URBAN WASTEWATER REUSE FOR AGRICULTURE: GOVERNANCE PARADIGMS AND INSTITUTIONAL ARRANGEMENTS IN AUSTRALIA AND INDIA

By

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Thesis submitted for the degree of

Doctor of Philosophy

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August 2007

DECLARATION

I declare that this thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar titles and that to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text.

All the publications resulting from this Ph.D. research study including those under review have been the sole construction of the authors.

GANESH B. KEREMANE
August 2007

Acknowledgements

ACKNOWLEDGEMENTS

Firstly, I offer my deeply felt thanks to God, for giving me the patience and strength to accomplish this research, and to my parents for their constant support over the period of my study.

I am greatly indebted to the University of South Australia for awarding me the President's Scholarship to pursue my PhD, and to the School of Commerce for providing me with living allowances, so making my stay in Australia possible and comfortable. Special thanks also to the Cooperative Research Centre for Irrigation Futures (CRC IF) for providing me with financial assistance to conduct the field work at both of the study sites in South Australia, and my sincere gratitude to the Australian Centre for International Agricultural Research (ACIAR) for funding my research in India.

My heartfelt gratitude to Professor Jennifer McKay, who as well as being my Principal Supervisor, was also my local guardian. Her encouraging support, valuable suggestions, and the freedom she gave me to develop my own ideas, are all deeply appreciated. Her dedicated attention to my manuscripts gave me the strongest stimulus to carry this work through. I am especially indebted to Professor Mervyn Lewis, Associate Supervisor, for his advice and suggestions that were valuable in improving my research work; also to Professor David Round for his encouragement and advice during the early stages of my research.

I have dedicated this work to my sister, Ashwini, who is not with us today to share the joy of my achievement; my special thanks to her for all her support and encouragement. I thank my grandmother who has always been my moral support throughout my study period, and I am grateful to my parents, brother, sister, and brother-in-law, for their continuous encouragement and support. I thank my wife, for being so considerate and sympathetic during the course of my study, especially during the final stages of my work.

Special thanks to Christopher Marles, Matthew Baines and Lester Sickerdick of SA Water Corporation for their time and cooperation. The information they provided on the reuse schemes in Australia has benefited my study to a great extent.

I thank the following people who have helped me carry out the Virginia pipeline case study:

- Vicki Vogit, Interpreting and Translating Centre, Adelaide, for translating the survey questionnaires from English into Vietnamese and Khmer.
- Tra, Tuong, Van, Nguyen, and Ty Chi for their time and help with conducting interviews with the market gardeners at Virginia.
- John Collins, Operations Supervisor with the Water Reticulation Services Virginia (WRSV) for his help and support during the field survey in Virginia. Gavin Limbert and Kylie Robinson of the Virginia Horticulture Centre for their guidance during the preliminary survey of the study area.
- Steven Smith of Onkaparinga Catchment and Water Management Board for his initial briefing about the Willunga Basin pipeline scheme, which motivated me to select that scheme for the study.
- John Gransbury, Hydroplan Irrigation and Water Resource Consultants, for providing me with first-hand information about the scheme.

I thank the following people for helping me carry out the Willunga pipeline case study:

- The management of the Willunga Basin Water Company (WBWC), particularly Norm Doole, Kym Davey, and Glen Templeman, for showing interest in my study and helping me to mail out the letter of invitation.
- Lucy Hyde, Viticulture Officer at the McLaren Vale Information Centre and Peter Hackworth of Phylloxera Board for their help in generating a list of the irrigators using reclaimed water from the Willunga scheme.
- Kirsty Willis and her staff at the Marketing Science Centre, University of South Australia, for conducting the telephone interviews with the irrigators at Willunga basin.

I thank the following people who helped me carry out the Indian part of the study:

- Sanjay Gupta and S. P. Tucker, Irrigation and Command Area Development, Government of Andhra Pradesh.
- Madar Samad, International Water Management Institute, Hyderabad, and Doraiswamy, Jalaspandana.

- Sithapathi Rao and his team at the Institute of Resource Development and Social Management (IRDAS), Hyderabad for helping me conduct the survey at the study sites in Hyderabad.
- Sreenath, from the Hyderabad Translation Bureau, for translating the questionnaires from English to Telgu.

My special thanks to June Marks, Flinders University, Adelaide; Gerrit Schrale, SARDI; and Anne-Maree Boland, DPI, Victoria, for their valuable suggestions and guidance at different stages in my research. I am deeply indebted to Satyanarayan G Naik for his time and cooperation and for creating the brilliant schematic designs of the research sites.

