows.

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[32] Reality is not likely to be as simple as this assertion. In the United States, the National Decentralized Water Resources Capacity Development Project (NDWRCDP) was established in 1996, funded by the USEPA, in order to break down barriers to greater acceptance and uptake of decentralised water services provision (see http://www.ndwrcdp.org/, accessed 6/6/2006).

Co-researchers at the University of New South Wales (Hal Colebatch, Rebekah Brown and Nyree Stenekes) have used similar adaptations of Scott's formulation of new institutional theory to trace institutional dynamics of water management. Stenekes (2006; Stenekes *et al.*, 2006) combined a governance (Rhodes, 1997) approach with new institutional theory to investigate stakeholder involvement in three in-depth case studies of urban water recycling. Stenekes highlights the importance of coordinating a diverse range of stakeholders for shared meaning and understanding of problems in a cognitive and institutional shift toward sustainability. And Brown (2003; 2004; 2005) used multiple case studies and institutional theory to characterise best management practice of stormwater management in local government – concluding that strong horizontal intra- and inter-organisational networks are important for institutionalising more sustainable stormwater management. Colebatch (2006) outlines the institutional context of water management, again using Scott's three pillars new institutional framework.

2.4 Sustainable Water Management Principles and Practice

Literature from engineering and physical sciences on sustainable water management is reviewed in this section to establish the place of decentralised technologies among the options for pursuing more sustainable water management. This section of the review begins with a broad overview of concepts of sustainability in general before focusing on sustainable water management and decentralised water management in particular. While this thesis is not about assessing the sustainability of decentralised water systems, this review is also important background for understanding and analysing discourses in the case studies of Chapter 4.

2.4.1 Environmental Sustainability and Sustainable Development

The ideas of environmental sustainability and particularly sustainable development[33], were popularised and given some definitional clarity by the report *Our Common Future* (World Commission on Environment and Development, 1987). This "Brundtland" definition of sustainable development is as follows:

[33] In Australia these terms are usually combined as 'Ecologically Sustainable Development' (Ecologically Sustainable Development Steering Committee, 1992).

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs (World Commission on Environment and Development, 1987, p. 43).

The operationalisation of this concept in policy and practice is widely debated and contested (Harding, 2006; Schubert and Láng, 2005), and no measurable criteria or indicators of sustainability have become generally accepted (Tortajada, 2003). Indeed Dryzek asserts that:

> Sustainable development is nowhere an accomplished fact, save in small-scale hunter-gatherer and agrarian societies… Such societies are becoming increasingly scarce. Sustainable development refers not to any accomplishment, still less a precise set of structures and measures to achieve collectively desirable outcomes. Rather, it is a discourse (Dryzek, 1997, p. 123).

However, as argued by Lafferty (1996), any vagueness of the definition is also advantageous to the life of the concept as a normative-political tool, as it enables multiple actors with various interests to still embrace the same terminology in pursuit of meeting their own needs through the decision-making process (Dryzek, 1997, pp. 123-125; Tortajada, 2003).

The idea that positive change should ideally be maintainable over time is definitely not new to the last few decades. The idea of 'safe yield', for example, has been in use in water resources and hydrology for many decades (Alley and Leake, 2004; Sophocleous, 2000), and outside of water, such as in fishing and forestry (Lafferty, 1996). While the typical state response to resource exhaustion in the past was to expand through colonisation and trade, now (i.e., since the 1960s) there is an emphasis on total limits on

not just individual systems or resources, but also the total ecological carrying capacity of the earth, which human activity may over-reach. Many argue that such limits are already effectively reached or exceeded (Daly, 1990; Hardin, 1968; Meadows *et al.*, 1992). The idea that such limits could at some point be reached by way of increasing population can be traced back to Thomas Malthus (1766-1834). Calls to temper economic objectives with social justice and conservationist responsibility are also evident in the works of other 18th and 19th century contemporaries of Malthus such as John Stuart Mill (1806-1873) (Lumley and Armstrong, 2004).

Opponents to the idea of tangible limits to natural resources have cited numerous indices of increases to global human welfare, not least the sustained increase in average life expectancy over recent decades (Simon and Kahn, 1984, p. 2). On the other hand, the Millennium Ecosystem Assessment project provides a significant weight of evidence that the earth's ecosystems are being weakened and are less able to provide services that humans need to live, due to inappropriate technology and development (Millennium Ecosystem Assessment, 2005a, b).

The Brundtland formulation of sustainability avoids the controversy of emphasis on absolute limits and the associated arguments for curtailing economic growth and development, but still calls for reduction in resource use and waste production due to the limits of social and technological systems operating within the ecological carrying or regenerative capacity of the earth. The Brundtland report also contributes the link between eliminating global poverty and environmental sustainability (Newman and Kenworthy, 1999; World Commission on Environment and Development, 1987). Thus a connection has been made between economic development and environmental protection – 'sustainable development' (OECD, 2006), where others see only a disconnect (Daly, 1990; Glasby, 2002; Tarlock, 2001).

The main principles of sustainability, according to Newman and Kenworthy's (1999) interpretation of the Brundtland formulation, are: the elimination of poverty; reduction in resource use and waste production in developed nations; global cooperation on environmental issues; and local community-based focus for implementation of

change[34]. However, there are many other sets of quite varied principles, including, for example, intergenerational equity, the precautionary principle and biodiversity conservation (Lafferty, 1996; Newman, 2005; United Nations, 1992b)[35]. In Australia, the most commonly used principles in legislation and policy (Harding, 2006; Heads of Government in Australia, 1992) are:

- Intergenerational equity (and sometimes also intra-generational equity);
- The precautionary principle;
- Conservation of biological diversity and ecological integrity; and
- Improved valuation, pricing and incentive mechanisms.

Implementation of sustainability presents another problem beyond defining or measuring sustainability (Dernbach, 2003). The United Nations *Agenda 21* document, adopted at the 1992 United Nations Conference on Environment and Development ('Earth Summit') presents an action plan for implementation of sustainability suitable for application at all levels of government internationally (United Nations, 1992a).

This research is not focused on evaluating the sustainability of decentralised urban water management systems, which would be a difficult task given the inherent vagueness in the sustainability concept. The discussion of sustainability in water management is important in this review for justifying consideration of decentralised water management as a worthy of investigation.

2.4.2 Sustainable Water Management Principles

Many authors cite present water scarcity and possible imminent clean water shortage crises as reasons for serious attention to be given to understanding and pursuing sustainable water management (Davies, 2004; de Fraiture et al., 2001; Gleick, 2003;

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[34] Carew-Reid *et al.* (1994, p. 135) include the 'subsidiarity principle' which deems that decisions should be made by the people directly affected or by authorities at the lowest appropriate level. (See also footnote 7.)

[35] Newman (2005, p. 278) outlines the institutionalising of the new thinking regarding sustainability in the Western Australian Government. While no theoretical framework of institutions is elaborated, the concept of institutionalising a new idea is quite similar to that of this thesis.

Hunt, 2004; OECD, 2003; Pearce, 2004; Seckler and Amarasinghe, 2001; Seckler et al., 1999; Serageldin, 1995). In Australia, the strain on water supplies in many state capital cities requires significant immediate and ongoing attention (Australian Senate, 2002; Dillon and Ellis, 2004; Government of South Australia, 2006; NSW Government, 2004; Radcliffe, 2004b). The traditional approach to augmenting supply to meet growing demand is no longer regarded as a desirable option (Australian Senate, 2002), due to growing awareness of the environmental impacts of such approaches as construction of new dams (World Commission on Dams, 2000).

The *Agenda 21* document includes a chapter on sustainable water management. A clear physical objective for sustainable water management is provided:

> Water is needed in all aspects of life. The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity of nature and combating vectors of water-related diseases (United Nations, 1992a, s. 18.2).

The remainder of the chapter then goes on to identify principles and means of operationalising this overall objective, through each of the sub-sectors of freshwater management. The inevitability of reuse is one specific physical outcome repeatedly mentioned. Some of the recurring ideas regarding the institutionalisation of sustainability expressed throughout the chapter (United Nations, 1992a, ch. 18) are:

- The need to address the institutional framework, building capacity at all levels, particularly local. A noted impediment to integration, and thus sustainability, is the fragmentation of responsibilities between different agencies responsible for water management.
- The need for public participation and community management, consultation and involvement in planning and implementation.
- The need for delegation and decentralisation of responsibility to lowest (most local) level appropriate.
- The need for full costing (including environmental externalities).

The last two factors are also mentioned as key elements of Australia's National Water Reform package (AFFA, 2004) which is aimed at promoting an economically viable and ecological sustainable water industry. Loucks *et al.* (2000) suggest that sustainable water management must entail constructive institutional change, and adaptive management – the ability to change course as new information comes to light.

Applying sustainability principles to the question of water management provides some clear guiding physical arrangements, such as those used by Steiner and Lehn (1999):

- Water should be replenished at the same rate it is abstracted;
- A base water level needs to be maintained in an ecosystem (for system specific needs);
- Addition of pollutants should not exceed the self-purification capacity of the receiving water or environment (noting that groundwater has very low capacity); and
- Regional approaches need to consider impacts both internally and externally.

Otterpohl and Grottker (1996) add to that:

- Nutrient as well as water mass balances should be stable in the long run;
- Soil and water quality should also be stable in the long run; and
- Energy use should be low and sourced from renewable resources.

2.4.2.1 The Emerging 'Soft Path' Paradigm for Water

The reality (or threat[36]) of water scarcity has brought environmental and sustainability values to the forefront of water policy debate. Many authors note an emerging discourse that, though not entirely congruous, has been labelled as the 'soft path' paradigm for water management (Gleick, 2000; Gleick, 2003; Harremoës, 1999; Mitchell, 2006; Pinkham, 1999). This path embraces the principles of sustainability and sustainable water management outlined above, and is also said to recognise the importance of

[36] This is an example of a socially constructed fact as in Section 2.3.2.1.6.

human and institutional components of the water management system (Pahl-Wostl, 2002).

Table 2-8 outlines the changing paradigm in summary form, including those aspects that are generally agreed upon in the literature. Not all aspects are widely evident in water management practice, however. Indeed, there is frustration in the water industry caused by reluctance on the part of the public (at least in Western liberal democracies) to accept changes to their lifestyle arising out of such a changed paradigm in the thinking of water experts (Po *et al.*, 2004; Uhlmann and Luxford, 1999). There is also frustration from those at the fringes of the policy process at the marginalisation of some of the more radical emerging alternatives (e.g., some elements of the new paradigm in Table 2-8) which necessitate change in the established organisational structure of water management organisations (Beneke, 2004).

Table 2-8: Paradigm shift in urban water management (adapted from Pinkham, 1999)

Aspect	**Old Paradigm**	**New Paradigm**
Human waste	Nuisance (odorous, pathogens)	Resource (nutrients back to agriculture)
Stormwater / used water	Nuisance (flooding, should be removed quickly)	Resource (alternate water source, should be retained, reused or allowed to infiltrate where possible)
Demand & Supply	Build supply capacity to meet growing demand	Manage demand in line with resource (supply) limits
Quality	Treat all to drinking quality	Supply water 'fit-for-purpose'
Cycle	Once through	Reuse, reclaim, recycle
Treatment infrastructure	'Grey' – i.e., unnatural, engineered systems	Mimic or include use of natural ecosystem services to purify water
Scale	Centralised: bigger is better (economies of scale)	Decentralised is an option (diseconomies of scale); avoidance of inter-basin transfers
Diversity	Standardise: limit complexity	Allow diverse solutions, determined by local needs and situations
Integration (physical)	Water, stormwater, sewage separated physically	Separation of water cycle is reduced because 'waste' water is reused not discharged
Integration (institutional)	Water, stormwater and sewage managed by different authorities / departments, under different budgets	All phases of urban water cycle managed in coordination, allowing physical integration and reuse
Public & stakeholder participation	Public relations exercise – public and other stakeholders are approached when final choice is made	Active engagement of stakeholders in collaborative search for mutually beneficial solutions (from start until end)

There is significant variation in the way that this emerging sustainability paradigm is socially constructed in discourse. For example, the discourse of recycling and

integration may mean, to technocrats, large-scale dual reticulation schemes for new development (for example), while to an academic researcher or a green activist, such terminology may mean village-scale, source-separating approaches. Thus the policy response may be determined by how these claims of emerging knowledge are constructed. In any case, Australian and New South Wales Government review committees have called for greater uptake of decentralised approaches to water management (Australian Parliament, 2005, pp. 102-104; Australian Senate, 2002, p. xvii; NSW Legislative Assembly, 2002).

2.4.2.2 Sustainable Water Management Discourses

As with environmental sustainability in general, sustainable water management is a contested discourse (Loucks *et al.*, 2000) with a number of related yet distinct discursive constructs employed. Some of these include water sensitive urban design (WSUD), integrated (urban) water management (IUWM) and total water cycle or catchment management. Water sensitive urban design is generally more concerned with physical systems than the latter two. Integrated urban water management and catchment management approaches (typically) address human interaction with the physical water cycle, addressing questions of appropriate responsibility structures to make management of the total water cycle more feasible.

2.4.2.2.1 Water Sensitive Urban Design

Water sensitive urban design was developed as a concept and practice by researchers and practitioners in the water-stressed region of Perth, Western Australia (Mouritz, 1996; Newman and Kenworthy, 1999). This discourse is based on many of the above principles, and is usually associated with the field of urban subdivision planning and design for stormwater management. Water sensitive urban design is often applied in new developments where questions of existing practice do not need to be addressed. However, proponents of WSUD apply it to all aspects of urban water (Foley and Daniell, 2004), and argue that this broader definition and application is, and should be, reflected in reality (McAlister *et al.*, 2004).

2.4.2.2.2 Integrated Urban Water Management

Integrated urban water management may emphasise any or all of: systems thinking to optimise material/resource flows, inputs and outputs (Coombes, 2005); the multi-functional and multi-objective nature of water system services (Mitchell, 2006); or the institutional integration required to enable inter-agency collaboration such as recycling of wastewater to supplement water supplies (Anderson, 2003). Rauch *et al.* (2005) describe the term 'integrated' as typically applied to water management as having vague and subjective meanings, and they recognize two conceptual levels of application: physical integration of the technical system with its environment; and integration of the human system with the technical system (e.g., through stakeholder and public participation). The Swedish Urban Water Research program represents the urban water system as being the integration of three subsystems: users, organisation and technology (Malmqvist, 1999; MISTRA, 2001).

Where applied to the interaction of human systems with the water cycle, the discourse of integrated urban water management is often employed in recognition of, and response to, fragmentation of responsibilities in relation to the water cycle, and seeks to draw all aspects of the governing of the human interface with the water cycle into the one framework, and to set up an organizational form to be responsible for this. For example, successful implementation of water recycling schemes may require adjustment to allow organisational integration of water and wastewater personnel, expertise and finance (Anderson, 2004, pers. comm.; cf. Radcliffe, 2004a, pp. 22, 45, 186). In many cases the regulatory requirements may also need to be finalised or made clear (Hatton MacDonald and Dyack, 2004).

Table 2-8 presents a more integrated perspective on the water cycle under a new paradigm for sustainable water management. Under the old paradigm, water supply, wastewater and stormwater had been very much physically and organisationally separated. This compartmentalisation of various water flows (not according to natural boundaries, but, instead, human use) is a considerable barrier to integrated water cycle planning and management (ACIL Tasman, 2005).

2.4.2.2.3 Total Water Cycle Management and Total Catchment Management

Total water cycle management and total catchment management again have similar foundational principles, but a slightly different sphere of application. The idea is that the organisational framework for the integration of land use and water planning should follow catchment boundaries (United Nations, 1992a, ch. 18) rather than existing political or administrative units. In New Zealand, water catchment boundaries were used as the basis to re-establish local government boundaries (Newman and Kenworthy, 1999). Adelaide has legally established catchment management districts, financed by local taxes, and managed with representation from government, industry and the community (Newman and Kenworthy, 1999), and catchment management committees have been set up through Australia, mostly in the last 20 years, to facilitate water management (Curtis and Lockwood, 2000; Gardner, 1999).

The institutions of water management have been built primarily around protecting the health of city residents (see Section 2.1), often overcoming significant environmental obstacles (such as hilly terrain or scarce water) in the commitment to big-pipe-in, big-pipe-out (centralised) infrastructure. Management structures of water service institutions have reflected the emphasis on technological intervention and systems. Technical knowledge and expertise has been built up in single-purpose organisations. Now there is widespread realisation of the mismatch between technological infrastructure, institutions and the natural water cycle that has been modified to provide for urban development (ACIL Tasman, 2005). Participatory catchment-based planning policies are beginning to address this mismatch (Buller, 1996; Letcher and Giupponi, 2005; Moss, 2001a).

Administrative organisations of water management have not only reflected early engineering thinking (see Table 2-8) but also political boundaries and time-scales, resulting in different autonomous organisations being responsible for the same catchment, or one authority transferring water between multiple catchments. Based on traditional engineering knowledge, urban water infrastructure and organisations split and manage the water cycle in a way that does not match but rather conflicts with natural ecological systems and catchments (Mouritz, 1996). Environmental protection

and conservation may not always be high priorities where (sometimes conflicting) organisational imperatives are written into legislation based on this historical background.

2.4.3 Sustainable Water Management Planning Tools and Processes

In order to better apply the principles and discourses of sustainable water management to water management practice, planning tools and processes have been developed for water management planning decision-makers. Many are not unique to water management. Tools that assess options against particular priority criteria are outlined in Section 2.4.3.1. Further tools and processes have been developed to facilitate integration of the results of measurement of options against different criteria and weighted according to priority. These are outlined in Section 2.4.3.2. So that such tools and processes do not marginalise some stakeholder groups, processes that engage all relevant stakeholders have been developed. These are outlined in Section 2.4.3.3.

2.4.3.1 Tools for Measuring Sustainability Criteria

The possibility of measuring sustainability is quite limited conceptually, as already discussed. But measurements can be made against criteria considered to be important for a particular problem. Such tools have been developed for assessment of various aspects of sustainability. Assessments of water management options are commonly supported by environmental, health, economic and social impact assessment tools.

2.4.3.1.1 Environmental Assessment

In the area of environmental criteria for sustainability, a number of material accounting and related tools are being developed (Daniels, 2002; Daniels and Moore, 2001) and applied to water sustainability assessments. These include material flux analysis (Jeppsson and Hellström, 2002; Tangsubkul *et al.*, 2005a), life cycle assessment (Bengtsson *et al.*, 1999; Kirk *et al.*, 2005; Lundin and Morrison, 2002; Tangsubkul *et al.*, 2005b) and ecological footprint analysis (Lenzen *et al.*, 2003).

2.4.3.1.2 Health Assessment

Modern health impact assessment methodologies generally use a risk assessment framework (Fewtrell and Bartram, 2001; WHO, 2004). Microbial risk assessment

(Ashbolt, 2004; Ashbolt and Bruno, 2003; Haas *et al.*, 1999; Hoglund *et al.*, 2002; Westrell *et al.*, 2002; Westrell *et al.*, 2003; Westrell *et al.*, 2004) followed existing chemical risk assessment approaches (Haas, 2002), focusing on dose-response models. The chemical risk assessment approaches used for water (USEPA, 1986, 2000; Weber *et al.*, 2006) have the limitation that there are many chemicals (e.g., xenobiotic compounds) present in water about which little is known (Eriksson *et al.*, 2002), and indicator organisms traditionally used for measuring microbial quality of water are no longer considered reliable (Ashbolt *et al.*, 2001). In Australia a catchment management approach to avoiding risks rather than removing by treatment is the preferred approach (NWQMS, 1994).

2.4.3.1.3 Economic Assessment

Tools such as life cycle costing (Ruegg, 1980) and cost-benefit analysis (Pearce *et al.*, 2006) for economic assessment of projects are well developed, and do not need elaboration here. There are also less widely used alternatives. One such is levelised cost (applied to water management), measured as the net present value of all costs divided by the net present value of water demand supplied *or conserved* (Fane *et al.*, 2003).

2.4.3.1.4 Social Impact Assessment

Social impact assessment tools are used to evaluate and facilitate management of intended and unintended social consequences of policies or projects, with the aim of improving sustainability and equity in the human sphere (Vanclay, 2002). Social impact assessment is very often done through survey instruments (Bruvold, 1981; Jeffrey and Jefferson, 2003; Robinson *et al.*, 2005; Syme *et al.*, 1999). However, there are more expanded approaches to ensuring social sustainability of water management projects than just measuring social impact of particular options. Social aspects of sustainability are considered more broadly in Section 2.4.3.3.

2.4.3.2 Multi-Criteria Assessment for Sustainability

There are various frameworks that recognise multiple criteria for decision-making, particularly around the questions of sustainability and environmental policy. One of the more common is the ‘triple bottom line’, but there are other frameworks that recognise alternative sets of primary criteria.

John Elkington is credited with the idea of the triple bottom line (Elkington, 1998; Suggett and Goodsir, 2002). The triple bottom line incorporates social and environmental performance with financial reporting, and is particularly oriented toward annual reporting for corporations. The idea has been taken up by the Australian water industry, with the term being employed in annual reports, conference titles and publication titles (e.g., Queensland EPA, 2004; Sydney Water, 2003). It is employed to varying degrees to either account for, or appear to account for, ethical and environmental performance (Adam, 2003).

While the triple bottom line is widely used, there are also alternative sets of primary criteria such as the five key areas for sustainability provided by the Swedish national Urban Water research program (Hellström *et al.*, 2000; MISTRA, 2001). In addition to social, environmental and economic criteria, health and technical functionality are added as separate primary criteria.

Various frameworks for conducting multi-criteria sustainability assessments (Jeffrey *et al.*, 1999; Resource Assessment Commission, 1992; van Moeffaert, 2002) with more detailed sets of criteria and indicators have been proposed for water management decision-making (Foxon *et al.*, 2002; Lundie *et al.*, 2005; Taylor, 2005), not just *ex post* performance reporting. These frameworks propose methods for measuring performance (e.g., see Section 2.4.3.1), weighting criteria and combining the results into a robust decision-making process. They also emphasise, to varying extents, the importance of stakeholder engagement in decision-making processes (e.g., see Section 2.4.3.3).

There are more technical-based decision support tools (McIntosh *et al.*, 2005), but these have not had very high acceptance (cf. Alkan Olsson and Berg, 2005). There are many practical, theoretical and philosophical limitations to "measuring sustainability" (Munda, 2005)[37]. There is a trade-off between technical rigour/complexity and ease of

[37] "Perhaps the main problem with modern-day neopositivism, like its predecessors, is that it still deceptively offers an appearance of truth. It does so by assigning numbers to decision-making criteria and produces what can appear to be definitive answers to political questions. Conforming to the bureaucratic

traceability such that public scepticism, differing values, perspectives and contexts tend to make acceptance of such technically-based decisions difficult (Sahota and Jeffrey, 2005). Thus a multi-criteria decision-aiding (MCDA) approach is being adopted by some (Söderberg and Kärrman, 2003) as a step forward from the more technical approaches to multi-criteria assessment (MCA) (Roy, 1990). MCDA aims to facilitate actors' decision-making in conformity to their goals rather than seeking to determine an absolute optimum decision for a particular problem. On this point, Healy and Ascher's (1995) study of the impact of a complex computerised analysis tool for forest management planning on the decision-making process of United States National Forests provides useful insights. The complexity of the tool confused interest groups and politicians; it became a source of new information for use by self-interested actors rather than hoped-for consensus; and other case-specific factors combined to force its abandonment. Healey and Ascher conclude that while new (and particularly technically-oriented) information may improve eventual outcomes, it may also polarise debate as power appears to be shifted from non-expert actors. In *Mediated Modeling*, Van den Belt (2004) has tied modelling and system dynamics approaches to stakeholder participation in an attempt to overcome problems of non-participatory linear decision-making while still raising shared levels of learning.

2.4.3.3 Stakeholder Engagement in Sustainability Assessment

There is a growing body of literature on public participation and stakeholder engagement in general (Bishop and Davis, 2001; Renn *et al.*, 1995; Rowe and Frewer, 2005a, b; Webler, 1998) and also in water management planning and decision-making (Blomqvist, 2004; Creighton, 2005; Creighton *et al.*, 1998a; Creighton *et al.*, 1998b;

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imperative of impersonality and value-neutrality, it seeks to reduce emotional and conflict-ridden political questions by translating them into scientific and technical answers. In the administrative managerial realm they are processed by technical methods that treat them as questions of efficiency, performance, and predictability amenable to bureaucratic decision procedures. The positivist methods of policy analysis have thus served intentionally or unintentionally to facilitate and bolster bureaucratic governance" (Fischer, 2003, pp. 13-14). Comparison may readily be drawn to the large bureaucratic management behind the sociotechnical system of water management, discussed earlier.

Jonsson, 2005; Morrison, 2003; Page, 2003; Rinaudo and Garin, 2005)[38]. In fact, with endorsement from various prominent statements such as *Agenda 21* (United Nations, 1992a) and the Århus Convention (UNECE, 1998), public participation is accepted widely as a key principle of sustainable water management (Mostert, 2003).

Reasons for participation can be divided into normative and functional (Webler and Renn, 1995). The normative basis for participation is that it is good in itself, and may be based on values of democracy; while functional arguments (Bush *et al.*, 2005; Meadowcroft, 2004, p. 165) generally centre around: improving the quality of the final decision; creating awareness of environmental issues; and increasing the acceptance of the final decision. Alternatively, participation can be seen as contributing to solving two problems associated with traditional decision making based on 'objective' scientific analysis (Renn *et al.*, 1995, p. 1): firstly, that of low acceptance by members of the public of such 'objective' decisions; and secondly, such a scientific approach may ignore local or anecdotal knowledge which may indeed contribute to improved solutions. (These are analogous to the last and first of the functional arguments above.)

However, the field is characterised by many and varied practical approaches from a variety of disciplines, but with no strong underlying or unifying theoretical base (Bishop and Davis, 2001; Renn *et al.*, 1995, p. 1; Webler, 1998). Even the basic definitions vary considerably. Basic questions of why engage in participation, when, by whom, and how, may bring quite different answers from different theorists and practitioners in the field. This review does not attempt to unify or even classify the literature according to each of those questions, but brief clarification on some points is offered. In relation to who participates, there is some overlap and difference between 'public' and 'stakeholder' participation. While the term *stakeholder* originally had a much more specific meaning, it is now understood more broadly in both the literature and in this dissertation as anyone with an interest in a process or issue (Donaldson and Preston, 1995); whereas *public* may mean only lay members of the public rather than organised stakeholders,

[38] This section interchanges between considering participation in general and participation in water management.

and may also include members of the public who do not see themselves as stakeholders (i.e., do not have an interest in the process or issue).

An early and significant work on public participation is that of Arnstein (1969). Arnstein writes from the point of view of a citizen activist, and thus is sceptical of representative government approaches to participation, favouring direct democracy. She outlines a continuum or 'ladder of citizen participation' from manipulation through to citizen control. Bishop and Davis (2001) present an alternative perspective on participation that envisages officials choosing techniques of consultation depending on the issue at hand and its context, rather than an *a priori* assumption that for participation to be meaningful rather than token it must be at the 'citizen control' end of a continuum of approaches.

Meadowcroft (2004) identified three strands of public participation, based on orientation of the process towards those who participate – i.e., the question of 'who'. The citizen strand emphasises opportunity for the individual citizen to participate in decision making. The community-centred strand emphasises local communities as being key players in managing their own affairs. And the stakeholder strand emphasises participation of organised interest groups and their representatives. Meadowcroft argues that the stakeholder strand has the greatest potential in public decision making for sustainable development. His argument is based on the centrality and longevity of group-based processes in modern society (e.g., the organisation) and their effectiveness in representing interests and perspectives and providing an environment for mutual learning from an already existing extensive knowledge base.

Constructive policy dialogue between disparate professional and other interest groups and decision-makers is an important challenge for sustainable water management (Falkenmark, 2004; Falkenmark *et al.*, 2004). Throgmorton (1991) suggested that the rhetorical discourse of policy analysis is shaped significantly by who is constructing an account or argument, and for whom. He defines a framework with three primary groups, each of which use and respond to different language: scientists, politicians (or public officials), and lay people or their advocates. (Falkenmark identified scientists, policy-

makers and stakeholders as groups requiring integration, and who facilitated dialogue.) Throgmorton concludes that the challenge for effective policy analysis is to be able to actively mediate all of these discourses.

A significant motivator for the growth of empirical and theoretical work in the area of participation in water management is past failures of recycled water initiatives due to public or community opposition (Hartley, 2003; Hartley, 2006; Khan and Gerrard, 2006; Uhlmann and Luxford, 1999). A literature review (Po *et al.*, 2004) of public perception of water reuse concludes that the traditional approach of deciding, announcing and defending a solution is no longer effective; and even extensive education after project implementation is regarded as inadequate. They propose that successful implementation requires the involvement of local communities prior to the inception of any water reuse projects, and strengthened decision-making arrangements with continued community and stakeholder participation (Brown, 2003; Busenberg, 1999; Fischer, 1999; Peltenburg *et al.*, 2000; Vlachos and Braga, 2001).

There is a significant variety of approaches and directions taken by researchers in the field of water management as to how participation should occur. Some emphasise processes of engagement for mutual learning, criticising rational accounts of decision-making (Pahl-Wostl, 2002). From this perspective, public participation is favoured where it achieves active engagement (Arnstein, 1969). Various methods (Carson and Gelber, 2001; Renn *et al.*, 1995) for engagement such as citizens' juries (Carson *et al.*, 2003; Crosby, 1995; Kenyon, 2005) and citizens' advisory committees (Lynn and Kartez, 1995) have been developed and variously applied to water management.

Others in the field of participation in water management decision-making emphasise the pre-existing social attitudes and behaviours independent of action (e.g., as *ex ante* inputs into the project design), typically revealed through surveys and other forms of social research (Po *et al.*, 2004; Po *et al.*, 2005; Roseth, 2003).

Still others emphasise paying attention to structural or institutional aspects of public involvement. The institutional aspects considered for socially sustainable water

management decision making include public trust in water authorities (Hurlimann and McKay, 2004; Marks and Zadoroznyj, 2005), governance arrangements (Söderberg and Åberg, 2002), the capacity and adaptability of organisational systems and motivation, and ability and opportunity of householders (Söderberg and Åberg, 2002). A governance approach to water management whereby ongoing stakeholder relationships become part of water management institutions is recommended by Stenekes (2006; Stenekes *et al.*, 2006).

2.4.4 Sustainable Water Management Practice

This section reviews current and cutting edge water management technologies, practices and trends, many of which are directly associated with implementation of sustainable water management principles, tools and processes reviewed above. Additional emphasis is given to decentralised water management practice, consistent with the overall focus of this dissertation.

2.4.4.1 Recent Water Management Technology Improvements

Progress in water recycling and desalination[39] efficiency (both in terms of cost and energy) has been made possible largely by developments in membrane science and technology (Asano, 1998; Asano and Levine, 1996; Mujeriego and Asano, 1999; Schiffler, 2004; Smith, 2005; Sydney Water Corporation, 2006). In the water industry, water recycling is a widely recommended and accepted solution path for more sustainable water management (Anderson, 2003; Anderson, 1996, 2006; Radcliffe, 2004a; Rathjen *et al.*, 2003).

Outside of the water industry, acceptance of recycling has been lower (Jeffrey and Jefferson, 2003; Marks *et al.*, 2003; Po *et al.*, 2004; Uhlmann and Luxford, 1999). Negative public perception of water recycling centres on fears of ingestion of or exposure to contaminated water through inadequate treatment or accidental cross-connections in dual reticulated systems. The eventual response for pro-recycling policy-

[39] While costs are decreasing with technology advances, desalination of ocean water is still more expensive than conventional water sources. The competitiveness of desalination for inland and/or highland areas is weakened due to transport costs (Zhou and Tol, 2005).

makers has been to conduct public education programs, followed by social research programs, and only in some cases followed by actively engaging the public in water management policy and planning (Stenekes *et al.*, 2003; Stenekes *et al.*, 2006).

The barrier of negative public perception combined with economic constraints surrounding recycled water adoption mean that there is only limited (even though as yet unreached) potential for large-scale recycling projects to overcome long term water scarcity. The economic constraints include the cost of advanced treatment processes and the cost of retrofitting existing development (Hatton MacDonald and Dyack, 2004).

Reuse schemes around Australia account for the recycling of around 10% of sewage effluent (Radcliffe, 2003). Many of these schemes are for irrigation or industry, and a few residential dual reticulation schemes are also in place, such as the Rouse Hill scheme in Sydney (Cooper, 2003). It is usually considered that recycled water is best treated according to its intended use, such that its quality is 'fit for use' and thus resources are not wasted in unnecessary treatment (Government of South Australia, 2006; Mitchell and White, 2003; NSW Government, 2006). Recycled water for residential use usually receives the highest levels of treatment; nevertheless it is residential use that is the subject of most controversy (Po *et al.*, 2004).

Membrane technology is significant for both centralised and decentralised applications of water treatment and reuse (Fane and Fane, 2005). There is also innovation in other forms of advanced treatment (beyond membranes) based on physical, chemical and biological processes (Robinson *et al.*, 2005). Journals such as *Desalination*, *Advances in Water Resources* and *Water Research* publish papers regularly concerning such innovation.

New technologies are being developed that can allow water recycling to be applied at widely different scales. Aquifer storage and recovery is a developing approach for storing recycled water that may be applied at a centralised or decentralised scale. Aquifer storage and recovery provides attenuation for seasonal (and other) demand fluctuation (Barnett *et al.*, 2000; Dillon *et al.*, 2006). Improvements to on-site and

small-scale treatment technologies (Crites and Tchobanoglous, 1998; Ho *et al.*, 2001; Lens *et al.*, 2001; Otterpohl *et al.*, 2002) are providing new options for decentralised application of water recycling and conservation.

The types of technologies available for decentralised application include downsized versions of centralised technologies as well as specifically decentralised technologies. Water sourced from rainwater tanks (Coombes and Kuczera, 2002) or other local sources may be disinfected using small-scale point of use or point of entry treatment technologies (Mintz *et al.*, 2001) such as ozonation, ultraviolet disinfection or reverse osmosis. Recycling (e.g., of greywater) may use scaled-down wastewater unit treatment processes similar to those of large scale systems (e.g., membrane bioreactors) (Friedler *et al.*, 2005; Green and Ho, 2005; Otterpohl, 2002; Otterpohl *et al.*, 2002).

New decentralised technologies are also being developed that do not imitate centralised systems. These include wetlands (including subsurface flow) (Holt and James, 2006; Li *et al.*, 2003), urine diversion (Jönsson, 2002; Jönsson *et al.*, 1999; Vinnerås, 2002), dry sanitation and composting toilets (Berger, 2004; Fittschen and Niemczynowicz, 1997; Walker and Davidson, 2004), vacuum toilets and vacuum transport (Otterpohl, 2001), aerobic package units (Diaper *et al.*, 2001; Ho *et al.*, 2001), etc.

Technologies for urine and faeces diversion and reuse are collectively known as ‘ecological sanitation’ or ‘ecosan’. The technologies of ecosan are designed to ensure that nutrient-rich human waste is returned to agriculture without mixing with other forms of waste or diluting with water – thus closing the loop of the nutrient cycle (Esrey *et al.*, 1998; Werner *et al.*, 2004a)[40]. This may involve dry or composting toilets (Berndtsson and Hyvönen, 2002), urine-diverting toilets or a number of other possibilities. Greywater is kept separate and ideally reused on-site (Esrey *et al.*, 1998). Many of these technologies are being developed in northern Europe with application there (Vinnerås and Jönsson, 2004) and also in developing countries, where the

[40] In addition to conserving the finite and non-renewable worldwide supply of nutrients, ecosan also aims to conserve water (which would otherwise be used as a transport medium for waste), reduce groundwater contamination and reduce eutrophication of waterways (Narain, 2004; Werner *et al.*, 2004a).

technology is transferable (Esrey *et al.*, 1998; Langergraber and Muellegger, 2005; Werner *et al.*, 2004b). There are adherents to 'ecosan' throughout the world, including Australia (White and Turner, 2003), but relatively few active implementations.

Some aspects of decentralised approaches have been introduced in urban areas as part of centralised systems. For example, in Berlin, small-scale stormwater technology poses a challenge to the existing centralised system, with a reordering of technical structures and also social responsibilities. More people are now involved, with a new set of responsibilities (Moss, 2000; Moss, 2001b). The technology had been long dismissed by water managers but promoted by environmentalists. But as the technology improved, water utilities and the environmental regulator became more accepting and eventually actively supportive.

However, very few examples exist of developed urban communities with totally decentralised water services. There are some eco-villages (Fermskog, 2004; Fittschen and Niemczynowicz, 1997; Hanaeus *et al.*, 1997; Mels and Zeeman, 2004; Panesar and Lange, 2004) and source-separating projects (Wendland and Oldenburg, 2004) in countries such as Sweden, Germany and The Netherlands. And there are also more examples of individual houses that are designed to be self-sufficient, such as the Sustainable House in Sydney (Mobbs, 1998). These are nearly all niche projects driven by motivated communities or researchers, and only to a small extent by governments or water authorities.

Australian eco-village-type developments do not tend to adopt so many features of decentralisation and self-sufficiency, though there are a number of innovative projects embracing WSUD and IUWM principles (Mitchell, 2006; Mitchell, 2004). But source separation is still almost entirely untried in Australia. The Currumbin Valley Ecovillage is one of the most self-sufficient in Australia (see Section 4.4).

There are also Australian examples of suburb-level recycling such as the Sydney Olympic Park and Rouse Hill projects in Sydney (Gardner, 2003). However, in these cases of dual reticulation recycling schemes as the only intervention, the system is still

centralised, with the original source and eventual disposal of the water, nutrient and contaminant streams being the same. Only the quantity of total material flux is reduced by the presence of recycling.

2.4.4.2 Demand Management and the 'Low Hanging Fruit'

In addition to improving water supply and treatment technologies, a number of other approaches have been identified and implemented to reduce the stress caused by water scarcity. Reducing the demand for water is one such logical response for solving the problem of water scarcity, especially the 'demand' for unprofitable uses of water such as distribution system losses. Many of the 'low hanging fruit' of demand management (Mitchell and White, 2003) have already been picked, particularly through innovation in water efficient household devices.

Demand management may also be applied through implementation of market incentives (or community education, or even legislated restrictions, in addition to technological improvements) to modify human behaviour (Buckle, 2004). Such pricing mechanisms include stepped tariffs and full cost pricing for water (including 'externalities' in the price of water to the customer) (IPART, 2003; Piccinin, 2004; Shadwick, 2002).

An additional form of market reform that is challenging the traditional natural monopoly status for urban water suppliers is opening the market to competition. (Corporatisation and privatisation are already commonplace worldwide.) In Australia, competition has already been introduced in Melbourne, where three different retailers operate in quasi competition, and in Sydney, where a proposal by Services Sydney to recycle sewage from Sydney Water and sell it in competition to Sydney Water has been upheld by the National Consumer Commission (NCC, 2004a)[41].

2.4.5 Decentralised Approaches to Sustainable Water Management

This section specifically and primarily overviews decentralised (or local) technologies and physical systems for water management rather than decentralised (or local) organisational control or management of the water cycle. There is secondary interest in

[41] Also see http://www.ncc.gov.au/publication.asp?publicationID=188 (accessed 4/5/2006).

decentralised administration, but very little literature to draw from in relation to this. First, key components of decentralised water systems are reviewed leading to an example (Figure 2-2) of what a decentralised urban water system may look like on the ground. Then sustainability characteristics of these systems are assessed in a generalised comparison to centralised systems.

2.4.5.1 Principles and Components of a Typical Generic Decentralised Technical System

Every water management scenario has its own unique characteristics; therefore it is not meaningful to identify a generic best-practice decentralised water management system. There are many different decentralised configurations possible. This section reviews technologies and physical water management systems that are toward the decentralised end of a continuum of possible approaches, so as to give a concrete picture of the (generalised) type of decentralised water management system that is of interest in this research.

The following sections list water management system components that are, at the time of this research, considered as important to achieving sustainable water management in Australia and/or overseas (Berndtsson and Hyvönen, 2002; Mitchell, 2006; Newman and Kenworthy, 1999). This selection identifies broad principles of decentralisation leading to generalised examples of system components rather than a technical description of a specific system configuration.

2.4.5.1.1 Rainwater Capture and Use On-site

Rainwater collection and use on-site may be an important or essential water supply measure in decentralised water management systems. Rainwater tanks have been used throughout the history of many Australian settlements, particularly in rural areas. However, the use of rainwater tanks has become the subject of renewed interest and many recent studies (e.g., Chapman *et al.*, 2006; Coombes *et al.*, 2000; Jayaratne *et al.*, 2006; O'Toole *et al.*, 2006). There are disadvantages associated with significant capital cost per unit of water supplied by rainwater tanks, as well as high energy costs for pumping and embodied energy in replicated materials, etc. (Dixon *et al.*, 1999; Gardner *et al.*, 2006; Lai, 2003; Wulfinghoff, 1999). Alternative methods of rainwater capture

other than household tanks exist, such as communal tanks, as used at the Payne Rd subdivision in Brisbane (see case study in Section 4.3).

In the case that rainwater falling on roof surfaces is not collected for direct water supply, it will then become stormwater and should ideally be used or infiltrated (to the ground) on-site, possibly for later reuse (as is common practice in Perth) (see Section 2.4.5.1.3).

2.4.5.1.2 Closed Loop Water Recycling

Water scarcity throughout the world is prompting calls for alternative sources such as recycled water. However, water recycling can be done on any scale and is often centralised (e.g., Singapore's NEWater scheme). The ideal of closed loop water recycling aims for zero emissions of water or waste from a site (Otterpohl, 2001) and no inter-catchment transfers of water. Thus water and its waste products after use should be sourced and reused locally.

Local reuse requires some form of treatment, depending on the waste stream and its intended use. A number of methods and technologies exist, including membrane systems, septic tanks, aerated wastewater treatment systems, constructed wetlands, aquatic treatment systems, high rate anaerobic treatment, etc. (Crites and Tchobanoglous, 1998; Diaper, 2004; El-Gohary, 2001).

2.4.5.1.3 Stormwater Capture and Infiltration On-site

While rainwater, rather than stormwater, is more ideal for household uses, increasing capture and infiltration of stormwater on-site serves two purposes. First, it provides a source of water for garden plants. Allowing stormwater to replenish groundwater reserves by percolating through garden soil reduces the amount of piped water required for gardens. It may also be subsequently extracted for garden or other non-potable uses. Second, preventing stormwater from becoming urban runoff removes several immediate and flow-on costs and other deleterious effects of water and pollutant transport through cities (Moss, 2000). In Perth, Western Australia, urban stormwater retention basins capture stormwater, where it infiltrates into local surficial aquifers, which are used as a source for drinking water production.

Thus a decentralised water management system will maximise the amount of pervious area on-site, and use water sensitive urban design landscaping features (Newman and Kenworthy, 1999).

2.4.5.1.4 Source Separation

Wilderer (2001) identifies five household waste streams (including one for solid waste) that should ideally be kept separate at their sources: faeces (black water); urine (yellow water); wastewater from washing machines and bathrooms (greywater); wastewater from kitchen sinks (including kitchen refuse via in-sink food disposal devices); and solid waste (paper, plastics, etc.). The rationale for source-separating these streams is clear on examination of nutrient loads per waste stream in Table 2-9. Nutrients are much more concentrated in urine than any other stream.

Table 2-9: Nutrient loading in different household wastewater streams (Otterpohl, 2001)

Yearly Loads (kg per person)	**Total**	**Greywater**	**Urine**	**Faeces**
Total		25,000-100,000	500	50
Nitrogen	4-5	3%	87%	10%
Phosphorus	0.75	10%	50%	40%
Potassium	1.8	34%	54%	12%
COD	30	41%	12%	47%
Recommended uses		Reuse (e.g., irrigation)	Fertiliser	Biogas / soil conditioner

Some of the benefits of source separation are summarised as follows (Drangert, 2002; Jönsson, 2002; Otterpohl, 2001; Vinnerås, 2002):

- Most soluble nutrients are found in urine. By keeping this stream separate, receiving waters are protected and nutrients can be reused beneficially as fertiliser.
- Health danger is almost exclusively from faecal matter. Diversion and minimising dilution makes for much less material to sanitise. Alternative means of sanitising the compost material are therefore more readily applied, such as dry composting or energy recovery.
- Greywater is much simpler to treat and reuse on-site when not mixed with black or yellow water.

- Depending on reuse requirements, strict control of detergents and chemicals used in the household may be required. The advantage is more environmentally friendly product choices, but the disadvantage is more likely failure of treatment systems if the wrong type of detergent is used.
- Keeping waste streams separate means that less energy may be required for transport and treatment, and more of each product is salvageable and reusable.

2.4.5.1.5 Water Quality Fit-for-Purpose

A philosophy of providing water services with minimal resource usage is behind this phrase, which could be extended back one step further to examine provision of services traditionally provided by water by alternative means. If water must be used to provide a particular service, then it most likely does not need to be treated to drinking water standard. Thus when sourcing and reusing various water streams locally, it is possible to separate which sources can be used for which purposes depending on quality (Hurlimann and McKay, 2006).

2.4.5.1.6 Closed Loop Nutrient Recycling

Once waste streams are separated at their source (e.g., by urine-diverting toilets in particular), it becomes relatively simple to capture and reuse the nutrients contained in urine (Drangert, 2004; Lampert, 2003). Health considerations are relatively minor, but economic viability of yellow water use is lost when transport distances to agricultural reuse destinations become large (Vinnerås, 2002), unless a concentrated form can be produced (Ban and Dave, 2004).

2.4.5.1.7 Low Energy Use

The small scale of decentralised systems will ideally minimise transport pumping costs and greenhouse emissions. To ensure this outcome, gravity feeds should be used wherever possible, together with efficient pumping mechanisms where required. Treatment costs and energy should also be minimised by requiring water quality only fit-for-purpose, and embodied energy in small systems should be smaller than larger alternatives. Local energy (solar/thermal/hydrogen) should also be sourced.

2.4.5.1.8 Integrated Water Management

Integration of all elements of the water cycle, and of social structures to allow for such physical integration, is one more important characteristic of decentralised urban water management (Coombes and Kuczera, 2002). This characteristic is implicit throughout the foregoing discussion. Physical integration is illustrated by Figure 2-2.

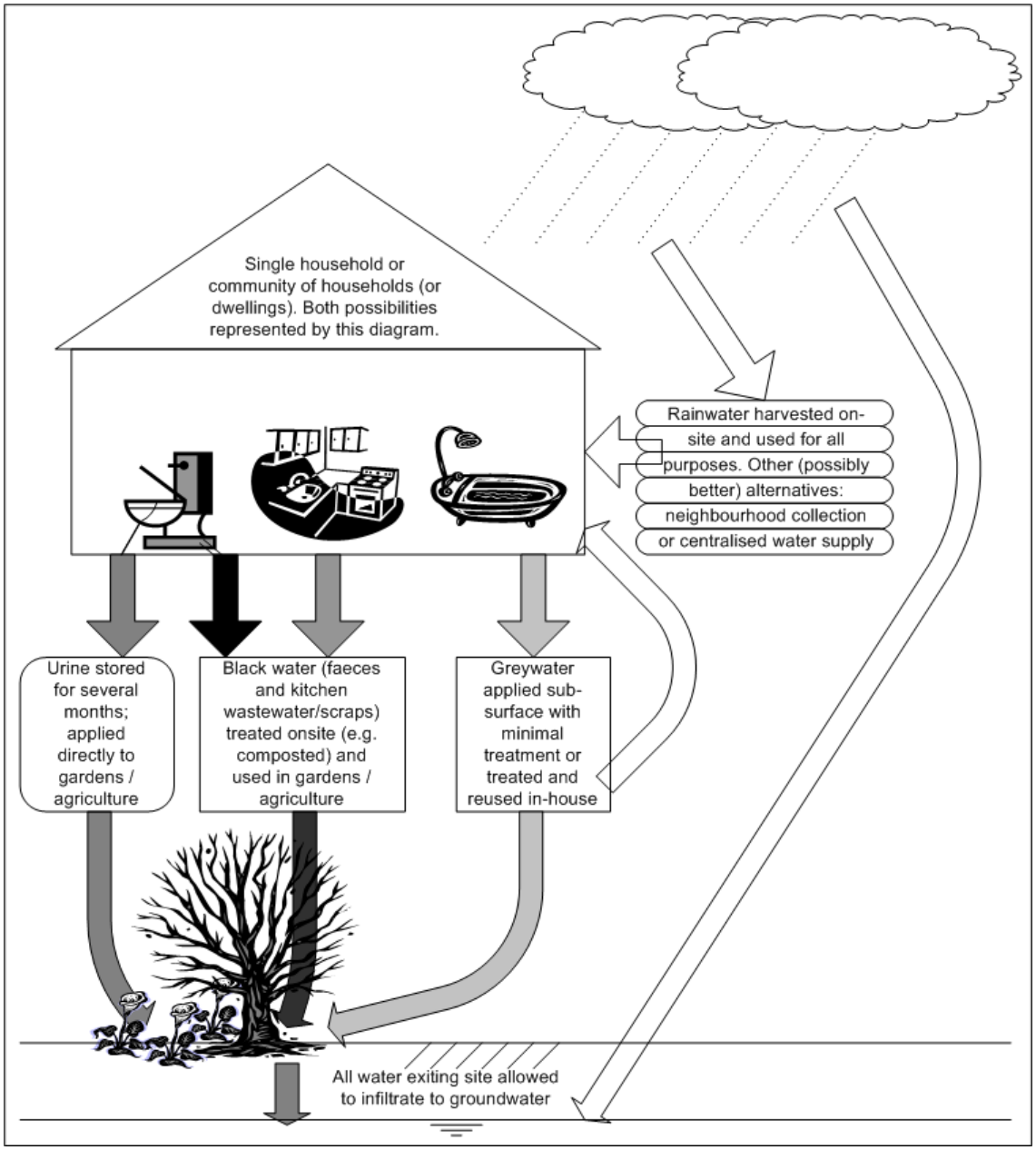

Figure 2-2: Decentralised urban water management: concept diagram for physical arrangement and flows at the household level

2.4.5.2 Generalised Assessment of Sustainability Factors for Physically Decentralised Systems

The primary reasons usually given for decentralised approaches are environmental (Jantrania, 2000; Lens *et al.*, 2001; Lienert *et al.*, 2006; Niemczynowicz, 1992, 1999). Table 2-10, following, outlines advantages and disadvantages of both physically centralised and decentralised water management systems.