I thank my friends and fellow PhD students: Diwakara Halanaik, Anna Hurlimann, Wu Zifang, Sang Hoon and Nurul, for their continuous support during the course of my study.

Likewise, I also thank my friends at home: Satheesh, Srinivas, Vijay, Dharmesh, Pramod, Suresh, Arunkumar, Basavaraj, Yuvaraj and Mahantesh, who have supported me throughout the study period.

I would like to thank the Head of the School and the School of Commerce staff for their encouragement and support during my PhD study at the University of South Australia.

I would like to thank Geoffrey Foster for his meticulous editing, which has definitely enriched my work.

Finally, I wish to express my gratitude to all those others who provided assistance during my time at the University of South Australia.

Dedication

DEDICATION

Affectionately dedicated to,

Ashwini and my family

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Abbreviations

ABBREVIATIONS

AUD	Australian Dollar
ABS	Australian Bureau of Statistics
ACIAR	Australian Centre for International Agricultural Research
ACP	Agricultural Conservation Programme
ADB	Asian Development Bank
APFMIS	Andhra Pradesh Farmers Management of Irrigation System Act
ASR	Aquifer Storage and Recovery
BOOT	Build Own Operate Transfer
CAD	Command Area Development
CBO	Community Based Organization
COAG	Council of Australian Governments
CPI	Corruption Perception Index
CPR	Common Pool Resource
CRP	Conservation Reserve Programme
CSF	Critical Success Factor
CSR	Corporate Social Responsibility
DAFF	Dissolved Air Flotation Filtration
EIP	Environment Improvement Program
EPA	Environment Protection Authorities
ESA	Endangered Species Act
ESD	Ecologically Sustainable Development
EU	European Union
FAO	Food and Agriculture Organisation
GOI	Government of India
GWP	Global Water Partnership
ICAD	Irrigation and Command Area Department
ID	Irrigation Department
IDS	Institute of Development Studies
IMP	Irrigation Management Plan
IMT	Irrigation Management Transfer
IRDAS	Institute of Resource Development and Social Management
IWMI	International Water Management Institute

IWRM	Integrated Water Resource Management
JFM	Joint Forest Management
MoEF	Ministry of Environment and Forests
MoRD	Ministry of Rural Development
MoWR	Ministry of Water Resources
NCP	National Competition Policy
NEPC	National Environment Protection Council
NGO	Non-Governmental Organization
NHT	Natural Heritage Trust
NLWRA	National Land and Water Resources Audit
NRM	Natural Resources Management
NWI	National Water Initiative
NWP	National Water Policy
NWQMS	National Water Quality Management Strategy
NWRC	National Water Resources Council
OECD	Organisation for Economic Co-operation and Development
OGWRP	Old Goreangab Water Reclamation Plant
PIM	Participatory Irrigation management
PPP	Public-Private-Partnership
PWD	Public Works Department
STP	Sewage Treatment Plant
TC	Territorial Constituency
TI	Transparency International
UN ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNDP	United Nations Development Programme
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
UWWTD	Urban Wastewater Treatment Directive
WFD	Water Framework Directive
WUA	Water Users' Association
WWTP	Waste Water Treatment Plant

Glossary

GLOSSARY

KL	Kilo Litre (1 Kilo Litre = 1000 litres)
ML	Mega Litre (1 Mega Litre =1000 Kilo litres/1 million litres)
GL	Giga Litre (1 Giga Litre = 1000 Mega litres)
Urban wastewater	A combination of domestic effluent, water from commercial establishment and institutions, industrial effluent and Stormwater and other urban runoff.
Reclaimed water	Treated effluent suitable for an intended water reuse application and is synonymous with 'reused water'.
Recycled water	Output or product from wastewater that is usually treated to some extent, and redirected back into water use scheme. It is predominantly practiced in industry.
Effluent	Water that flows out of treatment plants.
Black water	The heavy and solid part of wastewater containing animal and food wastes and wastewater from sources like toilets.
Grey water	Wastewater from households like water from kitchen, washing clothes and bathroom.
Storm water	Rainwater collected on roofs, driveways and roads which is carried away in a system of Stormwater drains that is separate from sewers.
Water recycling	An umbrella term for the process of treating wastewater for beneficial use, storing and distributing recycled water, and the actual use of recycled water.
Direct reuse	The use of reclaimed water that has been transported from wastewater treatment plant to the point of use without intervening discharge to a natural water body, such as agricultural and landscape irrigation.
Indirect reuse	Use of reclaimed water indirectly such as taking water from a natural water body or groundwater that reclaimed water had been discharged or recharged.
Unplanned water reuse	A situation where downstream supplies are drawn from sources to which wastewater is discharged, and source water quantity and quality is not controlled by the user. This is common worldwide for wastewater reuse.
Planned water reuse	A situation where reclaimed water is used either directly or indirectly, without loosing control of quantity and quality. This includes planned direct and indirect reuse.

Potable water reuse	An augment of drinking water supplies by highly treated reclaimed water. This includes direct and indirect potable water reuse.
Direct portable reuse	Type of wastewater reuse that supplies reclaimed water directly to water supply system. This implies the pipe-to-pipe system that connects reclaimed water line directly to water treatment plants without intervening discharge to a natural water body.
Indirect potable reuse	Use reclaimed water to augment portable water supply. This includes the discharge of reclaimed water to potable water reservoir or groundwater to allow mixing with natural water.
Irrigation	Application of reclaimed water to land. This includes spray irrigation done by spraying reclaimed water from sprinklers or orifices in piping, and subsurface irrigation done by dripping reclaimed water from drippers or emitters.
Restricted irrigation	Is the irrigation of all crops except salad crops and vegetables that may be eaten raw or uncooked.
Unrestricted irrigation	Is the irrigation of all crops including salad crops and vegetables that may be eaten raw or uncooked.
Formal institutions	Rules that are readily observable through written documents or rules that are determined and executed through formal position, such as authority or ownership.
Informal institutions	Rules based on implicit understandings, being in most part socially derived and therefore not accessible through written documents or necessarily sanctioned through formal position.
Water Users Association (WUA)	Self-governed water institutions wherein the water users replace the State as the central actor in developing and managing irrigation systems
Panchayat	A basic unit of administration at the village in India. It is a local body of elected representatives. At the district level it is termed as *Zilla panchayat*.
Business model	A description of the ownership and organizational structure, and allocation of responsibilities and risks for operational management and/or infrastructure maintenance and improvement of a business.
Delegated management	Municipal government delegation of responsibility for management of aspects of its water supply utility to an external operator (which may be public or private).

Divestiture	Disposition or sale of an asset
Governance model	A description of the principles of good governance, and of the allocation of responsibilities and relationships between stakeholders for tasks and practices required for good governance
Public-Private Partnership	A government service or private business venture which is funded and operated through a partnership of government and one or more private sector companies; commonly referred to as PPP or P3

Publications

LIST OF PUBLICATIONS

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Abstract

ABSTRACT

Freshwater scarcity has engendered two immediate responses: different water allocation methods, and development and use of alternative sources of water. Water markets are seen as a means to achieve efficient allocation of the scare resources and urban wastewater reuse for non-potable applications appears as a viable option to augment traditional water supplies. This study focuses on the latter option from an institutional analysis perspective.

With the fitness-for-purpose argument surfacing on the global water governance agenda, the search for a reliable alternative source of water has triggered governmental support for the development of water reclamation and reuse laws, policies, and projects in many countries. The drivers of these are many including prevention of environmental degradation, availability of alternative users, communities willing to use the water, water conservation and economic advantages. However, the concept of (waste) water reuse has not been always well accepted by the community and the formal water supply organisations have been hesitant and involved private sector in provision of the actual services in developed countries.

This study examines different governance models for urban wastewater reuse in Australia and India. The study analyses the role of different societal sectors-public, private, and the community in provision and use of wastewater for irrigation. It encompasses three case studies representing different models of governance: (1) Virginia pipeline scheme built on the BOOT model, (2) Willunga pipeline scheme built on the divesture model, and (3) Musi irrigation scheme representing the case of unsupported community wastewater reuse.

The institutional environment for wastewater treatment and usage in Australia and India are different. The Australian reuse schemes are examples of institutional innovations and bureaucratic entrepreneurship backed up by clear quality standards, regulations, and stringent enforcement mechanisms. The results for Virginia pipeline scheme suggest that multi-sector partnerships (public, private, community) can lead to developing a successful reuse scheme. The Willunga scheme highlights the importance of community and private sector participation to tackle water scarcity challenges and provision of (waste) water services.

In India, the results for Musi irrigation scheme reveal that urban wastewater is largely used in a *de facto* illegal manner as there are no clear guidelines regarding the quality and use of wastewater for agriculture. In addition, different institutions and at different levels are involved with wastewater use. The focus of this study is the Water Users Associations (WUAs) originally formed to manage canal or river water. The study argues that since most of the wastewater reuse in India occurs on similar lines as the Musi case the WUAs appear to have an important role to play in managing wastewater use. Moreover, this will ensure participation of water users and facilitate coordination between various agencies and ministries essential for effective wastewater management. Nevertheless, uncontrolled irrigation practices using wastewater can pose serious threat to human and environmental health which requires immediate attention.