Table 2-10: Sustainability factors for centralised and decentralised water management systems

Aspect of Sustainability	Centralised Systems		Decentralised Systems	
	Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
1. a) Environmental: Climate change	* Possible 'economy of scale' in energy requirements	* High energy required by some treatment options (such as desalination) * All water treated to potable – meaning much is over-treated * Mixing of all waste streams requires extensive treatment of large volumes * Higher energy requirements for transport over long distances * Dams release CO_2	* Possible to have decentralised systems with low or no energy requirements (e.g., if streams not mixed)	* High energy requirements for some local treatment and pumping requirements (problematic when such systems extensively replicated)
1. b) Environmental: Nutrient cycle management	* Possible to create centralised system for urine nutrient recovery	* Unsustainable nutrient loss with all current systems	* Nutrients can be reused much more easily (if not diluted and mixed)	* Nutrient reuse may require involvement of many people
1. c) Environmental: Water conservation	* Conservation measures can be centrally introduced and controlled (e.g. recycling, desalination)	* Water used (or wasted) as a transport medium * Natural water balances shifted	* Minimal large-scale water transfer * Recycling possible on-site (minimal treatment or transport) reducing water import demand	* More difficult to control individual water users (uniform control measures not applicable)
1. d) Environmental: Catchment & water cycle management	* Potential for control and protection of entire catchments (e.g., for water supplies)	* Natural water cycle interrupted through inter-catchment transfers	* Natural water cycle mimicked more closely * Minimal inter-catchment transfers	* Potential[42] for mismanagement of water cycle in individual catchments

[42] The 'potential' for various mismanagement outcomes (or effective control, on the other hand) all suggest that outcomes depend significantly on the human input in the management of the system. Thus,

Aspect of Sustainability	Centralised Systems		Decentralised Systems	
	Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
1. e) Environmental: Pollution	* Significant reduction of environmental hazard through removal of sewage * Easier for government regulatory agencies to control	* High source of point pollution * Possible eutrophication of receiving waters * Diffuse pollution through sewer pipe leakages, etc	* Minimal point pollution * Minimal waste flows * Diffuse pollution can be minimised through adequate treatment and/or reuse	* Potential for widespread diffuse pollution (e.g., septic tanks) including pollution of inland waterways
2. Economic: infrastructure construction & renewal	* Infrastructure already in place (significant existing capital investment) * (Disputed) 'economy of scale' * Cities designed and constructed around centralised services provision	* Aging infrastructure will require significant and expensive replacement * Large infrastructure must be built in advance of need * Significant 'externalities' cost	* Minimal burden of renewal cost * Minimal initial capital required * Modularity: can be installed as-needed * Cheaper and quicker to achieve MDGs	* Funding schemes and cost analysis historically oriented to centralised infrastructure
3. Health Risk	* Public health systems in place to manage and tightly control water quality * Historical public health successes	* Low risk, but very high consequence, of system-wide contamination	* Theoretical demonstration and possibility of reduced pathogen risk for decentralised systems	* Pathogen release risk for inland waterways (& possibly water supplies) * Higher risk of localised contamination (low consequence)
4. Social[43]	* No need for communities of water users to become involved * Possible that sustainability might be achieved through technical intervention (allowing for singular engineering focus)	* Lack of community involvement may limit ownership and responsibility * Pursuit of sustainability limits or excludes social and behavioural dimensions	* Scope for people to become more involved in managing water * Possible that sustainability might be achieved through integration of social and behavioural dimensions	* Scope for people to create risks for selves and others by becoming involved * Complexity of a holistic perspective on sustainability where social factors are difficult to control or predict

whether these are indeed advantages or disadvantages is somewhat subjective, depending to a significant extent on one's perspective (or social construction). A conservative, water-industry perspective, has been assumed in this table.

[43] The social advantages and disadvantages of centralised and decentralised urban water management are much more complex and numerous than enumerated in this table. It should be readily apparent that the same objective reality (e.g., lack of community or user involvement) can be constructed as an advantage or as a disadvantage, depending on one's values. Thus the social dimension does not lend itself to a completely 'objective' outline of advantages and disadvantages.

More detailed review of the arguments, where necessary, with further discussion, is under subsequent subheadings. All arguments presented in the text are summarised in Table 2-10; but not all arguments in the table are presented in the text. Elaboration is only provided where needed. Therefore, the table is more complete; but the text is more detailed.

2.4.5.2.1 Environmental Factors: Climate Change

Water supply and treatment technologies emit significant quantities of greenhouse gases. But the amount is not in the same order of magnitude as some large emitters such as energy, transport and other industries. Large dams also release carbon dioxide and/or methane (World Commission on Dams, 2000, pp. 75-77), and the embodied energy in various water supply options is still an important consideration in the pursuit of sustainable water management, particularly if desalination or transport over long distances is considered (Cohen *et al.*, 2004; Marsh and Sharma, 2006). Furthermore, climate change is regarded as a significant contributor to water shortages – with shifting rainfall patterns typically leading to reduced rainfall and runoff for urban centres (Gleick *et al.*, 1997).[44]

2.4.5.2.2 Environmental Factors: Nutrient Cycle Management

The loss of nutrients is aided by once-through linear centralised water management systems. Centralised systems take large quantities of water from one location, mix a variety of nutrients and pollutants with that water during once-only use, and finally deposit the resulting waste stream at another point location relatively far removed from its various source locations. Valuable nutrients (particularly nitrogen, phosphorus and potassium in human urine) are diluted and removed from where they could potentially be reused (Berndtsson and Hyvönen, 2002; Burkhard *et al.*, 2000; Jönsson, 2002; Kärrman, 2001; Lens *et al.*, 2001). The combination and dilution of various (and fluctuating) waste streams in wastewater makes recovery of nutrients (and also water)

[44] For example, Perth has experienced a significant reduction in rainfall and runoff since the 1970s, necessitating multiple alternative water sources (Water Corporation, 2005). Nonetheless it is possible that if a few wetter years of data are considered as statistical outliers, Perth's current situation could be considered 'normal' – i.e., a result of long-term climate variability rather than anthropogenic climate change (Kuczera, 2006, pers. comm.).

difficult and expensive in centralised systems (Newman and Kenworthy, 1999). Further, estimates for the amount of available rock phosphorus for use as fertiliser range from less than 100 to 150 years' supply, at current rates of use and extraction (EcoSanRes, 2005; Otterpohl and Grottker, 1996; Runge-Metzger, 1995; Schertenleib, 2005; Steen, 1998).

Closing the nutrient cycle tends to be more of a concern for northern European nations, and closing the water cycle tends to be more of a concern for water scarce regions, such as (parts of) Australia and the USA (as implied in Loudon, 2004).

2.4.5.2.3 Environmental Factors: Water Conservation

Only a small fraction of potable water supplies are actually needed for drinking, cooking and other forms of body contact. But a large quantity of potable water is used as a transport medium to remove waste (e.g., toilet waste) where non-potable water, or even no water, could be used instead.

2.4.5.2.4 Environmental Factors: Catchment and Water Cycle Management

Decentralised systems help to achieve a reduction and localisation of flows in the 'urban metabolism' (Hermanowicz and Asano, 1999; Lens *et al.*, 2001); or the minimising and balancing of material flux (Lettinga *et al.*, 2001). (This argument also extends to nutrient cycle management.)

2.4.5.2.5 Environmental Factors: Pollution

Centralised systems have become significantly less polluting to the environment in recent decades. But Otterpohl and Grottker (1996) question the 'sustainable' claim for advanced end-of-pipe treatment technology due to the centralised nature of the overall system, which they say is ill-conceived (based on other arguments, including some of the arguments summarised in Table 2-10).

2.4.5.2.6 Economic Factors

Many of the centralised big-pipe systems around the world are reaching an age of around 100 years, and infrastructure renewal is (or may soon be) a priority for water service providers and/or governments. One estimate for Australian urban water

infrastructure replacement was AUD50 billion in 1993 (Johnson and Rix, 1993). Rehabilitation of the pipe system in Germany is estimated at EUR100 billion (Wilderer, 2001). For the United States, one estimate (for water supply infrastructure only) is USD250 billion over the next 30 years (AWWA, 2001, 2002). And for the whole world, the cost of infrastructure renewal over the next 25 years is estimated at USD10 trillion (Zehnder *et al.*, 2003).

Economic advantages of decentralised systems, argue von Hauff and Lens (2001), arise largely due to the much smaller initial capital expenditure required. There may actually be a 'diseconomy of scale' for large systems (Fane *et al.*, 2002; Rocky Mountain Institute, 2004). Further, small-scale systems do not have to provide excess capacity for future growth but can be duplicated only when needed (Fane, 2005). However, these advantages are offset by the existing capital investment in centralised infrastructure (von Hauff and Lens, 2001). Mitchell *et al.* (2002) demonstrate that decentralised greenfield developments in Brisbane can compare favourably on a cost basis. Full costing of externalities may also favour alternatives to centralised once-through systems (Hatton MacDonald, 2004).

Mitchell *et al.* (2007) enumerate several costing principles, which, if employed, would considerably remove bias currently favouring centralised systems in terms of cost (cf. Fane and Mitchell, 2006). For example, the inclusion of water demand *conserved* in levelised costing (see Section 2.4.3.1.3) helps to remove bias toward conventional large-scale, supply-oriented solutions (Fane *et al.*, 2003).

In the case of developing regions, decentralisation enables needed water and sanitation services to be more cheaply and rapidly implemented for local areas (Jackson and Gariba, 2002; Lens *et al.*, 2001; Parkinson and Tayler, 2003).

2.4.5.2.7 Health Factors

Fane argues that theoretically (though not yet empirically) there should be less pathogen risk for users of decentralised systems, compared to centralised (Fane, 2005). However, the risk of pathogen and nutrient release to waterways and the environment is an additional risk for decentralised systems, considering the case of Sydney's catchment

(Charles *et al.*, 2004); but this additional risk may be significantly mitigated by improved management, maintenance and design of onsite systems (Deal *et al.*, 2005; Etnier *et al.*, 2005; Willetts *et al.*, 2007; Yeager *et al.*, 2006).

The history of success of centralised water infrastructure in protecting public health (Melosi, 2000) is a significant argument in favour of centralised systems[45].

2.4.5.2.8 Social Factors

The scope for community participation in decision-making and involvement in taking ownership of, and responsibility for, its own wastes is a normative argument sometimes used in favour of decentralised systems (PHPS, 1997; Pinkham *et al.*, 2004).

Decentralised systems may (but do not necessarily have to) be associated with devolution of operation and management responsibility to lower levels (Schertenleib, 2005), including (at the more decentralised extreme) the individual user or homeowner, or a body corporate or similar entity. To grant water users and other stakeholding actors greater involvement and ownership of water services is a departure from the traditional hydro-social contract (Turton and Ohlsson, 1999) that implies centralised state control.

Public perception of reuse (Marks *et al.*, 2003; Marks, 2006) is a significant social barrier to decentralisation. The potential for negative public response to the scale of service is another potential barrier; but there is scant and conflicting evidence on this. Customer surveys by Sydney Water (Roseth, 2003) indicate that a significant majority of customers approve of the idea of decentralised systems for sewage and its reuse, and

[45] This was one of four arguments for centralised systems presented in a conference report of Spencer (2004), in which he recounted the arguments of Lindsay Edmonds of the Water Corporation (WA) regarding Perth. The arguments were: the population and demographics of Perth call for centralisation; centralised sewage collection and long ocean outfalls have protected the local environment from eutrophication; public health is favoured by tighter governmental control through centralised systems; and Perth's affluence has favoured centralised infrastructure – where the community has the ability to pay and the preference not to have responsibility themselves. Virtually no other literature was found arguing a general case for centralised water infrastructure over decentralised, apart from that describing specific cases such as the case presented in Section 4.1.

of water being supplied ‘fit-for-use’. Beneke (2004) has undertaken a preliminary study in Germany assessing the readiness of the public and of water management institutions to turn toward decentralised concepts. Her conclusion was that the public tends to be forced into centralised approaches through legislation and norms rather than choice, and that the few who have experienced decentralised approaches are generally receptive to the concept. On the other hand, experience in Sydney Water’s Priority Sewage Program (connecting residents in urban fringe areas to the centralised wastewater service) suggests that those who have been accustomed to decentralised sewage (typically the septic tank/absorption trench) are eager to be connected to the more ‘modern’, centralised and less locally polluting system of their urbanised counterparts (Stenekes, 2006) (see Section 4.1). This is possibly because many on-site systems fail due to lack of maintenance and poor design and/or implementation (Beal *et al.*, 2005a; Beal *et al.*, 2005b; Charles *et al.*, 2004; Gardner, 2005), notwithstanding efforts to improve their management and performance (NSW Department of Local Government, 2000). Another potential barrier is the ‘not in my backyard’ response toward decentralised approaches (Uhlmann and Luxford, 1999).

Beneke’s (2004) preliminary research of receptivity to decentralisation in Germany indicates that the physical scale of a decentralised approach is more of a barrier for the ‘institutions’ (i.e., established organisations) of water management. Furthermore, Beneke’s findings suggest that water management organisations are indifferent toward and ignorant concerning decentralised options, being already committed to centralised infrastructure.

2.5 Conclusions Drawn from the Literature Review

This literature review has presented a brief history of institutional factors considered relevant to the centralisation of urban water systems. The alternative of decentralisation was broadly examined, followed by the review of frameworks for analysing institutional dynamics. In the last section, a review of current water sciences literature suggested that there is sufficient evidence to justify the pursuit of decentralised water systems, at least as one option, for increasing sustainability in water management. Whether this would be most appropriately pursued through decentralised administrative structures or not has

not been answered in existing literature. Moreover, the research questions do not call for specific focus on that particular question but call for an open and general analysis of any and all institutional factors that may be important.

This concluding section pulls the literature review together to set the direction for the remainder of the research. First the emerging knowledge of Section 2.4 is analysed using the institutional framework introduced in Section 2.3. Then the interdisciplinary direction taken for this research is placed within the broader literature of interdisciplinary enquiry in water management.

2.5.1 Organisational Fit for New Knowledge and Changing Values

Advancement in engineering and environmental science has generated new ideas for the sustainable management of the water cycle and human interaction with it. However, limited application of this knowledge suggests that behavioural and institutional reasons may come into play. If this is the case, engineers need to understand how engineering knowledge is to be applied in the governing of the sociotechnical system of water use.

The current paradigm shift toward embracing sustainability, as outlined in Table 2-8, is generating a variety of knowledge and technological innovations. The extant sociotechnical water system tends to more readily generate and accommodate innovations that fit easily within the existing institutional frame[46]. As an example, Sydney Water's *Water Plan 21* (Sydney Water, 2002) focused primarily on: demand management; leakage reduction; pricing mechanisms; recycling effluent, stormwater and greywater; desalination; and accessing local water supplies (rainwater collection, aquifer storage and recovery). Subsequent New South Wales State Government decisions in favour of desalination show similar focus on interventions that match the existing linear, centralised sociotechnical system, despite environmental concerns.[47]

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[46] This is an example of structure influencing action as per Giddens' (1984) structuration theory (see Section 2.3.2.1.3). It is also an example of path dependence (Melosi, 2000).

[47] NSW Government Minister Frank Sartor made it clear, in his verbal address to a 2005 international conference in Wollongong on "Integrated Concepts in Water Recycling", that this decision was premised on the conviction that people would not accept recycling (Colebatch, 2008, pers. comm.).

These measures are similar to those proposed by water managers throughout the developed world (Maksimovic and Tejada-Guibert, 2001; OECD, 2003); they generally fit into the existing sociotechnical system.

Much knowledge for a more sustainable water use regime now exists. There are many different technologies and physical system designs that demonstrate improvements in at least some aspects of sustainability. But those that are more difficult to implement or manage unless there is a challenge to the existing sociotechnical system seem to have little impact. This may be because they are not supported by organisational/regulative structures (and to some extent shared values and norms, also).

Historically there has been a fit between organisational structure and the values and knowledge behind traditional solutions, where the established technical engineering bureaucracy was taken for granted. However, shifting knowledge and values leads to the institutional setting coming under stress.

While the emergence of new knowledge for decentralised physical systems has been clearly documented, emerging new values are less often explicitly spelt out in the literature. The second research question focuses on the institutional dynamics surrounding the emergence of more user involvement in water management. This question is much more about values than knowledge for sustainability. Evidence for any change of values or institutional dynamics is not so easy to document. It is not argued that both decentralised physical systems and user involvement are necessary corollaries, so the research questions can be examined somewhat independently. But they are also related, in that decentralised physical systems are often tied to increased user involvement, whether in perception or in reality.

Figure 2-3 illustrates an idealised model of institutional stress, adjustment, and the institutionalisation of emerging discourse – as knowledge, values and regulations all shift. Reconceptualisation of water cycle management has occurred extensively in the cognitive sphere (as outlined in Section 2.4). However, a corresponding shift in norms is not as evident, while a regulatory shift is even less evident, as shown in the figure.

This figure conflates both research questions, for the purposes of illustrating the process of adjustment in institutionalisation. But, as stated above, the values and regulatory shift toward user participation and responsibility are not argued to be necessary corollaries to decentralised physical technologies. In fact, the link is tested through one of the hypotheses put forward for testing (Hypothesis 2.3, see Table 1-3).

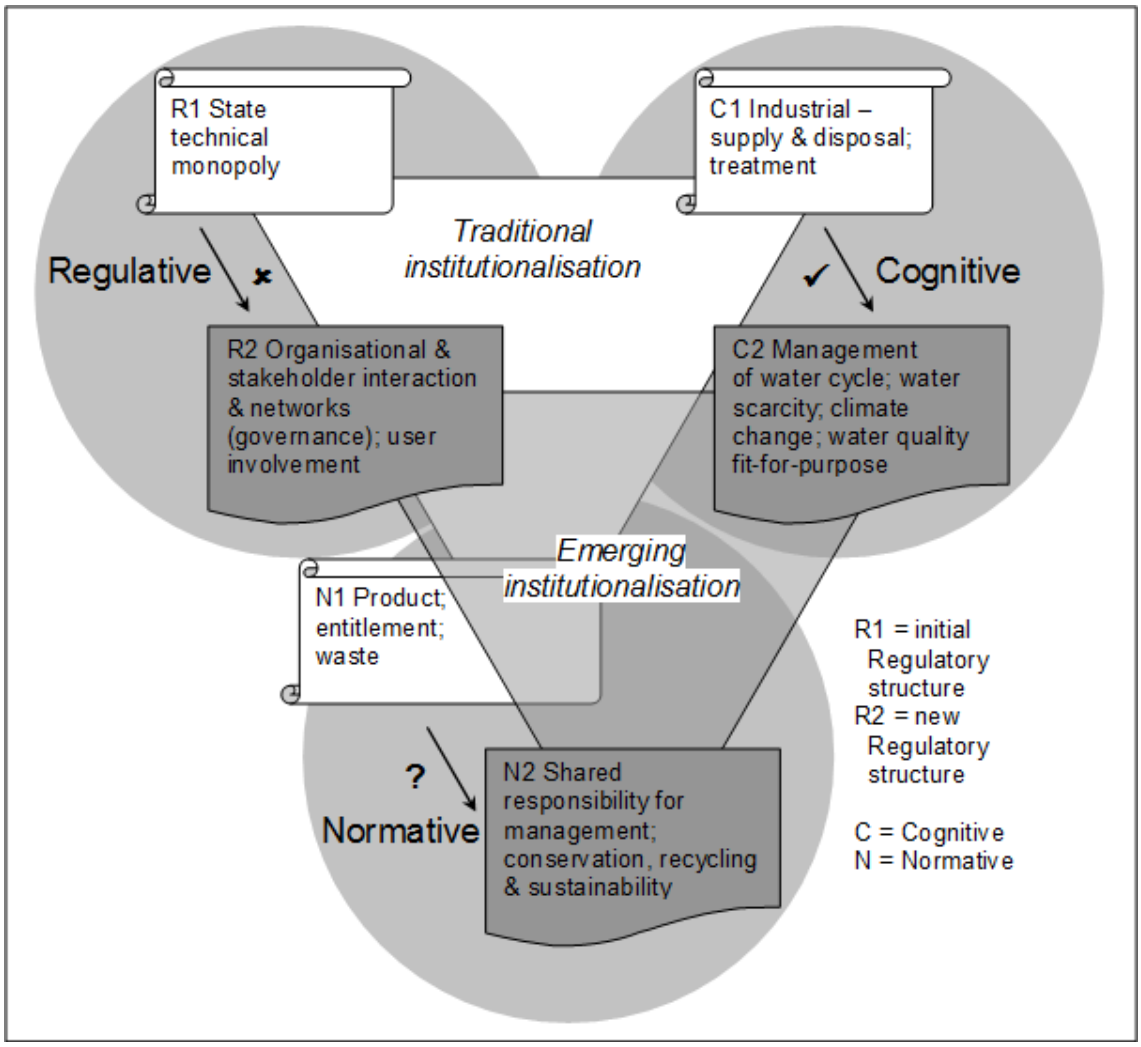

Figure 2-3: Transition from traditional to emerging institutionalisations of water management

Figure 2-3 alludes to the working hypotheses (see Table 1-3) brought into the case study research. Hypotheses 1.1, 1.2, 2.1 and 2.2 all suggest that change to decentralised technologies (1.1 and 1.2) or user involvement (2.1 and 2.2) requires shift in all three of Scott's pillars (1.2 and 2.2) and will not succeed if there is misalignment of these pillars (1.1 and 2.1). Hypotheses 1.3 and 1.4 extend the proposition that, to institutionalise

adoption of decentralised technologies in urban water management, more is required than just a cognitive paradigm shift. While ideas for sustainable urban water management practice are obviously necessary, Hypothesis 1.3 proposes that, to have any impact on practice, such emerging ideas need an organisational location where they are considered to be part of acceptable discourse. Hypothesis 1.4 proposes that a conducive organisational structure will include a broad network of stakeholders with diverse discourses.

Hypothesis 2.3 proposes that the acceptance of user involvement is a helpful condition for enabling uptake of decentralised physical technologies. Thus the link between user involvement and decentralised physical technologies is not simply assumed but tested.

2.5.2 Interdisciplinary Directions for Water Management Research

Past attempts to improve the water system, and more recently, its sustainability, have focused on technological efficiency and innovation (Moss, 2001c, p. 5). However, recent challenges and difficulties have suggested that a wider perspective on problem definition – including the institutional aspects of the sociotechnical system – is needed (Moss, 2001c, p. 5).

The tendency to focus initially on technological solutions (e.g., see the discussion in Section 2.4.3.1) is reflected by the Australian Government's 'National Research Priorities' statement of 2002 and subsequent enhancements in 2003 (DEST, 2003). The priority listed first is sustainability, and the first goal listed under sustainability is improving water use and reuse. The statement of enhancements notes that after releasing the initial priorities, the government collaborated with social science researchers and modified the framework "to ensure that scientific and technological applications – many of which have significant economic, social or ethical implications – take account of the community's capacity to initiate and respond to change" (DEST, 2003).

This shift of focus from technological fixes to social behaviour/acceptance and then on to active public engagement in water policy and management (see Figure 2-4) is argued

to be a necessary step toward sustainability (Stenekes *et al.*, 2006). This thesis is based on the possibility of yet further gains through a broadening of focus (or paradigm shift) to include institutionalisation of decentralised options as an alternative to the existing institutional structure supporting centralised water management.

Sustainable urban water management in Australia is a multi-dimensional challenge, of which technological innovation is only one of many important foci for research. This thesis focuses on the institutional aspects of urban water management: the policy and organisational challenges (and innovation) for transition toward what is proposed to be a more sustainable water management approach – i.e., closing the loops of water and nutrient transport through decentralised management options.

The focus on decentralisation of water management also partly rests on the interest (see the second research question) on the possibility that such an approach may provide a more realistic scale for greater social sustainability through public engagement in and ownership of the provision of urban water services.

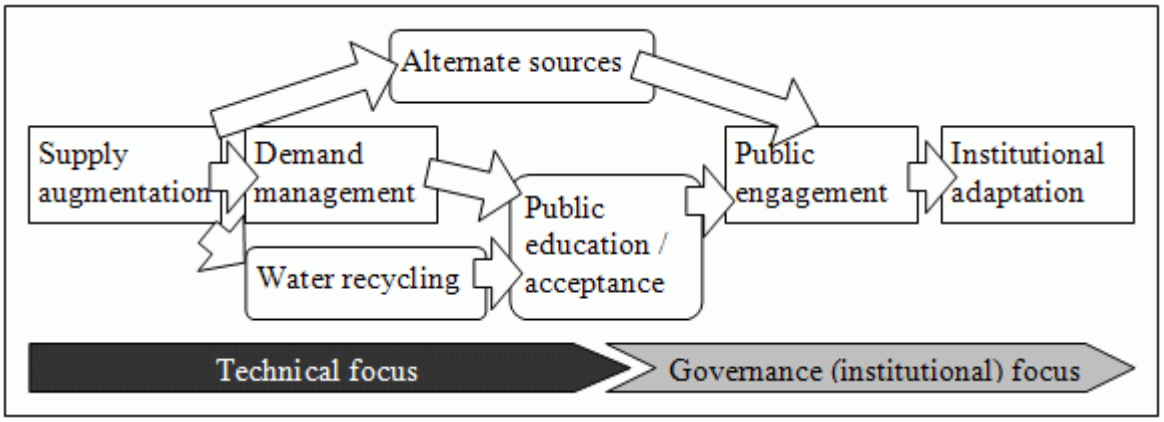

Figure 2-4: The changing paradigms and foci of water management underlying the research direction of this thesis (adapted from Livingston *et al.*, 2004b)

Problems of sustainable water management are increasingly recognised as multi-disciplinary (Jeffrey *et al.*, 2000; Loucks *et al.*, 2000; Maksimovic and Tejada-Guibert, 2001). This research helps build the small but growing empirical base for the use of new institutional theory in environmental studies. There is a significant gap in the

understanding of social (and in particular institutional) dimensions of implementing and managing decentralised technologies for urban water management. This research attempts to bridge engineering and social science disciplines to contribute to filling that gap.

The theoretical framework primarily employed in this thesis is Scott's three pillars of institutions, from the sociological theory of new institutionalism. This framework is supplemented by additional social sciences frameworks and approaches, including the social construction of the policy process and its associated discourse. This has important bearings on the research methods, as explained in the following chapter.

3 Research Method

This chapter provides elaboration and defence of the research design. The research questions outlined in Chapter 1 focus on the examination of institutional explanations or factors that might be important for understanding why centralised water services options tend to be favoured over decentralised options (even though the latter may contribute to more sustainable outcomes), with the view to identifying how decentralised options could be more successfully institutionalised. The 'institutional approach' chosen for this study was introduced in Chapter 1 and elaborated in Chapter 2 as Scott's (1995) formulation of institutions as carriers of social order through established knowledge, values and regulatory structures. The choice of research questions and an institutional perspective guided the choice of methods.

3.1 Rationale for Choice of Methods

The application of such an institutional approach to the research questions was achieved primarily through the method of investigation of cases of attempts at decentralised innovation. Data collection for the case studies was performed through interviewing and document review. Prior to selection of the case studies, additional scoping interviews and an on-line survey were also performed. These helped guide initial understandings of professional norms and practice in water management, thereby leading to refinement of research questions, hypotheses, methods and case studies chosen. The samples for the initial scoping interviews and on-line survey overlapped the case study interview samples to some extent. The rigour of each of these methods has been refined primarily in the tradition of the social sciences (Babbie, 2004; Neuman, 2003); however, they have inter-disciplinary application.

The following theoretical propositions guided the research design:

- Water services provision is understood as being a sociotechnical system (requiring inter-disciplinary research methods addressing both social and technical aspects);

- Institutions are the carriers of technology in sociotechnical systems, being the sedimentations of what is known (discourse based on social constructs), valued, and regulated or organised; and
- Institutions constrain and enable social action; and are the product and source of such action (i.e., structuration, as outlined in Chapter 2).

The chosen mix of research methods was selected from a wider range of possible methods in order to appropriately answer the research questions. The chosen mix had to provide data that could be used to analyse institutional aspects of water management practice. This suggested qualitative research methods, including:

- Document review (which could include legal, policy, operational, design, communication, public relations, etc, documents);
- Field observation;
- Questionnaires;
- Interviews;
- Focus groups; and
- Case studies.

Many of the above methods were used to collect scoping and/or case study data. While field visits were made for each of the case studies, there were no phenomena observed or measured directly that contributed to the analysis. The key phenomena were social processes, which, in most cases, occurred at times (e.g., the past) or in places that were not accessible[48]. Focus groups were avoided because of the added complexity in ensuring reliability of data compared with individual interviews. (However, there were occasions when interviews were conducted with two respondents at the same time.)

The scoping interviews and on-line survey (or questionnaire) were useful for preliminary scoping research, but were found to offer limited insight into institutional processes around water management decisions. Random sampling across multiple water

[48] One meeting of the Gold Coast Waterfuture Advisory Committee was attended on 3 March 2005, but agenda items were not directly related to the Pimpama Coomera case.

management situations and standardised questionnaires were found to return data that lacked the level of detail and completeness for understanding the institutional factors behind water management decision-making. For this reason, data returned from these methods are only briefly reported in subsequent chapters. Their role was primarily in refinement of the research method, choice of case studies and refinement of the research questions and hypotheses.

Use of multiple methods and multiple sources is considered desirable in qualitative research, insofar as it builds 'triangulation' or verification of the data (Yin, 2003b, pp. 97-99). Data was primarily sourced through interviews and document review for the case studies. Scoping interviews and the on-line survey weakly supported the case study approach, but are not relied upon to support the conclusions of this research. The on-line survey was also only relevant to the region of three of the four case studies. The lack of an equivalent on-line survey for the fourth case is justified for two reasons. One is that the context for the fourth case was a different state with quite different legislated and organisational arrangements for managing water (state government versus local government). The other is that the on-line survey results play only a very minor role in supporting the conclusions of the case study analysis for the three relevant cases.

3.2 Ethics and Consent

Research involving humans was conducted under ethics approval granted by the University of New South Wales. This included all interviews – both scoping and case study interviews – and the on-line survey. The procedure was followed such that before participating in the study, each potential participant was given:

- Disclosure of study purposes and intended circulation of arising publications;
- Assurance that their identity and that of any other parties referred to would be kept confidential (unless otherwise desired); and
- Opportunity to consent to continue, or withdraw with no further participation.

Original full interview transcripts were kept in password secured electronic audio and text files. Where excerpts of interviews were circulated (e.g., as quotes in publications), names and any other identifying data were removed. Thus confidentiality and

anonymity were preserved throughout. Exceptions occurred in a few interview cases where the nature of the persons' positions meant that to quote them may leave little doubt as to their identities for readers with inside knowledge of the cases studied and/or Australian water industry key players. In these cases, the individuals concerned gave prior consent for their identities to be revealed. In reporting the case study data, their identity has not been explicitly revealed but the identities may be apparent to some readers.

3.3 Scoping Interviews of Water Industry Key Players

About 20 scoping interviews were carried out over the course of about one year, early on in the study (i.e., 2004). The purpose of these interviews was to explore the research problem and refine the research method, such that the thesis questions would be meaningful to the water industry, and understanding of water industry professional norms and practices would be enhanced. Further, data gathered during the in-depth case studies was more readily understood in light of the scoping interviews. Thus the scoping interviews shaped the understanding of how practitioners perceived the problem of managing urban water sustainably, thereby providing a sense of what things are considered (by the industry) as doable and worth discussing (e.g., in this thesis).

Interviewees for the scoping study were selected using a snowball purposive sampling technique (Babbie, 2004, p. 184). This meant that subjects were sought from a variety of different categories, as outlined in Table 3-1, and that interviewees were asked to suggest other people that could be interviewed. The sample included people from New South Wales and Queensland (and one from the Australian Capital Territory) from a variety of professional backgrounds. Some participants were opposed to decentralised water services provision; others were strong protagonists for change. Some were from top management; others were in lower levels of management. Table 3-1 outlines the professional background and location of the scoping study interviewees (as well as case study interviewees, discussed later).

Table 3-1: Interviewee breakdown for scoping interviews and case studies

Participant Group	Scoping Interviews	Bundeena Maianbar Case	Three Cases in Queensland	Sub-totals
State Government	7	5	14	26
Water service provider	5	8	7	20
Resident community		9	3	12
Council officers	2	3	6	11
Consultants	2	1	3	6
Environment groups	1	1	3	5
Developers			5	5
Councillors		1	3	4
Contractors		1	1	2
Academics	1		1	2
Water industry associations	2			2
MPs		1		1
Total	20	30	46	96

Notes:

- For further detail of case study interviewee breakdown see Table 4-3, Table 4-14, Table 4-25 and Table 4-32.
- There are some apparent discrepancies with the above tables due to different possible counting methods. See notes for each table to clarify.
- The three Queensland cases are grouped together because many of the participants were interviewed for more than one of the Queensland cases.

The format of these scoping interviews was semi-structured (Minichiello, 1995). Questions asked were somewhat dependent on the position and background of the interviewee; however, the following prompts were invariably used to guide discussion:

- What the participant thought would be sustainable water management;
- How the participant thought transition to such a situation could/would be achieved;
- Participants' experience in sustainability innovation (i.e., what projects they had worked for); and
- Their experience of and perspective on the institutional arrangements enabling/impeding effective water management (e.g., organisational structure, stakeholder relations, etc.).

In some cases there were two interviewees, and/or two interviewers[49]. Transcripts were created either from audio recordings (if the interviewee consented to being recorded) or from written and/or typed notes taken during the interviews.

3.4 On-line Survey of Water Management in Southeast Queensland Councils

An on-line (Internet) survey was carried out after most of the scoping interviews were completed. The purpose of this survey was to understand water and wastewater management decision-making within local-government water management authorities in southeast Queensland[50]. Thus a useful contrast was provided between the background/normal professional practice of water management, and the case studies, which each highlight somewhat unique cases of innovation[51].

The standardised on-line survey was structured to gain a contextual understanding of the planning processes occurring in local government as they related to water recycling – from the perspective of those in the council most responsible for water recycling project management. There were 34 questions in total (see Appendix A). A variety of response types were elicited, including multiple choice, rating-scale and open-ended. The survey was modelled on the work of Brown (2003), who surveyed local governments in New South Wales regarding organisational implementation factors for stormwater management.

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[49] The other interviewer was a fellow Ph.D. student, Nyree Stenekes. She used these shared interviews in her scoping and/or case study methodology for her Ph.D. thesis (Stenekes, 2006).

[50] The survey was also done in collaboration with fellow Ph.D. student, Nyree Stenekes. It had a focus specific to her research focus on water recycling (Stenekes, 2006), but included questions about decentralised initiatives for sustainability.

[51] This is not to say that the local-government water authorities surveyed did not display innovation in pursuing sustainability in water management. Rather, the on-line survey provided a useful comparison of commonplace practice against a methodologically more specific case study approach for particular cases of innovation (failed or successful).

The survey was restricted to the 19 southeast Queensland councils. It targeted the employees of each council (or each council's corporatised water authority) most responsible for decision-making and planning of water services projects. After identifying the appropriate person, the web address of the survey was emailed to the 19 target people (one per council), and responses were received from 11 of these. The three Queensland case studies were all located in two of the 19 southeast Queensland councils, but only one of those two councils was included in the 11 respondents[52].

The survey was divided into six themes, covering:

- Personal professional background;
- Nature of council's water recycling projects;
- Planning processes (internal workings of council);
- Decision-making processes;
- Stakeholder involvement (and external relations to other organisations); and
- General feedback.

The analysis was both qualitative and quantitative: though with only a small sample, statistical significance testing was not possible.

The on-line survey method is a relatively new technique that offered some significant advantages, although it also has some drawbacks (Mann and Stewart, 2000, pp. 66-75). The main reason for choosing the on-line approach was the logistical ease and speed of obtaining and processing results. Some of the drawbacks of this method included a small amount of extra preparation time in selecting and learning an appropriate on-line instrument, and also a possible sampling bias potentially favouring more computer-literate participants. However, given the widespread use and access to the Internet within managers in local councils, the latter bias is not considered significant. In fact, given that the target group would have been accustomed to working on-line, it was thought that this approach would increase the response rate.

[52] The specific council is not named to preserve anonymity, as agreed with survey participants.

3.5 Hypothesis Building from Scoping Interviews and On-line Survey

As already stated, the purpose of the scoping interviews and on-line survey was to refine the method (including informing case study selection) and to refine the questions and hypotheses used in the research process. This section documents how the results of these preliminary methods informed the building of hypotheses.

3.5.1 Hypothesis Building from Scoping Interviews

The scoping interviews confirmed that decentralised technologies were widely considered as having more potential than indicated by their actual uptake. This gave support to the overall value of the research, and also the specific hypotheses that institutional factors are important to both exclusion and inclusion of decentralised technologies. The identification of institutional factors on which further research could focus was also aided by the scoping interviews. Many participants were frustrated with perceived regulatory, organisational and cultural inhibitors to innovation and an apparent bureaucratic commitment to traditional and risk-averse approaches. These findings contributed to Hypotheses 1.1 and 1.2 (see Table 1-3 for all hypotheses).

Participants also frequently expressed a desire for a favourable re-aligning of organisations, such that better coordination and focus on policy and technology innovation for more sustainable water management could be possible. Recurring ideas for more sustainable water management included recycling, reducing demand, more integration and closing of loops (including decentralised options). This broadly supported and contributed to the formation of Hypotheses 1.2 and 1.3.

Many of the scoping interview participants also suggested that more stakeholders and players could be beneficially involved in water management decision-making and/or operation, including household water users. This finding contributed to Hypotheses 1.4, 2.1 and 2.2.

3.5.2 Hypothesis Building from the On-line Survey

The on-line survey highlighted how local councils typically framed water management problems technically. Water management problems were also dealt with by technically trained and focused departments, using technical decision-making tools. There was not much integration with other stakeholders or factors outside engineering-related council departments. Further, most innovation reported followed a centralised infrastructure model. These findings all contributed to the formation and refinement of Hypotheses 1.1 through 1.4. For more detailed results of the on-line survey, see the paper (Livingston *et al.*, 2004a) reproduced in Appendix B.

3.6 Case Studies of Centralised and Decentralised Projects[53]

Studies of real-life organisational processes, with complex interlinking of variables that are difficult or impossible for the researcher to control, are ideally suited to case study research (Yin, 2003a, b). However, case study research also has its limitations and critics, given that (just as with any form of research, although often more so in case study research) it is particularly difficult to eliminate bias, to be systematic/repeatable, and to generalise to entire populations. However, this research attempts to draw conclusions that are able to be generalised conceptually rather than statistically. Research for statistically significant findings in such a new field of study, with minimal extant impact on policy and practice, is not yet a practical option due to the small number of cases of decentralised innovation. Further, the demands of the institutional approach require in-depth analysis of qualitative data from a small sample size (due to the practical time and human resource constraints on conducting in-depth research).

3.6.1 Selection of Cases

To be suitable, each case needed some form of innovative decentralised water and/or wastewater technology or system (in contrast to current conventional systems) to have at least been considered (e.g., by the project proponent or other key players), if not adopted. Emphasis on user involvement, or the consideration of its inclusion, was also

[53] This section is based on the extensive work of Yin (2003a; 2003b) in establishing the case study as an accepted and documented form of social scientific research.

desirable for the second research question. But this criterion was difficult to meet; and the first research question was considered as the primary question and the second one only secondary. Therefore this criterion was not forced.

For a case to be included, it needed to be recent or current, so that data were more readily available. It needed to be for an urban (or peri-urban) and preferably residential location. Accessibility by the researcher was also a guiding criterion; hence cases were restricted to regions associated with two state capital cities in Australia: Sydney and Brisbane. Out of an initial list of about ten, four cases were chosen. More detailed selection rationale for each case is outlined in Table 3-2. The basis for selection of the initial short-list was that the author (and/or research team at the University of New South Wales) had an existing knowledge of, or connection to, the case.

Table 3-2: Rationale for selection of case studies from short-list

Case	Location	Selected	Reasons for Selection or Non-selection
Bundeena Maianbar water cycle management strategy	Sydney, NSW, Australia	Yes	Decentralised options well documented but not chosen. Important to include a case with a 'negative' outcome.
Kogarah Town Square	Sydney, NSW, Australia	No	Key players did not return attempts of contact.
Michael Mobbs' Sustainable House	Sydney, NSW, Australia	No	The case was considered too 'niche' and thus not able to be generalised.
Bringelly development area	Sydney, NSW, Australia	No	Lack of access to, or awareness of, case specifics, given it was at an early stage.
Fig Tree Place	Newcastle, NSW, Australia	No	This case is the subject of, and in part a product of, other research.
Aurora	Melbourne, Victoria, Australia	No	Access: it was decided to work in Queensland rather than Victoria, in addition to New South Wales.
Inkerman Oasis	Melbourne, Victoria	No	Access: as above.
Pimpama Coomera Waterfuture	Gold Coast, Queensland, Australia	Yes	This case is considered a leading example of innovation in Australia, and includes some decentralised components.
Payne Rd residential subdivision	The Gap, Brisbane, Queensland, Australia	Yes	This case had a significant number of decentralised components, and key players were accessible.
Currumbin Ecovillage	Currumbin Valley, Gold Coast, Queensland, Australia	Yes	A leading example of a fully decentralised community water system in Australia.
Gebers Ecovillage	Stockholm, Sweden	No	Access: while including data from other countries would have been extremely valuable, it was considered impractical and beyond budget. (This eco-village, and others in Sweden, were visited by the researcher in 2002.)

More details of the four chosen cases are outlined in Table 4-1, and their locations are shown in Figure 4-1. There was a deliberate variation in a number of factors; and such variation was considered desirable for the sake of comparison. An advantage of including a project (Bundeena Maianbar) considered unsuccessful from the point of view of achieving innovative/decentralised/integrated water management is that "unsuccessful" projects are rarely reported compared to the "success stories" of integrated urban water management (Mitchell, 2004).

All case studies were low density residential. This was not by design, though, as decentralised water services provision for high-rise buildings could also have been within the scope of this research. Inclusion of a case with high density dwellings would have made for an even more robust and generalisable case study selection. While attempts were made to find a suitable high-rise case study, a practically accessible one was not found.

3.6.2 Case Study Unit of Analysis

The unit of analysis for each case study was the entire sociotechnical system, with an emphasis on the institutional (rather than technological) components: i.e., cognitive/knowledge frames, values/norms and organisations/regulations. The question was how these institutional factors impact on the technologies considered and chosen, and how change in the prevailing typical institutional arrangement may impact on future outcomes (e.g., through greater acceptance of decentralisation).

3.6.3 Data Sources

Data was collected up until early 2006, primarily by interviewing key participants, but was also collected from documents relating to the case studies. The key players were chosen as those people who were most influential and/or vocal in the project planning process. Document review was useful for providing background factual information, and as a source for verifying some interview data. Documents, however, were not usually as good data sources as interviews for answering 'how' or 'why' questions or identifying diverging discourses and perspectives. The documents reviewed included planning documents and reports, letters, minutes, and news clippings.

3.6.4 Interviewee Sampling Technique

Almost 80 case study participants were interviewed, spread fairly evenly across each case (see Table 3-1). Participants were selected with a snowball purposive sampling technique (Babbie, 2004, p. 184; Minichiello, 1995, p. 160). In practice, this meant that, as potential interviewees were contacted, and at the end of each interview, the participant was asked who else was influential (or would be a good person to interview). The sampling method was also purposive, in that interviewees were sought from a variety of pre-determined categories (as outlined in Table 3-1). The measure of success of this approach was the degree of convergence or divergence that the ensuing suggestions yielded. For each case a high degree of convergence was achieved such that there were rarely situations where a decision was needed to choose between too many potential interviewees. On only one occasion was an interview aborted due to the interviewee being unsuitable due to lack of participation/stakeholding in the project.

The snowball sampling technique cannot be defended as being a means of surveying the general attitudes, beliefs or values of a particular category of people (such as the community). Rather, snowball sampling identifies the key participants and how their knowledge and values framed and influenced action and outcomes. For example, it was widely reported that the majority of community members in Bundeena and Maianbar were very eager for a conventional sewerage solution. This was verified by reports of surveys conducted by project staff and community members. However, the snowball sampling technique tended to select those community members who were more active or vocal in the process – particularly those with dissident ideas. While bias toward active participants is in most respects desirable for this type of research, the probable misrepresentation of the community's majority view due to the dissident views of interviewees selected was recognised and partially counteracted as explained in Section 4.1.2. Potential bias in sampling of community participants is considered far less significant for the three other cases, all of which were greenfield developments (i.e., with essentially no resident communities).

3.6.5 Interview Format

In-depth interviews were conducted using a semi-structured format (Minichiello, 1995, p. 68). All participants were asked the same general questions (or prompted with keywords), but were allowed to respond at length as appropriate to them. Sometimes participants pre-empted questions they would otherwise have been asked. The advantage of minimal interviewer-guidance was that less bias was introduced through wording of questions. When responses were not clear, follow-up questions were used as demanded by the circumstance.

The schedule of questions was open-ended, and essentially the same for each of the four case studies. A general introduction to the research project was given, stating the specific interest in the interviewee's perspective on the planning and decision-making aspects of the project. The questions followed this general outline:

- What was your involvement in the project?
- Why did this project come about?
- How was the decision (for water management system/s) made?
- What are your comments on the involvement and perspective of other relevant groups – e.g., regulators, community, etc.?
- Is the project considered a success?
- Do you think the community have become more aware or involved in taking responsibility for conserving water as a result?
- Who else should be interviewed?

The duration of interviews varied from a quarter of an hour to two hours, though interviews typically lasted 30 to 40 minutes. In most cases the interview was recorded. Transcripts were produced either from the audio recording or from handwritten notes when a recording was not possible. (Some participants objected to being recorded, or their company policy prevented it, and sometimes there was no functional recording equipment.) Transcripts were typed for further analysis.

The author conducted the interviews, and generally interviewed one participant at a time, although in some cases two were present. While a reasonable effort was made to

maintain neutrality on the issues raised, it would have been likely that interviewees positioned the interviewer as being pro-environmental from the introduction and questions given (even though the introduction and questions were kept very general), and this may have altered the responses given (cf. Kurz *et al.*, 2005). Further, language is an 'institutional fact' (Searle, 1995) subject to interpretation and cognitive framing, as has been argued for the analysis of the sociotechnical system of water management (see Section 2.3.2.1.6). Thus the evidence of data and argument on which this analysis is based is itself subject to processes of framing and interpretation. Therefore the method is designed and defended to be 'intersubjective' (Neuman, 2003, p. 74) rather than 'objective'.

3.6.6 Transcript Coding and Analysis for Case Studies

Transcripts were typed and coded for analysis using established methods of transcript analysis in social sciences (Minichiello, 1995). The coding and analysis were done both by hand and also with supplementary use of a coding and analysis computer program called The Ethnograph (Qualis Research, Colorado Springs, CO). The Ethnograph software package was only used for the Bundeena Maianbar case, due to time limitations. In addition, the software was not found to add significant rigour to the analysis beyond that of manual methods of coding, sorting and pattern-matching. The transcripts were coded using a list of code words corresponding to key words or themes relevant to the overall research questions. Selection and application of these code words through an iterative analysis process both reflected and helped to identify the significant discourses present. An example of part of a coded transcript is provided in Appendix C.

Explanations of case study outcomes are built by looking for patterns in interview transcripts, and matching these patterns with theoretical propositions (e.g., about institutional elements, such as: who gets to participate; what talk is considered acceptable; how it is framed; and what organisational forms or rules impact on what is valued or discussed). The method of analysis is made clearer in the case study analysis (Chapter 4).

3.7 Reliability and Validity of Research

Social enquiry usually takes place in a rich context with variables that are more numerous and more difficult to isolate than in the case of physical sciences. This means that reliability and validity may be more difficult to achieve in research using social science methods than in research using methods from the physical sciences. Reliability of the case study-based method was enhanced through adherence to the protocol as outlined in this chapter, and documentation of each step as it was carried out (Yin, 2003b, pp. 37-39). Reliability and validity were both maximised through triangulation of methods and data sources (multiple interviewees and documentary evidence within each case study) (Yin, 2003b, pp. 97-99). Generalisability of case study research is sometimes criticised; however, the use of a multiple case design is intended to overcome this drawback. This case study research was not intended to be statistically generalisable but analytically generalisable (Yin, 2003b, p. 37).

4 Case Studies of Decentralised Urban Water

This chapter summarises data from four case studies and provides analysis that seeks to answer the research questions and test the associated hypotheses as discussed below. Table 4-1 gives an introductory overview of the significant engineering or physical aspects of the four cases that contributed to their selection as examples of (or opportunities for) decentralised water management innovation. Case locations are shown in Figure 4-1. The cases were selected to give some variety in institutional contexts, scale and innovations implemented. The extent of variation of these and other factors, together with emphasis on qualitative in-depth (rather than quantitative) methodology (see Chapter 3), mean that statistical generalisations are not appropriate, and thus a small and diverse sample is acceptable. A summary of the institutional analysis is provided at the conclusion of this chapter, through a cross-case comparison.

Table 4-1: Overview of cases chosen for study

	Bundeena Maianbar	**Pimpama Coomera**	**Payne Rd, The Gap**	**Currumbin Ecovillage**
Stage at time of writing	Operational	Master plan approved; construction commenced	Development approved; construction one-quarter completed	Development approved; construction commenced
Green/brownfield[54]	Brownfield	Greenfield	Greenfield	Greenfield
Number of houses	1,200 lots (two suburbs)	50,000 lots (two large suburbs)	22 lots	144 lots
Driver	Sydney Water	Gold Coast Council	Developer & consultants	Developer (Landmatters)
Degree of decentralisation / type of system(s)	Conventional centralised system	Water cycle loop more closed with large-scale dual reticulation; rainwater tanks; grass swales	Significantly decentralised: 75% water sourced from rainwater tanks; greywater reused on-site	Completely decentralised: subdivision is self-sufficient for water / sewerage
Community involvement in operation and maintenance of water management system(s)	None	Minor role for householder maintenance of rainwater tanks (though policy not finalised, GCCC, 2005)	Body corporate responsible for shared infrastructure; householder for own tank(s) / greywater system	Bodies corporate responsible for shared infrastructure; householder for own tank(s)

[54] 'Brownfield' is used to identify locations where existing residential or commercial development exists, and 'greenfield' where there is none.