Based on the findings from the case studies in Australia and India, the study concludes with some suggestions or policy options for sustainable wastewater use in agriculture.

Chapter 1

Chapter 1: Introduction

‘You don’t miss your water until your well runs dry’

- old country proverb.

1.1 Context of the water crisis

Water is essential to the well-being of human kind, vital for economic development, and a basic requirement for the healthy functioning of all the world’s ecosystems. Even though there are sufficient freshwater resources to meet everyone’s basic personal and domestic needs, the extent to which people have access to these resources for various uses is limited. Reasons for this include: lack of distribution networks, excessive extraction of groundwater resources, and risk from the contamination by the pollutants. Water withdrawal statistics indicate that annual global water withdrawals have increased by more than six times and the rate of increase in developing countries is 8% (Hinrichsen, Robey & Upadhyay, 1997; UNESCO, 2003). In addition, many freshwater resources have become increasingly polluted, resulting in the shrinking of freshwater availability.

While there are some signs of greater efficiency in water use, the current indications of water use and management point out that the situation on the ground is getting worse and not better. In some places groundwater levels continue to fall and the options for increasing supplies have become expensive and are often environmentally damaging (Frederick, 2001). Water conflicts are worsening around the world, rivers are drying up, and pollution is unabated. The root cause of these problems is poor water governance, which has often been neglected in the past. Furthermore, rapid urbanisation and industrialisation has resulted in the squeeze on freshwater

supplies for agricultural uses and this necessitates we look for reliable, alternative sources of supply. Consequently, the water crisis situation has engendered new directions for water governance and development and use of urban wastewater as an alternative source of supply.

1.2 New directions for water governance

Water governance is a significant aspect of international development policy making. The United Nations World Water Development Report-2 (UNESCO, 2006) recognizes that water crisis is largely a crisis of governance, and outlines many of the leading obstacles to sound and sustainable water management. There is an increasing consensus on the need to improve water governance so as to achieve the Millennium Development Goals (Institute of Development Studies, 2007). So, good governance which often receives less attention than it merits is an essential aspect of effective water resource management (Bucknall, Damania & Rao, 2006; Solanes & Jouravlev, 2006; Hoekstra, 2006; Rogers, 2002). The situation demands a change or shift in water governance – the process of managing water resources. Gleick (2000) describes this shift or change as 'the changing water paradigm', discussed later in this chapter (section 1.2.3).

1.2.1 Water governance

The concept of governance has been widely debated since the 1990s and there are various definitions of this concept and approaches to it (Stoker, 1998). Chapter Three will cover more on this topic; this section presents couple of definitions to facilitate further discussions.

Governance according to Stoker (1998, p. 17) "is ultimately concerned with creating the conditions for ordered rule and collective action". Rogers (2002, p. 1) argue that "governance means laws, regulations, and institutions for technical persons". Kooiman (2003) provides a relatively broad definition of governance. According to him, governance is,

> "the totality of interactions, in which public as well as private actors participate, aimed at solving societal problems or creating societal opportunities; attending to the institutions as contexts for these governing interactions; and establishing a normative foundation for all those activities" (Kooiman, 2003, p. 4).

Extending these views to water governance, Rogers and Hall define water governance as:

> "the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society" (Rogers and Hall, 2003, p. 16)

Further, the authors state that water governance encompasses a large spectrum of aspects related to water and according to them:

> "the notion of governance for water includes the ability to design public policies and institutional frameworks that are socially acceptable and mobilise social resources in support of them. Water policy and the process for its formulation must have sustainable development of water resources as its goal, and to make it effective the key actors must be involved in the process"(Rogers and Hall, 2003, p. 16).

Drawing from the definitions cited above, water governance can be understood as a framework of political, social, economic, and legal structures within which societies choose and accept to manage their water-related affairs. It includes governments, the market forces that help to allocate resources, and any other mechanism that regulates human interactions. In simpler terms, water governance is the ongoing process of extracting, distributing, and using water created by the actors' purposeful actions within the present institutions or the rules-in-use.

Some aspects of the theory of governance are relevant to this study like the fact that governance is concerned not only with the State but also with relationships between the State and civil society and its private actors. Rogers and Hall (2003), agree when they say "governance embraces the relationship between a society and its government" (Rogers and Hall, 2003, p. 4). The Dublin Water Principles (1992), through its participation clause, states that water development and management should be based on a participatory approach, involving users, planners, the community, and policy-makers at all levels. The same notion is stressed in the Hague Ministerial Declaration (1998), and the Bonn Ministerial Declaration (2001).

The foregoing discussions lead us to a conclusion that water governance includes different institutions and actors surrounding water use, and all these key actors need to be aligned and work together to achieve good water governance. Thus, within the water sector, today there is a common consensus among policy makers and planners that integrated water resource management, increased participation of all water users, and a larger role for the private sector are the key principles that shape water policy and the management of water resources. This clearly indicates a shift in the water governance paradigm.

1.2.2 The shift in water governance paradigm

Many countries have had profound policy changes in recent years, referred to by scholars as shifts in the policy paradigm (Menahem, 1998). In public administration, the New Public Management (Larbi, 1999) is one of the much-discussed changed paradigms. In the water sector, there has been a similar change in paradigm (Gleick, 2000).

Water comes in many forms, with economic, social, religious, cultural and environmental values attached that are often interdependent; it has to be shared between different uses and different users. So governing water wisely is vitally important for sustainable water resource development; and the focus of governance in this sector needs to be shifted from 'water resource development' to 'water resource management'.

Traditionally, water management responsibilities have been vested with State or public agencies, with the assumption that public agencies possess all the necessary resources, expertise, and authority to manage this resource. However, policy makers and water planners now recognize and agree that public management has often failed to follow the basic principles of effective governance (UNESCO, 2003). While acknowledging the failure of public agencies to manage the resources in question, it is also accepted that user groups or communities are able to manage the resource more effectively than can the public agencies. Following this, there has been a noticeable policy shift, in the form of partial or complete transfer of management responsibilities from the public agencies to user groups (Ostrom 1990; Tang, 1992; Meinzen-Dick & Sullins, 1994; Rasmussen & Meinzen-Dick 1995; Lam, 1996a; 1996b; Meinzen-Dick & Knox, 1999; Agarwal & Ostrom, 1999; Ostrom, 2000a; McCarthy, Dutilly-Diane & Drabo, 2002; Holm-Muller & Zavgorodnyaya, 2003). Consequently, water users' associations have played important roles in facilitating effective water management, and their roles generally fit into two broad categories – (a) mobilizing and organizing the community of water users, officials, and professionals in support of management initiatives, and (b) providing communication and dissemination of information and technical assistance that is beneficial for water management (Blomquist, 1994).

In addition, inefficiency, corruption and lack of funds within the public utilities for extending access to services within the water and sanitation sector, have prompted increased private sector participation in addressing these problems. Although, private sector participation was strongly promoted on the water and sanitation policy agenda during the 1990s (Budds & McGranahan, 2003), its prominence in the water sector remains limited. Private sector participation generally refers to contractual agreements between a public sector (government) and private agencies that can range from large water companies (usually multinational) to small-scale informal operators or civil societies. Likewise, the forms or models of private sector involvement vary according to the allocation of responsibilities and so experts have various opinions about water privatization. Under such circumstances the Integrated Water Resource Management (IWRM) approach is a comprehensive approach to the development and management of water.

The United Nations World Water Development Report-2 states that:

> "the conceptual development of water management has paved the way for an IWRM approach which is a comprehensive approach to the development and management of water, addressing its management both as a resource and the framework for provision of water services" (UNESCO, 2006, p. 46)

Allan (2001) discusses the paradigms that have determined the way that water resources have been perceived and managed in the twentieth century and notes that IWRM approach is the fifth paradigm that emerged in the late 1990s. He argues that IWRM requires a holistic approach and an unprecedented level of political cooperation, and consequently that the next water resource management paradigm will be that water users assimilate IWRM as a political process and not just as technical, investment, or information sharing.

According to Gleick (2000) the new paradigm for water planning places a high value on maintaining the integrity of water resources, and the flora, fauna and human societies that are built around them. He argues that “the most important single goal of this new paradigm is to re-integrate water use with maintaining ecological health and environmental well-being” (p. 131). He further indicates that in addition to increasing the water allocation efficiency development and use of non-traditional sources of supply (reclaimed or recycled water) will play an increasing role in the water management agenda.