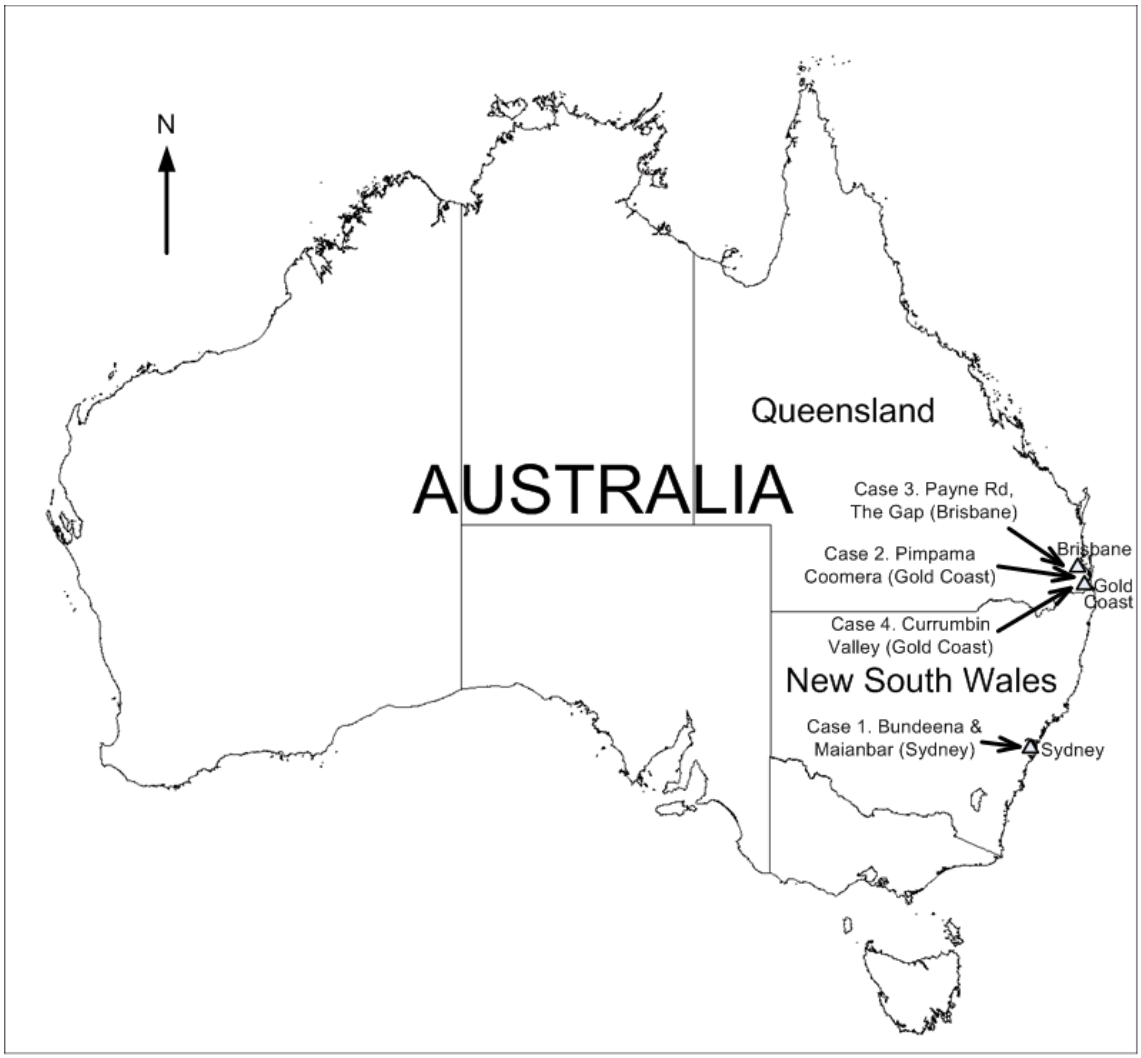

Figure 4-1: Case study location map

The first case (Bundeena Maianbar) concerns a project with a centralised outcome. The data from this case contribute to answering Research Question 1: To what extent do institutional factors operate to include or exclude decentralised technologies in urban water management? Since this is a case where decentralised options were excluded, the case provides data appropriate for testing of Hypothesis 1.1: Innovative decentralised technologies are excluded from urban water management because of entrenched or otherwise misaligned institutional factors: knowledge, values and organisational structure/regulations. This hypothesis could be somewhat and guardedly confirmed by observation of a very wide range of phenomena; but the interview-based nature of the research method restricted the range of observation possible for this research. Thus it

may be expected that there would be statements suggesting regulative, cognitive or normative bias of individuals and/or organisations against decentralised outcomes. The presence of detailed and scientific technical assessment supporting centralised options may suggest rejection of the hypothesis, if it is clear that there is sound reasoning to support centralised options.

The remaining three cases concern projects with, to varying extents, decentralised physical water management technologies and approaches. The data from these cases also contribute to answering Research Question 1: To what extent do institutional factors operate to include or exclude decentralised technologies in urban water management? These cases provide data appropriate for testing of Hypothesis 1.2: Successful uptake of decentralised technologies in urban water management requires a combination of shifts or innovation in all of three institutional factors so that they are aligned: knowledge, values, and organisational structure/regulations. Hypotheses 1.3 (see Table 1-3) is also tested with evidence from these three cases. For Hypotheses 1.2 and 1.3 (in particular) to be supported, one would expect successful decentralised innovation to be linked with organisational change. The presence of a case (including beyond the four studied in this thesis) in which decentralised innovation occurred within an established organisation would bring Hypothesis 1.3 into question.

A variety of actors from different stakeholder groups were involved as key stakeholders in each case (see Table 4-3, Table 4-14, Table 4-25 and Table 4-32); therefore data from each case help to test Hypothesis 1.4.

Each of the cases was different in terms of the amount of user involvement and responsibility planned for ongoing water management. Ideally one or more of the cases in the study would have included observation of householder interaction with decentralised water management innovations. However, the three cases that include decentralised innovations were, at the time of research, each under construction and completely (or, in the case of the Pimpama Coomera region, almost completely) yet to be inhabited. So Hypotheses 2.1 to 2.3 are still able to be tested, but not with as much depth or rigour as Hypotheses 1.1 to 1.4.

The presentation of each case follows a similar pattern. A brief background and project overview is presented first, followed by an institutional analysis to account for the institutional factors driving the respective outcomes. The cases are presented with decreasing amount of detail and explanation for each successive case. Analysis or explanation that applies generically is not repeated for each case since the presentation of each case follows a similar pattern. Further, the final two cases are smaller in most respects with fewer applicable document or interview data sources. The chapter concludes by bringing the discussion of the cases together in a cross-case comparison to answer the questions as outlined above.

4.1 Bundeena Maianbar Priority Sewerage Project

The Bundeena Maianbar water cycle management case study was chosen as an example of a case in which decentralised water management was one of the options considered for a brownfield site, but not adopted. This case illustrates an established organisational and regulatory structure with no organisational location for ideas and values supporting alternatives to the traditional centralised approach to water management.

4.1.1 Case Overview

Bundeena and Maianbar had no reticulated sewerage until 2001. Until then, most homes had septic tanks, pump-out systems or on-site aerated treatment systems (in decreasing order of prevalence). Due to ongoing problems associated with poorly maintained on-site systems, and a broader State Government Priority Sewerage Program, improving Bundeena Maianbar's water and sewerage systems became a focus for Sydney Water during the 1990s (the planning stage) and early 2000s (the construction stage). During the planning stage there were a number of options put forward and discussed, including local treatment and recycling, improved on-site systems, and transferring sewage to Cronulla. The latter option was chosen.

4.1.1.1 Background[55]

Bundeena and Maianbar are neighbouring peri-urban suburbs at the southern extremity of Greater Sydney, 36 km from the central business district. They are each entirely bounded by the Royal National Park and Port Hacking. A small stretch of national park separates the two suburbs (see aerial photo in Figure 4-2). The villages were originally settled illegally by squatters and fishermen. Such villages would most likely never have been planned under government town planning, due to their location on the foreshore of the Royal National Park. The combined population is relatively stable at about 2,700. (There are a number of holiday houses with temporary residents, such that this population swells significantly during weekends and holiday periods – though this trend has decreased as the permanent population has increased.)

Figure 4-2: Aerial photograph of Bundeena Maianbar and surrounds (source: Google Earth, http://earth.google.com, accessed 7/5/2006)

[55] Background information is drawn from PHPS (1997), SKM (1996) and Water Board (1992).

Houses were first built along the waterfront (beaches) of both suburbs. Later, Bundeena in particular extended back in toward the national park. However, there is now a definite boundary around the edge of the existing developed area beyond which no further expansion is permitted.

Commuters and high school students from both suburbs use an (approx.) hourly ferry service between wharves at Bundeena and Cronulla. Tourists and visitors also use this ferry service. There is one road through Royal National Park that connects the suburbs to Sydney. This road diverges for the two suburbs some distance away from each suburb, meaning that to drive between the two suburbs takes more than 10 minutes. Sutherland is the nearest main shopping and administrative centre – with the local council offices. To drive to Sutherland from either Bundeena or Maianbar takes more than 30 minutes.

There is a mix of residential, business and parks land zones, but no industrial. The vast majority is residential. Most properties in Bundeena and Maianbar are on sandstone hillside slopes, with shallow sandy soil. There are also some properties on low-lying estuarine areas with alluvial soils, or on sand dunes. The low-lying areas typically have a high water table and poor drainage, and are thus prone to flooding. Bundeena and Maianbar's average annual rainfall is 1290 mm (Kinhill Engineers Pty Ltd, 1993). This is higher than in most other parts of Sydney (especially those not on the coast), which are typically closer to 1000 mm per annum.

There has been a piped water supply to Bundeena and Maianbar since 1946 (PHPS, 1997). Prior to the commencement of the sewerage upgrade project, there was only a single 200 mm pipe through the National Park supplying the Maianbar Reservoir, which in turn supplied the two suburbs. The pressure in this pipe was often very high, leading to frequent breaks and above-average losses. Further, the peak summer demand would put the supply system under stress for a few days each year. Tank water has been used in addition to the town water supply by some residents – including for drinking.

While piped water had been available for decades, the disposal of wastewater had been entirely on-site until the sewer was connected around 2001. The on-site disposal was a significant concern to residents, council and State Government due to the health and environmental problems associated with faulty, and/or poor management of, on-site systems.

Since the installation of piped sewerage, about 80% of the residents had connected to the sewer by the beginning of 2005. Those previously on pump-out systems were generally the quickest to connect, due to the high cost of the pump-out service (according to various interviewees, 2004-5, see Table 4-3).

4.1.1.2 Priority/Backlog Sewerage Project Overview

The State Government has had an ongoing Priority Sewerage Program (also known as Backlog Sewerage under previous governments). The purpose of this ongoing program is "to provide improved sewerage services to those unsewered areas within Sydney Water's area of operations where improvements to sewerage services have been assessed as likely to provide significant public health and/or environmental benefits" (Sydney Water, 2002). The NSW State Government, through collaboration among the Environment Protection Authority, NSW Health and Sydney Water, has determined the priority areas of this program.

The most typical problem associated with the existing on-site wastewater management was the overflowing of septic tanks due to poor maintenance. This problem was exacerbated by the terrain. Shallow soils and high water tables did not provide adequate or ideal seepage zones. This created potential health problems as well as deteriorated receiving water quality.

The process for implementing the improvements to the water and sewerage services for Bundeena Maianbar was driven primarily by the State Government, through Sydney Water. There had been ongoing discussion about possible introduction of sewerage infrastructure to the suburbs for several years leading up to the 1990s, when action occurred. Table 4-2 provides a chronological overview of the process.

Table 4-2: Chronology of water and sewerage improvement for Bundeena Maianbar

June 1991	Water Board sent information packages and questionnaires to all property owners Water Board information caravan situated in Bundeena Public meeting at Bundeena Community Hall attended by 350 residents – nominations made for representation on the Working Party
July 1991	Working Party meetings commenced (including tours of innovative treatment plants) Water Board produced and distributed newsletters (until mid-1993) Second community questionnaire Public display at Bundeena Community Hall
April 1992	Options Report released Community representatives disbanded from Working Party
Nov 1994	Presentation of consultants' findings to community representatives
Dec 1995	Letter sent to all property owners and residents updating on the project status
Aug 1996	Environmental Impact Statement (EIS) submitted
Sep 1997	EIS Addendum submitted
June 1998	Determining Authority's Report released Letting of contracts, preparation of design documentation
Sept 2000 to Mar 2002	Construction of water and sewerage infrastructure for Bundeena Maianbar

Sources: EIS (SKM, 1996), Options Report (Water Board, 1992), *Village Noise* newspaper, *St George & Sutherland Shire Leader* newspaper, unpublished local flyers, interviews

In the early 1990s there was a community consultation process put in place by Sydney Water, which led to an Options Report which Sydney Water (then the Water Board) produced (Water Board, 1992). The Working Party behind the Options Report consisted of 13 people from Sydney Water, 13 people from the community, and six people from other local and State Government authorities/stakeholder groups. This Report identified three favoured options:

- Local treatment with effluent reuse (60% of effluent would go to an ocean outfall, however);
- Transfer effluent to existing Cronulla sewage treatment plant (STP) and ocean outfall; or
- Improved on-site systems.

The report stated: "The Working Party believes that the local treatment option with effluent reuse is the most environmentally friendly solution and constitutes total watercycle management." This was not based on any detailed assessment, however, so the recommendation was for equal weight to be given to each option in the assessment of options in the Environmental Impact Statement (EIS).

The EIS was released in 1996 (after initially being promised for 1993), with a subsequent Addendum in 1997 to increase the rigour of the assessment. Both documents recommended the transfer of sewage to the Cronulla STP as the most favourable option. A fourth option, that of potable reuse, was introduced during the EIS process, but was not recommended.

During the period between release of the Options Report and the EIS, Sydney Water issued periodic newsletters to the community; but the consultation process ended at the time of the production of the Options Report.

Construction of the sewerage infrastructure did not commence until the summer of 2000/2001, and was completed just over a year later in early 2002. Since then, property owners have progressively connected to the sewerage network.

4.1.2 Interviewee Selection

Key players from the project were interviewed, using methods and rationale as outlined in Section 3.6. The original Working Party outlined above provided a useful starting point for the identification and selection of interviewees. Political players were also added, as were other players who were influential after the Working Party was disbanded. Some of the original Working Party members had moved or were otherwise difficult to contact. Thus in the end, only three interviewees came from the original Working Party group – all of them community representatives. See Table 4-3 for a breakdown of the interviewees.

The community representatives provided an atypical sample of the community, however, due to the prioritisation of selecting those who were vocal and/or influential. Recognising this, the proprietor of the local supermarket was interviewed to gauge broad public sentiment, and also because he was quoted in a newspaper report as having been one of the first to connect, being very satisfied with the sewerage as provided. Many of the other residents interviewed had a particular concern, agenda or interest group that they were presenting or representing.

Table 4-3: Bundeena Maianbar case interviewee breakdown

Organisation / Group	People Interviewed
Sydney Water Corporation (SWC)	8
Consultants for SWC (for the EIS)	1
Resident community	9
Local environmental group	1
Sutherland Shire Council officers	3
Sutherland Shire councillors	1
State Government department officers	
Department of Environment and Conservation (DEC)	1
National Parks (now part of DEC)	1
Department of Planning	1
Department of Water Resources (now Dept of Natural Resources)	1
NSW Health	1
Members of Parliament (NSW State Government)	1
Construction contractors	1

Notes:

- Total interviews conducted: 27. Total interviewees: 30. (Four Sydney Water interviewees were interviewed in two paired sittings, and two community members [husband and wife] were interviewed together.)
- Quotes from interviewees are referenced using code names to preserve anonymity but still identify the interviewee's stakeholder category. For example, B19-SWC indicates interviewee 'B19', from Sydney Water Corporation. Some department names (e.g., Dept Water Resources) do not match current government departments and may be generic terms for ease of understanding rather than technically correct for that particular interviewee at the time.
- Interviews were conducted in November and December, 2004. Exceptions were B22 (January 2005), B23 (February 2005), B25 (April 2004), B26 (February 2004), B27 and B30 (January 2004).
- Transcripts totalled 95,000 words.

4.1.3 Institutional Analysis

The research questions guide the focus of investigation toward institutional factors, namely, the organisation and discourse evident in the action and outcome of this project. It is under these categories that further investigation was pursued.

The analysis here follows Scott's (1995) three pillars of institutions (cognitive, normative and regulative – see Chapter 2). In the discussion, 'discourse' covers both the cognitive (knowledge) and normative (values), which are discussed together in the following section. (As throughout this thesis, the term 'institution' here is taken to mean an established system of practice – the way that things are done – comprising regulatory, normative and cognitive elements. The term organisation denotes the collectives that employ people and resources to manage, in this case, water or some aspect thereof.)

4.1.3.1 Organisational and Regulatory Context

This section presents the organisational and regulatory context within which the Bundeena Maianbar Priority Sewerage Project (and water supply upgrade) took place. The formal regulatory and organisational structures are outlined, as well as the informal networks, and interviewees' perspectives of the formal and informal organisational structures. Data sources included both published documents as well as interview transcripts.

4.1.3.1.1 Water and Sewerage Management: State Government Responsibility

Originally, water supply was a function of local councils, but in the later part of the 19th century an overarching body on which councils were represented (the Metropolitan Water, Sewerage and Drainage Board [MWS&DB]) took over the councils' functions (although local councils retained some powers in relation to water quality into the 1980s). The MWS&DB had a large degree of operational autonomy, but in the 1980s it became a government agency, subject to more direct control from the State Government. It was corporatised in December 1994, further strengthening a large source of revenue for the government. It also was made subject to a number of other state regulatory bodies.

Sydney Water's current Operating Licence permits Sydney Water to supply water and to provide sewerage services. The licence also permits the provision of stormwater drainage; however, the responsibility for stormwater is shared between local governments and Sydney Water. The licence and *Sydney Water Act (1994)* also do not prohibit other persons from lawfully providing the same services as Sydney Water. But there are currently no known significant examples of others providing the same services as Sydney Water within Sydney Water's area of operations, except where on-site systems have been established in the absence of centralised infrastructure. The other potential exception to note is that, at the time of this research, there is a proposal for a commercial entity (Services Sydney) to recycle a significant proportion of Sydney's wastewater and sell that to customers (NCC, 2004b).

The State Government departments that have major roles in regulating Sydney Water's water management activities include the Independent Pricing and Regulatory Tribunal (IPART) (regarding pricing for consumers), the Department of Environment and Conservation (DEC) (regarding any discharges to the environment), the Department of Natural Resources (DNR) (regarding water resource allocations), the Department of Planning (regarding land use), and NSW Health (regarding water quality and public health). The Department of Energy, Utilities and Sustainability (DEUS) is also a key player in setting policy, and is currently managing the recycled water agenda and budget.

These organisational structures for water and sewerage management have been built up over a long period of time, and are well established (see Section 2.1). It was generally understood by the key players interviewed that "*the only people in the Sydney area, increasingly, who could do that [provide reticulated water and sewerage services – e.g., for Bundeena Maianbar], was Sydney Water*" (B3-Resident)[56]. However, there were a number of members of the Working Party who felt that the well-established bureaucratic nature of Sydney Water made their participation frustrating. "*Sydney Water – they are the worst example of a government monolith*" (B12-Resident).

There were a number of dissident views put forward on the nature of this monopolistic, technocratic organisational structure. One former Sydney Water senior executive suggested that he had planned to change the system to be more decentralised, but was not able to (B25-SWC). The member of the local environmental organisation and the DEC officer both suggested that the pricing and incentive structures heavily favoured centralised systems. "*Put it this way, if we had to pay the true value of the cost of our water and sewerage services, it would be exorbitant. It would certainly detract from big centralised systems that we have*" (B5-Dept Water Resources). "*If you look at a table of incentive structures, the outcomes are clear. Unless we can change these incentive structures, things will remain the same*" (B26-Environmentalist).

[56] Quotes from interviewees are italicised throughout this chapter.

Interviewees from the community (B7-Resident), government departments (B13-EPA), and also the member of parliament all noted the apparently conflicting objectives that Sydney Water is pursuing: to both reduce demand on potable water but also to sell water to make a profit: "*I just can't comprehend a group of people who are set up to make profits and sell water, running around and putting up proposals that are going to lose them money*" (B14-MP).

4.1.3.1.2 On-site Management: Local Government Unable to Manage Satisfactorily

Water supply, sewerage and stormwater drainage are all responsibilities of local government in NSW, except where a state-owned corporation is established to provide those services (e.g., Sydney Water for the Sydney region). Where there are on-site systems, the *Local Government Act (1993)* requires that approval be granted by the council for the purpose of ensuring reliable operation is maintained. Where there is a public sewer system, the council may also require mandatory connection.

Thus the oversight management of the on-site sewerage systems in Bundeena Maianbar was (and still is) the responsibility of Sutherland Shire Council. Sydney Water has no part in or responsibility for on-site systems.

There was some suggestion from a number of interviewees that Sutherland Shire Council had not fulfilled its obligations to inspect and police on-site systems leading up to the implementation of the sewerage system. "*They [the council] basically were quite happy for Sydney Water to take that off their hands*" (B3-Resident).

4.1.3.1.3 Stormwater Drainage: Local Government and Not Addressed

Stormwater drainage in Bundeena Maianbar is solely the responsibility of the local government – Sutherland Shire Council. Because the project was a Sydney Water project, even though stormwater issues were considered in the Options Report and EIS, solutions could only be recommended for Sutherland Shire Council to implement as they deemed appropriate. This split in responsibilities and the resulting lack of coordination was noted by community members:

> "*You usually talk about sewerage and drainage together. Well drainage here is pretty much –. There were never any drainage plans. So people*

are still getting a lot of drainage problems that they thought may have been fixed by the sewer. But sadly, no" (B7-Resident).

4.1.3.1.4 Environmental Planning Regulations

In 1994 there was a change to the NSW environmental planning legislation that gave the Planning Department much greater responsibility to provide independent assessment where State Government agencies were proposing their own projects. The Bundeena Maianbar sewerage project was started early enough to avoid this change in legislation, even though the EIS was not submitted until 1996. This meant that Sydney Water was its own Determining Authority, and therefore engaged a consultant to prepare the Determining Authority's Report (Sydney Water, 1998). The consent of the Planning Minister was not required. However, the Planning Department did review the EIS in greater detail than similar previous projects, as the legislation changes would have required Ministerial consent had this project started after the 1994 changes to the *Environmental Planning and Assessment Act* (B22-Dept Planning).

4.1.3.1.5 Community and Environment Organisations

Bundeena and Maianbar both have well-organised, active and vocal Progress Associations. Many of the community representatives on the Working Party and also many of the interviewees were involved at some point with these community organisations.

> "*The Progress [Association] is a very active one and generally speaking, speaks with a common voice representing most of the people. I know they did play a big part over the years with the sewer*" (B23-Councillor).

A local environmental organisation also became involved. The Port Hacking Protection Society (PHPS) obtained a National Landcare grant, which, along with voluntary contributions of time and other resources, was used to prepare a report on the management of the water cycle for Bundeena Maianbar (PHPS, 1997). While the Progress Associations were active before the project started, and primarily concerned with securing a government-funded solution to the existing problems associated with on-site sewerage (mis)management, the PHPS only became involved on the release of the EIS. Because the EIS promoted connection to traditional centralised big pipe

infrastructure, the report produced by the PHPS was aimed at highlighting deficiencies of the centralised approach compared to the advantages of local or on-site reuse options.

There were about two (depending on counting method) members of the PHPS that contributed to the PHPS report who were also involved with the Bundeena Progress Association. But the PHPS report was not intended as a representation of overall community opinion. The PHPS report suggested that community opinion was divided as follows:

- The majority (or at least a large minority) wanted conventional sewerage, but with reservations about economic and environmental costs. Thus they would have been interested in consideration of modifications;
- A significant minority wanted conventional sewerage urgently and at any cost; and
- A significant minority opposed conventional sewerage either because of anticipated consequential development or because of environmental impact.

(This assessment is consistent with that reported by interviewees and Sydney Water documentation.)

4.1.3.1.6 Inter-Organisational Networks

The environmental planning process increasingly requires collaboration between a network of government and other stakeholders (Meadowcroft, 2004). In the case of the Bundeena Maianbar Priority Sewerage Project, such a network did exist, due primarily to the requirements of environmental planning legislation. One interviewee from Sutherland Shire Council commented that the "*network [was] very loose and unstructured*" (B1-SSC Officer). The non-hierarchical nature of integrated networks of related organisational players in environmental governance (Margerum, 1999) may appear to be "*loose and unstructured*" to those more accustomed to vertical, hierarchical, mono-disciplinary organisational structures – so this isolated comment does not necessitate criticism of the inter-organisational network established for this particular project.

A more general lack of State Government inter-organisational coordination around the environmental planning process was identified by two interviewees:

> "*If we go and sewer it, the other government bodies should be right on our tail and helping us as well. So it seems as though the government bodies don't really work together. The community becomes deluded in all of this. That was just an example of how the government bodies don't really work together – it's just about them ticking the boxes. It's not beneficial to anybody, that's all*" (B19-SWC).

> "*Then when the applicant goes to the DEC for their licence, the DEC has to issue the licence consistent with the consent, because theoretically they're all supposed to link in. That's the theory. Maybe one day there'll be moves toward more single approval*" (B22-Dept Planning).

One State Government bureaucrat did provide a more positive reflection on State Government networks in relation to environmental planning, claiming that improvements have been made. "*There's a lot more inter-networking now. The networks of government these days are by far a lot more than they've ever been*" (B6-Dept Health).

Informal networks specific to this particular project were created by politicians (councillors and the local Member of Parliament) and environmental groups, although State Government authorities (including Sydney Water) and local council departments tended not to be mentioned by interviewees as being part of any informal network. An example is this comment from the MP: "*I relied pretty heavily in those days on the green movement for advice and support… It was never a formal arrangement*" (B14-MP).

4.1.3.2 Discourses: Knowledge and Values

There were a number of ideas that were significant in shaping the action[57], and it is important to identify them as distinct rhetorical themes – reasons for taking action – before seeing how the participants mobilised them in defining the problem and

[57] 'Action' refers to the communication, actions and processes of the players (individual and organisational) involved.

validating the action taken. These themes became the basis of a shared discourse – shared language and understanding. Thus ‘discourse’ for this discussion is defined as a shared language and understanding which people hold or use to form a coherent account (after Dryzek, 1997).

These themes can be looked at just as ideas, but in this context they are seen as part of the action, the vehicles for interaction between the participants in working out the answer to a problem in the governing of water use and management. Section 4.1.3.3 deals with how these discourses were mobilised, impacting on the planning process and outcome.

The terms ‘ideas’ and ‘knowledge’ are used here somewhat interchangeably. ‘Knowledge’ does not differentiate scientific knowledge from other forms of knowledge. All knowledge brought to bear by stakeholders in environmental planning is significant insofar as it shapes the contributions, decisions, actions and buy-in to a collective decision of the individuals and groups who adhere to it. The position on knowledge taken here is after Berger and Luckman (1971) who hold that all knowledge is socially constructed, and therefore has to be understood and appreciated within its social context to appreciate its contribution to policy and practice in everyday life.

This case study reveals a number of different discourses from a variety of participants. The problem frames they each represented varied between and sometimes within the respective organisations or backgrounds from which they came. While this was not a longitudinal study, there is evidence to suggest that individuals’ problem frames also varied across time. Some participants’ problem frames varied (or perhaps were broadly encompassing) according to what aspect of the problem they were considering.

The problem frames are generalised and summarised in Table 4-4 according to the issues that were of concern. Some characteristically preferred options for water and sewerage (and typical adherents) are also indicated; however, the focus of this table is the multiple problem frames. It is not intended to categorise the particular groups of participants/stakeholders.

Table 4-4: Problem frames of Bundeena Maianbar case study participants

Problem Frame	Issues of Concern	Examples of Preferred Options	Examples of Adherents
Sewage removal	Health & environmental nuisance of on-site systems	Centralised sewerage (and/or possibly local treatment plant / recycling)	This perspective was evident in all stakeholder categories
Centralised technocratic expertise	Sewerage should not be the responsibility of council or the public but should be dealt with by the experts	Centralised sewerage	Sutherland Shire Council, Sydney Water, Government departments
Entitlement to progress	On-site systems considered inferior and archaic	Centralised sewerage	Some residents, Sydney Water
Minimisation of householder involvement	Time, effort and skill required to manage or dispose of sewage	Reticulated sewerage (centralised or local recycling)	Many residents, council officers and regulators
Minimisation of homeowner expense	Cost of connecting to sewerage	Subsidised sewerage and/or continuation of (or improved) on-site	Most residents (particularly those with difficult/expensive terrain)
Anti-development	Sewerage connection may promote further urban development	Continuation of (or improved) on-site	Some residents
Integrated water cycle management	Water conservation and reuse, broader environmental problem	Improved on-site systems and/or local recycling	Some residents and some bureaucrats

The problem frames (or discourses) listed in Table 4-4 appeared in participant interviews, and were also reflected in written documents. The following sections elaborate on these discourses and the values and ideas that contributed to them. These discourses were identified through interpretive analysis of the case itself, and in the context of wider societal (environmental) discourses (Dryzek, 1997).

4.1.3.2.1 Sewage Removal

The ‘sewage removal’ discourse holds that sewage is unsafe and should be removed as quickly and as far away as possible. This discourse has been prevalent from early days in the history of the understanding of urban sanitation (Mayne, 1982; Melosi, 2000), and with good justification: the public health improvements ensuing from reticulated sewerage are undoubted. For Bundeena Maianbar, the expression of this discourse was motivated by perceived or real adverse health and environmental impacts of (often poorly maintained) on-site sewerage systems.

The sewage removal discourse has an established tradition of knowledge built in the domains of engineering and microbiological sciences. Societal values of health and cleanness are also core to this problem frame for the management of sewage. Environmental values have also been attached to this discourse, as sewage removal also removes excessive nutrients and pollutants from the local environment, the most visible impact to community members and also other stakeholders.

However, sewage removal tends not to consider the wider environment – hence the 'integrated water cycle management' discourse, discussed later. As one interviewee, a former chief executive officer of Sydney Water, explicitly stated: "*Sydney Water, at one of the meetings, said 'We've been thinking about disposal, we've not been thinking about water cycle'*" (B25-SWC).

In this case study, Sydney Water employees typically took the view that health and environmental values were upheld best by this 'sewage removal' discourse:

> "*Yes, as far as improving the environment, yes, we have, because you had open drainage, you had sewage flowing out into the gutters, and [now] you don't have that*" (B19-SWC).
>
> "*The premise on which we operate is that we protect the environment; we protect the health and welfare of the people*" (B19-SWC).
>
> "*The best option to stop pollution of either the park or the marine environment was to take the stuff away*" (B20-SWC).

This discourse was evident, at least in part, in interviews with officers from the local council, and some residents, also. Further, the Health Department interviewee expressed similar views: "*Probably, the [Health] Department, even now, are of the view that they're better off having a sewage treatment works that takes away the waste, rather than having an on-site disposal system*" (B6-Dept Health).

Some of the earlier quotations suggest that many did not recognise the possibility of health and environmental values being satisfied by anything other than centralised sewerage disposal. The last quote suggests an awareness of other alternatives, while the following quote expresses strong dissidence to this discourse: "*Actually the attitude of conventional sewerage systems and outfalls has got to change completely*" (B14-MP). Interestingly, this interviewee did not strongly support any other alternative discourse or option, but gave implicit support to the sewage removal option, citing environmental lobby groups as his advisers (as quoted above in Section 4.1.3.1.6).

Official project documents such as the Environmental Impact Statement (SKM, 1996) also appealed to the norms and knowledge base of this discourse as justification for the centralised solution recommended. Under the heading "Justification for the Proposal" the following excerpt from the Executive Summary illustrates the centrality of the sewage removal discourse to the decision-making:

> The provision of a comprehensive reticulated sewerage scheme will reduce the risk to public health, improve the amenity of the area and eliminate the opportunity for septic seepage and overflows from entering local drains and receiving waters (SKM, 1996).

The printed media also gave some support to the discourse of sewage removal – particularly the more regional Sutherland Shire paper, although it only ran occasional brief factual news items. One such article affirmed the scheme as reducing public health risks and adverse environmental impacts in Port Hacking (Adolphe, 2000). The local community newspapers *The Village Voice* and *The Village Noise* for Bundeena Maianbar, while often promoting an array of alternate ideas and values, rarely directly supported or challenged this discourse.

The only printed document that really challenged this discourse is the *Tragedy of the Commons* report produced by the Port Hacking Protection Society:

> To then propose a solution which increases both the demands for water to consume, and the volume of contaminated water that needs to be disposed of, should be seen as compounding the original problem. Expenditure of

> increasing amounts of energy as a means of implementing the preferred solution, seems to compound the original error. Yet this set of outcomes is embedded in the adoption of conventional sewage 'solutions' (PHPS, 1997).

This discourse of sewage removal (see summary in Table 4-5) has become universal in recognition and acceptance, due to the worldwide uptake of centralised sewerage systems and the resulting improvements in public health over the last one to two centuries. It is not surprising, therefore, that many different participants from virtually all different stakeholder groups adhered, at least to some degree, to this discourse. It was certainly influential in terms of the eventual outcome. However, there were dissident views and alternative discourses. Some other discourses complemented this one, while some were dissident. These are outlined in the following sections, starting with those that are more complementary to the sewage removal discourse, and moving to those that are more dissident.

Table 4-5: Summary of the sewage removal discourse

Values	Knowledge base
Environmental protection Public health	Engineering Environmental science Microbiology (traditional disciplines)

4.1.3.2.2 Centralised Technocratic Expertise

The 'centralised technocratic expertise' discourse (see summary in Table 4-6) defines the water and sewage management problem as being the domain of centralised technical bureaucracies with established expertise. The problem frame comes from a broader discourse that holds that environmental problems are best left to administrative officials with professional expertise and the authority of government to identify and implement solutions (Dryzek, 1997; Fischer, 1990). The water industry was established on and has traditionally celebrated such values and expertise (Aird, 1961; Henry, 1939). However, this discourse was generally assumed or implicit rather than explicit in the statements of Sydney Water employees; thus the supporting quotes here are from other stakeholders.

There was a perception amongst many in the community that Sydney Water was making decisions based on their established professional expertise and knowledge, filtering out other alternatives.

> "*At the time we were looking at Memtec [membranes] as a tertiary [treatment] option… They [Sydney Water] were dead against it, I suspect because they didn't own the technology at the time*" (B11-Resident).

> "*Sydney Water is an engineering company. They know how to put in reticulated sewerage systems and they're quite convinced that the only way to do it is reticulated sewerage*" (B3-Resident).

This perspective was also shared by other government agency stakeholders. For example, the interviewee from the EPA also suggested that "*Sydney Water like the centralised system because it's all within their control; it's the game they understand*" (B13-EPA). A council employee said of Sydney Water "*I think they were scared of any other paradigms. They stayed with what they knew best*" (B1-SSC Officer). Conversely, one of Sydney Water's project managers claimed that Sutherland Shire Council were keen to rely on Sydney Water's centralised expertise: "*The council were keen and they were keen to get rid of it [i.e., the responsibility for managing sewerage]*" (B18-SWC).

There were many comments made about the engineering and 'big pipes' mentality embedded into the organisation of Sydney Water. Such professional engineering values matched a large infrastructure outcome, and this was observed by a number of participants both within and outside of Sydney Water. Not all necessarily objected to the decision or the way it was made, though the dissidence in some of the responses was clearly evident.

> "*The Water Board engineers, in those days, were not interested in recycling. They were interested in building treatment works. You know what civil engineers are like, they like to be able to take their grandchildren along and say, 'I built that.'… [The chief engineer] wanted an engineering solution. He brought in some old-fashioned engineers from Newcastle, who went back to basic engineering*" (B25-SWC).

That quote was from a former chief executive officer of Sydney Water. The next two quotes are from a community member and a State Government bureaucrat. There were more similar quotes, but these three are given to illustrate and substantiate the observation of Sydney Water's entrenched centralised technocratic and engineering values.

> "*It's hard to fathom, but someone told me they're just made up of a lot of the old engineers, and their thinking is build it big and build it strong. So that's pipes and whatever*" (B7-Resident).

> "*That's one thing I think needs to change – Sydney Water's pipes and pumps mentality. There's still lots and lots and lots of engineers there, and they like building big structures*" (B13-EPA).

The perspective of those directly involved within the organisation of Sydney Water was unsurprisingly supportive of the engineering values and knowledge behind the decision-making and eventual project outcome. One of the project managers said, "*It was the best engineering solution*" (B18-SWC).

The Village Voice reported a split view within Sydney Water:

> Water Board Environmental Scientist Colin Heath said it was an accurate perception that sections of the Board see Bundeena as providing a model opportunity to design an exemplary, locally-based treatment and recycling system, but added that there were also plenty of engineers within the organisation just keen to undertake the pipe to Cronulla option (Anonymous, 1991).

The tension between traditional engineering and newly realised sustainability values was also noted by the consultant hired to do the Environmental Impact Statement. Functional efficiency was weighted more highly than sustainability in the EIS:

"We didn't assess sustainability. We didn't go to that level of detail. We just complied with the objectives of the project – engineering, practicality" (B17-Consultant).

Table 4-6: Summary of the centralised technocratic expertise discourse

Values	**Knowledge base**
Professional engineering values	Past experience (with water and sewerage) Organisational knowledge

4.1.3.2.3 Entitlement to Progress

The 'entitlement to progress' discourse (see summary in Table 4-7) holds that problems can be solved by the application of innovative technology, leading to the continual improvement and progress of society as a whole – and that all are entitled to enjoy those solutions. The ideas of progress can be traced back to Francis Bacon in the sixteenth century (Faulkner, 1993). Today a broad cornucopian discourse asserts the ideal (or, for some, the reality) of the triumph of technology and enlightenment over nature (Dryzek, 1997).

This discourse of entitlement to technological progress in the case of Bundeena Maianbar's water and sewerage was motivated in part by the perceived inequality where the rest of Sydney had reticulated sewerage for decades, but these fringe suburbs were still without it. The value of equality here is only worth anything to its adherent if the desired change is seen as having virtue. In this case, where transport, communications, energy provision and other services were all delayed for Bundeena Maianbar relative to the remainder of Sydney, community members were often not interested in exploring innovation or alternatives but in following the 'progress' of the remainder of Sydney. "*Often people say that alternatives are second rate solutions and that we are entitled to the same as everyone else*" (B26-Environmentalist).

An article in the local community paper *The Village Voice* about one of the public meetings conducted in 1992 by Sydney Water reported a strongly felt question of many present: "Why can't we just have sewerage <u>now</u> like everyone else?" (Lawrie, 1992).

The Progress Associations were established, and maintained strong community support, based on this perceived need for petitioning support for lifestyle and technological progress to Bundeena and Maianbar. The community were well accustomed to prolonged struggles for 'progress' for infrastructure, and sewerage was no different: "*We were still fighting for it; it had been promised for 40 years and just wasn't happening*" (B7-Resident).

The perceived lack of progress and mental images of comparative filth associated with no reticulated sewerage in a modern, mostly sewered city such as Sydney meant that participants from all stakeholder groups felt entitled to 'progress'. Most assumed that would mean reticulated sewerage.

> "*It's pretty pathetic when you see almost raw sewage running down the gutters. Not a good image*" (B7-Resident).

> "*Ultimately the whole of Sydney has to be sewered; you can't have unsewered areas in a modern city*" (B15-Resident).

One of the older (retired) residents felt quite strongly about it: "*I'm all for sewerage. We even had sewerage when we lived in Bangkok, which is supposed to be a third world country [sic]. And there's no problem with sewerage there*" (B10-Resident).

There seemed to be an underlying assumption that progress in technology and improvement in lifestyle are inevitable, and to be increasingly expected and relied upon. This is explicit in the following quote:

> "*The bottom line is we have a lifestyle which, as we get more and more affluent and have smaller and smaller households, we use more water*" (B20-SWC).

The only direct challenge to this discourse – or a questioning of how 'progress' could be reinterpreted – once again came from the *Tragedy of the Commons* report, which asserted:

> Consistently in our society we reject the 'minimise consumption' strategy in favour of the increased usage/increased treatment options. There is a fundamental failure of rationality in this acceptance. The result is the tragedy of the commons in relation to water use (PHPS, 1997).

Table 4-7: Summary of the entitlement to progress discourse

Values	**Knowledge base**
Progress Convenience Functional efficiency Equality and fairness	All scientific disciplines – particularly engineering History and geography – awareness of what others have and have had

4.1.3.2.4 Minimisation of Householder Involvement

The discourse of minimising householder involvement in managing water and sewerage (see summary in Table 4-8) could have been combined (as a sub-discourse) with either of the two preceding discourses (depending on whether the rationale is that these concerns are a matter for centralised technical expertise or that technology advancement should reduce the amount of input required from the householder into such concerns). This discourse could also be characterised as the absence of discourse – i.e., the lack of interest in being party to the process of water and sewerage management.

One of the community representatives (who was actually actively involved in managing the water and wastewater on her own property) spoke on behalf of a suggested significant majority, saying:

> "*Overwhelmingly the community in Bundeena Maianbar were happy to go along with the Sydney Water option. What they wanted was a problem solved, and they didn't really care how it was solved. So if Sydney Water was going to take all of their junk over to the other side and they didn't have to think about anymore, they were happy with that*" (B3-Resident).

Many of the community interviewees were quite happy not to have to manage their own septic tanks any more, once reticulated sewerage became available. "*People don't want to deal with or think about their sewage*" (B2-SSC Officer). And: "*They just want to push [i.e., flush] the toilet… They care, but not to that degree*" (B19-SWC).

Regarding the possibility of options that required householder involvement, there was a lot of scepticism about the motivation and/or capacity of householders or the local community to properly maintain any on-site or decentralised systems. Two representative quotes (of many) follow:

> "*I think it probably is a bit of a dream to expect that there's going to be enough cooperation in the neighbourhood, because invariably those sort of systems do require a greater level of input from the householder*" (B16-Royal NP).

> "*If you leave those systems up to residents they invariably fail… Because if you leave it up to the resident, it doesn't get done*" (B13-EPA).

There were some interviewees who voiced alternate perspectives (though not all supportive) of householder involvement in water management. One suggested that the institutional framework was partially responsible for reproducing the discourse of minimising householder involvement: "*The institutional framework is not supporting people taking personal responsibility and managing their own risk*" (B26-Environmentalist). Another suggested a disadvantage of this discourse and its impact on policy: "*If you go to someone else and it's someone else's problem, you're less likely to conserve or do anything more*" (B1-SSC Officer). And finally, an alternative was given where householders could be involved insofar as being responsible but not in actually undertaking the work of maintenance: "*There are private companies who do that sort of thing*" (B3-Resident).

Table 4-8: Summary of the minimisation of householder involvement discourse

Values	**Knowledge base**
Ease of lifestyle Risk avoidance	Awareness of modern technology Experience with on-site septic systems

4.1.3.2.5 Minimisation of Homeowner Expense

As with the previous discourse, the discourse of minimising homeowner expense (see summary in Table 4-9) is more pragmatic than ideological. There was significant concern that whatever expenses were incurred should be covered by either the State Government or levies across Sydney rather than by the local community. (The

justification was related both to questions of affordability relative to low incomes, and also the comparative cost incurred for homeowners of connecting to the sewer, between Bundeena Maianbar residents, and those of the remainder of the Sydney Basin.) This concern was very important for a particular group of residents whose houses were situated such that connecting the house to the sewer at the property boundary would be quite expensive – e.g., where the elevation of the house was below the sewer line such that a pump was required. A number of houses along the beachfront (typically occupied by retirees) required a pump to lift effluent up to the sewer line, at the owner's expense. This was strongly opposed by those homeowners. One such homeowner identified this as the primary issue of community concern for the overall project:

> "*Our compensation investigation has just been denied by the [ombudsman's] office after an 18 month investigation. There's 100 households, 39 in Maianbar, that had to go to pump. That was our bone of contention from the start*" (B12-Resident).

These concerns were frequently addressed in the local community newspapers, with articles and letters containing emotive complaints or appeals. For example, one letter to *The Village Voice* community newspaper entitled "The billion dollar bum steer" deplored the possibility that homeowners would have to pay that part of the cost over $14,000 per lot, while the rest of Sydney were not required to when most other suburbs were connected (Westacott, 1991).

While outlining the "distortive impact" of subsiding conventional sewerage was the main financial/economic consideration of the *Tragedy of the Commons* document, that document also appealed for consideration of "social equity" relating to "the effects on the less wealthy" (PHPS, 1997).

Table 4-9: Summary of the minimisation of householder expense discourse

Values	**Knowledge base**
Economic Fairness	Knowledge of the rest of Sydney Alternate specialist engineering opinions Alternate pricing/subsidy arrangements

4.1.3.2.6 Anti-Development

Some community interviewees expressed a desire to keep the suburbs of Bundeena and Maianbar from being further subdivided or urbanised. The 'anti-development' discourse (see summary in Table 4-10) tied into environmental and also community values (though not always consistently), and was primarily grounded in the history and geography of the location. There was a strong desire among many long-term residents to preserve the unique characteristics and secluded ambience of the location. "*We're still a village atmosphere here*" (B12-Resident).

Higher density dwellings (which would be made more possible by reticulated sewerage) were opposed by most residents: "*It's not going to expand into the park, and it's not going to expand upwards if the current residents have any say in it*" (B9-Resident). However, this interviewee (unlike some others) did realise that development was a planning issue, separate from water and sewerage: "*I thought the thing to do was to solve the problems – the water quality issues were great enough that you had to solve those – and then fight the battles about development… There's no point clinging to outmoded technology and a dangerous water quality situation just to stop development*" (B9-Resident).

On the other side of the debate, there were a few who wanted to encourage further development from a property investment perspective: "*And of course, then there were people who wanted the sewerage system, so they can sell their land for a higher price*" (B25-SWC).

Table 4-10: Summary of the anti-development discourse

Values	**Knowledge base**
Village atmosphere Privacy Seclusion Stability Social cohesion	Local history and geography Development and growth trends elsewhere

4.1.3.2.7 Integrated Water Cycle Management

The 'integrated water cycle management' discourse (see summary in Table 4-11) emphasises the need for water to be managed on a more local scale with more closing of

water and nutrient cycles. It arose from broader sustainability and environmental discourses (Dryzek, 1997). Knowledge of the water cycle and water scarcity, combined with environmental values were at the core of this discourse. The changing wider discourse on water management toward sustainability (see Section 2.4.2.1), together with the presence of a number of environmental activists in Bundeena Maianbar, meant that this discourse of integrated water cycle management appeared in a variety of contexts from a number of sources.

The initial Options Report produced by Sydney Water (then the Water Board) was titled "Bundeena / Maianbar Watercycle Management Options Report" (Water Board, 1992). Holistic, sustainability-oriented thinking had evidently already influenced the Water Board. A former Chief Executive Officer of the Water Board from around that time provided significant influence in that direction: "*We need to solve the problems locally (at least in those large catchments)… That's why I keep coming back to the thought that every solution needs to be tailored to local environment – I am talking about the topographical environment just as much as the receiving water and ecology. Some systems just don't work in some places*" (B25-SWC). The same person also suggested: "*Try to go back to as close to the natural systems as you can.*" Of the eventual centralised solution, he was critical: "*It's not looking at the water cycle.*"

The idea of greater benefit from dealing with the problem locally was also expressed by one of the Sutherland Shire Council officers. "*I think things need to be dealt with on a local level. When we get water it is always from over there or further. Getting rid of our waste – it's like somebody else's problem. When you've got to deal with the problem yourself you're more aware of using extra water or resources or whatever, so I think it could be done on a more local level. All the better*" (B1-SSC Officer).

A similar view was also evident among some State Government bureaucrats: "*My personal view is that if they could have treated and used it on-site, that's probably the best option*" (B5-Dept Water Resources).

The *Tragedy of the Commons* document was very explicit in portraying the discourse of 'integrated water cycle management' – using that phrase in the document text. The authors built on knowledge of other Australian projects that had innovative and/or decentralised technologies.

While the *Tragedy of the Commons* presented in detail how integrated water cycle management could be achieved, those among the community who were environmentally aware or active (a minority, according to all known reports) tended not to express the overall concept of integrated water cycle management, but rather specific elements of it. These two quotes illustrate some local opinions showing preference for local water sources over town water:

> "*We don't like chlorinated Sydney water… In the city you probably wouldn't drink tank water. We're probably on the outskirts where drinking tank water is okay*" (B7-Resident).

> "*If they controlled the population then we'd be able to only rely on natural water sources which the sun does for us for nothing*" (B15-Resident).

Though not strictly part of the integrated water cycle management discourse, potential impacts on nutrient cycle management were also noted by one community interviewee: "*One other thing a lot of horticulturalists talked about was the loss of trees because of the burrowing of the pipes and the lack of nutrient because there's no nutrient from septics. We're seeing a bit of that*" (B7-Resident). Other supporting ideas and values expressed for this discourse included:

- Local solutions could be an example for other communities to follow; and
- Local knowledge and local management means earlier detection of problems.

The recognition of water scarcity could have been reported as a discourse in itself; however, it has only become widely prominent and a dominant discourse predominately after the project was completed, due to subsequent Sydney-wide water shortages. A

selection of comments related to water scarcity from interviewees, each from a different stakeholder category, are grouped together here:

> "*My only concern is that now they're not making proper use of that treated water. We've got the cleanest sewer outlet in the world, and it's going straight into the ocean. Given the state we're in with drought and water restrictions and all that, it could be so gainfully used on golf courses or things like that. So I think Sydney Water have really lost the plot a bit there, just pumping it straight out*" (B23-SSC Councillor).

> "*We're wasting a resource; we're flushing more water down the drains now*" (B11-Resident).

> "*We had water cycle concerns – that water use doubles when you are sewered*" (B26-Environmentalist).

However, there were still dissident perspectives that, contrary to this 'integrated' discourse, perceived water supply and conservation and wastewater disposal as being two unrelated areas.

> "*Once they get sewer, people are a lot freer with the water usage. We know that. I would make sewer versus saving water, they're two different – they're apples and oranges*" (B19-SWC).

The above quote notwithstanding, there was widespread recognition from all stakeholder groups that connecting to sewer would increase water usage.

A shire councillor questioned Sydney Water's ability and motivation to integrate multiple objectives given the way they were statutorily corporatised: "*The trouble with a lot of these public utilities now is they've got to make a profit… When profit becomes the criteria by which you do everything, then you lose a lot… [For example] all that good water going straight into the ocean*" (B23-SSC Councillor).

While the discourse of sewage removal was the entrenched, dominant discourse for many decades leading up to this project, the integrated water cycle management discourse was (and still is) a new alternative. But it is now gaining widespread support and acceptance. The other discourses listed in between these two could be framed as supporting or sub-discourses to either of these two polarised discourses. As in the case of the sewage removal discourse, adherents to this new discourse of integrated water cycle management were from virtually all different stakeholder groups (as evidenced, for example, by the Water Board's Options Report title that contained the phrase 'Water Cycle Management'). Thus the polarisation between the two alternative ends of this particular spectrum was not as evident as it would be if the two discourses were upheld exclusively by two opposing groups.