Water markets are seen as one way to achieve efficient allocation of scarce resources, while the reuse of urban wastewater is being considered as a viable method for augmenting traditional water supplies. This study focuses on the latter option which is source substitution. Source substitution allows the higher quality water to be used for domestic supply, and provides a suitable alternative for less critical uses (Hespanhol, 1997). Accordingly, water reuse on a large scale is now an option in many areas. The fitness-for-purpose argument is now on the global agenda of water governance, and the search for reliable alternative sources of water has triggered governmental support for the development of water reclamation and reuse laws and policies, subsequently leading to practical projects in many countries. Concepts such as water reclamation, recycling and reuse are now key components of the water and wastewater management policies.

The many drivers of these concepts include the availability of alternative users and communities willing to use the water, prevention of environmental degradation, water conservation and economic advantages. However, the idea has not been always well accepted by the community and the formal water supply institutions in developed countries have been

hesitant and have involved the private sector to provide the actual services. This study focuses on the use of urban wastewater for agriculture from an institutional analysis perspective.

1.3 Urban wastewater – a reliable alternative source of water

Agriculture is the largest consumer of freshwater resources, currently accounting for about 70% water withdrawals globally and over 90% in the developing world (UNESCO, 2003). With increasing population growth, urbanisation, and rapid industrial development, the availability of freshwater is likely to be one of the major limits to economic development in the decades to come. It is expected that water now used for agriculture will be diverted to the urban and industrial sectors (Serageldin, 1995). So there is a need to find a reliable new source of supply that can augment freshwater supplies and reduce the pressure on existing resources. Use of (treated) urban wastewater for irrigation is one way of responding to this squeeze on freshwater supply, particularly in the agriculture sector. The use of wastewater also helps close the loop between water supply and wastewater disposal (Bahri, 2001; Asano, 2001; Angelakis, Bontoux & Lazarova, 2003; Abu Madi et al., 2003; Po, Juliane & Nancarrow, 2004).

Wastewater reuse can be direct or indirect. Direct reuse is the planned and deliberate use of treated wastewater for some beneficial purpose, including for drinking, while indirect reuse refers to water that is taken from a river, lake, or aquifer that has received sewage or sewage effluent. Types of wastewater usage, with country-specific examples, are discussed in Chapter Two.

Wastewater use for non-potable purposes particularly for irrigation is a centuries-old practice. But it has been little reported or documented because the norm is to treat wastewater before use (Ensink et al., 2002). It's only in the recent past that development of water reclamation and reuse projects have received much impetus due to sever water scarcity challenges. Accordingly, use of (treated) wastewater for irrigation has increased overtime and will continue to increase in future. As an example, in Israel and Palestine treated sewage effluent will become the main source of water for irrigation, supplying 1000 million m^3 (70%) out of the 1400 million m^3 that will be used for irrigation by the year 2040 (Israel Irrigation Commission, 1995, cited in Haruvy et al., 1999, p. 303). Nevertheless, in many developing countries wastewater (untreated) is a highly important productive resource, and is a substantial and sometimes even primary source of cash income for thousands of small farmers and the landless (Scott, Faruqui & Raschid, 2004; Scott, Zarazua & Levine, 2000). The reasons for this include: increasing water scarcity, lack of funds for treatment, and a clear willingness by farmers to use untreated wastewater (Ensink et al., 2002).

Among the different applications of wastewater, it is believed that agricultural irrigation is the best use of wastewater after treatment (Pescod, 1992), and the presence of crop nutrients in wastewater benefits crop production (Ensink et al., 2002). However, due to the regular concerns raised over the potential health impacts of using untreated wastewater its usage cannot be encouraged. Neither can we impose absolute restrictions considering the amount of pressure on existing freshwater supplies. So, to address these issues, wastewater guidelines constituting a common vision and direction for wastewater management need to be developed, like the Hyderabad Declaration signed by representatives of international and national institutions at a global workshop in Hyderabad, India (see Appendix 1).

Section 1.2 of the Hyderabad Declaration states that, ‘with proper management, wastewater use contributes significantly to sustaining livelihoods, food security and the quality of the environment’. ‘Proper management’ here implies cost-effective and appropriate treatments suited to the end use of wastewater, supplemented by guidelines on their application (Hyderabad Declaration – section 2.1). Equally important are – (a) farmer and consumer education on risk management strategies (e.g. appropriate choice of crops and appropriate selection and timing of irrigation techniques) and (b) improved institutional coordination (especially between urban authorities, and the agriculture, health and sanitation sectors).

Urban wastewater reuse experiments around the world have demonstrated the feasibility of water reuse on a large scale and its role in the sustainable management of the world’s water (Anderson, 2003, p. 2). For example, in Israel, due to scarce water resources and the deteriorating quality of waters, the situation demanded a national policy recommending reuse of all municipal wastewater (Brenner et al., 2000). Similarly, many countries, such as Israel, Singapore, Namibia, Mexico, Vietnam, China, Japan, Australia, the USA, and some European countries, have seen replacement of freshwater by treated wastewater as an important conservation strategy contributing to agricultural production and have successfully implemented direct and indirect water reuse projects (Ensink et al., 2002; Po, Julianne & Nancarrow, 2004). However, there is apprehension in the world community about direct potable reuse due to uncertainties about water quality and negative public perceptions.

Currently, Namibia is the only nation with an operational direct potable reuse system, which contributes 4% of the total water supply of Windhoek, the capital city (Anderson, 2003). Recently, in Singapore, reclaimed water is mixed and blended with water from the city's

reservoirs, from where it is piped to taps in offices and homes, making it one of the few cities in the world to offer reclaimed potable drinking water (U.S. Water News online, 2003). In Australia, direct use of reclaimed wastewater for potable uses without added protection is considered non-viable (NEWater, 2002).

Despite all the advantages this resource has to offer, developing a sustainable wastewater reuse scheme is an onerous task; mostly because wastewater management spans a wide range of institutions and stakeholders which requires coordination of both policies and regulation governing the resource. An effective institutional network and a favourable regulatory and policy regime for wastewater management are essential to improve the acceptability of the scheme and delivering high value to the community and the environment. All these points highlight the importance of effective water governance and the institutional framework. These issues will be discussed in subsequent chapters and the next section aims to set the scene for these discussions.

1.4 Setting the scene

This section presents a brief note on the water governance regimes and wastewater reuse in Australia and India which are the study regions. Both countries have different water governance systems and institutional environments for water management. Needless to say the situation with wastewater management is also different in both countries.

1.4.1 Water governance in Australia and India

Water management in Australia is a complex process that falls within the power of the States, and hence there are many laws. Australia has a variety of institutional arrangements, framed under State laws for the provision of water services, and these are the product of a combination of historical, technical, geographical, demographic, and political factors (Powell, 1999; Srivastava, 2004). As pointed out by McKay (2007b, p. 151), "governance arrangements for water in Australia are complex with over 14 different types of legal forms of water supply businesses". Further, water governance structures have undergone notable transformation since the 1994 COAG reforms. There has been restructuring and institutional role separation within the public sector departments. The public sector departments have been transformed into corporations, with clear commercial objectives, that are subject to the same laws that govern the private sector (Srivastava, 2004). These reforms have moved the government, once the foremost organization, into a regulatory role on price and environmental impacts and have increased the role of the private sector in all aspects of water management (McKay, 2007b). As a result, a number of water utilities have contracted out their design, construction, and certain operational roles to the private sector, through service or management contracts. The process is usually termed corporatisation, in which the government owns the assets but contracts out the management (McKay & Halanaik, 2003). This was achieved through various models of private sector participation, one mode of governance (Kooiman, 2003).

In India, the constitutional provisions for allocating responsibilities between the State and the Centre fall into three categories, the Union List, the State List, and the Concurrent List. As most of the rivers in the country are inter-State, the regulation and development of the waters

of these rivers is a source of inter-State differences and disputes. Because of this, in the Constitution, water is a matter included in Entry 17 of the State List. This entry is subject to the provision of Entry 56 of the Union List that confers powers on the Central Government to regulate and develop inter-State rivers and river valleys to an extent declared expedient by the parliament to be in the public interest.

1.4.2 Wastewater reuse in Australia and India

The search for a reliable alternative source of water has triggered the development of water reclamation and reuse projects around the world. In developed countries like Australia wastewater use is more controlled and planned whereas in the developing world it is uncontrolled and still done in the *de facto* illegal manner.

In Australia, water is a valuable resource in short supply; according to the National Land and Water Resources Audit Report (Australian Water Audit, 2002) it is estimated that water resources from 26% of Australia's surface management areas and from 31% of its groundwater management units were fully or over-allocated. Adding to the problem of depleting resources, there is growing concern about the effects of large sewage discharges on the marine ecosystem. Reducing the discharge to the environment by re-use of treated wastewater would be a viable approach (Smith, 1998).