Table 4-11: Summary of the integrated water management discourse

Values	Knowledge base
Environmental protection Sustainability (Possibly) community cohesion, empowerment	Local knowledge Environmental science Water cycle

4.1.3.3 Discursive Policy Process: Narrative in Action

In the dominant paradigm of instrumental rationality (see Parsons, 1995), policy questions are framed in terms of a problem, options, assessment, choice and implementation, and this was the framework in which the Bundeena case was presented to the public. In reality, these steps are somewhat of an idealisation of the process.

There are a number of decision-making tools, frameworks, and processes that water industry professionals (typically engineers) use to guide this decision-making process (Foxon *et al.*, 2002; Lundie *et al.*, 2005; Taylor, 2005), and in the case of the Bundeena Maianbar project there was a simple one-page qualitative multi-criteria assessment summary in the EIS. The research questions call for institutional analysis of how this policy process occurred. Such an analysis should take into account the organisational and also social constructivist dimensions of the process – i.e., going beyond the comparison of the already-framed technical data. The decision-making (or policy) process in its institutional context for each of the case studies is vital to an understanding of how decentralised alternatives for water management may be excluded or enabled.

4.1.3.3.1 Mobilising the Discourses in Action

Discourse is significant because it is a part of shaping action. While Sydney Water was accustomed to a large degree of autonomy, the 'rules of the game' were changing. Sydney Water was subject to some scrutiny by other government bodies and new environmental planning legislation, although it was still allowed to put forward and approve its own proposals so long as plans to mitigate environmental impacts were documented (through the EIS process). Sydney Water chose to work through a community representative group. These discourses (Section 4.1.3.2) were the currency in the process of identifying and justifying the preferred outcome.

The same themes could be used to justify different courses of action, or different themes to justify the same course of action. For example, environmentalism and environmental values were espoused in order to support both the sewage removal and the integrated water cycle management discourses and their associated options. Furthermore, the council wanted the problem to be dealt with by Sydney Water, and Sydney Water wanted to be able to do the project in a way that matched their expertise; while residents wanted action from Sydney Water, whatever it was, fearing that if it was left longer the commitment and momentum to finish may disappear.

There was very high community expectation of a solution to the manifest problems, and consensus that "They" (in this case Sydney Water) ought to fix the problem. "*The community does not want to hear about sewage*" (B26-Environmentalist). "*And people just want to be able to flush their toilet*" (B1-SSC Officer).

Thus what emerged from the different narratives was a common, dominant narrative about the problem being best left to Sydney Water, which enabled concerted action to happen. The eventual dominant discourse was that Sydney Water would look after the problem – i.e., the discourse labelled 'centralised technical expertise' above. This became a vehicle for the 'sewage removal' discourse, even though there were many in the community, other stakeholders and even a small number in Sydney Water, who questioned this conventional approach.

Thus other options associated with other discourses were laid aside. The loudest voices were from the industry, which had vested interest in big pipes and traditional engineering solutions. A former chief executive officer of Sydney Water said that the project "*had nothing to do with the environment or customer satisfaction*" (B25-SWC).

The dissident knowledge tended to be isolated and discarded, such that the integrated water cycle management discourse was largely unincorporated into the decision-making process. The official documented response to the *Tragedy of the Commons* document was that "the document is written with a strong bias towards on-site treatment systems" (Sydney Water, 1998, p.58).

The integrated water cycle management discourse was never really mobilised, but could well have been accepted, as one community leader suggested: "*I don't think there was any great movement in Bundeena to have a local treatment plant. If an acceptable design had come up and the government was prepared to fund it I'm sure people would have supported it. But that never happened; it didn't get that far*" (B15-Resident).

4.1.3.3.2 Participants' Trust

The low degree to which information was shared between stakeholders in a trusting and reciprocal way inhibited the establishment of shared meaning between participants. Instead, perceptions were constructed such that the motives and credibility of other participants were quite frequently distrusted.

There were several community interviewees who questioned the credibility of Sydney Water in various aspects. One specific example is the way that water quality test results were perceived to be used as evidence of poor on-site management: "*They'd wait for the heaviest downpours, and then come in and do their testing. One time Sydney was absolutely flooded and devastated. The next day they were here doing the testing*" (B12-Resident). Another community interviewee suggested that Sydney Water tended to give "*unbalanced*" information, therefore she did not get much value from it (B7-Resident). One interviewee explicitly stated, "*I don't particularly trust Sydney Water*" (B7-Resident).

In contrast, council also questioned the credibility of the local community newspaper editors regarding their reporting of the sewerage management debate: "*They tend to twist things a bit. We gave them some facts and when it came out it was totally different. We don't deal with them anymore*" (B4-SSC Officer).

4.1.3.3.3 Nature of Participation

The Bundeena and Maianbar Progress Associations were quite active in lobbying support for providing a reticulated sewerage system (as discussed above in 4.1.3.1.5). Thus there were already active participants from the community when Sydney Water came to do the project. These active participants already had their solution before coming together with Sydney Water to discuss the problem. It was Sydney Water that initiated a formal consultation process leading up to the EIS. The chronology in Table 4-2, along with the following quote, suggest that the consultation process was not aimed at much more than satisfying the requirements of the planning legislation. This was the comment of a former president of one of the Progress Associations: "*After the first two or three meetings a lot of us had the feeling we were just there for show*" (B12-Resident).

The comments from interviewees and the consistent highlighting of community concerns in the local newspapers during the planning and construction stages suggest that the preparedness of the local community (and possibly some other stakeholders) to be involved was greater than the opportunity given.

Sutherland Shire Council staff, on the other hand, did not show desire to be more involved. One departmental officer said: "*Really it didn't have a lot to do with us*" (B4-SSC Officer). Another council officer (in the planning department) seemed to be quite approving of the way that Sydney Water handled the community: "*There is always somebody who is not going to be satisfied with the actual process that's adopted or pursued... Sydney Water did a good job of smoothing the community over*" (B2-SSC Officer).

The response of some Sydney Water staff to the desire of community members to be involved was also negative: "*You get the pains amongst them like anywhere else –*

people who just didn't give up" (B18-SWC). One of the project managers for this project showed his ignorance of community opinion, saying "*I don't think there was [sic] any true die-hard greenies saying they don't want this for environmental reasons*" (B29-SWC). Quite clearly there was a significant minority of stakeholders (who, in fairness, may not have identified themselves as 'die-hard greenies') who vocalised dissident views on this point.

These examples illustrate that the participation tended more toward providing information and marketing a pre-determined solution rather than setting out (as some desired) to "*consider how we can manage alternatives, or encourage creative thinking*" (B26-Environmentalist) – i.e., collaborative empowerment (cf. Arnstein, 1969). The interviews revealed some cynicism toward Sydney Water's glossy brochures and seemingly self-praising news articles on the work they were doing. (This criticism even came from one Sydney Water interviewee, B19-SWC.)

The engagement of stakeholders, including the public, did not have as significant an impact on the decision-making process as many of the interviewees had hoped. There was unresolved polarisation of views (B3-Resident, B7-Resident, B18-SWC, B26-Environmentalist) and a sense in the community of powerlessness to influence the outcome. This quote well characterises the community sentiment in this regard:

> "*But we got the impression that the juggernaut of Sydney Water was so intent on its engineering solution of the normal sewer and pipes and the 40 million dollars to pump it under Port Hacking, that there was no way we could change things*" (B7-Resident).

This sense of powerlessness contributed to some community members just accepting whatever Sydney Water proposed, while others became more entrenched in their opposition. In one news article in *The Village Voice*, the polarised groups were identified as 'NIMBYs'[58] and 'greenies'. "The significant split in the community that has become apparent during the consultation process shows no sign of lessening"

[58] NIMBY is an acronym for 'not in my backyard'.

(Lawrie, 1992). The "two vaguely (and occasionally overtly) hostile groups, the first of which [i.e., NIMBYs, who wanted to follow Sydney Water's preference of having the sewage taken to Cronulla] cannot understand the need for a long-winded and time-wasting consultation process, while the second [greenies] perhaps feels that this consultation is merely a token gesture in a process in which full sewerage is a foregone conclusion" (Lawrie, 1992). Community letters to *The Village Voice* tended to take these two opposing viewpoints, appealing to a variety of the discourses set out above, but entrenching these two opposing positions.

The EIS contained an Appendix that assessed the Bundeena Maianbar community consultation program (SKM, 1996, Appendix D). It is evident from this report that the Water Board's approaches to consultation have varied and developed during the time since the relatively recent introduction of consultation. The report emphasised the need for a multi-faceted approach to consultation, and highlighted some of the same deficiencies noted by the interviewees. One such deficiency was that "factionalism developed between the community representatives" (St. Clair and King, 1996) on the Working Party. This was evident in the publication of concerns by the majority of the Working Party community representatives who put their names to an article in the *Village Voice*, which said: "In general, the community consultation process has been not entirely successful. The selection of community representatives was neither democratic nor appropriate" (Szpak *et al.*, 1992). The remaining Working Party members refrained from putting their names to the article.

The available evidence suggests that the participation process was generally regarded as highly necessary, but was a source of frustration for most of the stakeholders in this case. While many of the problems with the participation process may have been quite difficult to avoid regardless of how the process was designed, the dynamic ended up taking the argument away from the local people such that they did not have a sense of ownership of the decision. Given the centralised solution that allows people to 'flush and forget', the need for buy-in is reduced. But, for more decentralised solutions, the participation process would need to generate more local ownership and buy-in (i.e., ownership and acceptance of, and involvement in, the process/outcome).

4.1.3.3.4 Dynamic Nature of Participant Perspectives

Many of the interviewees showed evidence of having changed their views, or of having been prepared to change their views, as to what was the most appropriate technical solution. The values underlying those views tended to remain the same – whether environmental sustainability, progress, or anti-development. The following discussion in the next subsection is one illustrating example of this principle. The importance of this point is that one-off community surveys are not a good predictor of future sentiment, as there can be many intervening factors (some outside human control, such as droughts) that may dampen or encourage enthusiasm for particular innovations.

4.1.3.3.5 Timing Right for Centralised Systems but Not Decentralised

That the time for improvement to the water and sewerage service provision in Bundeena had come was never in dispute. Most felt that the time was long overdue. It had been on the agenda for years, and there was political pressure for a solution to the perceived problems:

> "*It wouldn't have mattered what government was in power. If it hadn't have been done under us it would have certainly been done under the next one. Because the drivers were there – the community wanted it, the environmental movement wanted it. We've got a very strong environmental movement in this shire… So the political motivation was already there. So it would have had to have been done*" (B14-MP).

However, while the time to do something had most certainly come, the time was still not right for the consideration of alternatives to conventional sewerage. According to one Sydney Water interviewee: "*Their time had not yet come. Things would be different now. We are looking at more innovative/decentralised approaches*" (B24-SWC).

The MP suggested that the expertise and will to move to alternate systems are still lacking:

> "*I don't think we're anywhere near it. We've got a lot of political talk about it. But I don't know – I've only been out a couple of years – I don't know of any major moves toward getting any authority, outside Australia*

> *or inside, into looking seriously at it… But sooner or later somebody has got to say 'You know, the system that we've got is archaic, it's environmentally devastating, and we've got to look at alternatives'"* (B14-MP).

Apart from political support, perhaps an even greater motivator for alternate and innovative thinking has been the drought, which came after the completion of the scheme: "*Unfortunately we came before a drought. If the drought had been in the few years prior to [Sydney Water's] commitment on it, I don't think we'd have had any problem with [deciding on and implementing] greywater reuse*" (B7-Resident). The EIS consultant took an open but more equivocal view: "*Other factors would need to be looked at now. Water conservation and restrictions. We probably would have looked at other options. I'm not sure*" (B17-Consultant).

Government department interviewees also suggested that timing played an important role:

> "*At the time, with the benefit of hindsight, you may have done something else. But we are talking about a project that was… conceived in the 70s and implemented in the 90s. Sustainability wasn't, even then, that high on everybody's agenda*" (B13-EPA).

The drought, as specific to Sydney, and also the wider increasing focus on sustainability, have both significantly changed the way that participants would approach the project if it were to be planned now.

4.1.3.3.6 Lack of Adaptive Capacity for Innovation

A lack of organisational capacity within Sydney Water to adapt to innovation was seen by many interviewees as an important factor in determining the project outcome. One of the community members who wanted decentralised alternatives said: "*Our option would have required them to gain another set of skills, and usually big bureaucracies are not very good at that. Let's be practical and pragmatic about this. That's really what happened in the decision-making process*" (B3-Resident).

This perspective was shared also by a former chief executive officer of Sydney Water, who made several observations which all have the identification of a lack of adaptive organisational capacity in common: *"I was concerned, when I got to the top, that there were no policy people in the organisation.*" And *"They're so rigid and bureaucratic in the way they're going about it.*" And "*Bureaucracies have too many things on the way up that block you.*" When change does occur, his "*fear is that we'll get a water sensitive urban design model that becomes bureaucratized and becomes the standard model for every development*" (B25-SWC).

The interviewed MP also substantiated this perspective. He had worked for the Water Board before entering State Government politics. His comment on Sydney Water's adaptive capacity was:

> "*Personally I never trusted the Water Board in doing anything that's new. They were good at what they did, but their ability to – particularly back in my day and probably up until 10 years ago – their ability to do anything more than what they did, worried me. Their engineers always tended to be old school engineers; old style; and they didn't have a lot of vision at all in that sort of stuff. And that's probably why a lot of things were rejected by the Water Board. They just didn't want to touch things that they didn't know a lot about… You've still got a lot of reluctance from a lot of the Water Board to become involved in anything unconventional. It's endemic*" (B14-MP).

The interviewee from the environmental group also commented on Sydney Water's lack of organisational capacity to undertake any innovation outside of its current engineering disciplinary expertise:

> "*Sydney Water is risk averse – technically and politically. The culture is strongly engineering. This set of factors combines to produce a bias toward an infrastructure intensive position that will embed itself in that activity. It wants to protect its patch. It's not necessarily Machiavellian; it's just the nature of the organisation. They are fine people, but the*

institutional arrangements or structures are bound in traditional thinking and directed toward particular outcomes" (B26-Environmentalist).

Organisational capacity is built on the capacity of the human resources a company employs. For a variety of reasons (including downsizing) Sydney Water has, in recent years, lost staff in areas such as research and innovation.

> "*There are a few stumbling blocks. Changing Sydney Water's kind of entrenched attitude is one. There are some good people in Sydney Water with progressive views. There's some that were with Sydney Water with progressive views and have now left. I often wonder if they left because they weren't changing the direction quick enough*" (B13-EPA).

4.1.3.3.7 Organisational Fit for Centralised Sewerage

The established organisation of Sydney Water and associated regulators and the regulatory framework were all designed with centralised water and sewerage in mind. The knowledge and values necessary for reproducing centralised water and sewerage networks were readily available from those organisations.

Decentralised water and sewerage, on the other hand, is not the core responsibility of any existing organisations with responsibility for water and sewerage in Sydney. The organisations established by the NSW Government to manage water and water-related environments, infrastructure and activities are all established around or based on centralised urban water management. Sydney Water dismissed decentralised options: "*They did look at it and said it wasn't practical. That wouldn't have fitted into their way of doing things*" (B15-Resident).

Similarly, during the planning phase of the Bundeena Maianbar water and sewerage enhancement, there was no organisation established for whom sustainability was the driving issue. There is now the Department of Environment, Utilities and Sustainability (DEUS), although it is still not entirely clear what role this department is to play in delivery of sustainable urban water management. (Two interviewees said that sustainability would be the responsibility of the Department of Environment and Conservation (DEC), while only one said it would be that of DEUS.)

During the planning stage of the project, the Environment Protection Authority (EPA, now the DEC) was present, but it was not deemed that sustainable water management was relevant to the EPA, whose remit was to protect the environment from excessive or adverse impacts of development. Had the EPA viewed their job differently, however, it is possible that they could have argued the case for more sustainable alternatives than conventional sewerage.

Thus each organisation, during the planning process, protected its own established domain, and did not extend beyond its traditional boundaries of responsibility. The dissidents did not have access to adequate funding, knowledge, or expertise to make any significant impact either in terms of raising the importance of sustainability or, as a potential follow-on, the possibility of decentralised innovation. Thus it was very difficult for anyone on the 'outside' to have any influence in achieving any alternative outcome to traditional reticulated sewerage.

There was no organisation with adequate funding, interest or skill for handling on-site or local water and sewerage management. As one community member said, "*Council are not interested, it's not their thing. Sydney Water are not interested, it's not their thing. And it's a pretty big job to ask a community to organise itself when they weren't even sure if we were even going to get the sewer*" (B7-Resident).

One of the community interviewees speculated as to how Sydney Water might have been able to adapt its organisational structure to incorporate decentralised systems, as follows:

> "*When you're dealing with small systems, you need quite a different sort of mindset. And it would have meant that they would have had to set up another unit, which would have been able to handle the smaller systems. And under [the former chief executive officer of Sydney Water interviewed for this research] that might have occurred, but certainly there was no institutional will to do it. And it probably would have been quite difficult for that group to have existed within the Sydney Water*

bureaucracy. It probably would have been better if it had been contracted, or if Sydney Water had set up another unit outside of themselves to look after smaller systems" (B3-Resident).

At the time the project was planned, there was a whole-of-government approach to environmental protection, and specifically the cleaning up of waterways and beaches. This agenda had an organisational home in the EPA, as well as strong State Government support across departments, and was thus able to be (arguably) effectively implemented. Thus for Bundeena Maianbar, the project was implemented on this basis – of cleaning up the waterways: "*And that's what really drove the thing: it was a political decision because of the environmental policy of the government of the day. So that's what drove the things in the first place*" (B14-MP).

However, there had not been a whole-of-government approach for sustainability of water management. Sydney Water, according to the MP interviewee, was not going to make a decision to change the way it operated in order to achieve more sustainable water management:

> "*No. The Sydney Water bureaucrats won't make [a decision to change strategy] because they're geared to make profits. Governments build infrastructure. And I think that ultimately somebody at the political level has got to say, 'This is the direction that we're heading.' … And I reckon that's in the foreseeable future. Because I just don't think the city's going to cop it much longer*" (B14-MP).

At the time of the interviews, it seemed to one former senior Sydney Water manager that there was no substantial strategy from the State Government: "*I think they're hoping that by the time the strategy's finished it will all rain. I'm that cynical. And then the problem will go away*" (B20-SWC). The (then) Department of Infrastructure, Planning and Natural Resources (DIPNR) was also not clear on any total water cycle management strategy at the time of interviews: "*Planning is open to whatever they come up with and seems reasonably effective at the moment. At the moment we assess things on a project-by-project basis. There's not that broader strategic position on*

sewerage systems" (B22-Dept Planning). From July 1, 2004 DIPNR had, however, progressively introduced BASIX (the Building and Sustainability Index), that came as a result of significant multi-agency input concerning demand management.

Another possible organisational home could have been the local community – e.g., the established Progress Associations. The community was a very frail organisational base, however, because funding was very limited and the local council office was a half hour drive away. In any case, the Progress Associations were dedicated to plugging into the Sydney metropolitan pattern. Householders were accustomed to self-maintained (or un-maintained) systems. The only organisational alternative seemed to be Sydney Water.

4.1.4 Project Outcome

The directionally drilled pipeline across Port Hacking was a significant engineering accomplishment, and was achieved without significant technical problems.

At the time of interviews, approximately 80% of houses had been connected to the reticulated sewerage system (from estimates of several interviewees). There is no available data on quantities of water or wastewater transfers.

There are no known survey results to compare before and after values for health, environment, social or technical performance of the Bundeena Maianbar Priority Sewerage Project. Anecdotal evidence suggests there has been no noticeable difference in incidence of diarrhoeal complaints, and little difference in stream quality. However, drought conditions for most of the time since construction means that such anecdotal comparisons carry little conclusive weight.

There are a few occupants – particularly in Maianbar – who have contested the Sutherland Shire Council order that they should connect to sewer (at personal cost of several thousand dollars, depending on site specifics), citing financial difficulties and the lack of presenting problems with their existing on-site systems. One Bundeena resident, an environmental activist, was reportedly refusing to connect to the sewerage

under any circumstances (B9-Resident). However, most residents have welcomed the sewerage system.

The outcome of a conventional water and sewerage solution for Bundeena Maianbar represented, in the minds of several interviewees, a missed opportunity to implement an alternative approach with greater emphasis on local solutions for sustainability. Many people would have welcomed local reuse. The following comment was typical of many residents: "*I thought the option of a local treatment plant was the best. It happens all over the world*" (B9-Resident).

Interviewees from the National Parks and also Sutherland Shire Council both expressed similar sentiment regarding an opportunity missed: "*I think there was … really a good opportunity to do something different*" (B1-SSC Officer). Also: "*My feeling is that there may have been opportunity lost – and I know this is a feeling felt locally around Bundeena – to actually demonstrate other ways of managing sewage in a fairly unusual and contained village*" (B16-Royal NP).

This research does not propose to evaluate what solution should have been implemented for the project, but rather explain the outcome that occurred and explore the critical factors that constrained decentralised innovation, given that it was widely regarded as a possible option for the site.

4.1.5 Bundeena Maianbar Case Conclusion: Accounting for the Outcome

The following summary of the above discussion highlights critical factors that led to the adoption of the traditional centralised model for water and sewerage for Bundeena Maianbar, along with exploration of why the opportunity for decentralisation was missed.

First, there was a mentality of abundance – as revealed in the discourses of entitlement and sewage removal. Indeed, the water supply was relatively abundant at that time. The subsequent drought affecting Sydney has significantly altered the perspective of water

management decision-makers, such that it is clear that, had the Bundeena Maianbar water and sewerage project been planned during this drought, it is much more likely that another option (probably involving local reuse) would have been pursued. Thus it is plausible to conclude that specific situational drivers for change toward decentralised systems are very important enablers for decentralised systems. The lack of such drivers serves as a constraint, insofar as embedded positions are not challenged.

Second, the existing organisations for which water management was a concern were all established and regulated to provide centralised water and sewerage. Thus, while there was tension in some of the institutional pillars (with alternate discourses being evident to support both decentralised physical technologies and/or increased user involvement), there was significant alignment of institutional pillars supporting traditional centralised physical systems and solutions, also precluding user involvement. That is, there was significant institutional isomorphism (see Section 2.3.2.1.4). This finding supports Hypotheses 1.1 and 2.1 (see Table 1-3 for hypotheses), that innovative decentralised technologies (Hypothesis 1.1) and user involvement (Hypothesis 2.1) are excluded from urban water management because of entrenched (or otherwise misaligned) institutional factors: knowledge, values and organisational structure/regulations. That neither decentralised systems nor increased user involvement in water management eventuated is not inconsistent with Hypothesis 2.3, but also does not strongly support this hypothesis. There was definitely no specific organisational unit whose responsibility was to actively manage alternate systems, and it could be argued that the existing organisation(s) responsible for conventional water management did not have sufficient adaptive capacity to allow and incorporate such new approaches. This is not inconsistent with Hypothesis 1.3.

Third, poorly planned public participation risks entrenching participants in their preconceived opinions and thus likely preventing innovative solutions by not allowing mutual learning, which could lead to improved problem framing and options. Further, the risk of dissatisfying the public is likely to be perceived by decision-makers as higher in such polarised situations, thus making it more likely that a low-risk conventional option is adopted. While there were many stakeholders involved in this case, not many

felt engaged, and the community did not end up being involved in the eventual operation and management of the system implemented – a solution that is not addressing water scarcity. This is not inconsistent with Hypothesis 1.4.

Finally, the narrow problem framing for Bundeena Maianbar meant that the scope for solutions was largely limited to a centralised outcome. Because providing sewerage had been on and off the political agenda for decades, the problem was already quite rigidly framed for some participants – particularly the older residents – as one of removing sewage by conventional piped systems. Sydney Water was also able to discount alternative discourses by emphasising their dominant, traditional discourse – which not only framed the problem but also determined which values were important, whose knowledge to validate, and which options were worth investigating and adopting. This further supports Hypothesis 1.1. The expert, technical construction that Sydney Water was able to put on the framing of the problem and solution (in the EIS) did not incorporate external or contesting problem frames. There was a simple multi-criteria assessment presented in the EIS, though the criteria and weightings were all determined within Sydney Water, and sustainability was not one of them (B17-Consultant, quoted in Section 4.1.3.2.2). The change in preferred option from a local treatment plant to piping to Cronulla STP between the Options Report (to which the Working Party contributed) and the EIS (before which the Working Party was disbanded) highlights how a narrow problem framing (by excluding other participant perspectives from the planning process) is quite likely to replicate conventional outcomes and thus impede innovation.

4.2 Pimpama Coomera Waterfuture

The Pimpama Coomera Waterfuture case study was chosen as an example of a greenfield development that incorporated significant aspects of decentralised urban water management features. Institutional adaptation and characteristics were of particular interest. Hence this case helps to answer the question of what institutional factors are important for enabling decentralised urban water management.

This Waterfuture case shares similarities with the following two cases, all being located within the southeast Queensland region and under a similar regulatory context. There are also similarities with the Bundeena Maianbar case in that the project scale was suburb-level (though this Queensland pair of suburbs was much larger than the NSW pair). Further, both this case and the preceding one were managed by public (government) entities. Public management, along with the relative size of the projects, meant that the planning aspects of these first two case study projects were much more publicly accessible.

4.2.1 Case Overview[59]

The Pimpama Coomera region of the Gold Coast was deemed to be the next major growth area of the Gold Coast (2004 population: 426,000). The region's water supply was already under stress, and there was little chance that the forecasted 2056 population of 1,100,000 could be supplied with the same amount of water per capita as at present from traditional sources.

The existing (semi-rural) population was about 5,000 prior to the release of the master plan in 2004. The projected population capacity of the Pimpama Coomera region is 150,000 people – i.e., a significant proportion of the projected total population growth in southeast Queensland.

The existing residents sourced their water primarily from rainwater tanks, and wastewater was managed on-site. Gold Coast Water investigated ways to both provide alternate water sources and also to minimise demand in this new growth area. In addition to water scarcity, the environmentally sensitive nature of Moreton Bay (into which the Pimpama River and Coomera River release) and the surrounds drove the search for more sustainable water management.

The planning process was facilitated by Gold Coast Water, which engaged consultants to provide expert advice and established a stakeholder advisory committee to drive the

[59] Background information is drawn from Gold Coast Water (2004) and Gold Coast Water (2003a).

process and make recommendations to the councillors. Table 4-12 charts the timeline of the project.

Table 4-12: Chronology of Pimpama Coomera Waterfuture planning process

Mid 2002	Gold Coast Water held a series of workshops to discuss sustainable water services provision. Stakeholders from the Queensland State Government, Gold Coast City Council and other local governments attended.
Late 2002	An advisory Committee was developed, including representatives from resident associations, landholders and developers, environmental groups, industry associations, relevant State Government departments, Gold Coast City Council officers and Gold Coast City Councillors.
Early 2003	The advisory Committee and Council established the objectives and desired outcomes of the master plan.
Early 2003	The advisory committee adopted a multi-criteria assessment methodology for determining the eventual outcome.
Early 2003	Expert consultants presented 40 different water supply / conservation initiatives to the advisory committee, who reduced the number of initiatives to 24 for development of options.
Mid 2003	Options were developed and assessed. First there were 10 options. This was initially screened down to 7. High-level assessment further reduced this to 5 options.
Aug 2003	The 5 options were taken to the community through shopping centre displays and focus groups.
Late 2003	The advisory committee decided on its preferred option, guided by the community consultation and technical assessment.
Early 2004	The master plan was documented.
March 2004	The master plan was taken to Council for approval and endorsed.
2004 onward	Implementation of the master plan commenced, and continues.
As at May 2006	Construction and sale of properties continues (with over 2,000 houses built and a further 3,500 allotments under construction); the wastewater recycling plant is due for completion in 2007; and rainwater tanks are in the process of becoming mandatory.

Sources: Gold Coast Water (2004), Q14-GCW

4.2.1.1 Initiatives and Options

The expert consultants on the Waterfuture team brainstormed and researched a selection of 40 separate initiatives that would contribute to more sustainable water management. These initiatives included a wide spectrum of approaches, grouped under water supply (e.g., desalination, dual reticulation, rainwater tanks), wastewater (e.g., on-site treatment and reuse, composting toilets, urine-diverting toilets, greywater reuse), stormwater (various water sensitive urban design elements), education, financial incentives or controls, and miscellaneous (e.g., aquifer storage and recovery).

Approximately half of the 40 initiatives could be considered as decentralised initiatives. Many of the most decentralised initiatives – including composting and urine-diverting

toilets, on-site treatment and reuse and greywater reuse – were screened out on the basis of estimated likelihood and consequence (in terms of achieving the objectives – see below). Reasons given for the low scores were lack of previous use, legislative barriers and potential negative public perception (Gold Coast Water, 2003a).

The options that were generated for further assessment were groupings of the preferred initiatives. There were common elements that were deemed important and viable for all options, while the primary components of most options were dual reticulation, rainwater tanks, 'smart sewers'[60], and/or aquifer storage and recovery.

The final option comprised:

- Class A recycled water for toilets, gardens and fire hydrants;
- Aquifer storage and recovery (for recycled water);
- Rainwater tanks for bathroom, laundry and hot water;
- 'Smart sewers';
- Water sensitive urban design (e.g., grass swales); and
- Demand management and education.

When the master plan is implemented, the Pimpama Coomera water management scheme could be a worldwide first for a large development to incorporate such an extensive array of integrated water management initiatives. It will certainly be the first in Australia (Gold Coast Water, 2003b).

Nonetheless, the approach to infrastructure and management is predominately centralised. A single treatment plant will be the focal point for all recycling of water, meaning that, although the quantity of raw water used will be much reduced, water will in fact be transported even further and against gravity compared to a conventional once-through system. The recycled water cannot come on-line for a few years – i.e., until sufficient adjacent communities are providing the supply and demand necessary to enable treatment works to commence. Rainwater tanks are a more decentralised form of

[60] 'Smart sewers' are pressure or vacuum sewers designed and constructed to minimise infiltration.

water supply, and this is probably the first major project in Australia to stipulate both recycled water and rainwater tanks. Thus some of the sustainability objectives of decentralisation are achieved: water is recycled and also partially locally sourced in that rainwater is harvested and used at source rather than being transported. Furthermore, the users are more engaged with managing their water use (even if only by being visually aware of three different sources). The specific details of who would have responsibility for the management of rainwater tanks was not finalised at the time the interviews were conducted. Nor were they mandated at that time; and therefore some houses were constructed without rainwater tanks. The rainwater tank strategy was almost finalised at the time of writing, however (cf. GCCC, 2005); as was the process of mandating them.

4.2.1.2 Objectives and Outcomes

The objective of the master plan was "To ensure more sustainable urban use of the Pimpama Coomera Region's water resources, with sustainability being measured on a whole of life basis via a balance of environmental, social and economic outcomes" (Gold Coast Water, 2004). The master plan document elaborates extensively as to what environmental, social, and economic outcomes and measures are desired. The expected performance in relation to key environmental criteria is outlined in Table 4-13.

Table 4-13: Performance targets of the Pimpama Coomera Waterfuture master plan (Gold Coast Water, 2004)

Outcome	Performance target	Anticipated performance
Reduction in use of potable water	75% minimum (to 258 L/equivalent tenement/day)	84% minimum (to 165 L/equivalent tenement/day)
Reduction of infiltration and inflow into wastewater systems	50% minimum	50%
Quantity of recycled water used	80% minimum	86%
Quantity of treated wastewater released to Pimpama River	12.5 ML/d maximum	3.6 ML/d
Reduction in amount of nitrogen and phosphorus released to waterways	50% minimum	50%
Reduction in quantity of stormwater runoff	10% minimum	17%
Reduction in greenhouse gas emissions	20% minimum	30%

4.2.1.3 Location

The Pimpama Coomera region is at the northern end of the Gold Coast, to the south of Brisbane. Most of the development region is between the Pacific Motorway (linking

Brisbane and the Gold Coast) and the shoreline, though some is to the west of the Motorway. There are two rivers running through the region: the Pimpama and Coomera Rivers. The area is considered to be environmentally sensitive, and the base water quality of the region's waterways fair to good. The aerial photograph in Figure 4-3 indicates the approximate region.

Figure 4-3: Aerial photograph of Pimpama Coomera region (source: Google Earth, http://earth.google.com, accessed 8/5/2006)

4.2.2 Interviewee Selection

Key players from within and also outside of the advisory committee were interviewed, using methods and rationale as outlined in Section 3.6. The emphasis on the local community was much lower in this case than in the Bundeena Maianbar case, as the majority of the 5,000 existing residents were expected to relocate, such that virtually all of the 150,000 expected ultimate population were at that stage unknown. See Table 4-14 for a breakdown of the interviewees.

Table 4-14: Pimpama Coomera Waterfuture case interviewee breakdown

Organisation / Group	People Interviewed
Gold Coast Water (GCW)	5
Resident community	1
Gold Coast City Council officers (not in GCW)	2
Gold Coast City councillors	2
State Government department officers	
Environmental Protection Agency (EPA)	3
Department of Natural Resources and Mines (NRM)	5
Queensland Health	3
Department of Local Government and Planning (DLGP)	5
Environmental representatives	3
Coastal management academic	1
Development industry representatives	2

Notes:

- Total interviews conducted: 30. Total interviewees: 32. (Two NRM participants were interviewed together, and two DLGP participants were interviewed together.)
- Three of the five Gold Coast Water interviewees were on the Pimpama Coomera Waterfuture team.
- Of all 32 interviewees, 10 were on the advisory committee – with representation spread across all but two of the above categories.
- Many of the interviewees from the three Queensland cases were asked about involvement in multiple cases where applicable.
- Transcripts from all Queensland cases totalled 195,000 words.
- Quotes taken from interviewees are referenced using the same system as for the Bundeena Maianbar case. For example, Q17-NRM denotes an interviewee from the Department of Natural Resources and Mines.
- Q1-5, Q47 & Q48 were all interviewed in April 2004. The remainder (including Q1 a second time) were interviewed in February-March, 2005.

4.2.3 Institutional Analysis

The analysis here follows much the same pattern as that of the previous case; so to avoid repetition, less explanation is given of the method or the explanatory institutional framework.

4.2.3.1 Organisational and Regulatory Context

The organisational and regulatory context for all three of the southeast Queensland case studies was shared to a significant extent. All three projects occurred under the same State Government and largely concurrently – so that policies and personnel were mostly consistent across the cases. Many of those interviewed from State Government departments were involved in, or at least aware of, all of the projects under study.

Thus much of the description of the organisational and regulatory context in this section applies to the following two cases also, and is written with all three southeast Queensland cases in mind. Only the final subsection (Section 4.2.3.1.4), concerning the Gold Coast City Council, is written specifically for this case.

4.2.3.1.1 State Government Interdepartmental Strategies

There were a number of cross-government initiatives for water management reform in Queensland, primarily in response to present and future water scarcity. The *South East Queensland Regional Plan* outlined government priorities to ensure that "policy frameworks and subsidies support total water cycle management" and that institutional arrangements were reviewed for efficient and sustainable water supply (Queensland Government, 2005b). The review of policy frameworks relates to integrated water cycle management while the institutional arrangements indicated here concern sharing of bulk water supplies in the region. "*I think the reason behind that was that there's a bit of a view that perhaps with all the growth there needs to be more coordination between the state and councils about how we provide and deliver water for the future*" (Q7-DLGP). While this research focuses on decentralised case studies in southeast Queensland, such a move toward shared bulk water supplies under more control of State Government, with the possibility of a lucrative revenue source for State Government, is actually a centralising force (both physically and organisationally) on water management in southeast Queensland (Prasser, 2005).

The policy framework review was specifically aimed at reviewing legislation to remove impediments to rainwater tanks, dual reticulation and other integrated urban water management initiatives (Queensland Government, 2005a). Two interdepartmental committees were set up for this purpose: one each for rainwater tanks and dual reticulation. The Queensland Water Efficiency Taskforce was established jointly under the Natural Resources and Environment Ministries for evaluating a variety of measures to drought-proof southeast Queensland.

Institutional, regulatory and policy reform prior to the recent emphasis on water scarcity had been largely centred on other aspects of sustainable water management including environmental flows, increased treatment requirements before discharge of effluent, economic reform and full cost pricing (COAG, 1994). But with recycling of water becoming an increasing priority – and due to the cost of recycled water being higher than that of potable – the current agenda seemed to be taking a different twist to that of the previous decade: "*Under NCP [National Competition Policy], COAG [Council of*

Australian Governments' agreement on] water, there was initially this sort of real coming together of an economic agenda and an environmental agenda for the sustainable use of water. But now with the focus on recycling we seem to have that integration splitting apart where the environmental objective is heading in one direction and the financial in another" (Q49-DLGP).

The recent pursuit of interdepartmental collaboration was seen by interviewees to have been a result of political support and direction from the top of State Government. "*It was only when the government basically said at the last election 'We're serious about this, and we're going to make things start to happen' that all relevant areas of the agencies started to engage, because they've got strong political direction to do so*" (Q17-NRM). The election referred to was in February 2004, and that interview was conducted in February 2005. Comments made by interviewees closer to the time of the election (April, 2004) suggested that the agencies were "*not all working together [and] a bit disaggregated*" (Q5-NRM). Another comment at that time was:

> "*We have a number of departments working in their silos*[61]*… What I'd like to see is a whole-of-government approach working at a high level saying what is important. They need to move toward becoming more strategic and big picture, working collaboratively with all stakeholders*" (Q4-GCW).

One of the agencies often criticised for not supporting the pursuit of integrated water cycle management was the health department, Queensland Health. "*Queensland Health has a very conservative health approach*" (Q28-DLGP). One of the concerns was that rainwater tanks could provide a vector for mosquito-borne diseases. The Queensland Health representative on the Pimpama Coomera advisory committee said: "*Some people in our department weren't happy with rainwater tanks full stop. But it's a cross-government strategy, and it was accepted by cabinet at a higher level, that rainwater tanks were the way to go*" (Q16-Qld Health).

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[61] Organisational 'silos' are characterised by less effective horizontal networks between 'silos' or departments, although independent units may be highly effective on their own.

4.2.3.1.2 Queensland Planning Processes

The planning process in Queensland is much more in the domain of local government (compared to State Government) than it is in New South Wales (Q40-DLGP). This situation is to be expected, given the large size of the local councils, with Brisbane and the Gold Coast being the two largest councils in Australia (in terms of population, not land area). Thus for each of the three Queensland cases the role of the state planning authority (the Department of Local Government, Planning, Sport and Recreation [DLGPSR or DLGP]) was limited to non-planning functions. For the Pimpama Coomera Waterfuture case, the DLGP may provide subsidy support for wastewater infrastructure, and for all three cases the Building Codes section of the department was involved regarding guidelines and regulations for rainwater tanks and greywater reuse.

The Pimpama Coomera master plan was not a legally binding document, but has been accepted and endorsed by the Gold Coast City Council, independent of any input from the DLGP.

4.2.3.1.3 Councils Responsible for Water, Sewerage and Stormwater

Water management is shared between state and local governments in most Australian states. Unlike other states, local councils are the water managers for all parts of Queensland, including Brisbane.

> "*One of the real benefits we have in Queensland that you don't have in New South Wales is that planning, stormwater, water and wastewater are all under one roof. We have it here centralised in one local government. To that end that's been a real benefit*" (Q4-GCW).

The on-line survey (see Section 3.3 and Appendix B) identified trends in water management for innovative projects (primarily water recycling) for all southeast Queensland councils. The results of the survey show that most planning and decision-making for water and sewerage occurs within the engineering departments of councils (or a commercialised business of larger councils). Nearly all decision-makers were middle-aged male (civil) engineers. The primary function of staff and external consultants in performing water management planning was technical assessment.

Decision-making was largely based on in-house informal methods and established knowledge bases.

Further, analysis and interpretation of the on-line survey results suggested that sustainable water management was regarded primarily as a technical problem for engineers to solve (see Section 5 of Appendix B). Most local councils showed preparedness to pursue innovation in technical practice such as recycling of sewage effluent for agriculture or industry, while development of broader policy, organisational capacity, and integration of the knowledge and values of wider stakeholders, were less evident. Most innovation reported (19 of 25 projects) still followed a centralised infrastructure model. For more detailed results of the on-line survey, see the paper (Livingston *et al.*, 2004a) reproduced in Appendix B.

Thus, while local councils in Queensland have water, sewerage, stormwater and planning all in the same organisation, that did not make integrated water management a simple matter. "*The number one problem [for achieving sustainable water management] isn't the technical one, it's the institutional one. So for example in the Gold Coast, the council is big – the second largest in the country. So it's departmental; so it's developed silos*" (Q35-Coastal management academic). The larger councils have tended to develop somewhat autonomous water and wastewater units, operating as profitable businesses to provide income for councils. This may make it difficult to integrate with other council departments. For example, "*Gold Coast Water sets itself up as a bit of a target for criticism [internally within Council], because it is seen to be semi-autonomous… Its income is massive to the point where it provides a huge slug of money to the council every year. So Gold Coast Water's budget is never questioned*" (Q25-GCCC Councillor).

Further, while the split of stormwater from water and sewerage is not as major as in the case of Sydney (as discussed in the previous case study), stormwater still tends to be fragmented within various parts of the larger Queensland councils and away from water and sewerage: "*Stormwater is split between Planning (for flooding), Community*

Services (for water quality) and Engineering Services (for water quantity). All of those work within their silos and there's not a lot of collaboration between them" (Q4-GCW).

4.2.3.1.4 Gold Coast Waterfuture Team and Committees[62]

The Pimpama Coomera Waterfuture project was established with a dedicated project team of about eight people, including four experts seconded full-time to Gold Coast Water for that project. An advisory committee was established by Gold Coast Water with clear terms of reference (Gold Coast Water, 2003a) – i.e., to oversee the development of an integrated urban water management master plan for the Pimpama Coomera region. The project team provided scientific input to the advisory committee meetings, in matters as determined needful by those meetings. The advisory committee was composed of about 20 members, including councillors, the director of Gold Coast Water, State Government department representatives, several development industry representatives, environmental group representatives and a residents' association representative.

The decision-makers of Gold Coast Water were happy to submit themselves to the advisory committee process "*for a number of reasons. Unless you get buy-in from stakeholders [community and developers] it would be a very, very difficult path to actually make it happen… There was a very high level of buy-in. So it was a good process… Most councils are still at the inform stage, out of inform-consult-engage. A few try to consult but not very well. The Gold Coast Pimpama Coomera steering committee got towards the engage end of the spectrum*" (Q9-EPA).

Following the success of the Pimpama Coomera Waterfuture advisory committee and the master plan produced, the Waterfuture project team turned to consider the future water balance of the entire Gold Coast region, and a Gold Coast Waterfuture advisory committee was appointed in April 2004 with similar constituents as the Pimpama Coomera advisory committee.

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[62] The discussion in the previous subsections of the southeast Queensland organisational and regulatory context is applicable to all three Queensland cases. This subsection applies only to the Gold Coast Pimpama Coomera Waterfuture project.

While not directly impacting on the Pimpama Coomera project, there were occasions when this wider Gold Coast Waterfuture advisory committee was restricted in its influence apparently for political reasons. One instance was when a councillor raised the matter of raising the Hinze Dam (primary water supply for the Gold Coast) as an urgent matter for alleviating water supply shortage. The Gold Coast Waterfuture committee did not endorse this idea, so the councillor took it to another committee that did support it, and thus it was brought to a meeting of council and voted through. This move came under heavy criticism from several players, including other councillors: "*I was really disappointed because it was a political decision*" (Q19-GCCC Councillor). And another councillor was more critical: "*It's just a bizarre, banal decision – politically motivated – and makes no sense whatsoever*" (Q25-GCCC Councillor). Another instance of political interference was when the same councillor who pushed for the raising of the Hinze Dam succeeded in restricting the role of State Government department members of the committee to non-voting rights. The comment of another councillor was to suggest that the other councillors who voted for curtailing input from State Government experts were "*very protective of [their] sphere of influence*" (Q25-GCCC Councillor).

Nevertheless, the Pimpama Coomera Waterfuture advisory committee was able to operate relatively free of political interference. The examples of interference in the case of the wider committee serve to illustrate that advisory committees have limited powers, and can be overridden by political decision-makers wishing to ignore the advice.

4.2.3.2 Discourses: Knowledge and Values

Unlike the Bundeena Maianbar case, the discourses evident in this case emerged in a much more recent timeframe. There was not a long history of dialogue about a possible water management scheme in the Pimpama Coomera region. There had been a Northern Wastewater Strategy, but that was sufficiently unrelated such that there was little impact on the discourses that emerged in and surrounding the Pimpama Coomera Waterfuture project and advisory committee.

The discourses that emerged, therefore, generally reflected more future-oriented thinking than in the Bundeena Maianbar case. But there were still conflicting values and ideas between some discourses, as outlined in Table 4-15.

Table 4-15: Problem frames of Pimpama Coomera case study participants

Problem Frame	Issues of Concern	Examples of Preferred Options	Examples of Adherents
Water scarcity	Inadequate water supplies for future (and possibly even present) population	Any new water sources	All participants
Water management as public health management	Rainwater tank water quality and mosquito breeding; recycled water questioned for firefighting	Traditional water sources with known water quality and known minimal risk	Queensland Health, firefighters
Growth and development	Water needed for future growth and development	Dams, indirect potable recycling	Developers
Minimisation of householder responsibility	Lack of ability or motivation for householder maintenance	Avoidance of rainwater tanks	Some council officers, various
Community ownership of and responsibility for water	Importance of community ownership, involvement and responsibility for water	Decentralised options such as rainwater tanks	Gold Coast Water, Waterfuture team
Technological progress	Engineering excellence and innovation	Aquifer storage and recovery, piped networks, recycling	Various stakeholders – particularly engineers
Integrated water cycle management	Integrated, sustainable policy/practice for future water security	Recycling, rainwater tanks, swales, etc.	Various (even most) stakeholders
Indifference	None (or others outside of water)	Any option and/or conventional options	Public

4.2.3.2.1 Water Scarcity

The presence of drought throughout Australia and particularly southeast Queensland[63] highlighted a water supply shortage for the region (considering population growth projections). While the specifics of this discourse varied widely, the present water

[63] The Hinze Dam (capacity 170 GL) reached a low of 29% in February 2003, but by May 2006 had reached 100% again. Water scarcity for the southeast Queensland region was still a reality in May 2006, however, as the combined SEQWater supply (Wivenhoe, Somerset and Northpine dams, total capacity 1,760 GL) was at 31% capacity – the lowest in 100 years (sources: http://www.seqwater.com.au/content/standard.asp?name=DamOperationsandMaintenance, http://www.goldcoastcity.com.au/t_gcw.asp?PID=2895, and http://www.goldcoastcity.com.au/t_gcw.asp?PID=1638, all accessed 8/2/2006).

shortage and even an impending water shortage crisis were widely acknowledged and discussed. For Gold Coast Water, as with other local government councils and water business units in southeast Queensland (see on-line survey results in Section 3.1 of Appendix B), water scarcity was a significant motivator for improved water management solutions. "*Drought changed the way the entire nation looked at water supplies*" (Q4-GCW). This enabled the council to "*do something serious*" (Q27-Environmentalist). "*Gold Coast City Council would be leading the way out of sheer necessity… Suddenly the penny's dropping*" (Q36-Environmentalist). The Pimpama Coomera Waterfuture planning process "*is recognising the scarcity of water and the value of water*" (Q31-NRM).

Water supply and demand figures and calculations were widely available in the media, government reports and websites, and the idea of a water supply shortage was not disputed. The values associated with this knowledge were more diverse (see Table 4-16). For most, the water scarcity discourse led to discussion of how to supplement supply – either through traditional or alternate supply sources. For some, the alternatives such as tank water were "*the way of the future*" (Q19-GCCC Councillor). For others, the source of the water was not important, so long as more water was found.

For the development industry, whose land-developing interests were said to be key drivers and influencers in the Gold Coast City Council (Cuthill, 2004) and even the wider Queensland State Government planning legislation (Q25-GCCC Councillor), "*It has taken something severe like the worst drought in history – and something that is very apparent to people – 'There's no more water folks' – to kick us into some sort of action*" (Q25-GCCC Councillor). The desire of the developers to continue development (but sustainably) led them to embrace this discourse and look for solutions: "*The constraints of sustainability are recognised by the development industry and they're wanting to get on board*" (Q44-Development Industry).

Table 4-16: Summary of the water scarcity discourse

Values	Knowledge base
Sustainability for future generations Maintaining standards of living Continued growth and development	Natural resources science and water supply engineering Climate change and hydrology

4.2.3.2.2 Water Management as Public Health Management

Water supply and sewerage have been driven by health knowledge and values for well over a century. So water and related professionals have had good reason to establish a discourse about the importance of public health in water management. "*Water and sewerage is a health business. We always have been, we always will be*" (Q15-GCW).

The health discourse (see Table 4-17) was emphasised, particularly by Queensland Health, in order to oppose aspects of the two main proposed alternate water sources: water tanks and recycled water. Concerning rainwater tanks, "*The issues there were non-maintenance of tanks and the flow-on effects of that – primarily vector issues with mosquitoes – dengue fever and so on… So I guess we got the message across that if we bring these in, they've really got to be looked after, and council's got to look at mechanisms to audit that*" (Q16-Qld Health). Water quality was also a concern for rainwater tanks: "*We can't guarantee supply against potable standards*" (Q21-GCCC Officer).

While health concerns related to household use of recycled water have been prominent for other proposed recycling projects, the principal area of concern relating to health impacts of recycled water for Pimpama Coomera were related to firefighting. The issue had become a nationwide concern for firefighters' associations and unions, who did not want the perceived additional risks associated with firefighters using recycled water from fire hydrants instead of potable. The project team, however, would have preferred to save both materials and water by using a smaller diameter pipe for the potable water. (This matter was unresolved at the time of the interviews.)

So the health discourse was primarily upheld in this case as a tempering influence on innovation in alternate water supplies and their uses. The implicit values were protecting human health and minimising additional risk incurred by innovation. The knowledge base included the tradition of past experience as well as scientific health risk assessment – although the latter was scarce due to lack of past experience with these alternate supplies.

Table 4-17: Summary of the water management as public health management discourse

Values	Knowledge base
Human health Risk and uncertainty avoidance	Scientific health risk assessment Traditional water and sanitation engineering

4.2.3.2.3 Growth and Development

The current and projected rates of population growth in the Gold Coast region were significantly higher than the rest of Australia. For the period 2000-2005, average annual population growth for the Gold Coast local government area was 3.4% compared to a national average of 1.2% (ABS, 2006). The strong emphasis on development was associated with and supported by a discourse of economic growth that values economic and population growth as desirable and good. See Table 4-18 for a summary of the growth and development discourse evident in this case study.

The importance of a secure and economic water supply to maintaining such growth and development were often emphasised by proponents of this discourse. "*The primary tenets of the UDIA [Urban Development Institute of Australia] are time, cost and certainty… We're wary of general mandating of things like rainwater tanks, greywater. As a whole Gold Coast development industry, we don't want onerous conditions that could send growth elsewhere*" (Q46-Development Industry).

The most obvious solution for some was to build more dams. A residents' representative just assumed that dams were necessary to allow continued growth and development: "*Why are we going to be almost running out of water all the time? Why can't we put another couple of dams in somewhere?*" (Q20-Resident). One councillor took advantage of this apparent simple solution by making a politically expedient recommendation to council to raise the dam wall, as "*the developers wanted*" (Q12-Environmentalist), in preference to alternate water supply strategies. Most water professionals, however, considered this approach questionable on financial grounds alone, if not environmental grounds also. The councillor who chairs the Water Sustainability Committee questioned the sustainability of this thinking based on dams: "*This is a thinking that we've got to now get rid of, and that's not to rely on dams for our future water sources*" (Q19-GCCC Councillor).

Many of the developers felt that the best source of additional water, considering the cost, which "*they were always looking at*" (Q20-Resident), was indirect potable reuse[64]. This was also supported by another member of the advisory committee (Q35-Coastal management academic), but they did not have close to sufficient voting support to carry this proposal back to the council.

There were plenty of dissident voices to the discourse of growth and development, such that it would be quite legitimate to also categorise an anti-development discourse. However, the anti-development discourse was not influential in the outcome of the project or even prominent in the water management planning process, as development in the Pimpama Coomera region was considered certain. The following two quotes from dissident voices are included to illustrate the extent to which the discourse of development and growth were perceived to be driving the project (and planning for the region).

> "*It's very much a philosophy here driven by the development industry. [This includes] State Government. And they're just saying 'bring the people up and we'll house them.' And that means more jobs, more taxes, that means growth, and somehow that's all good. But there's been really very little regard for all the repercussions of that. You get these knee jerk reactions which hopefully are going to come up with some decent solutions*" (Q25-GCCC Councillor).

> "*But the fact of the matter is you should really look at what is sustainable, and then say this is the population that we can take. And they haven't done that because they're so driven by development. Jobs, jobs, jobs*" (Q36-Environmentalist).

[64] Indirect potable reuse occurs where treated wastewater (i.e., recycled effluent) is released into a body of water (i.e., the raw water supply) for further treatment before distribution as potable water.

Table 4-18: Summary of the growth and development discourse

Values	Knowledge base
Profit Economic growth Material prosperity	Economic data and market indicators Population trends

4.2.3.2.4 Minimisation of Householder Responsibility

Many water management professionals expressed considerable distrust toward householders in relation to the responsibility of operating and maintaining water-related infrastructure and processes within their property boundaries. "*If you put in place a fairly expensive maintenance system, are people just going to ignore it and not do it?*" (Q9-EPA). This concern was based on limited experience with urban on-site water management but perceived "*similarities between a rainwater system and an on-site sewerage system*" (Q32-NRM) – generally associated with rural areas.

Operation and maintenance of rainwater tanks was often highlighted. It is "*always an issue, and will probably be the dominant one*" (Q35-Coastal management academic). Another advisory committee member identified "*the bigger issues*" as being about "*governance*" of rainwater tanks (Q32-NRM). Exactly what was meant by these bigger governance issues was not clear, however.

Emphasis on avoiding reliance on householder maintenance of rainwater tanks was out of concern for protecting the householder and the council from risk associated with water quality problems. "*We need still some fairly heavy handed regulation to protect people and public health and so forth. That's a regrettable outcome. It would be good to be able to devolve that responsibility but I don't think we can really. You'd need fairly fool-proof systems*" (Q34-GCW). However, concern for the lifestyle of the householder was also raised by one advisory committee member:

> "*I can't even mow the lawn, let alone maintain rainwater tanks… You might have to go to a situation where it's built into your rates and it's mandatory that someone comes around and inspects your rainwater tank and maintains it for you. I think the average householder won't be able to cope with the rainwater tank in that respect*" (Q35-Coastal management academic).

Legislation for council and/or external inspections seemed to be promoted by some as the solution, while others promoted education of householders. The following quotes emphasise inspections:

> "*It's just a matter of changing the legislation so the council have got permission to go on and inspect all the systems and perhaps charge people an inspection fee*" (Q32-NRM).

> "*Whether it's through Plumbing Code or the Health Act, we'll require periodic external audits by suitably certified inspectors – probably three to five year intervals or something like that, to make sure the tanks are being maintained correctly. And then the local governments will be given the job to make sure the audits happen, and any deficiencies they'll have to follow up, and deal with it*" (Q17-NRM).

Neither this discourse (see summary in Table 4-19) nor the Pimpama Coomera Waterfuture project had settled on inspections as being the solution, as responsibility for such inspections would require significant additional council resources. "*Local governments have thrown their hands up in horror: 'How on earth can we possibly afford to have a regular inspection program. That's going to take manpower like you wouldn't believe'*" (Q30-EPA). Thus one suggestion was that Council incorporate inspections of rainwater tanks into existing inspections (Q34-GCW). Another suggestion was that since Council did not have the resources to inspect more than about 1% of properties, ownership and responsibility should be passed to the individual, but with Council providing an "*extensive, ongoing consultation, education campaign*" to ensure "*it should work*" (Q39-GCCC Officer). The idea of the importance of education in regard to maintenance was also shared by others (e.g., Q16-Qld Health, Q20-Resident, Q44-Development Industry).

There were some dissident voices to this discourse. These voices questioned the emphasis on minimising householder responsibility in managing rainwater tanks. These two quotes illustrate:

"*I've been running rainwater tanks all my life. There's hundreds of thousands of people on rainwater tanks, and they haven't got to be checked every day*" (Q20-Resident).

"*I can't see that we'll get to the point where there's got to be inspections of rainwater tanks to make sure that there's mosquito screens or that there's not algae growing, or that people aren't pumping water from the wrong tap into them and that sort of stuff. But yeah, there is going to be a fair degree of self-management. But I don't know if there's a real lot that can go wrong*" (Q25-GCCC Councillor).

Most of the examples given for this discourse suggest that there is a lack of knowledge (from lack of experience) regarding urban householder maintenance of rainwater tanks. (However, for the approx. 5,000 existing residents, on-site sewerage systems and rainwater tanks had been the norm.) The emphasis on this discourse (in its varied forms) may in this case serve as a contributing factor to preventing attainment of such experience and knowledge. While the place of rainwater tanks in the strategy, and how they would be maintained, was yet to be determined at the time of the interviews, at the time of writing it was most likely that householders would actually bear most of the responsibility for ensuring regular maintenance (GCCC, 2005), although Queensland Health were said to require Gold Coast City Council to take responsibility for audits to ensure prevention of mosquito breeding and related illnesses (Douglas, 2006, pers. comm.).

Table 4-19: Summary of the minimisation of householder involvement discourse

Values	**Knowledge base**
Lifestyle ease Risk avoidance	(Possible) parallels with rural septic and rainwater tanks Varied professional opinions

4.2.3.2.5 Community Ownership of and Responsibility for Water

While the previous discourse relates to traditional discourses of water management (e.g., see Section 4.1.3.2.2 Centralised Technocratic Expertise), there was an opposing discourse of community involvement in, ownership of, and responsibility for, water management (see Table 4-20). The idea is that sustainable water management is

enhanced through engaging local communities and devolving responsibility and ownership to them. This discourse relates to Research Question 2, and also somewhat to Hypothesis 1.4 (see Table 1-3).

This discourse was not so evident in interviews as the previous discourse; supporting quotes here are only from one player, albeit a significant and influential player.

> "*We involved the community, so the infrastructure is owned by society. Changes to the way we provide infrastructure to society impact on community. For example, rainwater tanks, if they own and operate them, there is more responsibility to replace pumps and maintain water quality*" (Q4-GCW).

> "*The community and wastewater [have been] kept apart for so long. This project is about bringing them together*" (Q4-GCW).

This discourse is loosely related to a wider discourse of enhancing local capacity for more sustainable and integrated water management (United Nations, 1992a). The presence of this discourse helped to keep the more decentralised water management initiatives on the project's agenda.

Table 4-20: Summary of the community ownership of and responsibility for water discourse

Values	Knowledge base
Sustainability Community empowerment Community responsibility	*Agenda 21* (possibly) (United Nations, 1992a)

4.2.3.2.6 Technological Progress

The growth and development discourse was far more evident than that of technological progress in the Pimpama Coomera Waterfuture case. However, the technical professional nature of the majority of key players enabled an easy platform for a discourse of technological progress (see Table 4-21). One of the project team members suggested there was a technical emphasis in the project team: "*We are broader than pumps and pipes but a bit weaker on the social touchy-feely aspects*" (Q4-GCW).

One of the advisory committee members also noted the focus on progressive technology: "*We [have] still got very much a technology focus. Pipes running every which way and aquifer storage and all this sort of stuff – which is all good stuff. It keeps us civil engineers in work*" (Q35-Coastal management academic).

This discourse of technological progress harmonised with the discourse of minimising householder involvement – as technological solutions were generally favoured by the advisory committee and project team where such technologies could take the place of human interaction with the water cycle.

Table 4-21: Summary of the technological progress discourse

Values	Knowledge base
Progress Functional efficiency	Engineering

4.2.3.2.7 Integrated Water Cycle Management

The word 'integration' in the context of water can be almost as ubiquitous and thus devoid of substantive meaning as 'sustainability'. The *South East Queensland Regional Plan* states as its overall objective for water management in the region: "Water in the region is managed on a sustainable and integrated basis to provide adequate supplies for human and environmental uses" (Queensland Government, 2005b). The *South East Queensland Infrastructure Plan and Program 2005-2026* also uses similar language, and highlights the Pimpama Coomera Waterfuture project as an example of integrated urban water management (Queensland Government, 2005a).

The language of integration was employed in the higher levels of State Government departments and policy-makers. However, the interpretation and application of the language was not always consistent – with some players questioning the policy position of others. "*There's coming to be a recognition that while individual elements are fine, the issue with integrated urban water management is: how do you get an integrated strategy?*" (Q17-NRM).

A general trend in water management toward 'integration' (however that may be constructed – see Section 2.4.2) is generally evident in southeast Queensland. "*Gold*

Coast Waterfutures and Brisbane City Council are starting to go down the direction of whole-of-water-cycle sustainability" (Q5-NRM).

The Pimpama Coomera master plan uses the language of 'integration' to describe the proposed development, explicitly contrasting an integrated water cycle model to the "water intensive" traditional centralised mode of water management (Gold Coast Water, 2003b). In the words of one of the leaders of the project team: "*When we started looking at it, we realised it was all about entire water cycle management. We took off our water and wastewater blinkers. We wanted to create a total water sustainability plan for the region*" (Q4-GCW).

Others outside of the project recognised the emphasis on integrated water management, and reflected this discourse (see summary in Table 4-22) in describing the project. For example: "*It's an excellent project. It's got a lot of goodies – a lot of runs on the board – in terms of the integrated water management*" (Q29-GCCC Officer).

Table 4-22: Summary of the integrated water management discourse

Values	**Knowledge base**
Sustainability Environmental protection	Water cycle Environmental science

4.2.3.2.8 Indifference: A Lack of Discourse

Interviews were conducted with key players in the case – who were therefore unlikely to be indifferent. However, many of the key players reported indifference on the part of the community or the particular constituents they were trying to represent. See Table 4-23 for a summary of this 'discourse'. The following two comments from advisory committee members reflect some frustration with the apparent difficulty of engaging the community in the planning or management of water: "*In most cases the general public don't care*" (Q9-EPA). And: "*I suppose the community as a whole are very selfish, and they don't really get involved in things unless it affects them or their hip pocket*" (Q19-GCCC Councillor).

The communication and public consultation officer for the project reported that "*Trying to reach the broader population in that area has been very difficult. We have sent out*

newsletters to the people of the area, but we don't get a response from them. So the general community seems to be… pretty apathetic about what's going on" (Q14-GCW).

The community representative on the advisory committee had difficulty engaging any existing or new Pimpama Coomera residents in the residents' association, where such issues as water management were sometimes discussed. "*They just weren't interested in staying with us*" (Q20-Resident). He suggested that the complacency was associated with taking water for granted. "*Yes, well you put the water up to three dollars a glass and see how much they'll buck their ways up then. At the moment it's almost free. They've got other things on their mind – I don't know what it is – golf, or jet skis, or whatever*" (Q20-Resident).

Table 4-23: Summary of the indifference discourse

Values	Knowledge base
Lifestyle Cost of living	History of adequate water management

4.2.3.3 Discursive Policy Process: Narrative in Action[65]

The Pimpama Coomera Waterfuture master plan documentation (Gold Coast Water, 2003a) outlines a fairly comprehensive multi-criteria assessment performed to identify the preferred technical option. Thus the degree of 'scientific' objectivity appears more than in the Bundeena Maianbar EIS. However, this thesis argues that even this apparently unbiased assessment process necessarily remains socially constructed (again, after Berger and Luckman, 1971). Social construction of knowledge (as evident in the varied discourses) was clearly at play in this multi-criteria assessment. One explicit example will suffice. The project team and advisory committee considered a long list of initiatives aimed at providing integrated water management solutions. To reduce this to a manageable number, the initiatives were rated according to a combination of the likely performance against the determined objectives and the likelihood of being implemented. Thus initiatives that were considered unlikely were rated low, leading to their removal from the list to be considered. Some of the more innovative decentralised initiatives raised in the options report (Gold Coast Water, 2003a), such as composting toilets were

[65] See Sections 4.1.3.3 and 4.1.3.3.1 for an explanation of what is meant by mobilising of discourses into action.

given a low ‘impact score’ and discarded due to the lack of previous use, legislative barriers, and potential negative public perception. While this process was subjected to stakeholder and public input at the advisory committee, clearly the prevailing ideas and values (i.e., that which underlies discourse) of the technical-expert/engineering project team played a big part in determining the course of the project.

4.2.3.3.1 Right Timing: Drought

The most significant enabling discourse was that of water scarcity. Recent drought was a catalyst for the discussion of water scarcity and ways to solve that problem. Thus the significant incorporation of alternate water sources into the project was made possible.

There was a suggestion from one interviewee from a State Government department that the water scarcity discourse and associated solution-oriented discourses such as integrated water management have only recently gained currency and a high level of support:

> “*[It is] an issue that’s coincided with the water shortage in Queensland – the 2020 plan on water shortage… [So the director of Gold Coast Water is] asking the right question at the right time. If he’d asked this question five years ago I don’t think he would have got any airplay, because I know I didn’t*” (Q32-NRM).

This view was supported by another interviewee from Gold Coast City Council: “*I think the Waterfuture projects are great. I suppose my only criticism would be that we had to wait for a severe drought to do things like that*” (Q25-GCCC Councillor).

4.2.3.3.2 Alignment with State Government Strategy

Another key mobilising factor for the discourses of water scarcity and integrated water management was that these ideas and values were given political support and voice from the top of State Government. As discussed in Section 4.2.3.1.1, the Queensland State Government has embarked on a whole-of-government strategy to support integrated water management in the face of water scarcity, but not all agencies and agency staff have necessarily been supportive – e.g., “*because it wasn’t their idea”* (Q19-GCCC Councillor). The decision-makers of Gold Coast Water have actively tried

to engage the political support necessary to overcome any lack of alignment. This was done through targeting "*champion[s] within the organisation and also… at the political level*" and giving "*opportunity for them to have some stakeholding in the project, so that they feel as though they have some ownership in the project*" (Q34-GCW). A significant degree of State Government support is indicated in the following two quotes:

> "*There are a lot of people in State Government and even within this organisation who are accustomed with the way things are and have set themselves up within those organisations for that level of comfort, and probably resist fairly strongly any sense of need to change. So that's why it's important to tackle things politically so they get a clear message from the top… Politicians are very much on board with the project*" (Q34-GCW).

> "*The minister's very good. [The director of Gold Coast Water] and I go up on a regular basis to keep him up to date on what we're doing. He's very supportive*" (Q19-GCCC Councillor).

The director of Gold Coast Water served as a key champion of the project himself, and was able to influence other key stakeholders through the various forums and networks of which he was a part (Q39-GCCC Officer).

As noted earlier, Queensland Health provided the majority of hurdles from State Government (Q14-GCW, Q4-GCW). Queensland Health were caught without a policy position and were accustomed to conservativeness:

> "*We found it difficult because… our policy development seemed to be behind… Gold Coast Water are a very innovative sort of group… We weren't sure of our policy decision, because it was all untried, all new sort of stuff they were giving to us. But yeah, I think it's a great project myself*" (Q16-Qld Health).

4.2.3.3.3 Organisational Integration: Countering the Council Silo Effect

The Pimpama Coomera Waterfuture project significantly integrated the physical elements of the water cycle, and for effective governance, organisational integration

was sought between the different council departments involved with the water cycle. Many southeast Queensland councils, particularly the larger ones, have developed a significant silo effect reducing scope for integrated policy and action (Livingston *et al.*, 2004a). Gold Coast City Council, being the second largest (after Brisbane), was subject to this fragmentation. But the Pimpama Coomera Waterfuture project "*worked well at bringing together areas of council that were very much a silo affect before… I think we've got more structured relationships with certain areas of council*" (Q14-GCW).

The Gold Coast Waterfuture team were able to work "*very closely with [the] planning department*" (Q4-GCW). The benefits of the water authority being a part of the same local authority as planning and stormwater were clear to all the Gold Coast Water interviewees, particularly the director:

> "*[A] really big benefit for us, and the reason I think we've been able to push this as far as we have, is we're part of the council. So we have a very direct link into the town planning area, a very direct link into the plumbing and drainage area, and the building approval area. If we were a Sydney Water and Melbourne Water, this project would be very difficult if not impossible to do because they have to interface with so many other levels of government and agencies to get it to happen. And we just have to walk downstairs to a couple of guys downstairs in the plumbing area or a couple of guys in the planning area who can change planning policies and so forth to actually get those changes made. Where it then becomes difficult is where we have to go beyond the organisation and interface with the State Government*" (Q34-GCW).

However, there were individuals and sections within Gold Coast City Council who were perceived as unsupportive by Gold Coast Water interviewees. "*We benefited from good leadership and the integration of other players. But it was really frustrating and there were lost opportunities with other sections of council not helping*" (Q15-GCW).

The following two quotes illustrate a view within the Gold Coast Water team that they were leading reform in council, and other individuals or sections were hindrances, possibly because the ideas did not originate with them (Q19-GCCC Councillor):

> *"We're perceived as very pushy by all areas [of council], regardless of what we're doing – whether it's building something or just communication. Corporate Marketing hates our area because we're pushy and we want things moved… They move forward at their own pace; it's not the same. We do get a lot of angst from other areas… A lot of people are trying to be more with us, or keep up with us, or take the same path we have. But that is certainly a slow road, and this has been a great opportunity for us to build some of those strong ties with some of the key decision makers in other areas. But it still is a slow path to getting that organisational change to happen*" (Q14-GCW).

> "*We're leading the way, but our other departments of the council, unless I get up and move a council resolution, we are really finding it hard for them to get off their behinds, and work with us instead of against it*" (Q19-GCCC Councillor).

These claims are difficult to verify from the limited number of interviews conducted. However, one interview was conducted with a dissident voice from within council, whose "*involvement in [the project] was nonexistent*" (Q21-GCCC Officer). His criticisms included: "*They probably haven't involved all stakeholders*", but that developer and industry interests were driving the project, and that the interests of the public and his section of council were not looked after (Q21-GCCC Officer). One of the interested parties that he suggested was not being adequately consulted and involved was the section of council responsible for procedures and resources for maintenance and inspections of plumbing and rainwater tanks. He therefore saw his role as having "*to pull back the reins*" (Q21-GCCC Officer).

4.2.3.3.4 Organisational Fit: Creating a New Organisational Home

The director of Gold Coast Water and the project managers of the Pimpama Coomera project paid particular attention to creating an organisational home that would support integrated water management knowledge and values:

> "*[We] select people and set up the organisational arrangements for those people to encourage and drive innovation and not impede that innovation… I don't think anybody deliberately wants to stop innovation and particularly innovation associated with this project. I suppose it's trying to help people move out of the old paradigm of providing water and sewerage in the traditional way… That's part of the change management. It's then probably looking at our own organisation and saying 'Okay, what do we have to realign in our own organisation to make this happen?'*" (Q34-GCW).

The realignment was achieved largely by setting up a new project team with seconded experts having the necessary knowledge to develop and implement integrated water management plans. The advisory committee was set up to help achieve alignment with other sections of council (who were either represented on the committee or invited as non-voting observers). Once the project is complete, "*Transitioning that back into an organisational and operational context is the next and the biggest hurdle for us*" (G14-GCW). It was not completely clear how this would be achieved.

4.2.3.3.5 Nature of Participation: Active Stakeholder Engagement

Stakeholder collaboration for this project was primarily through the advisory committee, although there were also focus groups and public supermarket displays. The approach to community and stakeholder engagement, particularly through the advisory committee, was commended by a number of interviewees:

> "*I think it's great getting the community involved. I think you end up with far greater outcomes if you spend money getting the community involved*" (Q31-NRM).

> "*There needs to be more of it. It could probably be made more streamlined with experience and all the rest of it. I mean, the Gold Coast were basically breaking new ground to a certain extent. So it was a bit of a slow and arduous process. But certainly the community buy-in needs to be much more common*" (Q9-EPA).

The project team considered that they were collaborators with the advisory committee, and that the advisory committee had ownership of the direction of the project: "*The 'we' doing this is the advisory committee – they are the community. The Waterfuture team does all the work and consults with the committee – discusses whether they are happy with that*" (Q4-GCW). The project team, in fact, had "*tried to involve the committee in option development but they said 'You're the experts, you do it.' The committee built a good rapport with the Waterfutures team and trusted professionals*" (Q4-GCW).

The involvement of State Government stakeholders was considered by a number of interviewees to add benefit to the process and outcomes. "*They added significant value… They have a good grasp of issues, a higher perspective, and are also involved in wider forums*" (Q4-GCW).

A number of interviewees commented on the extra time and expense that the advisory committee process would have incurred: "*It's a long time in just time to go through all this. And the costs must be horrific. Now whether just the technical committee could have done it all…*" (Q20-Resident). Another noted: "*It was expensive, that's the down side of it*" (Q32-NRM). Adding to the lead-time was the delay in the committee adapting to form a working relationship. According to one member, the committee was not really "*comfortable with the direction*" until about the third meeting, after going through "*norming and storming*" (Q27-Environmentalist). The extra level of technical assessment required to furnish the advisory committee with enough information (presented in an understandable form) to make a decision would possibly have been the biggest additional expense (Q35-Coastal management academic).

Public consultation (e.g., supermarket displays) showed strong support for rainwater tanks, but support with reservations for recycled water. Focus groups (undertaken as a check) confirmed this view, and also chose the same eventual option as the advisory committee itself (Q14-GCW). When the committee eventually made its decision, "*some people may have had reservations about certain aspects of Option 3*[66]*… [But] Option 3 was the unanimous choice*" (Q9-EPA).

One recurrent observation was that the "*advisory committee was very developer-heavy*" (Q14-GCW). This may or may not have been a criticism. Indeed, about a quarter to a third of the advisory committee members represented development industry interests. For one interviewee, this represented "*political foresight to have them inside the tent*" (Q32-NRM) due to their economic and political power in the region. Nevertheless, the usual antagonists to the developers, the environmentalists, endorsed the project: "*That's as far as I can gather pretty well leading the way*" (Q36-Environmentalist). And they also endorsed the process: "*It was really a fair go at it [for both the environmentalists and developers]*" (Q27-Environmentalist).

Another problem was that of obtaining representation from a "*future population that doesn't exist*" which was "*a real dilemma*" (Q34-GCW). This was addressed in the subsequent wider Gold Coast Waterfuture advisory committee by inviting school captains to the meetings, and giving them time to present their views.

Some advisory committee members found it difficult to adequately consult with their constituents. Three expressed doubt in their own efficacy in doing so. The residents' association representative said he had tried to report back to residents' association meetings, but these were poorly supported: "*We've tried, but it's really hard to get some of those people involved*". His summation was: "*Well I've got a lot out of it, but I don't know if the other way has worked*" (Q20-Resident). The environment organisation representative suggested this could be a more widespread problem for all stakeholders:

[66] Option 3 is the option that was outlined in Section 4.2.1.1.

"*I could have engaged them more if I had more time, but I think most people were in the same position*" (Q27-Environmentalist).

Perhaps a contributing factor to the problems of committee members giving limited representation to their constituents was the amount of information given by the project team. "*One of the bigger criticisms of the process was the amount of information that was distributed at short notice… Another criticism would be simplifying things so that the stakeholders can understand it very quickly*" (Q44-Development Industry). Another said the technical information, though necessary, "*lost us at times*" (Q27-Environmentalist).

Different interviewees suggested the consultation process and outcome were strongly directed by Gold Coast Water (Q20-Resident, Q39-GCCC Officer). This was stated as an observation rather than criticism in both cases – along similar lines to this quote from a third person: "*You pretty well know what the final goalposts look like, but if you bring the community along with you as you go you end up with a lot more acceptance*" (Q31-NRM).

4.2.4 Project Outcome

At the time of writing, only a small portion of the Pimpama Coomera area has been developed – and not enough for any recycling plant to come on-line for a further few years into the future. And there have also been some delays and changes to rainwater tank implementation and policies, as discussed. So while on paper it is the largest example of integrated water management with such a significant water saving percentage, it is still too early to document outcomes.

However, there are other measures of success, including the fact that "*a lot of local governments are starting to copy it*" (Q17-NRM), and that it is seen as "*a role model for everyone else, everything else*" (Q32-NRM). There are some parallels between the principles and process of the Pimpama Coomera Waterfuture project and the Sustainability Framework of the Water Services Association of Australia (Lundie *et al.*, 2005). Both have impacted on each other, as learning has been shared in both directions.

This thesis is largely based on an assumption that decentralised approaches to water management such as rainwater tanks and closed loop recycling represent improvements in sustainable water management. While assessing sustainability from a water scarcity perspective, this view appears to have the weight of evidence. However, it must be noted that the greenhouse gas emissions associated with pumps for rainwater tanks can be significant, especially for current conventional rainwater tank pumps. One interviewee acknowledged this, but justified the direction chosen as follows: "*Yes, we recognise that we're going to be less greenhouse gas friendly for a period of time. But given that it's either that, or we shut the communities down to a certain extent, we make a decision. But we will try and get the energy side of it running as quickly as possible*" (Q9-EPA).

4.2.5 Pimpama Coomera Case Conclusion: Accounting for the Outcome

Gold Coast Water guided the initial problem framing of the Pimpama Coomera project to a significant extent. The choice of name in 'Waterfuture' and the choice of experts in water recycling for the project team clearly set resolving water scarcity on the agenda. This is not altogether different from the heavy influence and narrow problem framing of Sydney Water for the Bundeena Maianbar case. However, there were three significant factors which allowed decentralised innovation to occur.

First, there was a highly influential circumstantial factor of drought. This fuelled the discourses of water shortage and integrated water management, enabling concerted focus and action on alternatives to traditional water supply and wastewater removal. Thus the cognitive and normative institutional pillars for water management in this case study underwent significant shift.

Second, Gold Coast Water management consciously established a new organisational unit to deal with the project. Experts were brought in from various consultancies, and integration within Gold Coast Water and other council departments was actively pursued. Alignment with State Government policy and agencies was also pursued. This

creation of a new organisational home enabled the development and implementation of new ideas and values (supporting sustainable water management through some decentralised approaches). While the outcome was a mix of centralised and decentralised technologies, this case still supports Hypotheses 1.2, 1.3 and 1.4 (see Table 1-3): that decentralised technologies for urban water management are supported by: alignment of institutional pillars; an organisational home for emerging ideas and values; and networked links with other organisational actors.

And third, Gold Coast Water and Gold Coast City Council voluntarily established an advisory committee as the decision-making body, responsible for making the ultimate recommendation to Gold Coast City Council. Thus all relevant actors and stakeholders were actively engaged and able to influence the outcome. This evidence adds support to Hypothesis 1.4.

This case study provided somewhat conflicting evidence in relation to Research Question 2. There was only limited support for a discourse of increasing user involvement, but this seemed to be an important element in keeping decentralised technologies on the agenda, providing some support to Hypothesis 2.3. But the support for this hypothesis is offset by the more widely expressed discourse of minimising householder involvement, reflecting traditional institutionalisation of urban water management by engineering professionals. Thus Hypothesis 2.1 is also somewhat supported, because only very limited user involvement (in rainwater tanks) eventuated.

Given that the scale of reuse and other water management technologies employed in this case was quite mixed between centralised and decentralised infrastructure, and arguably predominately centralised, the support for all hypotheses (for both research questions) must be somewhat diminished.

4.3 Payne Rd Subdivision

The Payne Rd case provides an example of a much smaller scale water management scheme than the previous two cases. In this case, decentralised initiatives were selected for a 22-lot subdivision. The decentralised approach was partly due to limitations in the

centralised network and partly in an attempt to pursue a more sustainable alternative to urban greenfield development. The case illustrates a receptive organisational location for innovation, albeit simplified by being a small (one-person) private developer with consultants chosen specifically for the project.

4.3.1 Case Overview

The land at 599 Payne Rd, The Gap, Brisbane was used for farming for much of the 20th century. However, it was rezoned as Emerging Residential, and a travel business owner bought it with the view to develop the land. The site is 3.75 ha, with an average lot size of 1,100 m^2 (Gardner *et al.*, 2006).

The site is situated at the end of Payne Rd, which adjoins Waterworks Rd, a major arterial route into Brisbane. (Brisbane city is 9 km away.) Beyond the end of Payne Rd there is a disused water supply – the Enoggera Reservoir (see Figure 4-4). The land slopes steeply downward from the road, at an incline of approximately 1:4 (Q6-Consultant). There is a State Forest above the site. The elevation of the site posed pressure problems for water supply above RL 76 m, a contour that divides the site approximately in half (Q6-Consultant).

Figure 4-4: Aerial photograph of 599 Payne Rd, The Gap and surrounds (source: Google Earth, http://earth.google.com, accessed 8/5/2006)

There was also a problem with providing sewerage services to the site because of the notion that the existing sewer main did not have adequate capacity (Q6-Consultant, Q10-Consultant). (This notional lack of capacity was, however, disputed by an experienced senior Brisbane Water interviewee [Q1-BW].) In any case, the perceived difficulties in supplying conventional centralised water and sewerage led the developer and his team of consultants to pursue more localised alternatives that would reduce total water import to, and export from, the site.

An objective of the project was to "demonstrate that the residents can substantially reduce the water and energy components of the eco-footprint of urban subdivision at cost-effective prices, without requiring major lifestyle changes" (UDIA, 2003). Water management planning was done by a consultant with informal consultation with the client (the developer) and the Brisbane City Council. "*We drove it from a technical perspective, with some input from [the planning consultant]. We would take those ideas*

along over a series of meetings to council, and work them through, and get feedback, and perhaps change things a bit, until we got to the point where everybody was happy with it" (Q10-Consultant). There was no public involvement in the planning, nor any available documentation of exploration of options and criteria or detailed technical assessment.

Rainwater tanks were designed into each house, with two 75 kL communal water tanks taking overflow, fed by gravity, at the bottom of the site's slope (Gardner *et al.*, 2006). Mains water trickle feeds the communal rainwater tanks, which in turn feed the tanks at the individual houses via a pump. The estimated reliance on the centralised water supply is only 25% – with the other 75% coming from the rainwater that falls on the 22 houses' roofs (Q6-Consultant, Q10-Consultant).

Reliance on the mains sewerage was to be reduced by reusing greywater. Treated greywater[67] was to be used in backyard subsurface irrigation. Soil moisture probes automatically redirect any excess greywater to sewer. Black water (along with any excess greywater) is sent to a sewage holding tank at the bottom of the site for nocturnal discharge, when there is extra capacity in the sewer main (Q6-Consultant, Q10-Consultant).

Whether or not the subdivision was declared by council to be in the service area for Brisbane Water was a matter of debate amongst interviewees. Several argued for each case, or that it had been declared but then 'undeclared'. The reason for this uncertainty was that it was illegal in Queensland for greywater reuse to occur in areas with sewerage services. This legislation was under review at the time of the interviews.

The site was considered too steep for water sensitive urban (stormwater) design to be applied to the roads. But water sensitive urban design principles were applied to individual lots and also the whole subdivision. A portion of each rainwater tank was

[67] Greywater was to be treated on-site by a Biolytix© aerobic vermiculture composting system (see http://www.biolytix.com/ourProducts/products_specific.htm, accessed 18/5/2006).

allocated for use in stormwater management, and at the bottom of the site there was a bioretention area (Q6-Consultant).

The 22-lot subdivision comes under a community title, under which residents share responsibility for (contracted) maintenance of communal components such as the three shared rainwater tanks.

The Payne Rd subdivision development is currently under construction. See Table 4-24 for a timeline of the development.

Table 4-24: Chronology of Payne Rd development

2000	Land rezoned to "Emerging communities"
2001	Project conceived
2002 following	Detailed design
2004-2005 (approx.)	First six houses constructed
As at May 2006	Still only six houses constructed (with three houses sold); stage two yet to commence

Sources: Q10-Consultant, Q23-Owner/developer, Q6-Consultant

4.3.2 Interviewee Selection

Key players were selected and interviewed, using methods and rationale as outlined in Section 3.6. While the breakdown in Table 4-25 shows a total of 25 interviewees, a large majority of the government department officers played only a peripheral role and were selected for their involvement in all three Queensland cases or for their general, regulatory or institutional context knowledge and input.

Table 4-25: Payne Rd case interviewee breakdown

Organisation / Group	People Interviewed
Owner/developer	1
Brisbane Water	2
Brisbane City Council officers	3
Brisbane City councillor	1
Consultants	3
Contractor	1
State Government department officers	
Department of Local Government and Planning (DLGP)	5
Department of Natural Resources and Mines (NRM)	4
Environmental Protection Agency (EPA)	2
Queensland Health	2
Resident	1

Notes:

- Total interviews conducted: 23. Total interviewees: 25. (Two NRM participants were interviewed together, as were two DLGP participants.)
- As noted earlier, quotes taken from interviewees are referenced as Q*x*. (See notes to Table 4-14.)

4.3.3 Institutional Analysis

4.3.3.1 Organisational and Regulatory Context

The State Government context for this case follows that outlined for southeast Queensland in Section 4.2.3.1.

The organisations involved in this case were primarily the developer (and consultants) and the Brisbane City Council. The Environmental Protection Agency was not involved at all, as there was no discharge of effluent to the environment. The Department of Local Government and Planning and its Building Codes section were revising greywater reuse legislation, which was relevant to the project. The project went ahead of the revisions, which were intended to promote greywater reuse in sewered areas.

Brisbane City Council established a fast-tracking development approvals system for projects meeting sustainability criteria, and this provided some assistance and "*incentive*" to the developer in the case of this project, because council "*really wanted to push [it]*" (Q1-BW). Brisbane Water provided advice as to network capacity for provision of water and sewerage services to the site, while Brisbane City Council managed the development approval process.

4.3.3.2 Discourses: Knowledge and Values

Table 4-26 outlines the discourses (problem frames) evident in the Payne Rd case study. The discourses are elaborated in the following sections.

Table 4-26: Problem frames of Payne Rd case study participants

Problem Frame	Issues of Concern	Examples of Preferred Options	Examples of Adherents
Traditional engineering	Conserving professional traditions	Traditional piped networks	Brisbane Water (to some extent)
Public health management paramount	Water quality and mosquito-borne illnesses	Traditional water sources and disposal	Queensland Health, some at Brisbane City Council
Minimisation of householder responsibility	Lack of ability or motivation for householder maintenance	Traditional piped networks	Brisbane City Council
Integrated water cycle management	Sustainable development, self-sustaining communities	Rainwater tanks, recycling	Developer and consultants

4.3.3.2.1 Traditional Engineering

A discourse of traditional engineering (see Table 4-27) was not demonstrably held by any interviewees, for they showed support for innovation. But some interviewees made reference to this discourse being held by others. Thus it was described by way of critique rather than support. In this respect, and substantively, it is similar to the centralised technocratic expertise discourse of the Bundeena Maianbar case (Section 4.1.3.2.2). The traditional engineering discourse that interviewees described was more tied to existing organisations and patterns of doing things that tended to frustrate or hinder innovation rather than being associated with individual objectors to the project.

Some Brisbane City councillors were said to "*have very much … a traditional approach of pipelines and dams*" (Q17-NRM). (But other councillors, and one in particular, were very supportive of innovation.)

The organisation of Brisbane Water was also viewed as being heavily influenced by the traditional engineering paradigm of water supply and wastewater disposal. This was most evident in statements from some Brisbane Water employees who themselves had a more innovative view, as in the following two quotes:

"Engineers are very reticent to try anything… I can see that we've been doing a lot of things wrong as engineers – and it has cost this country. The first sustainable developments are not being done by engineers. Engineers were against water recycling and rainwater tanks… Engineers are our own worst enemy" (Q1-BW).

"*Reuse fits in between water and sewerage, so there's a need for an independent subgroup*" (Q47-BW).

There were obstacles to the Payne Rd project's development application from different parts of Brisbane City Council, regarding various aspects of the development including the water and wastewater management systems. All were able to be resolved. Regarding the notion that there was insufficient sewer capacity for conventional sewage discharge, one Brisbane City Council officer in the Water Resources section suggested: "*That's where you get waffle from Brisbane Water. You'll find that the service provider will try as much as they can to have resistance to something new*" (Q18-BCC Officer).

Table 4-27: Summary of the traditional engineering discourse

Values	**Knowledge base**
Tradition Professional engineering values	Established engineering knowledge Organisational knowledge

4.3.3.2.2 Public Health Management Paramount

Concern for public health was particularly evident from Queensland Health. Because this discourse was not central to the key proponents, it is labelled here in a way slightly different from the previous cases; though it was supported by similar values and knowledge (see Table 4-28). Queensland Health was concerned about greywater reuse in sewered areas: "*I've got health concerns. I'd like to see subsurface irrigation only*" (Q2-Qld Health); and also the use of rainwater tanks: "*We have ongoing problems with dengue fever, Ross River fever, etc. There are major concerns for any increase in mosquito breeding*" (Q2-Qld Health). These comments were made in reference to all Queensland cases.

Appeals to this discourse may also have been based on underlying value placed on avoiding risk and/or responsibility for possible public health concerns. The following comment was from an employee in the section of Brisbane City Council responsible for regulation of on-site water management devices: "*I know we're trying to push water tanks, but I'm not a great believer of using water tanks in Brisbane, with the pollution. It's not too bad out at The Gap, I suppose*" (Q29-BCC Officer).

Table 4-28: Summary of the public health management paramount discourse

Values	Knowledge base
Public and householder health Risk avoidance	Scientific Anecdotal

4.3.3.2.3 Minimisation of Householder Responsibility

The discourse of minimising householder responsibility for this project (see Table 4-29) had some similarities to that for the Pimpama Coomera Waterfuture case. In this case, none of the key players (including the proponents) had much confidence in householder management or responsibility for maintaining and operating the water management devices within the property or the group title estate. For example: "*They [householders] haven't been able to manage septics or on-site systems for the last 50 to 80 years*" (Q2-Qld Health). The discourse diverged, however, as to what the solution would be. The project proponents (the owner/developer and his consultants) were certain that a group title system of management would work; whereas others – particularly from Brisbane City Council or Brisbane Water – were sure that the group title would not be successful but that, for example, Council intervention would be required.

The project was designed with total reliance on a community title scheme – with contracted maintenance – for the ongoing operation of the site's shared water management system. When asked how much work would be involved for the householder, the answer was: "*Nothing. Under the community management scheme… you pay 30 dollars a week to have somebody maintain all of that, to have 24 hour callout if anything goes wrong*" (Q6-Consultant).

> "*People will not do the maintenance. So you have to have a mechanism to do it. I don't do the maintenance at my house, but I have someone who comes and does it. I've always had that mentality. So the community title*

gives the mechanism where you can have people come in seamlessly and it just happens" (Q45-Consultant).

This confidence in the community title to ensure effective management was not shared by others. The dissident views expressed as follows still support the overall discourse of minimising householder involvement in water management, but disagree with the reliance on a community title scheme to provide that management. Reasons for this lack of confidence included a perception that community title management of decentralised water systems "*doesn't work overseas*" (Q1-BW). Another interviewee extrapolated general experience with group title estates:

> "*People don't want to spend the money or be involved. A group title estate when you've got sewerage and water supplied, and all you've got to look after is your gardens, is one thing. But when you've got to look after your water tank, your greywater reuse area and everything else like that, there's people that just don't want to be involved in that. I think it's either going to fall down or get very expensive, to have somebody maintain it all*" (Q29-BCC Officer).

This officer reasoned that there would be too many lifestyle changes required for "*everything to work*" properly, and that this expectation was too high, especially for tenants, should the houses be let.

The view of most in Brisbane Water and Brisbane City Council was that there would have to be more Council intervention to ensure ongoing operation:

> "*I don't think it will be left to fail, but I think council will have to be involved a little bit more*" (Q29-BCC Officer).

> "*We are very reticent about people treating their own sewage on their own property… Going on-site is fraught with danger… Body corporates [sic] don't work for wastewater treatment plant… You could have community owned plants with someone like the water authority or council*

looking after it. Our own operation people are not keen on that, but that would be the best outcome" (Q1-BW).

However, one interviewee at Brisbane City Council did not want to assume any responsibility for problems with maintenance: "*The position we're taking is it's the homeowner's responsibility*" (Q41-BCC Officer).

The underlying value of risk avoidance was explicitly stated by one interviewee: "*Our experience is that there's a high risk of failure in operation and maintenance between either the maintenance company or the householder… You want to minimise perceived risks to the community, or risks to the public entity*" (Q18-BCC Officer). The town planning consultant's response was: "*It's about risk management. Local authorities are not risk tolerant*" (Q45-Consultant).

Table 4-29: Summary of the minimisation of householder responsibility discourse

Values	**Knowledge base**
Lifestyle ease Risk avoidance	Various professional opinions Possible parallels to rural on-site systems Possible parallels to community title overseas

4.3.3.2.4 Integrated Water Cycle Management

The integrated water cycle management discourse for this project (see Table 4-30) was shared by all the proponents (i.e., the owner/developer and his consultants). They wanted the sustainability initiatives to be an improvement on the existing services, but not so extreme that it could not soon be the norm or 'middle of the road'. Indeed, they wanted these initiatives to help influence future development norms. The following quotes all reveal their position in this regard.

"*We've ended up middle of the road; you're never going to be totally environmental. The water cycle management is probably the most important [aspect]… We want this to be the norm*" (Q6-Consultant).

"*The very strong direction is that sustainable development will become the norm*" (Q10-Consultant).

"*I firmly believe in my heart the future is being a lot more self-sustainable. We can't continue to use all the resources all the time*" (Q23-Owner/developer).

Table 4-30: Summary of the integrated water cycle management discourse

Values	Knowledge base
'Mainstream' sustainable development Self-sufficiency	Environmental science/engineering

4.3.3.3 Discursive Policy Process: Narrative in Action

Given that the Payne Rd project is by a private developer, a development approval does not constitute as significant a decision of government as for the previous two cases. Thus there is less documented or anecdotal evidence as to what factors led to the eventual outcome. Nevertheless, the more limited evidence obtained is analysed and presented here.

4.3.3.3.1 Local Government Support

As in the previous case, there were people that served as champions for this project, in the opinion of some interviewees. Finding champions within the council was considered by one interviewee to be a necessity for this type of development to occur – "*because the greatest barriers to getting sustainable projects are overcoming the inertia of the status quo*" (Q45-Consultant). The people most often talked about as champions (or terminology with similar meaning) were a council officer and an influential councillor. The need for champions was argued by one interviewee as follows: "*Possibly the biggest frustration was the lack of expertise within the council that understood about it all*" (Q23-Owner/developer).

While the council did have a fast-tracking process for development applications marked as sustainable (as discussed above), there were still several hurdles relating to council staff lacking expertise and guidelines or policy direction. One of the consultants that worked on both this project and that of the next case (Currumbin Ecovillage) elaborated his frustrations on this point. This relates primarily to Brisbane City Council, but also to some extent Gold Coast City Council (i.e., as relates to the next case study):

> "*At a high level in council, they were extremely helpful. But at a lower level, the checking officer type of level – it's not that they're unhelpful, it's just that they don't know… They don't have the skills or the training or guidelines to deal with it. So they're put in a position of oftentimes appearing unhelpful because they just don't know actually how to deal with it… The councils I believe could be more proactive in inviting policy, at the very least policy, to deal with these things. And after policy, usually guidelines follow. Guidelines are somewhat of a poisoned chalice at times, because by the time something is put into guidelines it becomes very rigid and then people start to treat them as rules… And the original reasons for doing them are forgotten. Policy can be extremely useful because it sets out why and sets out comprehensive background for reasons you're doing things. But oftentimes, well certainly with Gold Coast and Brisbane City Councils, they haven't had policy to support what is being done. And so that has made it difficult across the whole process to achieve outcomes… My understanding was their decision was to get a few developments on the ground and see how well they worked, and then write the policy, so essentially trying to wait for the developers to do all the backbreaking work. And then they'd try and sum it all up and write a policy around it, which is pretty back to front*" (Q10-Consultant).

However, the benefits of lagging policy were identified by another interviewee: "*I think personally it's better the way it has [eventuated]. Some people would disagree with me, but I think part of the problem is until you have something on the ground it's often hard to know what are the real policy issues you've got to address*" (Q17-NRM).

4.3.3.3.2 Partnership between Traditional Adversaries

A consultant who was one of the most influential drivers of the project emphasised the need for partnerships between a variety of stakeholders to achieve beneficial outcomes to all. "*The partnership is absolutely critical. We will not get sustainability without creative, innovative partnerships*" (Q45-Consultant).

The key partnership identified was between council and the developer: "*So you need to move from an adversarial relationship to partnership. And that's not what people are used to. They don't like change. They're frightened. They've been shafted by many, many developers. So therefore you're assumed to be a liar because you're a developer*" (Q45-Consultant).

The Green Development Forum was also engaged both to support the project and also to support other like developments. The consultants involved in this case were wanting to establish a niche in sustainable design, and the "*council were interested in exploring alternatives to conventional supplies*" (Q10-Consultant). Thus the project and the partnerships "*came at the right time in many ways*" (Q10-Consultant).

4.3.3.3.3 Community Participation

The small neighbouring local community did not have a significant interest or impact in the outcome or process of the Payne Rd development, and there were no other significant stakeholder groups apparent that either were or should have been engaged – apart from the Green Development Forum. Nevertheless, the project team spoke a language of inclusiveness and participation in relation to the local community: "*We were very concerned about the community acceptance*" (Q45-Consultant) and "*People were informed all the way through, and they were generally all happy*" (Q6-Consultant). The positive community response was verified by one of the residents involved in a local historical society: "*There doesn't seem to be any anti-feeling in the community toward the Payne Rd site – mainly due to the sustainability side of it… There were no problems, no jumping up and down by anyone*" (Q11-Resident). The local councillor concurred: "*Everyone was quite happy about it. It was fantastic*" (Q22-BCC Councillor). The one known exception was one neighbour who "*spat the dummy… All she was objecting to was the fact that someone's building across the road where she's had for so long pretty pristine sort of views and privacy. Now all of a sudden it's going to be a hive of activity*" (Q23-Owner/developer).

4.3.4 Project Outcome

The success of the integrated water management features at the Payne Rd development is not yet known, because not all houses have been constructed, and the very few that

have been sold have not been long inhabited. Interviewees were only prepared to give qualified statements as to its success (e.g., Q18-BCC Officer, Q23-Owner/developer).

There was considerable interest in the ongoing operation of the water management system, and therefore the Department of Natural Resources and Mines, together with Brisbane City Council, were conducting a long-term monitoring study of physical – and possibly social – data and outcomes of the system. Early reporting of water balance (for three occupancies only) suggested "potable water savings well in excess of 50% compared with a traditional subdivision"; but energy use was significantly higher than for conventional water treatment and distribution due to inefficient small pumps (Gardner *et al.*, 2006).

Nevertheless, at this early stage, the local councillor was prepared to endorse its success: "*Yes, I think the project sets a benchmark*" (Q22-BCC Councillor).

Several interviewees questioned the long-term efficacy of such reliance on rainwater tanks. "*With the rainwater tanks – that's just tinkering really, but it makes people feel good and it raises people's awareness of water uses*" (Q22-BCC Councillor). And with town water topping up the tanks, some interviewees suggested the tanks will be either full of town water (Q1-BW) or that "*in six months everyone will flick the switch and turn it off. It will be done away with… It's good in theory*" (Q42-Contractor).

One reason for the concern was that city people may not conserve water like country people on rainwater tanks do. This could lead to various elements of the system being overloaded, resulting in no savings in water usage and additional energy used for pumps that operate frequently (Q29-BCC Officer).

4.3.5 Payne Rd Case Conclusion: Accounting for the Outcome

This case is a successful example of implementation of decentralised alternatives primarily because a private developer chose to embrace and promote values and ideas associated with innovative and sustainable water management. A loosely networked organisational home for these values and ideas was established through choosing

appropriate consultants and forming a partnership with the local council based on mutual pursuit of more sustainable development, even though the council was largely sceptical of many elements of the design. This evidence provides strong support for Hypotheses 1.2, 1.3 and 1.4 (see Table 1-3). The support for Hypothesis 1.4 should be somewhat moderated because there was only a small network of stakeholders involved; the local community was not involved in the planning process.

The findings with regard to Research Question 2 (concerning user involvement in urban water management) were mixed. The system was designed so that the household user did not have to be involved, but rather a third party contractor would do the work, engaged under the community title. However, from the point of view of the Council, operation and maintenance of the system were the householder's responsibilities. So there was some support for user involvement, from some parties, but not from others. A somewhat mixed result eventuated, and thus support for Hypotheses 2.1, 2.1 and 2.3 should be regarded as present, but weak and inconclusive. That user involvement is a related issue to decentralised physical systems, and that institutional factors are also important, seems clear. Further evidence and experience is needed to better characterise the relationship(s).

4.4 Currumbin Valley Ecovillage

The Currumbin Valley Ecovillage is another example of an urban fringe subdivision greenfield development implementing decentralised initiatives for water management. This subdivision is for 144 lots, and has a number of features aimed to enhance social, environmental and economic sustainability in areas such as energy, waste, transport, community living and water.

This case provided the most decentralised example of water management of any of the four case studies, as 100% of the water requirement was planned to be sourced on-site (from rainwater tanks). All wastewater was planned to be either reused or discharged to the environment within the 110 ha site.

There were organisational similarities to the Payne Rd case, where a private developer gave primary focus and channelled resources toward establishing a sustainable subdivision, partnering with consultants, local government, and, to a limited degree, State Government.

This case was chosen to supplement the Payne Rd case, because developer-driven water suburban management schemes are less typical than local or State Government-driven schemes; but developer-driven schemes may become more commonplace, both to enable development in water scarce areas and also because developers are in a better position (as argued later) than water authorities in many cases to implement decentralised innovation.

4.4.1 Case Overview

The Currumbin Ecovillage is located at 639 Currumbin Creek Rd, in Currumbin Valley, at the southern end of the Gold Coast. (See Figure 4-5 for an aerial photograph of the site. The site is between Currumbin Creek and Piggabeen Rds. Evidence of bulk earthworks can be seen toward the top right of the figure.)

Figure 4-5: Aerial photograph of the Currumbin Ecovillage site and surrounds (source: Google Earth, http://earth.google.com, accessed 8/5/2006)

The area is zoned as Park Residential. The subdivision was not 'declared' by council to be in the service area for sewerage services. A town water mains does reach to the property boundary, but does not extend any further into the valley. Most existing properties in the zone are multiple hectare sites, with on-site sewerage, rainwater tanks, and, if available, town water supply. The development approval for the Ecovillage includes properties ranging in size from 600 m^2 to 5000 m^2. While this does not strictly comply with the town planning scheme, the council deemed that the intent does comply, given that 80% of the site will be open space (GCCC, 2003a, b).

The owner-developers of the Ecovillage have not managed other developments, but have established a small company, Landmatters Currumbin Valley Pty Ltd, specifically for this development. They describe themselves as "*radically green*" (Q13-

Owner/developer) and have defined a project statement explicitly holding the desire to inspire more sustainable living and building[68].

The development has several innovative characteristics aimed toward sustainability, including: 'edible landscapes'; energy efficient housing; environmental and public open space; strict waste management protocols with emphasis on composting and recycling; on-site employment and community facilities (reducing transport and increasing social cohesion); and integrated water management achieving self-sufficiency in water and wastewater.

As in the case of the Payne Rd development, the Currumbin Ecovillage water management planning was not done in the formal way that the Pimpama Coomera Waterfuture master plan was established; however, unlike the Payne Rd development, it did involve a very elaborate public consultation step. Water management options were determined by the owner-developers (who had travelled internationally to review sustainable water management technologies) in consultation with their engineering consultants. But they took their plans, while still in the formative stages, to the community through open days and public meetings, seeking directive input from the community. While this consultation step may not have had much impact on the eventual technical details, the consultation has provided the development with other benefits as detailed later.

The water management scheme was intended to be 'closed loop' such that all water would be sourced from rain that falls on-site, and wastewater would be used for irrigation on-site (GCCC, 2003a). Each house was to have a rainwater tank between 30 and 75 kL. Excess rainwater was to be held for communal firefighting. During extremely dry periods (estimated < 5% of the time) water was to be imported via water tankers. Demand management was also planned.

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[68] See the project statement under the title: "The Ecovillage at Currumbin: Project Criteria", at http://www.theecovillage.com.au (accessed 1/9/2006).

There was to be no external sewerage connection. One of the four precincts within the subdivision was to have lots of sufficient area (> 3000 m^2) to allow on-site wastewater treatment. Treated wastewater was to be used on-site for irrigation. For the remaining three precincts, a reticulated sewerage system was to feed a communal wastewater recycling plant that would also serve irrigation needs. Each house was to have its own primary settlement tank, with effluent then transported in 50-75 mm pipes to secondary treatment with textile filters. Tertiary treatment was to be by microfiltration and ultraviolet radiation, with chlorine dosing for the reservoir. The recycled water was to be reticulated back to each house for toilet flushing and outdoor uses (with a separate coloured tap).

Roads were designed as rural lanes with swales. There were to be essentially no stormwater pipes, and very little curb and guttering. Ponds and wetlands were to be used to capture nutrients and pollutants.

The development was planned to be managed by levels of bodies corporate: a principal body corporate was to be responsible for the entire community; with subsidiary bodies corporate operating below that (e.g., for individual precincts).

The submission for preliminary approval "*was as detailed as anyone else's development permit*" and also "*really thorough*" (Q26-GCCC Officer). But it needed to be detailed in order to get approval, given the number of elements to the plan that were out of the ordinary. "*They could have had an approval to subdivide that land into 128 lots… and they'd be out there and sold them in the boom two or three years ago, if they'd done the standard developer response*" (Q26-GCCC Officer).

The Currumbin Ecovillage subdivision development was under construction at the time of writing. See Table 4-31 for a timeline of the development.

Table 4-31: Chronology of Currumbin Ecovillage development

1995-1997	Idea conceived (culminating with the owners/developers meeting various influential people at the Living City Expo 1997)
2000 (approx)	Directors commenced full-time work on project
August 2003	Preliminary approval granted
Early 2004	Office established on project site
Late 2004	Development permit granted (mid-level approval – not the finer grain of approval for precinct/s)
Early 2005	Bulk earthworks construction commenced
As at May 2006	First stage civil works mostly completed with over 90% of lots sold[69], one house under construction, wastewater treatment plant almost complete

Sources: Q13-Owner/developer, Q37-Owner/developer, Q26-GCCC Officer

4.4.2 Interviewee Selection

Key players were selected and interviewed, using methods and rationale as outlined in Section 3.6. While the breakdown in Table 4-32 shows a total of 26 interviewees, many of these played peripheral roles only and were selected more for their involvement in either of the other Queensland cases or for their general, regulatory or institutional context knowledge and input.

Table 4-32: Currumbin Ecovillage case interviewee breakdown

Organisation / Group	**People Interviewed**
Owner/developer	2
Gold Coast Water	1
Gold Coast City Council	3
Gold Coast City councillor	2
Consultants	1
State Government department officers	
Department of Local Government and Planning (DLGP)	5
Department of Natural Resources and Mines (NRM)	4
Environmental Protection Agency (EPA)	3
Queensland Health	2
Resident	1
Environmental representatives	2

Notes:

- Total interviews conducted: 24. Total interviewees: 26. (Two NRM participants were interviewed together, as were two DLGP and two Brisbane Water participants.)
- As noted earlier, quotes taken from interviewees are referenced as Q*x*. (See notes to Table 4-14.)

[69] This sales figure was taken from http://www.theecovillage.com.au (accessed 8/5/2006).

4.4.3 Institutional Analysis

4.4.3.1 Organisational and Regulatory Context

The organisational and regulatory context of this project is very similar to that of the Payne Rd case, with the project involving primarily the developer (and consultants – some of the same ones as for Payne Rd) and the local council (in this case Gold Coast City Council). However, in this case the EPA did have an approval role because all treated waste is to be discharged to the environment.

In Queensland, the Environmental Protection Agency has two arms – a regulatory arm and the 'Sustainable Industries' arm. The Sustainable Industries arm was also heavily involved in this case in a support role. One of the interviewees from Sustainable Industries commented about their role: "*Our role is not necessarily long-term. We're more than delighted when other parts of government pick it up and run with it [sustainable water management]… [Sustainable Industries] should disappear; should do itself out of its function. And sustainability should be a core element out of all government agencies*" (Q9-EPA). (Sustainable Industries, as the name implies, also targets industry when promoting sustainable development practice. In this case, the development industry was the target.)

4.4.3.2 Discourses: Knowledge and Values

Table 4-33 outlines the discourses (problem frames) evident in the Currumbin Ecovillage case study. The discourses are elaborated in the following sections.

Table 4-33: Problem frames of Currumbin Ecovillage case study participants

Problem Frame	Issues of Concern	Examples of Preferred Options	Examples of Adherents
Sustainable self-sufficiency	Sustainable self-sufficient communities	Rainwater tanks, recycling	Developers, consultants, some at Gold Coast City Council
Motivation of change in other developers' practice	Influencing better practice for sustainable development for future generations	Rainwater tanks, recycling, etc.	Developers
Community management	Social cohesion and sustainability values	Local, decentralised	Developer, (some) Gold Coast City Council officers
Anti-development	NIMBY-type concerns	No development (or piped, out-of-sight, solutions)	Some nearby residents

4.4.3.2.1 Sustainable Self-Sufficiency

Unlike the previous three cases, the terminology or discourse of 'integrated water cycle management' was not prominent. In its stead, there was a discourse of sustainable self-sufficiency in water (see Table 4-34). This discourse implicitly builds on the discourse of integrated water cycle management, but the emphasis is on closing the water cycle rather than merely integrating it.

The project proponent made the objective of self-sufficiency or closing the loop on the water cycle a very high priority: "*We're heading for self-sufficiency. If you can't demonstrate it here, we're lost*" (Q37-Owner/developer). This is also the only case study (of the four considered) to include consideration of closing nutrient cycles as part of the water management strategy: "*We've got fantastic use for this nutrient-rich water. So what we've got is bio-mimicry – we're eating the stuff, the nutrients go through us, down the toilet, back onto our yards. We grow the food and we eat it. Obviously we're importing some nutrients. And we're probably going to be exporting in biosolids*" (Q37-Owner/developer).

Other stakeholders and observers shared, or at least reflected, this "*ideological commitment to being separate from the water and sewerage system*" (Q32-NRM). It was this discourse of self-sufficiency that won the approval of otherwise anti-development environmentalists: "*I'm interested in the fact that they're trying to be*

completely self-sustaining within the community. Because we'd like to see a lot more of that, if that was possible" (Q36-Environmentalist).

One of the neighbours was happy to accept the innovative development, sharing the same concern for water scarcity underlying this discourse: "*But the next big problem we will have is water anyway. Where [will] we get the water?*" (Q33-Resident).

Table 4-34: Summary of the sustainable self-sufficiency discourse

Values	Knowledge base
Self-sufficiency Preserving or mimicking natural systems	Environmental, natural resources science Ecological sanitation and decentralised water management knowledge

4.4.3.2.2 Motivation of Change in Other Developers' Practice

The idea of motivating a change in standard developer practice was expressed often enough and by enough people for this to be a discourse in itself. This discourse relies on being coupled together with the previous one of sustainable self-sufficiency, and could be argued to be an extension of that discourse. The knowledge base was the same, but the values different (see Table 4-35). The values underlying this discourse were based on sharing and extending sustainability to others and for future generations. The proponents wanted to be seen as world-leaders in sustainability. "*If something's good and it sells well, it will spread like a rash. So this is the real intent behind this development – that is, to create a model that is world's best practice, but actually sells well, and therefore actually can be replicated*" (Q37-Owner/developer).

Overcoming the barriers for other developers was very important to the proponents. The obstacles they recounted included: lack of support from financial institutions for risky investments, leading to developers producing what consumers are known to consume (i.e., a vicious circle); and regulations and guidelines applied meticulously and inflexibly by bureaucrats and technocrats. (Organisational aspects are discussed in more detail below.) The developer intended to break through these obstacles to help other future developers innovate for sustainability.

The project proponent further articulated this discourse as follows: "*We wanted a great place to live, and to educate and inspire sustainable development practice awareness…*

One of the things is to get these projects on the ground. And that's actually what this project is about" (Q37-Owner/developer).

If the developer's values had been entirely based on economic return, other key players argued that they would have pursued a significantly more standard type of development. The following two quotes illustrate:

> "*Their vision is to have the world's best eco-village… They could have done a very simple development and probably have finished it by now if they'd gone the conventional path*" (Q10-Consultant).

> "*I would suggest 80% of doing this was because of their own social philosophies. Because [one of the owner/developers] wanted to demonstrate, and do something special… But he'd have a few less grey hairs, I'd say, and would have made more money, doing it the standard way. So he'll develop a niche, and maybe he'll do more of them*" (Q26-GCCC Officer).

Table 4-35: Summary of the motivation of change in other developers' practice discourse

Values	Knowledge base
Promoting and sharing sustainability Future generations Recognition as world-leaders	As for previous discourse (Table 4-34) Knowledge generated by and specific to the project

4.4.3.2.3 Community Management

The community management discourse (see Table 4-36) was affirmative of householder involvement in the management of the water cycle. Unlike the previous three cases, only one of the interviewees selected for this case expressed any doubt about the community management system working. This could have been for a number of reasons, such as the critical importance of the on-site systems working for water supply (whereas the other two Queensland cases had a permanent mains water supply component), or the type of people that are likely to live there. This quote explains the thinking that extra pressure on householders will encourage good management:

> "*We're passing responsibility back to each house owner… If you've got a finite supply, you won't leave the tap running on. Because it costs you money, it's a hassle, and, in our development, it will be social pressure…*

If the water truck's coming in every six weeks, your neighbours are going to [observe and comment about that]. So that's the ultimate water saving device, to restrict your supply. It's just a question of how many tanks do you want to put on to drought-proof your property. So that passes the responsibility back to the owner. That's when there's a change" (Q37-Owner/developer).

Further, the Ecovillage was being marketed to target people with interest in sustainable living. Such people were therefore thought to be more likely to take care of ongoing operation and maintenance of the water management scheme (see further discussion of this in Section 4.4.4). This thinking was evident in the following quote by the Council officer responsible for assessing the development application.

"*This development could not operate, and will not be successful, if the people that move in are the type of people that can only live in a standard suburban environment. These people are only going to move in there knowing that they have to take their own waste down, that they have to compost, that from time to time their water supply might be a bit dicey… They have to be committed to the sustainability initiatives to want to live there. People that aren't, won't want to live there… They've managed to create a really good social village out there*" (Q26-GCCC Officer).

This perspective of probably adequate community management was also shared by one of the Gold Coast City Councillors:

"*I think in the Ecovillage there's a high propensity that that's going to all work very well, because people make a decision that's the kind of living environment they want, and they actively want to make it successful… Some people will fight and fight and fight about it, and go on about algae and mosquitoes as if it's the end of the earth. I think that, by and large, people who currently manage their own wastewater with on-site sewerage facilities and that sort of stuff – it becomes part and parcel of their living environment… They're not difficult to maintain and there's not a great*

level of difficulty in implementing or integrating those things, I don't see any great problem with them" (Q25-GCCC Councillor).

As for the similar discourse in the Pimpama Coomera Waterfuture case (in Section 4.2.3.2.5), this discourse is possibly related to *Agenda 21* (United Nations, 1992a). In the context of the Ecovillage outcome, key stakeholders were happy to accept this discourse, enabling the project to go ahead with householders (under a community title) bearing the responsibility for management.

Table 4-36: Summary of the community management discourse

Values	Knowledge base
Sustainability Community empowerment Community responsibility	*Agenda 21* (possibly) Local knowledge

4.4.3.2.4 Anti-Development

There was a significant anti-development discourse (see Table 4-37) associated with the development as a whole. This did relate in part to the water management strategy. For example, odours from settling ponds that were proposed initially could have been a problem for one neighbour. That neighbour organised a petition that was submitted to the council, objecting to the development. But the majority of signatories were merely signing it from an anti-development perspective rather than for the specific concern regarding odours from a sewage treatment plant. The neighbour who organised the petition realised this: "*A lot of people wanted not to have it. A lot of people wanted to buy the place if nothing came of it… Nothing else but jealous*" (Q33-Resident). He later became supportive of the project after a change to the sewerage design that removed his odour concern.

Table 4-37: Summary of the anti-development discourse

Values	Knowledge base
Natural environment Possible jealousy and/or guarding of own (relative) wealth	Local knowledge Knowledge of property values

4.4.3.3 Discursive Policy Process: Narrative in Action

As discussed for the previous case, the discursive process in this case had relatively few players. There was one extremely influential player (the developer) who strongly emphasised the discourses of self-sufficiency and inspiring sustainable development.

4.4.3.3.1 Government Support

Gold Coast City Council were in general supportive, but the complicated and unusual nature of the proposal necessitated more time for assessment: "*It's not the standard, it doesn't fit the tick-the-box*" (Q37-Owner/developer). Coupled with staff changes (sometimes requiring restarting the process), this was a source of frustration to the developer, who wished for "*absolute fast-tracking with council*" and "*financial incentives from all forms of government*" (Q37-Owner/developer).

Gold Coast Water did not provide much in the way of support or hindrance, by their own admission, but affirmed the concept as "*fantastic*" and had "*no problem*" with them not connecting to town water (Q34-GCW).

As discussed above, the EPA were involved both in the regulatory arm and also the Sustainable Industries division. The development assessment team at Gold Coast City Council "*met with [the] EPA… and said 'we think this is a good thing'. And together, you basically agree to cooperate*" (Q26-GCCC Officer). The regulatory arm of the EPA had no problem in quickly approving the proposed discharge (Q8-EPA), while Sustainable Industries played a facilitating role:

> "*Our role here is not to actually get things built and done down to the final detail. Our role is to facilitate people taking it on board and going away and doing it… Our role simply is to facilitate, get some pilot exercises up, report and make the information widely available and promote the concept… We had a vested interest in terms of finding a home for [a water recycling] demonstration plant*" (Q9-EPA).

This water recycling demonstration plant did not end up being used by the Ecovillage, but Sustainable Industries still provided support and also gave the project publicity

through an award provided together with the Urban Development Institute of Australia, Queensland.

One of the developers urged the importance of finding "*a champion person that loves the project, who can just be your liaison point and point you in the right direction and the right people*" (Q13-Owner/developer). Such a person was found in Sustainable Industries (Q13-Owner/developer, Q26-GCCC Officer).

4.4.3.3.2 Community Engagement

Community consultation is not required before a development application is submitted, but:

> "*Landmatters chose instead to go to a community consultation before an application was made, and essentially seek ideas from the community about what should happen, and it worked extremely well… [But] the development industry can be pretty sceptical of [dealing with lobby groups]… [Developers] play things close to their chest so nobody knows. Because, if you give somebody a glimmer of what's going on, they distort it and exaggerate it*" (Q10-Consultant).

The reasons the developer initiated early community consultation was both to seek input for ideas and also to build support:

> "*We wanted to put it to the valley residents. This is a very sensitive area. We wanted to have support, and knock out as much objection as we could and also have input form them as to what they might want to have included… We took on board most of people's concerns and issues. We got some fantastic suggestions*" (Q13-Owner/developer).

This was done through letterboxing the area with an invitation to attend a public meeting with workshops, presentations and opportunity for questions. This approach yielded 280 people at the first meeting, then 250 at the second a week later. This was an "*unprecedented amount of community consultation*" (Q26-GCCC Officer). According to one observer: "*I think they went to pretty extraordinary lengths*" (Q36-Environmentalist).

When the proposal was submitted (in preliminary form), there were 15 responding submissions to council, six of which were late, and three (of the 15) were in support. One of the objecting submissions was in the form of a petition with 754 signatures (GCCC, 2003a). The person who led the petition "*now goes out and plants trees on the site every second weekend… I think it's fair to say most of those people are now supportive of it because they now understand*" (Q26-GCCC Officer). The developer kept this dissident involved (as discussed above), even asking him to review the plans. Over time he became supportive.

4.4.4 Project Outcome

Similar to the Payne Rd case, construction has only just started, and thus there are few outcomes that can be conclusively elaborated other than the approval of a more radical design. Plenty of praise has been directed at the developers, e.g.: "*I think what the developer is doing there is just fantastic*" (Q34-GCW). If implemented as approved, the planned community will be one of the most innovative and largest 'sustainable' (or sustainability-oriented) communities in Australia.

Unsurprisingly, there is also some scepticism and reservation about whether it will actually work in practice: "*I think it's a good conceptual plan… [But are] there enough environmentally concerned people? They get entrenched in their day-to-day life. Have they got time to manage the rainwater system?*" (Q21-GCCC Officer). Another interviewee shared similar concerns:

> "*I think most of the people who buy there will be fairly motivated individuals – because it's not cheap – and will probably make it their business to make sure they can manage with it. It's possible over time people will sell, and the idealism of the original concept may diminish somewhat. And then you may get pressure from people wanting to hook into town water and sewer*" (Q36-Environmentalist).

While environmentally motivated people may be the original inhabitants, it remains to be seen how long such a situation of motivated inhabitants might last. The freehold land

titles may in the future be rented or sold to occupants who may have less motivation. The intention of the proponents was that the community's social norms (Q37-Owner/developer) as well the fallback option of by-laws enforced at the body corporate level (Q13-Owner/developer) should keep the community's water management scheme in operational order.

4.4.5 Currumbin Ecovillage Case Conclusion: Accounting for the Outcome

Like the previous case (Payne Rd), this case is a successful example of implementation (at least to the stage of planning approval) of decentralised alternatives because of the developer's values and choices. In this case, a new organisation (Landmatters) was established to manage the development. Other stakeholders were more actively linked into a slightly broader network than in the case of the Payne Rd development. Thus the evidence from this case supports Hypotheses 1.2, 1.3 and 1.4 (see Table 1-3): that alignment of institutional pillars and an organisational home with networked stakeholders are important for enabling decentralised innovation.

This was the only case where user involvement was widely accepted and actually significantly adopted. The alignment of institutional pillars supporting user involvement in urban water management supports Hypothesis 2.2. Further, the extent to which the physical water management technologies were decentralised (which was more than in any other case) adds weight to Hypothesis 2.3, that acceptance of user involvement is a helpful (but not necessary) condition for enabling uptake of decentralised technologies.

4.5 Cross-Case Comparison

The four case studies were each unique for Australian conditions and provided a number of points of difference. In the Bundeena Maianbar case, due to its geographical setting adjacent to Royal National Park, the first directionally drilled submarine water service pipelines in Australia were deployed. The Pimpama Coomera Waterfuture master plan was a first in Australia (and possibly the world) for such a large-scale development to have so many innovative water management features. The Payne Rd development was unique in terms of the limitations imposed by the elevated and sloping

site, and also in that it was planned to be mostly but not completely self-sufficient for both water and sewerage. The Currumbin Ecovillage was probably the most radically decentralised of all subdivision developments of its size (or larger) in Australia, particularly in terms of self-sufficiency for water management.

The richness of variation of these basic features, as well as discursive and institutional aspects, allowed many comparisons to be drawn. The drawback was that due to lack of replication of any one case type, concluding generalisations were weakened to some extent. Nonetheless, each of the case studies provided supporting material for some of the hypotheses posed (see Table 1-3). No single case provided sufficient evidence to test all of the hypotheses, but all hypotheses were tested with evidence from at least one case. There was consistent support for Hypotheses 1.2, 1.3 and 1.4: that alignment of institutional pillars and an organisational home which includes networked stakeholders are important for enabling decentralised innovation. The Bundeena Maianbar case provided evidence supporting Hypothesis 1.1, that institutional factors are a strong factor in excluding decentralised options, regardless of technical assessment (see Section 4.1.5). But the support for Hypotheses 2.1 to 2.3 was not so consistent. A summary of the analysis of each case is provided for comparison in Table 4-38. More detailed discussion follows.

Before turning to the institutional framework for comparison, other alternative explanations for the different case outcomes are briefly considered. One significant factor was that the Bundeena Maianbar case was a brownfield site while the other cases in Queensland were all greenfield. This poses a significant potential problem for making generalisations about other factors (such as institutional factors) that could enable or inhibit decentralised innovation, as it could be argued that the presence of existing development is the most significant factor, with very little evidence from this study to support or deny that claim, due to the difficulty of isolating variables in case study research. However, the existing development could in any case be argued to be an institutional factor: where existing practices and expectations (discourse and organisation) channelled the process. (And on the other hand, for the greenfield sites,

the developers/proponents could argue for planning and designing for a particular type of resident since there were no pre-determined community expectations.)

Table 4-38: Summary analysis of the four case studies

	Bundeena Maianbar	**Pimpama Coomera**	**Payne Rd, The Gap**	**Currumbin Ecovillage**
Organisational flexibility: new 'home' created?	None	New organisational unit established, wide network of stakeholders	New approvals unit in council, developers working in partnership	New Landmatters company established, links with other agencies
Project champion or 'institutional entrepreneur'	Champion for conventional solution (MP)	Gold Coast Water Director	Developer & local government officer(s)	Developer & EPA Sustainable Industries officer
Planning & decision framework	Options report & EIS elaborated options, criteria, and basic MCA	Elaborate planning process with detailed MCA	Consultant made decision but not through formal planning framework	Developers made decisions with guidance from consultants and community
Participation extent	Stakeholders and community consulted (or informed) to meet obligations	Active participation sought from community and all stakeholders	Community consulted informally for acceptance; strong partnership with stakeholders	Proactive participation strategy initiated by developer
Participation techniques	Public meetings, 'Working Party', newsletters	Stakeholder workshops, advisory committee, shopping centre displays, focus groups	Informal communication and meetings	Public meeting, mailed letters, workshops, open house & phone line
Mobilising discourse(s)	Sewage removal & technocratic expertise: lowest common denominator solution	Water shortage: crisis enabled action	Integrated water management	Self-sufficiency

In addition, the presence of other greenfield cases where decentralised innovation is not pursued, or brownfield cases where decentralised innovation is pursued, could add support to the argument of this thesis, depending on other variables. There are many greenfield developments all around Australia where traditional water and sewerage services are being provided – and by all varieties of organisations and planning processes. Specific cases would need to be studied in more detail to make further generalisations. And some examples of brownfield (retrofit) developments that have been highly decentralised include Michael Mobbs' Sustainable House in inner Sydney (Mobbs, 1998), and also some of the eco-villages in Sweden and Germany (see Section

2.4.4.1). (Many are also greenfield.) Again, these cases would need to be studied in more detail, and were not chosen, partly due to limitations of access, time and resources, and partly because such eco-villages are unique in other respects, such that generalisation from those cases would be less appropriate.

It should also be noted that water scarcity was not a factor in the Bundeena Maianbar case, which occurred before nationwide drought, while the other cases occurred during or after the drought. It could also be argued that this drought factor was the most significant factor enabling innovation, making generalisations problematic. But again, this can be meshed with the institutional explanation by noting that water scarcity is a discursive construct – an institutional fact rather than a 'brute fact' (Searle, 1995, pp. 2-29).

Thus the generalisations made from these case studies were made while acknowledging that other explanations and frameworks for interpretation are possible. Scott's (1995) new institutional theoretical framework (see Figure 1-2) has been chosen as the primary analytical framework, and is adhered to for the comparison of cases that follows.

4.5.1 Organisational Context and the Regulative Pillar

The organisational contexts of each case are briefly compared before examining the reflexivity of organisational structure – i.e., the flexibility and adaptability of the organisational structure to follow changing patterns of action rather than only determining the direction of action[70].

The first two cases (Bundeena Maianbar and Pimpama Coomera) were driven by government (state and local), while the latter two (Payne Rd and Currumbin Ecovillage) were driven by private developers. There are also other possibilities such as public private partnerships (PPP), build-own-operate (BOO) or build-own-operate-transfer (BOOT) schemes (AusCID, 2005); or a more radical possibility of community-driven projects (e.g., some of the eco-villages mentioned in Section 2.4.4.1). None of the cases

[70] Cf. Giddens' (1984) theory of structuration.

address any of these other types of schemes; and this comparison also does not cover such organisational approaches.

4.5.1.1 Organisational Contexts

The organisational context for the Bundeena Maianbar case (in New South Wales) was significantly fragmented, in that partial responsibility for water cycle management in the suburbs was effectively passed, without much interaction or collaboration, from the local government (responsible for stormwater and on-site systems) to the State Government Sydney Water Corporation (responsible for reticulated water and sewerage in the Sydney region). In both New South Wales and Queensland there was improving integration between State Government departments concerned with water cycle management – particularly in Queensland where inter-departmental committees and a task force were set up for improved water cycle management outcomes. While the Queensland State Government was developing whole-of-government policies and directions related to water conservation, the New South Wales Government had not done so at the time of planning the Bundeena Maianbar project. Subsequent State Government policy initiatives have done more to address this since water scarcity became a significant driver in NSW (NSW Government, 2004, 2006).

Each of the Queensland cases demonstrated stronger inter-organisational and informal networks that significantly contributed to enhancing organisational capacity, supporting Hypothesis 1.4 (see Table 1-3). For the Bundeena Maianbar case, inter-organisational networks were in place due primarily to environmental planning regulations. The Pimpama Coomera advisory committee had State Government department representatives who were able to provide significant input and linkages. The Payne Rd and Currumbin Ecovillage projects operated in a partnership approach between the respective councils and developers, with key people from each ‘championing’ the project.

4.5.1.2 Reflexivity of Organisational Structure

For the Bundeena Maianbar case, existing structure reproduced action in the likeness of existing centralised technocratic patterns of water management. Minimal departure from traditional approaches meant that there was little reflexivity required for the

organisational structure of Sydney Water, other State Government departments, or the Sutherland Shire Council. This case supported Hypothesis 1.1 (see Table 1-3).

It could be argued that a developer is in a much better position than a water authority to create an accommodating organisational location for sustainable water discourse and practice. This is for a number of reasons, including the greater flexibility that less public and organisational accountability gives. And small, new organisations are by nature much more flexible than established government bureaucracies. However, Gold Coast Water has shown in the Pimpama Coomera Waterfuture case that it is possible for established government authorities to adapt organisationally to foster innovation (see Section 4.2.3.3.4). This supports Hypothesis 1.3.

4.5.1.3 Project Champions or Institutional Entrepreneurs

The creation of new organisational forms requires an institutionalisation project, under the leadership of an 'institutional entrepreneur' – one or a group of organisational actors with sufficient resources who see an opportunity for change. The institutional entrepreneur cuts across institutional rules, norms and/or cognitive frames in acting from rational or strategic choice to realise interests they value highly (Beckert, 1999; DiMaggio, 1988). Such an institutional entrepreneur was clearly evident in the Pimpama Coomera case, though less so in the other two Queensland cases. There were 'project champions', but they were not so clearly instrumental or necessary in creating change for a new organisational home for new ideas, as there were no existing organisations from which to create such change. However, in all cases, project champions were influential to some extent (see Table 4-38). Project champions were also influential in constructing influential discourse, considered next.

4.5.2 Discourse: The Normative and Cognitive Pillars

The relative importance and impact of the discourses apparent in all four cases are summarised in Table 4-39. For explanation of what each discourse was, see discussion throughout earlier sections of this chapter. The first three cases had similar discourses present during planning deliberation in comparison to the last case. For the first three, the discourses at play could be summarised by saying that integrated water management was held in tension with more traditional discourses such as public health and

engineering technical knowledge and professional values and also the discourse of minimising householder involvement and the associated risks (or redistribution of risk). The final case was much more radical, with significant discourses being about self-sustained sustainable development (versus anti-development).

The fact that there was variation in both the discourses present, and in which discourses were influential, suggests that initial problem framing and stakeholder participation is likely to significantly alter the discursive direction of water management planning processes. People can have different (and changing) perspectives and act in different ways accordingly, depending on the action in which they find themselves located. That community opinion is not a static input into the planning process can be seen from three of the cases under study. For the Bundeena Maianbar case, some of the interviewees who supported the centralised outcome showed an interest in alternative ideas and approaches (see Sections 4.1.3.3.4 and 4.1.3.3.5). While community representation was minimal (and not very meaningful considering that most of the 5,000 existing residents were planning to sell or in the process of selling their land and moving away), most stakeholders for the Pimpama Coomera case were open to new ways of thinking due to the problem of water scarcity. In the case of the Currumbin Ecovillage, a community leader who initially led an opposing petition turned around to become supportive of the project (Section 4.4.3.3.2). Such transformation of intent (see Section 2.3.2.1) is allowed for by the new institutional framework (March and Olsen, 1989, p. 66), but often excluded from predictive approaches (Po *et al.*, 2004; Po *et al.*, 2005; Roseth, 2003) that see attitudes and behaviours as predetermined and independent of action.

Table 4-39: Summary matrix of case study discourses

Discourse	Bundeena Maianbar	Pimpama Coomera	Payne Rd, The Gap	Currumbin Ecovillage
Sewage removal	*Dominated the outcome*			
Centralised technocratic expertise	*Dominated the process: vehicle for above discourse*			
Traditional engineering			Existed 'out there' as a hindrance to innovation	
Public health management paramount	(Evident in the 'sewage removal' discourse)	Significant in limiting extent of innovation	Prevented support from state and local government	
Technological progress		Maintained an engineering focus for solutions		
Entitlement to progress	Another supporting discourse for outcome			
Growth and development		Divergent views, but highly influential		
Minimisation of householder involvement/ responsibility	Another supporting discourse for outcome	Divergent views, but significant moderator of outcomes	Generally accepted; led to automation for risk avoidance	
Minimisation of homeowner expense	Dissident discourse for a few only			
Anti-development	Dissident discourse but not influential			Significant impediment only at early stages of development
Water scarcity		*Dominated the outcomes – crisis enabled action*		
Integrated water cycle management	Dissident discourse lacking 'organisational home'	Commonly used/ accepted, often more rhetorical than substantive	*Accepted as mainstream idea of sustainability by all key players*	
Community ownership and responsibility		Few adherents, but influenced decentralised initiatives		Accepted by key stakeholders – enabled significant decentralisation
Sustainable self-sufficiency				*Dominated motivation, process and outcomes*
Motivation of change in others' practice				Supported the above discourse
Indifference		Common among community, limiting input		

Note: Italicised cells indicate most important and/or influential discourses for each case.

4.5.2.1 Problem Framing

In each of the cases, there was an initial framing of the problem by the project proponent, which to some extent set the discursive and physical direction of the project. For example, the name of the Bundeena Maianbar 'Backlog' or 'Priority Sewerage Project' suggests a predetermined outcome based on established historic approaches (supporting Hypothesis 1.1, Table 1-3). On the other hand, 'Waterfuture' suggests change for improving the future – and links to the sustainability theme. Implementation of sustainable water management relies heavily on the creation and carriage of discourse – creating a story with shared values among stakeholders. Other factors such as organisational integration, flexibility, adaptive capacity, and functional networks with other stakeholders then influenced the outcome to varying extents.

4.5.2.2 New Ideas and Organisational Fit

In the Bundeena Maianbar case, new knowledge about integrated water cycle management did not have an organisational home, and was thus always a dissident discourse. There were no relevant organisations or departments at that time for whom integrated water cycle management or sustainable water management was a driving concern. However, in the Gold Coast Pimpama Coomera Waterfuture case, such new knowledge was given a new organisational home by creation of the Waterfuture team (see Section 4.2.3.3.4). As discussed above, the two private developers were not a part of existing water management organisations, and thus were able to incorporate their chosen ideas and values into their newly created organisations from the start. For the developer of the Payne Rd subdivision, integrated water cycle management was central; while a more radical self-sufficient ideal was the basis for the Currumbin Ecovillage developers' organisation, Landmatters.

Thus, Hypothesis 1.3 (see Table 1-3) is positively supported by each of the three Queensland case studies, and the evidence of the Bundeena Maianbar case is consistent. That is, a supporting organisational home supports the alignment of institutional factors such that new ideas for water management are part of accepted discourse (see also first row of summary Table 4-38). The alignment of discourse and organisation in these

three cases also supports Hyothesis 1.2 (and in addition, in the Currumbin Ecovillage case, Hypothesis 2.2 – see Section 4.5.4).

4.5.3 The Planning Process

The consideration of planning processes here is still from an institutional perspective, but the processes cannot be linked specifically to any of the three pillars (regulative, normative or cognitive) to the exclusion of others, hence are considered under a separate heading.

4.5.3.1 Multi-Criteria Decision Aiding or Assessment

The presence of a multi-criteria, participative option development and assessment process, while beneficial, did not seem to be a highly determining factor in choosing between options in at least three of the cases (see third row of summary Table 4-38). What seemed more important was whose knowledge and values were utilised in developing and choosing options. This is not to say technical assessment addressing multiple criteria was not important in the cases studied or are not important in general; they were vital to ensuring that the options put forward were optimised according to the multiple criteria established. The argument here is that, considering the evidence of the case studies, choices between such technically optimised options are more determined by institutional and discursive factors, and their alignment, than has often been understood[71] (as predicted in Hypothesis 1.2, see Table 1-3).

4.5.3.2 Participation: Extent and Mechanisms

The extent and degree of formality of participation (public and stakeholder, see Section 2.4.3.3) for each case seemed more closely related to the size and degree of impact of the project. The relative lack of formal participation in the Payne Rd case (see Table 4-38) did not appear to jeopardise or diminish potential for decentralised outcomes,

[71] The on-line survey results (see Figures 1 and 2 and Section 3.3 of Appendix B) highlight the emphasis given by engineers to technical assessment for water management projects. Technical assessment was undertaken most often, but there was less evidence of awareness of institutional and discursive inputs such as may have been revealed through intra-organisational (i.e., between council departments or 'silos'), stakeholder and community engagement. Despite this lack of awareness, those inputs may have still significantly influenced problem framing and determination of outcomes.

which have eventuated as planned to the time of writing. This supports the idea that there is no single approach to participation that should be considered generalisable for all situations (Bishop and Davis, 2001).

There are, however, some lessons that can be drawn from comparison of participation in each of the case studies. These will be considered in relation to the three functional arguments for participation considered in Section 2.4.3.3: improving the quality of the final decision by wider exchange of ideas and mutual learning (cognitive); creating awareness of environmental issues leading to attitude and behaviour change (behavioural); and increasing acceptance of the final decision (strategic).

In the Bundeena Maianbar case, only the strategic aspect of participation was apparent. Even then, many in the community had low levels of trust and acceptance due to what appeared to be inconsistent or insincere public consultation. For example, the community members invited to the Working Party felt as though they were not able to have any impact on the decision-making process, leading to possibly greater frustration than if there had been no community representation (see Sections 4.1.3.3.2 and 4.1.3.3.3). But project planners for each of the three Queensland cases attempted to prioritise public and stakeholder participation; and in each of these cases there was a link between active attempts at participation and the removal of stakeholder and/or public objections.

Another aspect of participation in the Bundeena Maianbar case that worked against a strategy of increasing the acceptance of the outcome was the way that public meetings were used. The public meetings tended to alienate and reinforce opposing views, leading to a ‘them and us’ mentality (cf. Creighton, 2005). Public meetings have several drawbacks. They give much more exposure to the ‘incensed and articulate’ than to the unengaged, and also give the impression that a decision has already been made. Creighton (2005) has labelled this as a ‘decide, announce, defend’ type of strategy. Creighton recommends an interactive approach as preferable to public hearings. However, public meetings were used with apparent success in the Currumbin Ecovillage case. The manner in which they were conducted in the Currumbin

Ecovillage case was not simply a case of 'decide, announce, defend'; the public 'meeting' was structured into small group workshops and question time where people were assured that they could contribute to the direction of the project, and did so.

Participation for awareness leading to attitude and behaviour change in public water users was not strongly evident in any of the cases. In the Bundeena case, this could have been possible had the dissident discourses gained more acceptance. (And attitude and behaviour change probably did occur for such dissidents and those who would listen.) However, in the three Queensland greenfield cases, the lack of an existing community (i.e., residents) mitigated against the achievement of this outcome/aspect of participation, at least for the general public or community of water users. The participating stakeholders may indeed have experienced increasing awareness and behaviour change, notwithstanding their existing exposure to issues of water conservation. A positive example of this from the Pimpama Coomera Waterfuture case is the developers' adoption of water sensitive urban design. For example, rainwater tanks were being installed in some subdivisions before they were mandated as part of the finalised Pimpama Coomera master plan.

Participant interviewees for the three Queensland cases revealed a significant level of mutual learning having taken place for improved overall outcomes. This was possible due to the range of stakeholders engaged and the breadth and depth of knowledge they brought (e.g., see Section 4.2.3.3.5). This supports the argument of Meadowcroft (2004) that a stakeholder orientation to participation (rather than a community-centred orientation [e.g., the Bundeena Maianbar case] or a citizen orientation) is more effective for representing interests and encouraging mutual learning (see Section 2.4.3.3). The Pimpama Coomera Waterfuture advisory committee brought expert and other forms of knowledge into the process, enabling more possibilities and probably more sustainable outcomes. The Currumbin Ecovillage brought in local knowledge that enabled the eventual outcome to be more in harmony with local values, while government stakeholders with water management expertise were also brought into the planning process (even though the EPA's recommended water recycling plant was not eventually used). Further, the consultants for the Payne Rd project also collaborated with each

other, the client, the Green Development Forum, and local government personnel, enabling mutual learning. This evidence all supports Hypothesis 1.4 (Table 1-3).

4.5.4 User Involvement

There was significant variance in the level, nature and perception of user involvement in each case. In the first three cases, user involvement was overwhelmingly viewed negatively, although in two of those there were adherents, and in one of those, the discourse of user involvement was thought to have had an impact in the resulting uptake of decentralised technologies through keeping them on the agenda. Institutional factors were arguably important in the exclusion (to varying extents) of user involvement for those first three cases. Thus weak support is provided for Hypothesis 2.1 (see Table 1-3). Hypothesis 2.2 is also supported by the Currumbin Ecovillage case, where there was alignment of all institutional factors concerning user involvement, and user involvement was most fully adopted. The fact that this case also demonstrated the most significantly decentralised physical technologies for water management also suggests support for Hypothesis 2.3.

4.6 Conclusion

The four cases researched have provided evidence for answering the research questions of this thesis, as presented throughout and summarised in the cross-case comparison. The next chapter turns to a more speculative consideration of how the conclusions from these case studies can be generalised for enabling institutionalisation of future decentralised water management. The final chapter summarises the conclusions.

5 Pathways for Change: Institutionalising Decentralisation

This chapter discusses the implications of this research for water management practice for water managers and planners (typically engineers). Thus, while the work is at the boundary of two quite different disciplines (engineering and social science) and has potential benefit for both disciplines, the focus here is primarily on the findings and implications for engineers rather than for social scientists.

Essentially this chapter provides an outline of important *institutional* factors (i.e., regulative, normative and cognitive, and their interplay) that this thesis suggests should be considered if decentralised water management is desired and/or pursued; and the argument also rests on evidence that it *should* be desired and pursued (as reviewed in Chapter 2 from existing literature). The most significant contribution of this work is the identification of organisational options for 'institutionalising new ideas' for decentralised water management (Section 5.4).

Initially this chapter briefly recapitulates the state of knowledge regarding questions of the technology of decentralised systems (Section 5.1) and how it will be operated and maintained once installed (Section 5.2). Then a planning framework is proposed, building on other work (Section 5.3), before returning to the organisational options for decentralised water management (Section 5.4). The proposed framework of Section 5.3 incorporates the organisational flexibility and participative governance (i.e., stakeholder networks) highlighted as important to enabling decentralised approaches in the findings of the case study research presented in Chapter 4. Those findings form the basis of the more speculative findings (or propositions) of this chapter.

The discussion in this chapter sometimes extends to include consideration of how any case of urban water management innovation may be enabled, not only decentralised innovation. The research questions are about institutional aspects of decentralised water management, not innovative or sustainable water management in general. However,

there are some similarities such that in this chapter the generalised case of innovation (for sustainability) can be interchanged with the specific case of decentralisation. It would not be correct to assume that decentralisation and sustainability are equivalent. Both, however, represent new ideas or innovation in urban water management. It was therefore considered more useful to extend this discussion to include consideration of enabling any innovation in urban water management (whether for sustainability or decentralisation) where the principles and their application are similar. This applies particularly to Section 5.3, and, to a lesser extent, also to Section 5.4.

5.1 Decentralised Urban Water Management: Physical Arrangements

There has been significant desktop and some field research into optimising the physical systems for decentralised urban water management, as discussed in Chapter 2. The theoretically ideal source-separated, decentralised system upheld in this thesis (see Figure 2-2) was not completely replicated in any of the case studies. And, as discussed in Section 2.4.5.1, ideal technological arrangements are best determined for a particular case rather than for generalised situations. Such case-specific assessment and design of decentralised systems was beyond the scope of this thesis, in any case. Thus this chapter focuses on the application of broadly inclusive principles for physically decentralised urban water management. This includes the modes presented in each of the three 'successful' case studies, through to more decentralised alternatives such as source separation (as in Figure 2-2).

5.2 Decentralised Urban Water Management: Management Systems

There is much to be resolved in the question of how physically decentralised systems may be ideally managed in terms of ongoing operation and maintenance. (The question of ideal organisational models to allow the institutionalisation of decentralised technology is addressed as a separate question in Section 5.4.) The case study interviews of this research (see Chapter 4) reveal a very wide range of ideas (often based on very limited experience) regarding how decentralised systems could or should be operated and managed.

There are multiple options for either maintaining or modifying the traditional hydro-social contract (where a central authority is responsible for providing and managing water services – see Section 2.4.5.2.8). Arguments against allowing for individual householder responsibility have quite widespread support – as evidenced from interviews in three of the four case studies, and also the literature. For example, West (2001), Fane and Fane (2005) and the NSW Legislative Assembly (2002) all advocate centralised management of on-site sewerage services.

The more radically 'green' examples of decentralised water management systems are much more likely to require householder involvement in operation and maintenance – such as the Currumbin Ecovillage (Section 4.4) and northern Europoean eco-villages, etc. (Section 2.4.4.1). However, Holt and James (2006, p. 21) proposed four organisational options[72] for operation and management of emerging urban reuse technologies (rather than direct householder operation and maintenance):

- Local regulatory body (e.g., local government or water authority);
- Body corporate owns and operates the system;
- Private company owns the systems and the service provision is leased (e.g., BOO schemes); or
- Hybrid models (combinations of the above three options).

Evidence from the case study research was not sufficient to answer the question of what type of management system would be best to ensure decentralised water management systems are adequately operated and maintained. Further ongoing research is needed in this matter. Such research will benefit from further elapsed time, given the recency of many innovations. The three Queensland cases of Chapter 4 are examples of such recent

[72] Note that this list has similarities to the discussion in Section 5.4.4, but the interest here concerns effective operation and maintenance rather than enabling consideration of decentralised options at all. The United States Environmental Protection Agency also has developed guidelines for five different management models (USEPA, 2003).

innovations, one of which (Payne Rd) is already the subject of an extensive monitoring program, the results of which are forthcoming[73].

It is speculated that a participative approach to the water management planning phase (as detailed in Section 5.3, below) will predispose stakeholders and the community to greater commitment to any non-centralised management of decentralised systems, should that be pursued. Even centralised management of decentralised systems will require organisational flexibility, networks with other stakeholders, and public acceptance, such that the following discussion is relevant in any case. For example, it is the general public who typically report, and so initiate repairs to, leaking drinking water mains or blocked sewer mains.

5.3 Water Management Planning to Allow Decentralisation

Existing water management planning frameworks were reviewed in Chapter 2 (Section 2.4.3.2). Such frameworks reflect a policy orientation of simple instrumental rationality (see Parsons, 1995), in attempting to facilitate change toward more sustainable practice in water management. Current planning frameworks deal with specific projects rather than broader strategies and organisational design (as in Section 5.4). The recommendations of this section (Section 5.3) are focused on project planning. This section speculates how such frameworks might be modified to incorporate and allow for institutional drivers (cognitive, normative and regulative) in water management planning processes. These drivers can be quite strong, depending on the degree of institutionalisation and institutional isomorphism at play (see Section 2.3.2.1.4), and can act somewhat independently of rational choice (DiMaggio, 1988).

The case studies researched highlight two significantly different contexts for water management planning. One is that done by a water management authority (as in the first two cases), and the other is that done by a private developer (as in the latter two cases). And there are other alternatives (mixing public and private sector involvement) not

[73] Preliminary results of the ongoing monitoring of the Payne Rd development (Gardner *et al.*, 2006) are based on only three occupancies. Attention was focused on water balance and energy use.

covered in the chosen case studies of this research, such as public private partnerships or BOO/BOOT schemes.

While many of the principles of this section may be applied across any of these contexts, the relevance of this section is primarily for the established organisational form of the public or statutory water service provider. This is because this traditional form of water service delivery has reached a stage of institutionalisation where planning and decision-making frameworks are subject to strong institutional drivers that may constrain innovative behaviour. Therefore, in essence, this section elaborates a framework that may lend legitimacy to the change initiating processes of 'institutional entrepreneurs' (see Section 4.5.1.3) who reintroduce agency and interest (rational choice) into organisational processes to bring about change (DiMaggio, 1988, pp. 14,15) toward decentralisation (or other innovations) in urban water management.

In both the case studies where a water authority undertook water management project planning, it is argued that organisational and discursive factors were highly influential, notwithstanding the possibility of other determining factors such as water scarcity or brownfield versus greenfield development – which could, in any case, be argued to be discursive factors (see Section 4.5). Thus the proposed alteration to water authority planning frameworks, in the following subsection, speculates how these institutional elements may be addressed.

A private developer, or other private water planning or service delivery organisation, may also benefit from applying this or a similar formalised planning framework, or from less formal strategies or checklists (e.g., Jones, 2005; Pinkham *et al.*, 2004). But whether the choice is made to apply such a planning framework, and the possible benefit available, will depend on a variety of factors including the organisation's age, size, and organisational flexibility. The evidence of the two case studies involving projects driven by private developers suggests that formal planning frameworks are not essential to ensuring innovative decentralised urban water management outcomes from private developers. Developers tend not to undertake elaborate multi-criteria analysis. This is probably due to lack of resources or experience, and because financial drivers

(including the cost of performing elaborate analysis) override other drivers. The developers' commercial interests also prevent public involvement in, and documentation of, option development and assessment and detailed design. Thus there is greater reliance on choosing consultants and/or other partners/project champions who are able to guide the developer in an optimal or innovative (e.g., decentralised) course. Similar decision-making and organisational querying/embedding phases (as in Figure 5-1) are still recommended, but would need adaptation to the project and context as each situation demands. More experience and research is required with developer-led water management innovation to make further generalisations.

Public participation may be a key area of difference in the application of this planning framework between a private organisation (such as a developer) and a public water service provider. Private developers often have little incentive, coercion or requirement to involve public communities or other stakeholders. Since they are generally driven by profit, there are more limited (primarily functional) arguments for their use of participation (see Section 2.4.3.3). Further, even if a developer chooses to involve communities or other stakeholders, the legal and trust relationships are likely to be quite different compared to the case of a statutory water authority. On the other hand, a water authority has significant legal, public and professional expectation of transparent, community-oriented decision-making involving stakeholders (including the public).

But one of the most significant underlying reasons for arguing for greater public and stakeholder participation (and/or governance approaches and horizontal integration, etc.) in water management planning (Brown, 2003, 2005; Stenekes, 2006) is to challenge existing institutionalised discourses, especially in the case of established technical water management bureaucracies. The arguments for participation applied by this framework follow those of Brown and Stenekes, as applied to such technical bureaucracies. Hence their application to private organisations may be less important, depending on whether there is any need for challenging existing institutional forms. (Other arguments for participation [as outlined in Section 2.4.3.3] remain applicable, however.)

5.3.1 Existing Assessment/Planning Frameworks for Water Authorities

The most relevant water management planning framework to this thesis was produced for the Water Services Association of Australia by a team of researchers at the University of New South Wales that included the author of this thesis (Lundie *et al.*, 2005). Findings of the research for this thesis are reflected to some extent in that framework. That 'WSAA framework' also drew from another Australian framework focusing on stormwater management planning (Taylor, 2005), the Swedish Urban Water program (Malmqvist, 1999; Malmqvist and Palmquist, 2005) and a British framework for sustainable water services (Ashley *et al.*, 2004).

Each of these frameworks, and also many other documents such as the draft Australian guidelines for water recycling (NRMMC and EPHC, 2005), emphasise stakeholder and public involvement throughout project planning. Each presents some detail of social criteria important for a project's success, and also details a process promoting networks and partnerships with other stakeholders and the public. What tends to be lacking, however, is an appreciation or explanation of how to take account of, and influence, the institutional context within which a project is delivered, and the associated constraining drivers against innovative change; or how institutional elements may be employed to enable innovative change.

This research found that project outcomes are heavily dependent on established institutions (organisations, values, ideas), which construct both the problem and its solution. The contrast between the private developers' flexible organisations based on sustainability-oriented discourses, and the public water service providers' more rigid organisations but greater obligations and/or attention to multi-criteria types of analysis, is further evidence of the importance of institutional form.

This is not to say that the rational choice of objectives is not a valid aim, or even an explanation, of decision-making[74] – the multi-criteria decision support approaches recommended in these frameworks are necessary components of water management project planning. But there is a tendency for established organisations to reproduce the form of outcome that reflects the institutionalised structure – what people know, what they value, and how they are organised. Alternative courses of action are likely to be assessed unfavourably (e.g., under economic or social criteria) because the organisations are not structured appropriately and do not provide a home for discourses that would support these alternatives. The Pimpama Coomera project director paid conscious attention to this when establishing the Waterfuture project team as a separate unit (see Section 4.2.3.3.4).

Recent research on integrated urban water management supports the conclusion that supportive institutional arrangements (stakeholder involvement and policy alignment) are required (Brown, 2003, 2005; Hatton MacDonald and Dyack, 2004; Mitchell, 2004; Stenekes, 2006; Stenekes *et al.*, 2004; Taylor, 2005; Vlachos and Braga, 2001). This is quite different to the traditional technically driven nature of water management solutions. The recommended approach outlined below is that implementation of water management planning processes such as those referenced above be supported through organisations that are prepared to adapt and develop their institutional capacity (Brown, 2004) for undertaking innovative and integrated urban water management.

5.3.2 Recommended Modified Planning Approach for Water Authorities

The speculatively recommended modification to typical water management planning processes adds stages at the beginning and end for the purpose of adapting and creating organisational 'fit' for new ideas. Some of these principles were outlined in Lundie *et al.* (2005) but are more explicit here (see Figure 5-1 and explanation following).

[74] A body of literature argues between incremental and rational decision-making since a paper by Lindblom (1959), as acknowledged by the British framework (Ashley *et al.*, 2004).

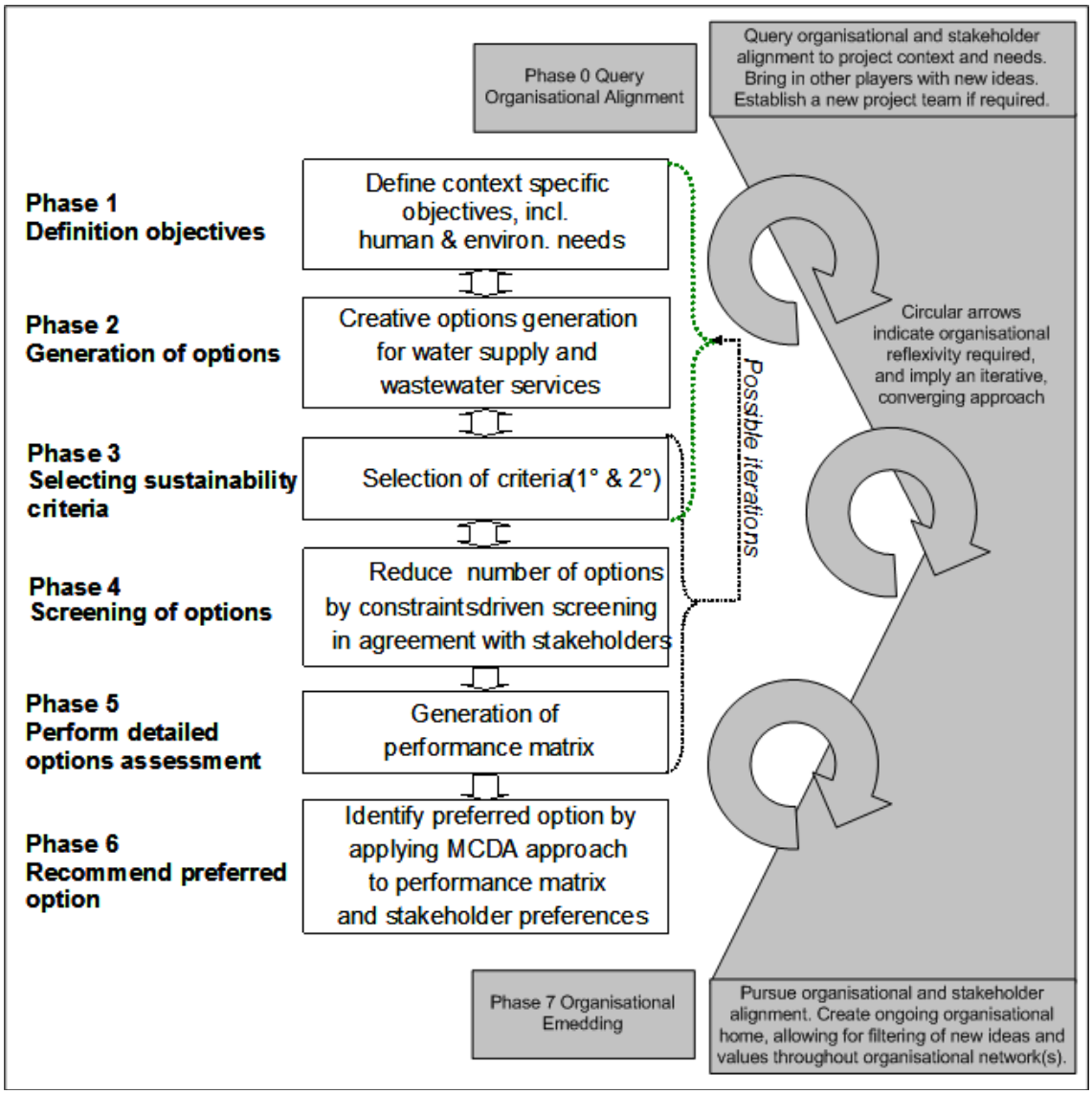

Figure 5-1: WSAA Framework planning phases with proposed additions (additions highlighted with grey fill) (adapted from Lundie *et al.*, 2005)

Figure 5-1 shows the planning phases as proposed in the WSAA framework (Lundie *et al.*, 2005), with proposed alterations. The planning phases proposed by Lundie *et al.* are similar to those of Taylor (2005) and Ashley *et al.* (2004). Each has a different number of phases (six, twelve and seven, respectively) but they each, in essence, describe setting of objectives, identifying options and criteria, assessing options against the multiple criteria and coming to a decision. Taylor (2005) and Ashley *et al.* (2004) add a monitoring and evaluation phase at the end, primarily to reflect on and improve the outlined planning process. This is implicit in Lundie *et al.* (2005).

The process and logic of these existing frameworks emphasise the technical aspects of the water industry's pursuit of delivering water services more sustainably. There is mention of institutional aspects, but the institutionalisation of sustainability in water management organisations is not so clearly explained. Indeed, technical assessment is one of the traditional strengths of water service providers.

The proposed added first and last phases of the planning process in Figure 5-1 emphasise the importance of the relationship between (organisational) structure and action – i.e., structuration (Giddens, 1984). The addition of these phases gives scope for modification of structure as a result of action to happen consciously, not just incrementally by chance. These phases are really ongoing, as accentuated in the figure; and, just as there is for the other phases, there will inevitably be iteration between phases.

The purpose of the added phases is to query and then establish organisational structure and alignment in relation to the ideas and values being embraced for more sustainable outcomes. The findings from the case studies (where decentralised outcomes are used as a proxy for broader sustainable outcomes in general) are used to elaborate on how an organisational home may be ensured for innovative water management projects, and decentralised water management outcomes in particular.

5.3.2.1 Querying Organisational Alignment

A water management project planning situation can never be started without some initial idea of objectives, criteria, and options. The realisation of need for a project and commitment to undertaking a planning process relies on some level of awareness of objectives, criteria, and options. These are all based on values and ideas (discourses) held by those people who are either advocating or responding to the perceived need for a project. The director and senior managers of Gold Coast Water, before setting up the Pimpama Coomera Waterfuture project, project team and advisory committee, made some important and influential guesses – even plans – about the project before any of their participative planning process began. (Their planning process was similar to those referenced above, and in fact was referenced by both Australian frameworks.)

The selection and recruitment of experts in water recycling for the Waterfuture project team illustrates this. Those conceiving the project held to ideas and values that validated the option of water recycling, leading to a commitment to resourcing the project with personnel specialising in that knowledge, before actually embarking on the collaborative planning process of setting objectives, criteria, options and so forth. This is important, because this initial problem framing allowed for the creation of an organisational home for new ideas. The director (particularly) and managers of Gold Coast Water acted as 'institutional entrepreneurs'. They consciously queried their organisation and determined that the likely needed alternate water sources would require adaptation of the existing organisation to succeed (see Section 4.2.3.3.4). On this evidence, the early establishment of an interim or new organisational unit may be in order, depending on the size and nature of the project, to provide an organisational home for innovation – for new ideas and values to be accepted and pursued through the ensuing planning process.

The interaction between organisational structure and progressing through the project planning phases is likely to be iterative and converging rather than linear. It will often be necessary to repeat phases as new information or opportunities arise, as is already well-documented (Ashley *et al.*, 2004; Lundie *et al.*, 2005; Taylor, 2005). The planning process is multi-dimensional with both technical and organisational components that should be interwoven. That is, a technical decision for innovation may not have as much impact without attention to concurrently addressing the organisational context within which that technical decision is to be made and implemented.

Thus, from the perspective of project planning, the proposed first level of organisational alignment and fit is focused on the department or organisational unit responsible for the project, and is carried out at the inception of the project (before establishing – and enabling establishment of – any participative planning process). The next 'layers' of organisational alignment – inter-departmental, inter-organisational – may be addressed through the participative aspects of the planning process – e.g., by establishing a project steering committee.

The Gold Coast Pimpama Coomera Waterfuture project established good inter-organisational alignment of values and ideas with most State Government authorities, developers, environmental groups, and some departments within Gold Coast Council. Queensland Health and the firefighters' association were two organisations with whom alignment was more difficult, due to conflicting ideas or values. The Technical Services section (specifically Plumbing and Drainage) of Gold Coast Council was also not so well aligned with the Waterfuture project, and therefore less cooperative, according to multiple interviewees (see Section 4.2.3.3.3). According to one interviewee, the reason for this was that Gold Coast Water had not enabled participation and consultation with the Plumbing and Drainage section. This demonstrates the importance of seeking alignment of those who may not agree to a proposed project.

Inter-organisational alignment can be two-way. Gold Coast Water was not only responding to State Government initiatives and policies for water recycling, rainwater tanks and sustainable water management in general, but also actively promoted alignment between State Government departments. Projects benefit from the presence of supportive broader policies, strategies and regulations, but can also influence these – as in the case of all three Queensland projects studied. The size and influence of Gold Coast Water and its Pimpama Coomera Waterfuture project may have been an important enabler for this to occur; and other projects may not necessarily make similar impact. (The extent of organisational alignment sought will naturally be in proportion to the scope of the project.)

So, to summarise the first phase of querying organisational alignment, the following reflexive questions may be addressed:

- What are the likely solutions to the problem? Is there potential for innovation?
- Does the organisation have an organisational home for innovation – whether a single unit or a pattern of linkages between units?
- If not, what staffing resources can be acquired, equipped, or otherwise empowered, to provide an organisational home to facilitate innovation?
- What other organisations or stakeholders have expertise possibly desirable for this project? Are adequate linkages in place?

- What organisations or stakeholders may have dissident views or hindering regulations? Is there scope for them to be involved in planning?
- Is it possible to form inter-organisational network(s) and mutually come toward a shared understanding?

5.3.2.2 Embedding Organisationally

Toward the latter stages of planning a project, and moving toward its implementation, it is important that the shared values and innovative ideas be reflected back in the project's organisation and ongoing network of stakeholders. Moving towards sustainability (and decentralisation, as one possible case) means a paradigm shift among all water users (i.e., among the entire population); and this is both cognitive (what people believe) and behavioural (what they do). One single technocratic decision will not be so important for ensuring transition towards sustainability, compared to an accumulation of small decisions and changing patterns of 'normal practice'[75] (Colebatch, 2006). Thus it is important that the planning process impact not only the technical system, but also the social (institutional), in the sociotechnical system of water management.

Once the planning process has ended, the knowledge and values harboured by the stakeholders and/or project team involved should be instilled permanently into the organisational structure – i.e., institutionalisation should occur. In the case of Gold Coast Water, the Waterfuture concept was translated into a citywide sustainable water management project, and there was also suggestion (by one interviewee only) of a council restructure based on some of the initiatives of Gold Coast Water toward integrated water management (Q39-GCCC Officer).

[75] A comparable (but smaller-scale) example is the transformation of cigarette smoking (and related forms of tobacco use) in Australia, during the period from 1970 to 2000, when it changed from being mainstream and normal to being problematic – even deviant. There was no single 'decision' (by government or anyone else) to delegitimise smoking (although governments at various levels supported moves which had this effect).

5.3.3 Principles for Effective Participation

Consultation of stakeholders (including – even especially – the public) is increasingly recognised as vital to ensuring successful implementation of water management systems (Creighton, 2005; Morrison, 2003) (see also Section 2.4.3.3). Stakeholders are part of the sociotechnical system, so must inevitably play a role in ensuring sustainable outcomes. Consultation strengthens social capital (Taylor, 2005) for dealing with the water management problem. This is important, because the increasing complexity of achieving sustainable water management necessitates sharing the water problem among more stakeholders and disciplines. Engaged and empowered stakeholders and public communities enable stronger commitment to and ownership of problems and their solutions (Carson and Gelber, 2001).

While Bishop and Davis (2001) suggest a downside of participation might be that it provides an opportunity for veto, others (e.g., Stenekes, 2006) suggest that the public community and other stakeholders do participate in water management schemes in any case, even if it is only to force the abandonment of proposals, or by refusing to adopt or use innovations that are made available to them. Innovations are vulnerable to veto from outside, even if there is no formal participation. Public involvement in the planning process is important for securing commitment. This is evident in the Bundeena Maianbar case, where the 'expert collective' largely made decisions independent of other interested stakeholders. Some residents still (at the time of writing) have not connected to the sewer for ideological (and/or financial) reasons. In these situations, the planning and decision process is critical. In this context, the important thing is not whether the option assessment process convinces the experts, but whether the use of such assessment forms part of a broad mobilisation of understandings and practices among both users and providers, as opposed to a short cut to a 'decision'. The proposed framework is intended to both inform and support changing beliefs (discourses) and practices (organisational structure) as they interact.

So the question is not whether the public and other stakeholders will be participants but how they will participate, or, for project planners, how to engage their participation. The

cases illustrate three broad reasons for prioritising stakeholder engagement and participation (Bush *et al.*, 2005; Lundie *et al.*, 2005; Meadowcroft, 2004, p. 165):

a) Cognitive: allowing wider participation allows a wider range of knowledge to be brought to bear in a complex process.
b) Strategic: consulting stakeholders at an early stage, and throughout the project, makes it less likely they will oppose the project.
c) Behavioural: sustainability calls for a realignment of attitudes and practices by water users. Participation in the planning process is part of this realignment.

5.3.3.1 Degrees of Engagement and Empowerment

There are degrees to which the public can be engaged in any decision-making process (Arnstein, 1969). It is not necessarily appropriate to assume that maximum participation is always the most appropriate path for all projects (see Section 2.4.3.3), or that participation necessarily should be seen as a continuum (Bishop and Davis, 2001). But Arnstein's and other similar continua or discontinuous sets of approaches (such as that of Bishop and Davis) do provide project managers and other stakeholders with a clear range of options for what might be expected or possible in terms of participation in a decision-making process.

Based on comparison of participation in the cases studied (see Section 4.5.3.2), it is argued that it is more important to clearly identify and mutually agree on the terms of reference (or extent of powers) when involving the public or other stakeholders than to attempt to simply move towards the empowerment end of the participation spectrum.

5.3.3.2 Community Opinion Not Static

That community opinion is not a static input into the planning process can be seen from the cases studied (see Section 4.5.2). Therefore participation should not be restricted to feeding survey results of 'what the community thinks' into a decision-making process. Community opinion is not a static phenomenon independent of social action. While it is true that public opinion is typically against such innovations as potable recycling, experience of other projects beyond this research also shows that opinions change and people discover their preferences during the action of a project (Stenekes, 2006; Throgmorton, 1991). Thus engaging the community at an earlier stage in a project is

more likely to promote trust rather than antagonism toward innovation (Creighton, 2005). Further, as stated above, participation is also about the behavioural and attitudinal changes brought about in stakeholders (Curtis and Lockwood, 2000), and the degree of commitment established.

5.3.3.3 Enabling Articulation of Discourses

In each of the cases under study there were a number of apparently influential discourses. There were discourses that enabled action to occur, and others that tended to negate, limit or oppose action (see Section 4.5.2). The enabling discourse(s) for water management solutions did not always match or rely on the technical-expert defined construction of what sustainable water management would look like. It is argued, therefore, that the construct or concept of sustainability should not be limited to a technical-expert defined end product, but rather be conceived as a consensus of a diverse range of values and knowledge at any one time – i.e., always a 'work in progress' (Colebatch, 2006). Thus the recognition, articulation and mobilisation of multiple diverse discourses can actually contribute to sustainable water management.

The move toward sustainable urban water management (and decentralised urban water management, as one possible form) requires a shift from old discourses of growth and technical engineering to discourses of sustainability and integrated water management. The articulation of these discourses (rather than obscuring the underlying values by multi-criteria calculations and assessments) will help to make the cognitive and behavioural shifts more conscious. Traditional expert-determined sociotechnical water management systems and the technocratic planning process, on the other hand, have not recognised or incorporated multiple discourses.

5.3.3.4 Representatives' Inclusion of Constituents

Participation is about creating structures for giving voice and enabling feedback for stakeholders and stakeholder groups. Some stakeholder groups are well organised and have effective processes of representation established (e.g., trade unions). However, others are merely categories rather than established organisations or cohesive groups, such as the public community of water users. (This was evident in the case of the existing community of Pimpama Coomera, where members of the public were not in

any cohesive representable group – see Section 4.2.3.3.5.) This means that the process of representation needs to be given more attention for such groups or categories that are not so good at representing themselves. There is a danger that stakeholder representative meetings can become the 'process', displacing the need for members to consult with their constituents. Where steering committees or other similar representative bodies are used, it is recommended, therefore, to check in the latter stages to ensure that the community is still being carried with the steering committee. Other forms of communication and consultation may be employed to overcome this gap (see Section 2.4.3.3).

5.4 Organisations for Institutionalising Decentralised Innovation

Central to this thesis is that new ideas (or cognitive frames) for decentralised urban water management need an organisational home – i.e., alignment with the regulative pillar (as well as the normative). This is an extension of the work of other new institutional theorists. Here, new institutional theory is applied to the problem of institutionalising alternative forms of water management in the pursuit of sustainability, and specifically decentralised approaches in the case of this research project (discussed further in Section 5.4.1). This section attempts to apply the findings to practical pathways for change for water management institutions and organisations, addressing the question of what organisational forms are most appropriate for enabling and managing decentralised innovation.

There is a risk of being too prescriptive in describing an 'ideal' organisational form. Initially the speculated pathways for change are considered in general form such that applicability to different types of organisations is maintained. Then some possible organisation types (such as public, private and hybrid) are considered separately (Section 5.4.4). The creation of a 'new organisational home' for a new idea is possible in any such type of organisation, but the mode of application will be slightly different. Greater attention is given to organisational types reflected in the cases studied (i.e., more attention is given to the water authority and private developer types than public private partnerships, BOO or BOOT schemes).

Where decentralised innovation is considered, simultaneous attention to organisational design as well as technical may be important, because water management organisations have historically been centralised in parallel with the centralising of infrastructure (Section 2.1). Hypothesis 2.3 (Table 1-3), which suggests a positive link between user involvement and decentralised physical systems, has been upheld, albeit weakly (see Section 4.5.4).

The recognition of an organisational implementation dilemma due to organisational structure built around entrenched discourse is not new. Brown (2003; 2004; 2005) has argued a case for greater horizontal (intra-organisational and inter-organisational) integration and networking to facilitate the adoption of a new integrated urban stormwater discourse. Brown's work considered the case of implementation by local government – a uniform form of organisation; whereas this work considers a more general case where different types of organisation are evident within the organisational field for urban water management. The findings of Brown are still relevant and important, however.

Also, the work of Stenekes (2006) addresses governance of state and local government water management, with conclusions that stakeholder participation and organisational integration for shared understanding is vitally important.

This work has linkages with the work of both Brown and Stenekes, but covers a wider variety of organisational case-types (private developer as well as public/government projects) and also a different specific outcome (decentralised urban water management). Thus the generalisations applicable are different. Both Brown and Stenekes recommend ongoing loose networks emphasising governance approaches, horizontal organisational integration and strong stakeholder participation for continued cognitive reframing, to enhance the ongoing development of shared understanding and practice of sustainability. The position taken here is not contrary, but allows for the possibility that the creation of new organisational homes may be a means of sedimenting and institutionalising new urban water management discourses and practices. This may

mean that once decentralised forms of water management are institutionalised, ongoing focus and allocation of resources to fostering stakeholder networks and dialogue may not be as important, or may only be required periodically to address new understandings of sustainability as they come to light. It is unclear yet whether, out of the increasing technical and social complexity (Geldof, 1995) of modern water management, there will emerge a new form of water management that will reach 'taken for granted', institutionalised status.

Many environmental and social theorists argue that multiple and diverging problem frames and definitions, rather than being viewed as a source of frustration to policy and planning processes, can help maximise beneficial outcome for a majority of stakeholders (Dryzek, 1997, pp. 197-201; Hajer, 1995, p. 7). Thus broad and ongoing discursive participation in problem definition through to planning and implementation stages is vital to ensuring optimum outcomes (Stenekes, 2006; Stenekes *et al.*, 2006). Rather than a rationally expert-defined desired end product, sustainable urban water management is better perceived as a 'work in progress' that may take further cognitive, normative and regulative twists which no one can presently foresee (Colebatch, 2006).

5.4.1 Aligning the Pillars: An Organisational Home for New Ideas

As repeated throughout this dissertation, Scott's (1995) formulation of institutions holds that an institution, or sedimentation of practice, is built on regulative (or organisational), normative and cognitive pillars; and that each of these pillars is necessary for a social practice to be institutionalised.

Others have applied this theory to show how weakness in addressing one or more of these pillars prevents institutional change or reform. For example, Caronna's (2004) study of the United States health care field suggested that tension between normative elements and changing cognitive and regulative elements led to dissatisfaction but also opportunity for re-alignment for a new era in health care. And Alam's (2003) study of environmental policy-making in Bangladesh concluded that institutionalisation of environmental reform in developing countries tends to follow a pattern of institutions

based on first regulative, then normative, and finally cognitive elements – as change becomes more embedded and effective.

The case studies of urban water management in Australia have shown that the rising prominence of a water scarcity discourse since the realisation of nationwide drought is providing an opportunity for a realignment of institutional elements. Altered cognitive frames and the environmental values are present (e.g., in the new paradigm for water management outlined in Section 2.4.2.1), but not yet completely institutionalised into water management practice due to lack of opportunity for organisational alignment. That is not to say that the paradigm shift to sustainable water management is complete, but that, where that shift is happening, organisational reform is sometimes lagging (see Figure 2-3).

To effectively and legitimately create such an institutional realignment (or a new organisation or even new institution) may call for an 'institutional entrepreneur' (as elaborated in Section 4.5.1.3).

5.4.2 Reflexivity of Organisations

Achieving organisational change need not require new organisations, but is more likely to come from self-analysis in existing organisations, a process termed 'reflexive modernisation' (Beck, 1992) or organisational 'reflexivity'[76] (Hajer, 1995). An historical understanding of the progressive institutionalisation of the water sociotechnical system (Section 2.1) is the beginning of reflexivity: reflection on why the otherwise 'taken-for-granted' water management structures are institutionalised the way they are, and evaluation of what might be required to facilitate new knowledge claims. An example of how such change may occur is through incremental adoption of partial answers, which eventually accumulates to broader change in consciousness and values[77].

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[76] Reflexivity is the self-analysis and resultant modification of an entity.

[77] To continue the 'smoking' analogy of an earlier footnote (Footnote 75), smoking was once a generally accepted and permissible behaviour in Western societies. However, a cognitive shift embracing new understandings of health has seen a more gradual shift in social norms and regulations such that smoking

Already there are many developments around the world where some aspects of decentralised innovation have occurred in the pursuit of sustainable water management. One flagship example in Australia that receives significant publicity is the Newington (Sydney Olympic Park) water recycling plant – where dual reticulation provides recycled water for toilet flushing, clothes washing and outdoor uses. Further examples of innovation such as this one (or more decentralised examples such as the Currumbin Ecovillage) will assist such incremental change. Such incremental change may actually be more a matter of mimetics and institutional isomorphism than reflexivity (see Section 2.3.2.1.4).

Reflexivity of organisations is particularly important for established organisations where structure and embedded values and ideas have been moulded around traditional practice. The simultaneous ability of institutions to not only constrain but also enable action is possible because of such reflexive capacity. As already discussed, the approach of Gold Coast Water to organisational change to enable new directions in action and practice in water management demonstrates such reflexivity.

The direction of reflexive organisational change is less open to generalisation. It will be dependent on characteristics of the existing organisation and its context as well as the type of organisation. Possible examples are given in Section 5.4.4.

5.4.3 Organisational Context: Inter-organisational Networks

Stenekes (2006) emphasises the need for a governance approach to build shared understandings; and Brown (2003; 2004; 2005) emphasises a need for similar inter- and intra-organisational integration to overcome the technocratic dominance of established traditional discourses. These conclusions are also applicable here, particularly to cases

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is now generally unacceptable in many western societies. The regulatory changes have been gradual and incremental, yet the eventual overall shift in the place of smoking in society is transformational. In a similar way, a transformation to sustainable water management, including adoption of decentralised practice (though not necessarily coupled with complete rejection of existing centralised infrastructure), may be brought about incrementally through opportunistic projects.

where decentralised urban water management is a possibility for established technical bureaucracies such as state and local government water service providers.

Organisational and regulatory fragmentation and conflicting or 'perverse' incentive structures are commonly referred to as the (problem of) institutional arrangements for water management. Much has been written addressing this problem and the need for policies and regulations supporting integrated, sustainable and/or decentralised water management (e.g., Hatton MacDonald and Dyack, 2004), or criticism of lagging regulations (McKay, 2003). This perspective only addresses the regulative pillar of institutions, but is nonetheless valid, even if limited. The regulatory arrangements for decentralised water management have been recently addressed in a document by the New South Wales State Government in an attempt to facilitate negotiation of these regulations for proponents of private decentralised water management (DEUS, 2006). This is one form of inter-organisational networking to enable decentralised urban water management.

The findings of the case studies present a number of other challenges for those responsible for broader water management organisations and policy frameworks. Notwithstanding the conservatism of Queensland Health, the whole-of-government policies and strategies favouring water recycling and rainwater tanks in Queensland were thought to be considerably helpful to advancing the innovations proposed for the three Queensland cases. The provision of an organisational home for innovation within State Government regulators (i.e., the EPA's Sustainable Industries) helped two of the three Queensland projects (Pimpama Coomera and Currumbin Ecovillage). At the time of the Bundeena Maianbar Priority Sewerage Project, such inter-departmental networks or whole-of-government approaches for the pursuit of sustainable water management were largely absent.

5.4.4 Considering Different Organisation Types for Decentralised Water

Decentralised urban water management may be enabled by a number of different organisational homes or organisation types. The creation of new legitimate

organisational forms is done by a process of institutionalisation (DiMaggio, 1988). The following types are not intended to be exhaustive, but are intended to touch on the possibilities, acknowledging the limited empirical base that the case studies provide.

5.4.4.1 New Organisational Forms within Existing Government Bureaucracies

The creation of a new organisational unit (such as a project team in the Pimpama Coomera case) has been demonstrated to be a successful means of facilitating effective alignment of institutional pillars for innovation in water management. The challenges of this approach are in the areas of establishing permanency once the project team moves its focus on to another project, and also in establishing legitimacy of the team as it interrelates with other established sections of the organisation. These were discussed for the Pimpama Coomera case.

5.4.4.2 Public Private Partnership, BOO and BOOT

Private organisations entering into contracts or partnership with government and/or public water authorities may still be mapped within the same organisational field as public or government water service providers. Each of these forms still has the same or similar: regulations; professional expertise, conferences and associations; regulators; and organisational stakeholders. And therefore institutional isomorphism (mimetics) is still applicable between these organisational variants (DiMaggio and Powell, 2002).

Many Australian water treatment plants are awarded to private operators on a build-own-operate (BOO) or build-own-operate-transfer (BOOT) basis (AusCID, 2005). This is another potential organisational form for delivering decentralised urban water services (although large recycling schemes such as the Rouse Hill dual reticulation recycling scheme are the most decentralised of such projects already existing). The government involvement in setting up and overseeing such contracts means that institutional isomorphism is likely to come into play. This sort of organisational form was not studied or investigated, and further institutional analysis of such forms would be beneficial.

5.4.4.3 Private Entrepreneurial Developer

Both case studies of innovative water management by private developers in this research were characterised by a private land developer focusing and forming their organisational structure on the project at hand. Thus both cases provide ample supporting evidence of how a private developer may form an organisational structure supportive of decentralised or sustainable values and ideas. In the Payne Rd and Currumbin Ecovillage cases, the organisational form was new and therefore naturally appropriate for the innovation.

Cases where already existing and established developers undertake water management planning and decision-making will probably require organisational reflexivity to provide legitimacy to new forms of knowledge; however, further examples should be observed and studied.

5.4.4.4 Organisations Specifically for Decentralised Urban Water Management

Another speculative option is the creation of new government departments specifically for the delivery of decentralised urban water management. For example, in Sydney, a 'competitor' to Sydney Water could be established to provide decentralised urban water services. This is purely speculative, and is put forward very cautiously.

There is an organisation set up to support capacity for (but not actually deliver) decentralised water management in the United States – The National Decentralized Water Resources Capacity Development Project (NDWRCDP), sponsored by the United States EPA. While this project's emphasis is on less densely populated areas, this may be still another option for a government department being established to facilitate moves toward decentralised urban water management, in a similar way to the Queensland EPA's Sustainable Industries arm.

5.5 Conclusion

The objective of identifying and implementing sustainable water management is not a single decision or task. The implementation of decentralised water management is similarly not successfully achieved merely by technical identification of superior

outcomes. Change in water management practice to being more sustainable, including the use of decentralised approaches, is the continuing work of aligning understandings, values and practices, as well as aligning the organisations and governing processes which both reflect and facilitate those understandings, values and practices.

6 Conclusions

This concluding chapter briefly summarises the main findings of the study, their significance, limitations, and areas for future research.

6.1 Summary of Study Findings

This study set out to address questions of innovation and institutionalisation in decentralised urban water management. Table 6-1 summarises the results of hypothesis-testing for two guiding research questions (compare Table 1-3).

Research Question 1 asked to what extent institutional factors operate to include or exclude decentralised technologies in urban water management. Analysis of literature helped to map existing and historical sociotechnical systems of water management. Scott's (1995) version of new institutional theory was used to provide a framework for understanding water sociotechnical systems where social practice is carried by regulative, normative and cognitive elements, comprising institutions.

The current changing paradigm for water management from supply-side thinking to conservation and the struggle for its implementation through established organisations suggested a need for attention to be paid to organisational design for more effective institutionalisation of changed practice. Analysis of the literature and the researched case studies suggested that institutional factors are indeed a significant and valid explanation for the current dominant centralised pattern of water management, and the apparent exclusion of decentralised options. The institutional factors identified include the alignment of cognitive frames or 'taken for granted' thinking, values, and regulatory structures – all based on historically important and justifiable choices.

The case studies then provided evidence to examine the extent to which institutional factors are associated with, and important to, the uptake of decentralised water services provision. Specifically, the interest was in whether there is need for organisational change to provide a new organisational location where new cognitive frames are part of accepted discourse. Analysis of three cases of 'successful' decentralised innovation (in

contrast to one where decentralised innovation was seriously discussed but not adopted) showed that a (new) organisational home is closely linked with, and likely to be necessary for, the enabling of new ideas to impact on action (i.e., become institutionalised). Such a new organisational home was typically created by one or more 'institutional entrepreneurs', who saw opportunity for change and had sufficient organisational resources to act to realise their interest. Effective methods of strong stakeholder engagement and inter-organisational networks were also found to be linked to the creation of shared meaning and legitimacy for the organisational and technological change. These links were argued to be stronger than the observed link between adoption of decentralised innovation and methods of technical assessment and multi-criteria types of analysis, for the observed cases.

Research Question 2 examined the extent to which institutional factors operate to include or exclude user involvement in urban water management. The case studies did not provide abundant evidence for this question; however, there was a small amount of evidence that user involvement was excluded, in part, due to similar institutional factors that excluded decentralised technologies; and inclusion was also enabled by similar institutional factors. Evidence of practical experience of user involvement, and institutional factors enabling it, was not able to be analysed in much detail. The evidence from the statements of case study informants suggests that decentralised technologies can be framed either to be linked with or independent of increased user involvement in water management. Evidence from actual practice was more limited, but seemed to suggest that user involvement is a closely related issue to decentralised physical systems. Further evidence and experience is needed to better characterise the relationship(s). Thus no strong answer to the second research question is proposed.

The implications of the findings of this study for policy and practice were discussed in detail in Chapter 5, where pathways for change were presented for institutionalising decentralised urban water management thinking and practice. The study suggested that existing planning frameworks are often strongly focused on seeking rational expert justification for legitimising change to more sustainable practice, but are often weaker in addressing institutional factors, namely organisational alignment to shared

discourses. The study proposed different principles for, and examples of, appropriate organisational design for enabling and managing decentralised technological innovation for urban water management. Reflexivity to ensure alignment of institutional pillars (cognitive, normative and regulative elements), and inter-organisational and stakeholder networks for maintaining shared meaning (as ideas of sustainability continue to be refined) were argued to be important for enabling institutionalisation of decentralised urban water management.

Table 6-1: Summary of answers to research questions by hypotheses tested

Hypotheses (Grouped by Research Question)	**Extent Confirmed**	**Limitations**
Research Question 1: To what extent do institutional factors operate to include or exclude decentralised technologies in urban water management? *Answer: To a significant extent.*		
Hypothesis 1.1: Innovative decentralised technologies are excluded from urban water management because of entrenched or otherwise misaligned institutional factors: knowledge, values and organisational structure/regulations.	Confirmed: significantly	Many other factors can also contribute to excluding decentralised technologies.
Hypothesis 1.2: Successful uptake of decentralised technologies in urban water management requires a combination of shifts or innovation in all of three institutional factors so that they are aligned: knowledge, values, and organisational structure/regulations.	Confirmed: significantly	Many other factors can also contribute to uptake of decentralised technologies.
Hypothesis 1.3: Alignment of institutional factors to support decentralised technologies for urban water management (i.e., the condition of Hypothesis 1.2) is improved by an organisational home where new ideas and values are part of accepted discourse.	Confirmed: significantly, with caveats	A case where decentralised technologies arise in an unchanged organisational environment would moderate support for this hypothesis, if found.
Hypothesis 1.4: Alignment of institutional factors to support decentralised technologies for urban water management (i.e., the condition of Hypothesis 1.2) is improved by an organisational structure that includes a broad network of stakeholders with diverse discourses.	Confirmed: significantly, with caveats	One of the researched cases of successful implementation of decentralised technology displayed relative deficiency in stakeholder inclusion.
Research Question 2: To what extent do institutional factors operate to include or exclude user involvement in urban water management? *Tentative answer: To a significant extent.*		
Hypothesis 2.1: User involvement in urban water management is excluded because of entrenched or otherwise misaligned institutional factors: knowledge, values and organisational structure/regulations.	Confirmed: moderately	Evidence was gathered primarily for Research Question 1. Thus only limited evidence to draw from.
Hypothesis 2.2: Successful uptake of user involvement in urban water management requires a combination of shifts or innovation in all of three institutional factors so that they are aligned: knowledge, values, and organisational structure/regulations.	Confirmed: moderately	Evidence was gathered primarily for Research Question 1. Thus only limited evidence to draw from.
Hypothesis 2.3: The acceptance of user involvement is a helpful (but not necessary) condition for enabling or enhancing uptake of decentralised technologies.	Limited confirmation only	One case showed this link strongly, another weakly, and a third did not. (The other was not relevant.)

6.2 Significance of Findings

This thesis significantly contributes to the understanding of institutions of urban water management, particularly as institutional factors relate to physically centralised and decentralised urban water management. While institutional theory and explanations have been applied to other aspects of urban water management, this appears to be the first study to use this theoretical and methodological approach for questions of implementation of decentralised urban water management technologies and approaches.

New institutional theory provided a useful and insightful means of explanation of centralising and decentralising forces on water management projects and institutions. This significantly extends understanding beyond typical rational choice (e.g., technical or multi-criteria assessment) or community acceptance explanations of planning choices and outcomes.

But lest the significance is pushed too far, it must be stated that the new institutional explanation of decentralised urban water management outcomes was not shown to be the only valid explanation. The implications for policy and practice that this explanation highlights are not intended to exclude consideration of other social and/or technological factors that may also be highly important.

The use of new institutional theory in environmental and sustainability studies in general is a new and emerging field, and this study contributes to its empirical base. While this work does not suggest any modifications to new institutional theory, empirical support is provided for the proposition that new ideas require an organisational home.

6.3 Limitations of the Study

The motivation for this thesis is largely based on an assumption that decentralised approaches to water management represent an improvement in sustainable water management. There is significant supporting evidence for this assumption; but the lack of agreed and/or philosophically appropriate approaches for measuring sustainability is one limiting factor for arguing the significance (but not validity) of the results. Further,

there is potential for significant unintended negative consequences of decentralised systems for sustainability. An example is the greenhouse gas emissions from replicated pumps for rainwater tanks at each household (for one particular type of configuration of decentralised water systems).

Another limitation is that there were only four cases studied, and each case was unique in many respects. Thus the ability to make generalisations is much more limited than if many cases were studied. The limited number of cases also meant that not all organisational types possible were studied. For example, no public private partnerships or BOO/BOOT schemes were covered.

The case study-based research method also has limitations in isolating variables and establishing causal links. There are a number of plausible alternative explanations other than those put forward for the trajectory of action in each case. With only four cases to draw on, it is difficult to argue strongly for the relative importance of some identified common factors over many others that could be identified. Some of these alternative factors (such as technical or physical constraints) have been acknowledged. This thesis does not attempt to prioritise institutional factors as the most important, but rather as important enough to deserve a more complete understanding.

Data collection for the case studies was also subject to many limitations. Communication in both directions for in-depth interviews is based on subjective interpretations of language and meaning. This reduced the reliability of isolated data, although triangulation was used to improve the reliability.

Further, the proposed changes to water management planning frameworks, and possible organisation types, for enabling decentralised innovation are speculative propositions based on limited empirical evidence with no field testing.

6.4 Areas for Future Research

This study presents a number of areas for fruitful future inquiry, some of which are implied in the foregoing discussion of limitations.

The replication of the same research method but using many more cases, including different organisational types, would improve the reliability and generalisability of the results reported.

The speculative proposed pathways for change could also be field tested. Ideally the proposed planning framework would be tested for more than just whether it could successfully enable implementation of decentralised water technologies, but also in a variety of different project types with varied outcomes (not necessarily decentralised).

Further research is required for the question of how decentralised urban water systems can best be operated and managed (e.g., by whom, and how to distribute risk and responsibility, etc.). This might be done through longitudinal studies of cases involving operational decentralised systems. (Such operational decentralised systems also need ongoing research and development to test for and maximise sustainability of outcomes against various criteria.)

Further to the above, and further to the second research question, if it is deemed that water users (i.e., the public) can or should take a more active role in operating and managing their water systems and use of water, then more specific research is needed to determine how the water user (whether environmentally motivated or ordinary citizens) can be mobilised to be part of the solution in sustainable decentralised urban water services. A more thorough examination of institutional factors would be germane, as well as extending the inquiry for other factors. This remains vitally important if the management of decentralised water systems is also to be decentralised, because at this stage, with the prevailing mentality that water management is the responsibility of the water authority and not the user, many of the more on-site or decentralised water management-focused developments attract only the more environmentally conscious and motivated occupants who choose to be a part of the solution. There are some exceptions, however, including the more widespread mandating of rainwater tanks for new or renovated houses. Such household use of rainwater tanks usually requires some level of user involvement in the management of the tank system. There is, therefore,

growing scope and potentially available data for the study of how water users can be mobilised into the framework for managing the urban water cycle.

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Appendix A – On-line Water Management Planning Survey

A printed version of the on-line survey form is presented on the following pages.

THE UNIVERSITY OF NEW SOUTH WALES

Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

CRC for Water Quality and Treatment

Wastewater Management Planning: Evaluation Survey

February 2004

Introduction

Thank you for agreeing to participate in this evaluation. The purpose of this survey is to understand your involvement, experiences and views of preparing or co-ordinating wastewater management strategies in your local area, with a particular emphasis on water recycling activities.

- Please set aside 30 minutes to complete this survey. The survey is set up in sections of questions that are related to each other. It is possible that some sections may not be relevant to you, in which case the survey may take less time.

- This survey is to be completed only by you (council's "**Manager of Water and Sewerage**").

- To answer the questions, there are no 'right' and 'wrong' answers. **What matters most is your opinion.**

- Please make sure you complete all relevant questions. This will assist us in analyzing the data.

Confidential information will be protected. The information you provide will be used to highlight trends/patterns in water management without identifying specific people or organisations. For example, individual councils will not be named. An overview of results will be published on this website and in conference and/or journal papers as a means of disseminating the conclusions.

If you have any queries, please feel free to contact ***Nyree Stenekes*** on (02) 6230 7723 or 0419 257 102 **OR** ***Daniel Livingston*** on (02) 9402 7733 or 0405 846 424 from the *School of Civil & Environmental Engineering,University of NSW* at any time.

How to send this survey back

- We ask that you complete the survey by 20th February 2004

- Please return it by post addressed to ***"Water Management Planning Evaluation Survey" School of Civil & Environmental Engineering, University of NSW, Sydney NSW 2052***.

- ***Or*** you can fax it to (02) 9385 6139

- ***Or*** fill it out online at www.cwwt.unsw.edu.au/managementsurvey

Part A. Information about you

This section is aimed at finding out about your own background and training to put your responses in context.

A-1. What position do you hold in your organisation?

_____

A-2. What department are you in?

_____

A-3. How long have you worked for this organisation ____ years

A-4. Have you worked in local government? ☐ No ☐ Yes ____years

A-5. Have you worked in state government? ☐ No ☐ Yes ____years

A-6. Have you had any other employment history (e.g. private sector) ? ☐ No ☐Yes ____years

A-7. What is your professional background?

Civil Engineer	☐	*Industrial Engineer*	☐	*Planner*	☐
Environmental Engineer	☐	*Chemical Engineer*	☐	*Social / Legal*	☐
Process Engineer	☐	*Environmental scientist*	☐	*Educator*	☐
Chemist	☐	*Microbiologist*	☐		

*Other (Please specify):*_____

A-8. What is your age ? (Circle appropriate range) <25 25-34 35-44 45-54 55-64 >64

A-9. What is your gender? Male ☐ Female ☐

Part B. Information about water management in your local area

This section is aimed at finding out which kinds of water recycling activities your council may be undertaking now or in the past to put together a database for future policy input.

B-1. What responsibilities does your council have in relation to water management in your local area? (*you can tick more than one box*)

Water supply ☐ *Sewerage* ☐ *Stormwater* ☐

Infrastructure planning ☐ *Operation & maintenance* ☐

*Other (Please specify):*_____

B-2. Are some of these water services the responsibility of a commercialized council business?

Yes ☐ No ☐ Don't know ☐

If yes, please specify which functions:_____

B-3. Please choose the following that best describes your Council's present situation in relation to water recycling (*you may tick more than one*):

(i) Council is <u>responsible</u> for planned water recycling projects (or was in the past) ☐

(ii) Council has <u>formal</u> plans to initiate water recycling (or has in the past) ☐

(iii) Council is <u>considering</u> plans to initiate water recycling (or has in the past) ☐

Please GO TO question B-4

(iv) Council has <u>no</u> involvement in water recycling plans or activities ☐

Please GO TO question C-1

*Other (Please specify & GO TO B-4):*_____

_____

B-4. **Details of three of your recycling plans/projects**

For the following five parts of this question - from (a) to (e) - please tick the boxes that best describe the nature of your main water recycling plans or projects.

There is provision for three projects. If you have more, please choose your three most significant. If you have only one or two, you may leave the other column(s) blank.

(a) What is the nature of the source water? (*you may tick more than one category or provide a brief description, if appropriate*)

Project 1		***Project 2***		***Project 3***	
Primary treated wastewater	☐	*Primary treated wastewater*	☐	*Primary treated wastewater*	☐
Secondary treated wastewater	☐	*Secondary treated wastewater*	☐	*Secondary treated wastewater*	☐
Tertiary treated wastewater	☐	*Tertiary treated wastewater*	☐	*Tertiary treated wastewater*	☐
Greywater	☐	*Greywater*	☐	*Greywater*	☐
Blackwater	☐	*Blackwater*	☐	*Blackwater*	☐
Household/ domestic	☐	*Household/ domestic*	☐	*Household/ domestic*	☐
Industrial	☐	*Industrial*	☐	*Industrial*	☐
Commercial	☐	*Commercial*	☐	*Commercial*	☐
Agricultural	☐	*Agricultural*	☐	*Agricultural*	☐
Rainwater	☐	*Rainwater*	☐	*Rainwater*	☐
Stormwater/runoff	☐	*Stormwater/runoff*	☐	*Stormwater/runoff*	☐
Other (Please specify):	☐	*Other (Please specify):*	☐	*Other (Please specify):*	☐

(b) What is the level of treatment that occurs prior to reuse or recycling?

Project 1		***Project 2***		***Project 3***	
Primary		***Primary***		***Primary***	
Primary treated wastewater	☐	*Primary treated wastewater*	☐	*Primary treated wastewater*	☐
Secondary treated wastewater	☐	*Secondary treated wastewater*	☐	*Secondary treated wastewater*	☐
Other (Please specify):	☐	*Other (Please specify):*	☐	*Other (Please specify):*	☐

Project 1	***Project 2***	***Project 3***
Secondary	***Secondary***	***Secondary***
Activated sludge ☐	*Activated sludge* ☐	*Activated sludge* ☐
Sequencing batch reactor ☐	*Sequencing batch reactor* ☐	*Sequencing batch reactor* ☐
Biological nutrient reduction ☐	*Biological nutrient reduction* ☐	*Biological nutrient reduction* ☐
Trickling filter ☐	*Trickling filter* ☐	*Trickling filter* ☐
Secondary clarifier ☐	*Secondary clarifier* ☐	*Secondary clarifier* ☐
Stabilisation pond ☐	*Stabilisation pond* ☐	*Stabilisation pond* ☐
Aerated lagoon ☐	*Aerated lagoon* ☐	*Aerated lagoon* ☐
Membrane bioreactor ☐	*Membrane bioreactor* ☐	*Membrane bioreactor* ☐
Other (Please specify): ☐	*Other (Please specify):* ☐	*Other (Please specify):* ☐

Project 1	***Project 2***	***Project 3***
Tertiary	***Tertiary***	***Tertiary***
Coagulation/ flocculation ☐	*Coagulation/ flocculation* ☐	*Coagulation/ flocculation* ☐
Granular-medium filtration ☐	*Granular-medium filtration* ☐	*Granular-medium filtration* ☐
Polishing pond ☐	*Polishing pond* ☐	*Polishing pond* ☐
Chlorination ☐	*Chlorination* ☐	*Chlorination* ☐
Ozonation ☐	*Ozonation* ☐	*Ozonation* ☐
UV disinfection ☐	*UV disinfection* ☐	*UV disinfection* ☐
Other (Please specify): ☐	*Other (Please specify):* ☐	*Other (Please specify):* ☐

Project 1		***Project 2***		***Project 3***	
Advanced		***Advanced***		***Advanced***	
Activated carbon filtration	☐	*Activated carbon filtration*	☐	*Activated carbon filtration*	☐
Air stripping	☐	*Air stripping*	☐	*Air stripping*	☐
Ion exchange	☐	*Ion exchange*	☐	*Ion exchange*	☐
Lime treatment	☐	*Lime treatment*	☐	*Lime treatment*	☐
Microfiltration	☐	*Microfiltration*	☐	*Microfiltration*	☐
Ultrafiltration	☐	*Ultrafiltration*	☐	*Ultrafiltration*	☐
Nanofiltration	☐	*Nanofiltration*	☐	*Nanofiltration*	☐
Reverse osmosis	☐	*Reverse osmosis*	☐	*Reverse osmosis*	☐
Other (Please specify):	☐	*Other (Please specify):*	☐	*Other (Please specify):*	☐

(c) What is the recycled water to be used for? (*you can tick more than one OR provide description, if appropriate*)

Project 1		***Project 2***		***Project 3***	
Urban	☐	*Urban*	☐	*Urban*	☐
Rural/Semi-rural	☐	*Rural/Semi-rural*	☐	*Rural/Semi-rural*	☐
Domestic	☐	*Domestic*	☐	*Domestic*	☐
Industrial	☐	*Industrial*	☐	*Industrial*	☐
Agricultural	☐	*Agricultural*	☐	*Agricultural*	☐
Open space	☐	*Open space*	☐	*Open space*	☐
Commercial	☐	*Commercial*	☐	*Commercial*	☐
Non-potable	☐	*Non-potable*	☐	*Non-potable*	☐
Indirect potable	☐	*Indirect potable*	☐	*Indirect potable*	☐
Direct potable	☐	*Direct potable*	☐	*Direct potable*	☐
Other (Please specify):	☐	*Other (Please specify):*	☐	*Other (Please specify):*	☐

Space for description of project(s) (if required):

_____

_____

_____

_____

(d) What infrastructure approach will be (or was) taken? (*Please read the key carefully before answering this question*).

KEY

System	***Description***
Centralised	Collection & transfer of wastewater to distant municipal wastewater treatment plant(s), followed by disposal, reuse or recycling.
Decentralised	Any or all of: collection, treatment, disposal and/or reuse of water/wastewater at the neighbourhood level.
At-source	Wastewater management at the source e.g. on-site greywater or blackwater reuse/recycling, dry conservancy ('composting') toilets, urine separation etc.

Project 1	***Project 2***	***Project 3***
Centralised ☐	*Centralised* ☐	*Centralised* ☐
Decentralised ☐	*Decentralised* ☐	*Decentralised* ☐
At-source ☐	*At-source* ☐	*At-source* ☐
Other (Please specify):	*Other (Please specify):*	*Other (Please specify):*

Space for description of project infrastructure approach(es) (if required):

_____

_____

_____

_____

(e) What stage is each project up to? (*You may tick more than one or provide more details in the space provided, if appropriate*)

Project 1		***Project 2***		***Project 3***	
Initial planning stage	☐	*Initial planning stage*	☐	*Initial planning stage*	☐
Council approved plans	☐	*Council approved plans*	☐	*Council approved plans*	☐
Construction phase	☐	*Construction phase*	☐	*Construction phase*	☐
Operational phase	☐	*Operational phase*	☐	*Operational phase*	☐
Decommissioned	☐	*Decommissioned*	☐	*Decommissioned*	☐
Plans abandoned	☐	*Plans abandoned*	☐	*Plans abandoned*	☐
Other (Please specify):	☐	*Other (Please specify):*	☐	*Other (Please specify):*	☐

Part C. Your role in water recycling activities

This section is aimed at finding out more about how the responsibilities for planning water recycling activities are spread around and co-ordinated among different people and groups within council. Potentially, this information will be used to help in future state policy initiatives.

C-1. In your opinion, what are the **main** reasons for the council's involvement (or non-involvement) in water recycling activities? (I.e. those activities identified in Part B. E.g. water supply scarcity, sewerage capacity, social/political, legislation, environment, health, etc.)?

_____

_____

_____

_____

_____

_____

If there are no existing water recycling activities or no plans to do so in your council, please GO TO the last page which provides space for any further comments.

Otherwise, please continue to question C-2.

C-2. What did you do (or what *will* you do) in relation to planning water recycling activities? (*you can tick more than one category OR provide description, if appropriate*)

project management	☐	*public health risk assessment*	☐
community liaison	☐	*environmental risk assessment*	☐
consultant liaison	☐	*social impact assessment*	☐
council liaison	☐	*technical assessment*	☐
liaise with government stakeholders	☐	*financial assessment*	☐

*Other (Please specify or describe):*_____

_____

_____

C-3. Were other staff <u>within</u> your department involved (or will they be involved) in planning for these water recycling activities?

Yes ☐ No ☐ Don't know ☐

Please enter the main staff (positions) and their involvement in the space below.

Staff Position	**Involvement in development/ Preparation of water recycling activities**

C-4. Were staff from <u>other</u> departments involved (or *will* they be involved) in developing/preparing the water recycling activities?

Yes ☐ No ☐ Don't know ☐

Please write in the space below (i) the council department (ii) staff position and (iii) what they did (or what they will do).

Council department	**Staff position**	**Involvement in development/ Preparation of water recycling activities**

C-5. Are there any internal constraints that you are aware of (e.g. relating to organisational structure) that would prevent council from planning & developing water recycling or other sustainable water management initiatives?

Yes ☐ No ☐ Don't know ☐

If so, please briefly explain why.

_____

_____

_____

C-6. Were consultant(s) engaged (or will they be engaged) specifically to assist with the process of planning with respect to these water recycling activities (not including implementation)?

Yes ☐ No ☐ Don't know ☐

If so, please state what tasks the consulting organisation(s) undertook (or will undertake*) (You can tick more than one category OR provide description, if appropriate*.)

project management	☐	*social impact assessment*	☐
community consultation	☐	*technical assessment*	☐
public health risk assessment	☐	*financial assessment*	☐
environmental risk assessment	☐		

*Other (Please specify or describe):*_____

_____

C-7. Were/are there any proposals to jointly manage wastewater with other councils in the catchment?

Yes ☐ No ☐ Don't know ☐

If so, please briefly explain why:_____

_____

If your council is <u>currently</u> recycling water, please continue to Part D. If not, please GO TO the final question.

Part D. Planning & development of water recycling activities in the context of wastewater management

This section is aimed at finding out more about the way that water recycling schemes are evaluated compared with conventional wastewater management options and whether this has any impact on water recycling outcomes.

D-1 What were the main options (inclucing water recycling) that were generated in the planning process to address wastewater management issues during planning processes? Please list 3 of the options in order of importance. (e.g. continue sewage disposal, improve septic systems, improve municipal sewage quality, reuse in greenfield developments, reuse for agriculture, water demand management, alternate onsite systems, etc.)

Option 1:_____

Option 2:_____

Option 3:_____

D-2 Were specific criteria used to select the preferred option(s) for managing wastewater? (E.g. environmental, social, economic, health, technical)

Yes ☐ No ☐ Don't know ☐

If so, please list three of the criteria in order of importance.

Criteria 1:_____

Criteria 2:_____

Criteria 3:_____

D-3 How were these criteria developed? (E.g. brainstorming, interagency discussions, community involvement etc)

_____

_____

_____

_____

_____

D-4 Were any of the following tools/methods used to select the preferred option(s)? (You may check more than one.)

Cost-benefit analysis	☐	*Life cycle assessment*	☐
Ecological footprint	☐	*Risk analysis*	☐
Environmental scorecard	☐	*Multi-criteria analysis*	☐
Informal discussion(s)	☐	*Don't know*	☐
		None	☐

*Other (Please specify or describe):*_____

_____

_____

D-5.a) Were there any difficulties that discouraged water recycling from being chosen as an option for managing wastewater in your local area?

Yes ☐ No ☐ Don't know ☐

D-5.b) If yes, what do you consider to be the main difficulties affecting the planning water recycling activities? Tick any that apply (*You may tick more than one, and note that these are just broad categories – your elaboration below will be more helpful*).

Regulatory	☐	*Risk*	☐
Departmental	☐	*Social*	☐
Technical	☐	*Procedural*	☐
Financial	☐	*Political*	☐
Stakeholder	☐	*Cultural*	☐
Organisational	☐	*Don't know*	☐
Environmental	☐	*None*	☐

D-5.c) Please elaborate on your answer, indicating how these difficulties affected outcomes.

_____

_____

_____

_____

_____

D-6. What do you think would need to be done to make water recycling a more attractive option for managing wastewater? Please explain why you think so.

_____

_____

_____

_____

_____

Part E. Role of stakeholders during the planning of water recycling activities

This section is aimed at finding out more about the way that stakeholder groups may have been involved in the planning of water recycling activities. Your responses will go towards helping to understand and facilitate stakeholder involvement in the future.

E-1 Were other government stakeholders involved in these planning processes?

Yes ☐ No ☐ Don't know ☐

If yes, please rate the level of involvement of the stakeholders below from 1 (*Very Low*) to 5 (*Very High*) or *N/A* if not applicable (by circling the numbers). Additional space is given to list up to 2 other government stakeholders.

Groups	*Not Applicable*	**Level of Involvement** *Very Low*		*Average*		*Very High*
Environment Protection Agency	N/A	1	2	3	4	5
Department of Local Government & Planning	N/A	1	2	3	4	5
Department of Natural Resources and Mines	N/A	1	2	3	4	5
Department of Primary Industries	N/A	1	2	3	4	5
Department of State Development	N/A	1	2	3	4	5
Department of Public Works	N/A	1	2	3	4	5
Health Department	N/A	1	2	3	4	5
Other local councils	N/A	1	2	3	4	5
Other, _____	N/A	1	2	3	4	5
Other, _____	N/A	1	2	3	4	5

E-2 Were any non-government stakeholders involved in these planning processes?

Yes ☐ No ☐ Don't know ☐

If yes, please rate the level of involvement of the stakeholders below from 1 (*Very Low*) to 5 (*Very High*) or *N/A* if not applicable (by circling the numbers). Additional space is given to list up to 4 other government stakeholders.

Groups	*Not Applicable*	**Level of Involvement** *Very Low*		*Average*		*Very High*
Residents	N/A	1	2	3	4	5
Community groups	N/A	1	2	3	4	5
Environmental groups	N/A	1	2	3	4	5
Small businesses	N/A	1	2	3	4	5
Consumers groups	N/A	1	2	3	4	5
Indigenous groups	N/A	1	2	3	4	5

Catchment management groups	N/A	1	2	3	4	5
Farmers' groups	N/A	1	2	3	4	5
Other, _____	N/A	1	2	3	4	5
Other, _____	N/A	1	2	3	4	5
Other, _____	N/A	1	2	3	4	5
Other, _____	N/A	1	2	3	4	5

E-3. What were the main means by which the non-government stakeholders were involved in planning processes? Please tick the boxes below and/or give examples (in the space below) of how they were involved.

Surveys	☐	*Workshops*	☐
Public submissions	☐	*Focus groups*	☐
Public meetings/hearings	☐	*Advisory groups*	☐
Newsletters/pamphlets	☐	*Citizen jury*	☐
Media releases	☐	*Information desk*	☐
N/A	☐		

Other (Space is provided here for further comment, explanation or examples.):

_____

_____

_____

E-4. What were the main aims of involving stakeholders in planning processes (in your opinion)?

_____

_____

_____

E-5 In your opinion, how successful were the attempts at involving stakeholders in the process?

Very successful	☐	*Moderately successful*	☐	*Neutral*	☐
Moderately unsuccessful	☐	*Very unsuccessful*	☐	*Don't know*	☐
				N/A	☐

Why do you think this is the case?

_____

_____

_____

E-6 Were there any difficulties in involving stakeholders?

Yes ☐ No ☐ Don't know ☐ N/A ☐

If yes, please describe any difficulties you experienced below.

_____

_____

_____

_____

_____

E-7 Did the requirements or practices of other stakeholders slow down the implementation of water recycling?

Yes ☐ No ☐ Don't know ☐ N/A ☐

If yes, please give details below.

_____

_____

_____

_____

_____

Any further comments

This is your chance to offer any other comments, information or statements based on your experience that you think would be relevant to understanding and improving current approaches to wastewater management, and water recycling initiatives in particular.

_____

_____

_____

_____

_____

_____

_____

_____

_____

THANK YOU – We sincerely appreciate your help in completing this survey and sharing your recycling experience.

Please tick the following box if you would like to receive results of the research emailed to you at the address you provide below…

☐ Yes, please email me research results

Email address: _____

(Note that your email address will not be used in any other way apart from this check to send you the results of the survey i.e. it will not be associated with the actual answers provided)

To return this survey:

Please return this survey in the enclosed stamped self-addressed envelope marked ***"Evaluation Survey" School of Civil & Environmental Engineering, University of NSW, Sydney NSW 2052.*** Alternatively, you can fax it to (02) 9385 6139 or fill it out online at http://www.cwwt.unsw.edu.au/managementsurvey

Appendix B – On-line Survey Results

The following conference paper presents results of the on-line survey, on the following pages.

Livingston, D., Stenekes, N., Colebatch, H. K., Ashbolt, N. J. and Waite, T. D. (2004), Water management planning in local government: organisational factors impacting effective policy for sustainability, In, *Conference Proceedings, Sewage Management: Risk Assessment and Triple Bottom Line, April 4-6*, Queensland EPA, Cairns.

Water management planning in local government: organisational factors impacting effective policy for sustainability

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Abstract

Achieving sustainable urban water uses is increasingly recognised as a major issue for local government planning and management. As a result, innovative technological approaches, such as recycling wastewater streams, have been initiated to address urban water sustainability problems. Successful implementation of sustainable water uses, such as water recycling, however, is a multi-faceted challenge. Not only must the technology be functional and cost efficient, it must also protect public health and the environment, and must be socially acceptable. This paper goes beyond the consideration of social acceptance, to examine the organisational planning and management processes of local councils (via an online pilot survey and interviews) with the aim of scoping some of the key factors relating to this challenge. Drawing on the work of Brown (2003), a number of critical factors relating to council organisation structure and planning techniques were identified as important either in constraining or enabling implementation of change (such as recycling) leading to sustainable water management. Some of these included the timing and nature of public participation, degree of inter-linking between departments within and beyond the council and the professional background of those responsible for wastewater management. Integration and stakeholder inclusion may be important means of developing and achieving sustainable water uses.

1 Introduction

Water managers in local governments in southeast Queensland are under pressure from rapid population growth and ensuing urban development, increasing water scarcity, and stringent environmental regulations relating to effluent discharge quality. Many councils have pursued innovative urban water[1] management initiatives, such as water recycling, as a means of enhancing the sustainability of water use in their local environments. While recycling or reuse of water is one of many possible innovations in practice, the contribution of water recycling to sustainable water management is the principle focus of this paper. Other approaches include better treatment technology, demand management or decentralised infrastructure approaches, some of which are also discussed.

Innovation in sustainable water management relies on water management institutions having adequate organisational capacity and appropriate structure, as well as access to sound technologies (Wakely 1997; Peltenburg *et al.* 2000). In contrast to the significant interest, knowledge and research into innovative and sustainable technologies, little attention has been given to the human and organisational dimensions of innovative sustainable water practices even though these are critical elements governing planning outcomes (Vlachos and Braga 2002; Stenekes *et al.* 2003). Water authorities must deal with increasingly complex challenges if they are to achieve sustainable water management. Several areas stand out as characteristic of contemporary challenges in water management: increasingly vocal non-government stakeholders participating in planning, limited financial resources for pursuing sustainability and more stringent

[1] 'Water' is taken to mean water supply, sewerage and stormwater.

environmental directives (Lundqvist *et al.* 2002). Organisational capacity is an important enabling factor if these challenges are to be appropriately managed, yet this focus of research is in its infancy (Ohlsson and Lundqvist 2000; Brown 2003, pp 2-4). Therefore, here we provide a preliminary exploration of organisational processes of southeast Queensland councils as a critical factor in enabling sustainable water management practices such as water recycling. This exploration is adapted from the evaluation done by Brown (2003) and has been achieved using a novel online survey research method.

We propose that achieving sustainable water management in the future will depend on strengthening the ability of local government organisations to co-ordinate and enable partnerships and coalitions with external community groups and water users (Brown 2003). Developing stable relationships among diverse but important actors is particularly important in handling potential opposition to change and the likelihood of exercise of veto power, whether by community groups, private organisations, or other government bodies (Busenberg 1999). The key to facilitating such change is the provision of opportunities for coalitions to integrate their different perspectives on what are the problems, the appropriate criteria for choice and the solutions that should be employed in local decision-making and planning.

2 Regulatory Context: Wastewater Management and Planning in Queensland

According to the traditional water management paradigm in Australia, government agencies have focused primarily on the need for efficient supply and disposal of water for human use. Water management is shared between State and local governments in most states; however, local government has the prime responsibility in Queensland[2]. Engineers have historically been the leading profession initiating solutions to urban water supply and wastewater disposal problems through the development and design of technical practices within this management context. For example, increases in demand for urban water services have traditionally been met through dam construction subsidised by State governments and piped network infrastructure investments.

Over the last few decades, however, the sustainability of this approach to water management has come under question. In southeast areas of Queensland, for example, population growth has been very rapid (up to 4% compared with the average of 1% for the rest of Australia), significantly increasing the demand for water services. Local authorities have been hard pressed to meet the demands for services, especially during times of recent drought. At the same time there has been growing community awareness of the environmental impacts of development and dam construction on some of Queensland's most valued natural assets and tourist havens. Reflecting these new priorities, changes have emerged at the Federal and state policy levels with the introduction of environmental flows (e.g. IGAE and the GOAG agreements[3]) and the promotion of sustainable water management through the National Water Quality Management Strategy (NWQMS 1994). In Queensland, as in other states, water authorities are being asked to invest significant amounts of money into upgrading treatment technology to reduce the level of nutrients in sewage prior to disposal to the environment (e.g. through biological and chemical nutrient reduction processes).

[2] through the Local Government Act

[3] The Intergovernmental Agreement on the Environment (IGAE) 1992 aimed at providing the basis for a new cooperative approach to the management of environmental issues in Australia. This led to the establishment of the Coalition of Australian Governments' (COAG) strategic framework for the efficient and sustainable reform of the Australian water industry (endorsed at the February 1994 COAG meeting) and consequent state water reform packages. The packages were partly in response to increasing recognition of the ecological crisis in the Murray-Darling Basin and aimed to achieve full cost recovery in the rural water sector and recognition of the environment as a significant water user.

Sustainable water management broadly concerns satisfying water demands without having to develop new natural resources as water supplies or waste sinks and preventing system degradation (Loucks *et al.* 2000; CoA 2002). The key principles of sustainable water management are conservation, efficiency, a whole water cycle approach, catchment level management and inclusion of stakeholders in management processes (United Nations 1992). In responding to these changing priorities, local water authorities have begun to focus on demand management and water recycling as means of improving local water sustainability, especially as increasingly stringent standards are required for wastewater effluent quality. With attention moving to the way that other parts of the water cycle interact (both ecologically and socially), a change in the role of communities has also occurred. Public and community groups are making important contributions to sustainable water management tasks (e.g. managing their own consumption and being involved in water decisions) contrasting historically with the passive role as residents receiving public services.

In this changing context many councils have initiated innovative water recycling schemes to make better use of their available water. Such approaches have been through single use in agricultural, open space and industrial applications. However, there is significant interest in domestic reuse and beneficial on-site recycling of blackwater, greywater and stormwater. Notwithstanding the interest in promulgating sustainable water uses, there are significant unresolved issues in institutionalising the practice - the underdeveloped regulatory regime, councils' limited resources, the significant complexity in managing external stakeholders, public health issues and financial constraints.

An on-going multi-disciplinary research project conducted by the School of Civil Environmental Engineering at the University of New South Wales[4] is exploring these issues in more detail. Specifically the project focuses on planning and management processes that impact on the capability of water authorities to promulgate sustainable water management through water recycling and decentralised approaches to management. The project draws on in-depth research into sustainable water management planning in New South Wales and Queensland consisting mainly of document reviews and stakeholder interviews with government and non-government participants in planning. As part of this research, an on-line pilot survey of south east Queensland local councils was carried out exploring the planning and management of water recycling initiatives in a local government context based on the approach by Brown (2003).

3 South-East Queensland Water Recycling Management – Trends and Patterns

The online pilot survey[5] targeted council employees responsible for water and wastewater management decision-making in southeast Queensland local councils.

The survey was divided into six themes, covering:

- Personal professional background
- Nature of council's water recycling projects
- Planning processes (internal workings of council)
- Decision-making processes
- Stakeholder[6] involvement (and external relations to other organisations)
- General feedback.

The aim was to gain a contextual understanding of the planning processes occurring in local government as they related to water recycling from the perspective of those in council most responsible for water recycling project management. The survey contained 34 questions in total. A variety of response-types

[4] A special acknowledgement is made to Brown (2003) who provided key conceptual input and support to this project – many thanks. (No responsibility is attributed for the quality of the final product.)

[5] See www.cwwt.unsw.edu.au/managementsurvey

[6] Stakeholders included external people and organisations (e.g. government stakeholders, community groups, business groups, residents etc).

were elicited, using multiple choice, rating-scale, and open-ended questions, which were then subjected to a qualitative analysis.

Eleven councils responded out of the nineteen that were approached. All of these councils had responsibility for water, sewerage and stormwater; however five had commercialised council businesses with responsibility for water and sewerage functions. These are reported together in the following discussion. The respondents – those responsible for water and sewage services – all had a civil engineering background. Most held managerial level positions and were situated in technical, engineering or public works sections of Council.

3.1 Driving forces for water recycling

Respondents were asked to provide the main reason for their council's participation (or otherwise) in water recycling activities. Given that all responding councils were actively undertaking water recycling projects, all of the driving forces constituted reasons for initiating recycling projects.

The most common reason given by the council respondents for initiating water-recycling projects was to conserve water resources (reduce potable water usage) and thereby offset impending water scarcity. One respondent explicitly stated that in their organisation, sewage is regarded as a valued resource rather than a waste as in the past. The motive to conserve water resources may be a reflection of a general value shift across the water industry – as evinced by this one explicit comment.

For more than half of the councils, recycling water was seen as a way of reducing current effluent discharges to sensitive riverine and marine environments (e.g. the Great Barrier Reef). Many confirmed that the tighter controls on the quality and quantity of effluent discharges to the environment under the Environment Protection Act (1994) have also made water recycling preferable to discharge. Several councils said that recycling water was a commercially beneficial option that enabled them to bring in or save money, e.g. as a means of recovering the increasing costs of sewage treatment.

3.2 Typical local council water recycling projects and approaches

All of the councils surveyed were actively involved in existing water recycling projects. Four councils had formal plans to engage in further projects, while two other councils had discussed the prospect of embarking on further recycling projects. In total, 25 projects were reported. Most (17) were in operation, two under construction and the remainder were still in planning stages.

In the majority of projects reported, the recycled water was applied to industrial, commercial, agricultural or open space uses. Only two projects were classified as involving domestic uses of the product water, and none of the projects reported direct or indirect potable reuse[7].

The most common infrastructure approach for the reported recycling projects was centralised collection of municipal effluent and redistribution for reuse (19 of 25). Typical source water was either secondary (14 of 25) or tertiary (8 of 25) treated sewage effluent sourced from municipal sewerage treatment plants. No projects were recorded as taking a fractional component of wastewater (e.g. greywater).

While not the focus of the survey, treatment processes for the recycled water were also recorded. Processes applied were predominately those associated with nutrient reduction, with disinfection primarily by chlorination (15), with some instances of ozonation, UV, microfiltration, and one instance of reverse osmosis.

3.3 Planning processes

Respondents were asked what kinds of activities they personally undertook during

[7] Direct potable reuse is not supported in Queensland, however indirect potable reuse (e.g. aquifer recharge or environmental flows) must be considered on a case-by-case basis (see QWRS 2001, p.7).

planning processes for recycling water. Almost all the respondents conducted technical and/or financial assessments in relation to the recycling projects. In several cases, non-traditional engineering tasks, such as liaising with stakeholders external to the organisation were also undertaken by the respondents. About half of the respondents were responsible for managing the overall project.

Clearly the emphasis was on technical management tasks, as Figure 1 indicates. Nine of the eleven council respondents undertook technical assessment compared to only two undertaking community liaison. This was most likely due to the nature of the projects, many of which were agricultural or industrial rather than domestic. Surprisingly, respondents indicated that none of the councils had undertaken health or social impact assessment themselves. (In some cases, but not all, these tasks were undertaken by consultants for the council.)

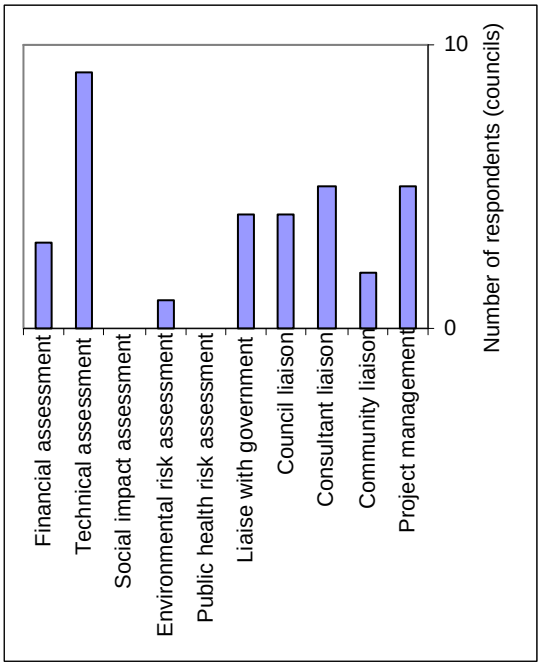

Figure 1 Activities undertaken by council respondents in planning water recycling

Information was also gathered about how planning tasks were shared in the organisation. Respondents were asked whether any staff members within their department or within other council departments had worked on planning the recycling projects. More than half the respondents said they worked with other staff in their own department e.g. other engineers and planners. Five respondents said that they worked with staff from other council departments e.g. strategic planning, administration, financial or legal, and operations departments. Only three respondents reported that staff from both their own department and other council departments were working together on the projects – these were mainly the larger councils with total equivalent full time staff of over 650.

A handful of the respondents said that they were the only person in their immediate departments that were concerned with planning the projects. Nonetheless, some of these worked with staff from other council departments. This situation tended to characterise the medium to small (but not the smallest) councils with total equivalent full time staff numbers of approximately 400 or 500.

Figure 2, below, is a condensed representation of the typical working relationships for the responding councils' water recycling projects (adapted from Brown 2003).

Most respondents could not identify any constraints imposed by organisational structure that would prevent the achievement of water recycling or other sustainable water management initiatives. However, several indicated that water recycling planning and management were affected by:

- Different pricing regimes for recycled water in different areas of council – e.g. prices in parks and gardens compared with industrial; and
- Limited staff resources.

Seven of the eleven councils employed consultants to assist with water recycling planning processes. Figure 3 outlines what tasks the consultants most frequently undertook. In all of these cases, consultants were hired to assist with technical assessment. Consultants also assisted in project management, community consultation, health and environmental impact assessment and

financial assessment of water recycling projects. In many cases the work that consultants were engaged to do was similar to that done by the respondents themselves, suggesting significant interaction between consultants and council staff during the planning stage.

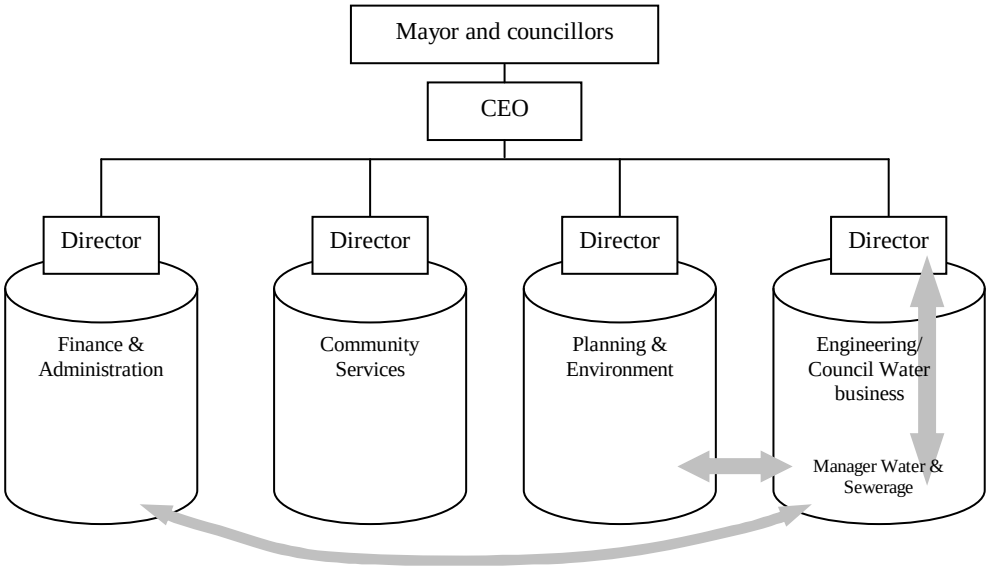

Figure 2 Indicative organisation chart for local councils. Arrows indicate the typical interactions between council staff and departments for water recycling projects. Thicker arrows indicate more frequent instances of interaction (adapted from Brown 2003).

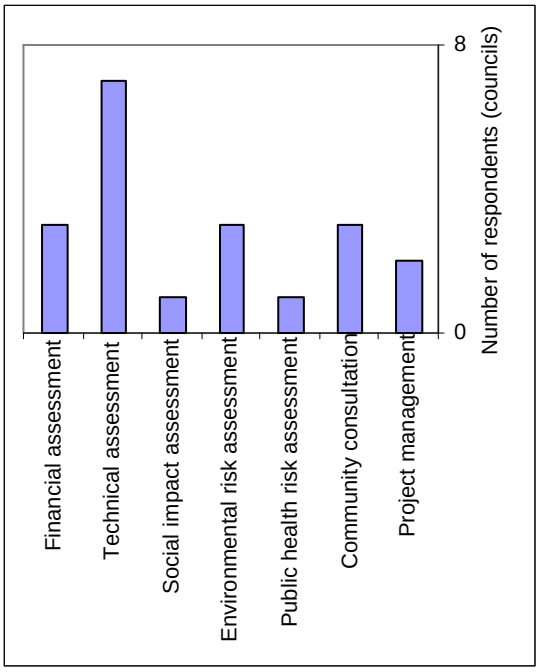

Figure 3 Activities undertaken by consultants in planning water recycling

Four councils reported plans to undertake joint wastewater management projects or strategies with neighbouring councils, but scant explanation was given as to what motivated these proposals outside of commercial viability. Joint activity mainly consisted of plans to develop a regional approach to wastewater management among Sunshine coast councils through 'SunWater', the commercialised business unit of the State government.

3.4 Decision making process

Respondents were asked to identify the kinds of wastewater management options that were proposed for consideration during overall planning processes. All councils proposed one or more innovative solutions, and nearly all proposed some form of water recycling as one of their options. Approximately half of the respondents also proposed conventional

alternatives such as upgrading treatment plants to increase effluent quality. About half also proposed no action as one of their options.

Respondents were then asked what criteria were used to evaluate the options. Only seven respondents knew which criteria had been used, while two claimed that no criteria were used at all. Those that did apply criteria for evaluating the options recorded about seven different criteria – as shown in Figure 4. An approximation is used as some of the wording varied slightly, however the meanings are the same.

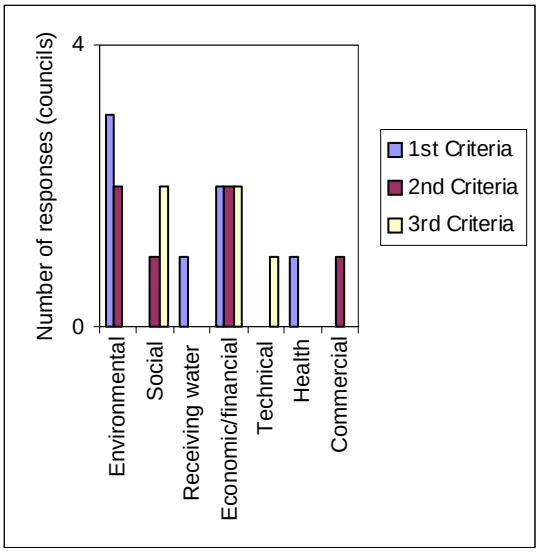

Figure 4 Top three criteria councils used to evaluate proposed recycling options

Environmental criteria were rated highly, but as Figure 5 demonstrates, formal financial decision-making tools were more often used than environmental tools. The environmental criteria may have been taken into account in other more informal ways.

The methods for generating criteria for evaluating the projects were somewhat varied. Seven of the eleven respondents revealed their methods. The seven responses were:

- Experience
- Internal consultation
- Regulatory conditions
- [name of commercial business unit] business planning
- By staff
- Community consultation
- Brainstorming

Respondents were asked if any decision-making tools were used to assist in selecting the preferred option. Figure 5 shows some of the main tools reportedly used. While there was not a large data sample, the figure demonstrates that emphasis was placed on financial assessment and that few instances of the use of environmental evaluation tools were reported.

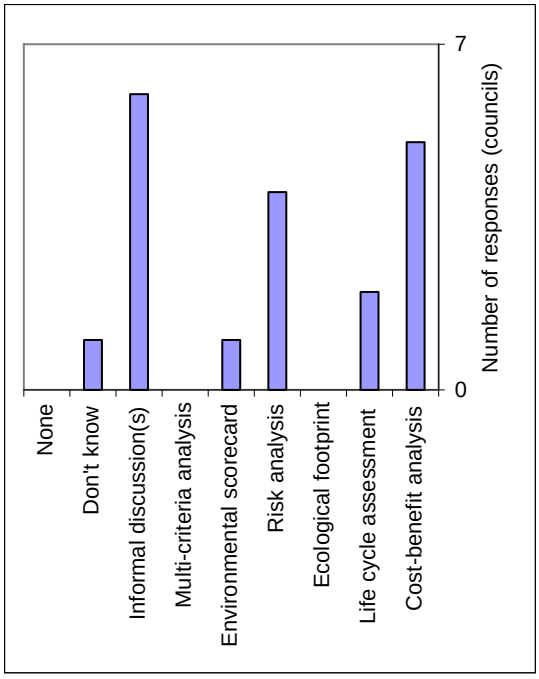

Figure 5 Decision-making tools used by local councils

The respondents were asked if there were any organisational or institutional difficulties that discouraged the adoption of sustainable water management practices such as water recycling. Eight of the eleven said there were difficulties. Financial difficulties were by far the most commonly reported; however regulatory, social and environmental difficulties were also reported.

When asked to elaborate on the difficulties reported, respondents highlighted the difference between the cost of producing recycled water (compared with potable water) and the customer preparedness to pay. For example, some companies and agricultural customers did not fully appreciate the benefits of reuse and as

a result, were unwilling to pay for recycled water. Other issues included the lack of recycling guidelines, the lack of regulatory support, negative industry and community perception, and the lack of financial support from higher levels of government. Only one reported a technical difficulty due to high salinity of local wastewater.

Respondents were asked to suggest actions that would make recycling water a more attractive option. Some of the suggestions were the direct inverse of some of the difficulties stated above, but there were also some unique ideas. Respondents suggested that there should be:

- More incentives and opportunities for industry to participate in water recycling schemes. E.g. two suggested that subsidies should be extended to projects that benefit private industry.
- More realistic pricing structures on current potable water supplies and wider recognition of the environmental consequences of not recycling. (One respondent reasoned that local governments, like businesses, make decisions primarily on financial criteria.)
- More grants and capital assistance committed by government for community based recycling schemes (to overcome difference in cost to recycle and likely selling price).
- Provision of recycling guidelines.
- Education of potential users concerning the benefits of recycling.
- Public education informing that there are insufficient raw water supplies for growing populations. One suggested the need to overcome community perception against potable reuse.

Two of the respondents volunteered their views on what they thought was the only viable option for water recycling in their council. Interestingly, one said it was non-potable reuse; the other said it was indirect potable reuse by discharging recycled effluent into a water supply dam for further treatment and distribution.

3.5 Stakeholder involvement

Almost all the councils surveyed said that they had consulted other government stakeholders during the planning phase of the water recycling schemes. Nine councils rated the involvement of the Environment Protection Agency as considerable. While most had some contact with the Department of Local Government & Planning (DLGP), only four councils had involved that department to any significant degree.

Six councils said that non-government stakeholders were involved. The non-government stakeholders with whom councils had the most involvement were the individual end users of commercial/industrial schemes, such as small businesses, farmers and consumer groups. Only two reported that they attempted quite a high level of involvement by residents, community and environmental groups. In both these cases, it was suggested that the involvement of a wider group of stakeholders brought difficulties, such as the inability to obtain sufficient support for the outcomes of consultation. In three cases, there were some low levels of involvement with consumer and indigenous groups during planning.

Many councils relied on surveys, newsletters, pamphlets and/or media releases (5 of 11), public hearings/submissions (4 of 11) and directly consulting with the end user groups. The main aims of involving the non-government stakeholders were reported as: encouraging acceptance and take-up of the projects, to find out people's perceptions and opinion, and to gauge their preparedness to pay. One council, however, wanted to develop a greater awareness and understanding of stakeholders' needs to improve their service delivery.

Of those who carried it out, most (4 of 6) said that non-government stakeholder consultation had been very successful. Two of these said it was because the end users (farmers & industries) wanted the recycled water they would provide. Two out of six, however, said that stakeholder involvement was only moderately successful (one of these reported

that people were not sufficiently interested enough to contribute to the process). One reported that though the consultation was 'very successful' the outcome was undermined by an anti-recycling media campaign and the project(s) were not progressed.

The main difficulties in government stakeholder involvement tended to be 'red tape' of other government agencies (being slow to give approval and requiring too much information). As for non-government stakeholders, the main difficulties were the time and resources taken to conduct public consultation – which in some cases resulted in the inability to obtain sufficient popular support for the outcomes of consultation. There was the feeling that potable reuse is both necessary and inevitable in Australia (and currently that happens as unplanned reuse anyway). The need to educate the public about the benefits of potable uses of recycled water was identified by survey respondents, but with the recognition that this may take a long time.

Councils reported interest in greywater recycling because of pressure from ratepayers to save water. However, there were comments that the benefits of such practices are not available in Queensland because greywater (and blackwater) recycling is illegal in sewered urban areas[8].

3.6 Professional background of decision-makers

The respondents mainly held managerial level positions in their organisations, but several were professional officers. Most were located in the technical, engineering, construction or public works areas of councils. Around half of these respondents were situated in separate business units of the council, which were responsible for water and sewerage services.

Four respondents had worked in the same organisation for more than 10 years. The remaining seven worked in their respective organisations for between one and six years. Almost all, however, were career local government employees who had worked in local government for a total of 20 or more years (8 of 11). Only two had worked for long periods (i.e. more than five years) in state government organisations. Three had worked in the private sector for long periods prior to joining local government.

The professional background of the respondents was almost entirely 'civil engineering' (9 of 11) (the others were chemical or environmental engineers) and only one had a business qualification. Most of the respondents were between 35 and 64 years of age, with 70% above 45 years; and all were male.

4 Research Limitations

The purpose of the pilot survey was to paint broad-brush strokes outlining planning processes for the relatively few councils in the jurisdiction of interest. The survey sample is thus relatively small, and statistical significance testing is not possible. Therefore, only broad findings have been achievable. The findings are also dependent on the responses of the target respondents – whether the questions were understood, the accuracy and detail of statements given, and the amount of time they allocated to complete the survey.

Therefore, the insights obtained into the management and planning processes of each council provides sufficient scope only for making preliminary conclusions. Many of the conclusions made, however, have been supported through document reviews and in-depth interviews of others who participated in water recycling planning processes in both Queensland and New South Wales. The latter was undertaken as part of our broader research project. Thus the following discussion can reliably give a broad overview of the way local government organisations are managing the current challenges of sustainable water

[8] Section 824(5) of the (Queensland) Water Act 2000 requires that all human and liquid waste from fixtures or appliances on a person's premises in a sewered area be discharged to the sewerage service provider's infrastructure. However, the Queensland Water Recycling Strategy signals state government plans to review the status of greywater recycling in sewered areas in the future (QWRS 2001, p.8).

management – an area where little information is currently available.

5 Analysis of Water Recycling Planning Processes: Trends and General Patterns

A relatively high participation rate in the survey (particularly given the short time frame allowed) and the content of the responses indicated that local councils have significant interest and willingness to explore sustainable water management issues. The survey results raise several important issues and trends in relation to the organisational context of sustainable water management. These interrelated issues can be summarised as:

- Problem location in the organisation (technical knowledge and expertise)
- Structuring of the problem (selection of options, criteria, solutions)
- Participation of external groups in planning (values and involvement).

These organisational factors, which are drawn from Brown *et al.* (2000) influence the achievement of policy objectives in local government such as sustainable water management through water recycling.

5.1 Problem location in the organisation (technical knowledge and expertise)

As evidenced from the survey results and checks of council organisation structures, councils are highly functionally separated, with water supply and wastewater tasks handled mainly by engineering, works or technical departments. In this context, there are currently many efforts to explore new methods of water management with the aim of achieving greater sustainability.

A general trend is that council engineers, who engage a few council colleagues and external consultants in planning their projects, are driving innovation in sustainable water management. Interaction in local government in relation to water recycling mainly occurs up and down the line of hierarchy in engineering departments. On the other hand, limited inter-departmental interaction is occurring across departments, but mainly among the larger councils who may have more resources and staff, and consequently, in-house expertise. The main in-house support is coming from the financial and planning sections of council (mainly for costing advice and water demand predictions respectively).

The engineering sections of councils, where the problem was mainly located, collectively felt the need to engage outside consultants to assist at critical stages in the planning process. Consultants were employed for both technical input and to conduct community consultation in relation to specific water recycling initiatives. These activities were managed and coordinated by the council engineer. Adequate in–house expertise for achieving sustainable water uses thus seems to be a critical factor in the development of the current water recycling strategies.

5.2 Structuring of the problem (selection of options, criteria, solutions)

Related to the important role of engineers in developing solutions to sustainable water management problems, were the kind of options, criteria and solutions that were generated in planning processes. Due to the reliance on technical expertise (both private and government), technical solutions to wastewater problems tended to be the most prevalent management responses, and alternatives such as organisational or institutional innovations were less commonly mentioned (as in Brown *et al.* 2000). The standard options generated for addressing water sustainability issues involved either conventional sewage management or modifying technical practice, such as upgrading sewage treatment plants or recycling sewage effluent for agriculture or industrial purposes. This represents strong innovations in technical practice, but shows limitations in considering the broader policy implications of sustainable water use.

The focus on centralised water recycling outcomes in the traditional areas of industrial and agricultural use indicates less emphasis on alternative potentially beneficial water management options, such as source separation, on-site blackwater and greywater management and other decentralised

approaches that may depend on modified institutional arrangements. To some extent, however, this narrowing of management responses has been shaped by state government directives in Queensland, such as the prohibition on greywater recycling in sewered urban areas, effectively preventing the development of decentralised management innovations.

5.3 Participation of external groups in planning (values and involvement)

The most common mechanisms for evaluating management responses were through 'experience', 'brainstorming' and 'internal discussions' and these occurred within the engineering sections. This indicates that the criteria used for evaluation were linked to the values among staff. While there are indications that strong environmental values played a role, in almost all cases cost-benefit criteria were the predominant criteria used. Thus it is not possible to say that the 'triple bottom line' is being widely formally employed to assess sustainable water management strategies such as water recycling.

While much of the decision-making went on among engineering professionals in council, some interaction was apparent with State government departments (e.g. EPA and DLGP). Interaction with potential water users depended on the nature of the project. For agricultural or industrial projects, where few or only one 'user' was present, significant direct interaction occurred with council (engineering) staff. For domestic or open space[9] urban recycling applications which tended to involve multiple users, there are indications of moderate to high interaction between council staff and diverse non-government stakeholders – i.e. residents, businesses, environmental groups, community groups etc. However, the degree and intensity of influence of non-government groups on sustainable water use planning and outcomes is less clear. On the whole, the influence of non-government stakeholders was not elaborated in the responses or simply marked 'not applicable', which suggests that more research is needed to establish this. The high degree of influence of technical staff in developing initial project options and criteria, however, is likely to have contributed to the way the perceived problems, the desired end-state, the objectives and the means to achieve them were defined (e.g. whether to concentrate on technical issues or lifestyle changes) (Brown *et al.* 2000).

6 Factors Influencing Sustainable Water Management

The organisational context of water management is a highly significant area for examination because of its impact on sustainability outcomes. However, there are few studies examining the way water authorities respond to the challenges posed by sustainability. This pilot survey of southeast Queensland councils provides insight into the ways in which local councils approach water use problems. The discussion suggests important factors that are likely to influence the pursuit of sustainable water management.

The dominance of local councils in urban water management activity in Queensland contrasts with the other states, where urban water management is shared among local governments and large statutory authorities (Johnson and Rix 1993). This means that some findings are more applicable to Queensland than other states. However, in general, the research suggests that the main factors influencing the initiation and progression of sustainable water management practices such as water recycling can be divided into the following inter-related categories adapted from those identified by Brown (2003).

6.1 Professional expertise

- There can be a tendency for drawing on narrow knowledge bases (e.g. engineering, economic) in problem framing, and the development of options and criteria for evaluating sustainable water use strategies.

[9] e.g. golf course or playing field irrigation with recycled water

6.2 *Intra-organisational*

- Locating the problem of sustainable water use among engineering sections, while enabling innovation, results in emphasis on technological outcomes and objectives rather than alternatives (e.g. organisational change).
- A moderate amount of inter-linking between local government departments is evident but there is little evidence of a 'whole of organisation' approach to sustainable water management.

6.3 *Inter-organisational*

- Evidence of formal links with other relevant players in planning sustainable water use (e.g. other government/non-government groups) is weak. Such a lack of linkages is likely to contribute to the technical framing of problems.
- There is evidence that harnessing public values and support for domestic water recycling projects has been challenging.

6.4 *Regulatory/directive*

- Functional separation of departments (environment vs water) and budgets (water supply vs sewerage) in many water authorities are likely to make recycling projects difficult to organise and finance.
- Pricing structures may restrict innovative alternatives. Centralised, 'once-through' approaches to water management are often heavily subsidised, and thereby discourage water recycling.
- Formal guidance on practice is lacking; guidelines for urban water recycling are unavailable at present (but are the focus of policy discussions).
- In some instances, current legislation is discouraging the development of potentially beneficial practices (e.g. domestic greywater recycling in sewered urban areas of Queensland)

It is the view of the authors that these regulatory, organisational and cultural factors need to be more adequately addressed by policy-makers if sustainable water management is to be enabled at the local government level.

7 Concluding Comments

This survey represents preliminary research and therefore concluding comments are broad and general. Further work is planned through interviews and case studies, including additional focus on decentralised approaches to water planning and management.

In summary, the traditional primacy of engineers in water planning and management is evident in the councils under investigation. The following comments are the based on the opinion of the authors, but draw on existing research by Brown (Brown 2003) and the authors. While the profession as a whole is moving forward in embracing environmental and sustainability values and principles, the framework of management is based on supply and disposal objectives and infrastructure-intensive means. These values are reinforced through the functionally separated organisational administration of water in councils. Perhaps because of this, environmental sustainability values in the context of local government - and also at the national and international levels (see Haas 1992) - have mainly been expressed through the development of innovative technical practices as solutions to water sustainability issues. The emphasis in Queensland has mainly been on centralised forms of water recycling, but there is significant interest in developing decentralised approaches (e.g. rainwater tanks, greywater recycling). However, this is not yet widely supported by integrated approaches to problem-solving that not only take into account multiple criteria and objectives, but that are subject to multiple framing by other relevant players in the planning process (Fischer 1999; Jelsma 2001).

There have been tentative efforts to embrace formal and informal consultative mechanisms involving affected or concerned external groups (e.g. public, potential users etc). However, wider public participation has largely taken place through one-off consultative exercises

(Reddel 2002) and some interaction with potential private water users. There are indications that public involvement is broadly regarded as a key part of progressing sustainable urban water management strategies (QWRS 2001). However, in the current management framework, non-government stakeholders seem to have little involvement in shaping initial sustainable water management plans but considerable veto power over them (Uhlmann and Luxford 1999; Stenekes *et al.* 2003). This suggests that the kind of institutional transformation needed to facilitate the shift away from supply and disposal planning to integrated water cycle management has not yet taken place.

Acknowledgements

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Appendix C – Example Coded Interview Transcript Excerpt

The following lines of interview transcript were excerpted from a much larger interview transcript for the Bundeena Maianbar case study. Thematic code words are in capitals. They act as tags and identifiers for sorting, manipulating and searching the database of transcripts for common themes. Tags were assigned to line number(s), and were able to overlap. So, in this example, lines 38 through 41 are tagged using both the $ and the # signs, which represent different thematic code words. Two thematic code words are mapped for each of the different signs. Further, those represented by the # sign extend through to line 48. The two thematic code words represented by the $ sign are ‘LOCAL_ORG’ and ‘ABILITY’. Those represented by the # sign are ‘CENTRALISD’ and ‘WCYCLE_SEP’. Thus, all four code words are tagged to the lines 38 through 41, and the latter two code words also tag the subsequent lines through to line 48.

```
#-PSPDRIVERS
MV: Something needed to be done in         29 -#
  Bundeena. That was quite clear.          30  |
  There's been a history for as long as    31  |
  whenever – from when this town started   32  |
  – that it needed to look after its       33  |
  sewage a lot better than it has been.    34 -#
#-CENTRALISD #-SILOEFFECT
  Really the only people in the Sydney     35 -#
  area are, increasingly, who could do     36  |
  that was Sydney Water. You see, in       37 -#
#-CENTRALISD #-WCYCLE_SEP $-LOCAL_ORG $-ABILITY
  smaller country towns, they have units   38 -#-$
  of people in council who know about      39  | |
  how to maintain septic systems and       40  | |
  on-site smaller systems. But when you    41  |-$
  get into a town the size of Sydney,      42  |
  things become more and more              43  |
  centralised in their management. And     44  |
```

```
  so increasingly it was Sydney Water,     45  |
  who had the management of that. And      46  |
  the skill to do that was lost in         47  |
  council.                                 48 -#

DL: Were council supposed to be            50
  responsible for -?                       51

#-CNCLNOINSP
MV: Yes, quite clearly. It's in the        53 -#
  legislation. They are still the people   54  |
  who must give the license if somebody    55  |
  wants to have an on-site system.         56 -#

DL: Does that imply that they have the     58
  responsibility to send somebody to       59
  inspect on a regular basis?              60

MV: Absolutely. They are responsible for   62
  ensuring that there is no sewerage.      63
  That was reinforced again two or three   64
  years ago with new legislation from      65
  State Government. If you just give       66
  someone at council call. [Name removed]  67
  is someone at council who has to give    68
  out the license is so he will know. So   69
#-PSPDRIVERS
  Sydney Water were basically told by      70 -#
  the State Government to do something     71  |
  about the situation in Bundeena          72  |
  because it came under the backlog        73  |
  sewerage program. At that time, there    74 -#
#-ENV_PRTCTN $-OPTIONS
  was a wave of “Sydney Water, let's do    75 -#-$
  something different.” They were going    76  | |
  to try to get environmental. Which is    77 -# |
  why a number of options did come up.     78 -$
  That was also when we asked the          79
  Federal government to give us $50,000    80
```

to produce that report, because we 81
said the EIS, to date, had not 82
produced viable alternatives and we 83
believed there were real alternatives 84
#-IMPOSED
that could be put in. But the EIS 85 -#
process did it like a juggernaut. Once 86 |
it goes in that is what is going to 87 |
happen, even though you might disprove 88 |
whatever you like, unless you get the 89 |
whole lot overturned its very unlikely 90 |
that you are going to shift their 91 |
position. And that's what occurred 92 -#