Water recycling is not a new concept in Australia. The practice of disposing municipal effluent to land at Melbourne's Western Treatment Plant, Werribee, has a history of more than 100 years (Dillon, 2000). The other early experience was in the City of Wagga-Wagga, where reclaimed water was being used in 1969, for landscape irrigation of sporting fields, lawns, and

cemeteries (Asano, 2001). Water recycling received a greater push when the issues of environmental health, sustainability, water availability and water quality for consumptive uses emerged as significant political issues during the 1980s (Taylor & Dalton, 2003). The Council of Australian Governments (COAG) reforms adopted in 1994 have further accentuated the importance of water reuse, and have also resulted in attracting private sector investment in water infrastructure (Dillon, 2000; McKay & Halanaik, 2003). As a result, by 2001-02, more than 500 wastewater treatment plants were recycling some or all of their treated wastewater (Radcliffe, 2004). Sustainable practice in water management is being institutionalised within corporations, and with government intervention (Marks, 2003). This is true with wastewater management as well and Adelaide, in South Australia, which is the study site in Australia, has two reuse schemes developed with public-private-community participation that have been operating successfully since their inception.

In India, there is a long history of wastewater use (untreated or partially treated). For ages, the marginalised communities in India have relied on the indirect use of wastewater to grow vegetables, fruits, cereals, flowers and fodder (van der Hoek et al., 2002). In recent years, as a result of rapid population growth, massive industrialization, and the growing number of cities that dispose of large amounts of sewage into bodies of water, the indirect use of wastewater has increased even further. Most wastewater irrigation, in the peri-urban and rural areas of India, occurs along the rivers that flow through such rapidly growing cities. The Musi River in Hyderabad is one such river, where around 250 households within the city use wastewater directly from the drains or from the river to irrigate their lands (Buechler, Devi & Raschid, 2002).

1.5 Statement of the problem

One of the latest crises of modernity is water scarcity. It has been established that this crisis is not a true water scarcity problem but a crisis of governance (Rogers & Hall, 2003; Colebatch, 2006; McKay, 2007b). And more recently, wastewater management and use is considered seriously as an integral part of water management policy in many water-scarce countries. Wastewater from point sources, such as sewage treatment plants and industries, provides an excellent source of reusable water and is usually available on a reliable basis, has a known quality, and can be accessed at a single point (Davis & Hirji, 2003). Urban wastewater use reduces the amount of waste discharged into watercourses and hence improves the environment. It also conserves water resources by lowering the demand for freshwater withdrawal (Khouri, Kalbermatten & Bartone, 1994).

Though it is believed that wastewater reuse can augment freshwater supplies, and help communities accrue substantial benefits, institutions and individuals leading the way in wastewater treatment and sanitation have often ignored the practice of wastewater reuse and its implications. In addition, the development of sustainable water reuse schemes often encounter technical, financial, commercial, regulatory, policy, social and institutional impediments (Davis & Hirji, 2003; Thiyagarajah, 2005; Dimitriadis, 2005). Many reuse schemes have stalled owing to these impediments (Hurlimann & McKay, 2006). Therefore, it should be realized that the potential benefits of water recycling and water conservation have been identified as two of the greatest challenges of our time (Dimitriadis, 2005).

Furthermore, it is needles to say that the water economy of any country is a complex system. The largest element in this complex system is the water supply industry consisting of publicly and privately owned systems of varying organizational forms and sizes (Blomquist, 1994). The situation is similar with wastewater, since wastewater management and use crosses into different sectors and involves inter-organizational relationships. So, understanding the actual operation of this complex system is important. In addition, Colebatch (2006) while examining the context of recycling as an institutional challenge raises a series of questions that clearly indicate that there is a need to direct our thinking towards the institutional dimension of water reuse/recycling which is less evident in the literature. The questions raised by the author are:

> "…how recycling can find a place in an organizational world built around an industrial paradigm of supply and disposal. Is the existing organisation to change its character, or is recycling to be added on? Is recycling to be accomplished centrally or does it need to be done at household or neighbourhood level, in which case, what organisational base is needed? What place would other stakeholders, such as health authorities or local government, have in these arrangements? How would the users be integrated into the structure?" (Colebatch, 2006, p. 24-25)

1.6 Research question and objectives

The research questions of this study are:

- ***What are the governance models that aid in implementing a sustainable water reuse in formal and informal water economies?***
- ***Does community social capital contribute to implement a sustainable water reuse project, and in what ways?***

The study aims to answer these questions by setting the following research objectives:

- Examine the institutional arrangements governing wastewater reuse for agriculture
- Identify the factors influencing private sector involvement in wastewater management
- Understand public perceptions and acceptance of water reuse for irrigation

- Understand the role of social capital in implementing a successful wastewater reuse scheme
- Understand the linkage between wastewater use and livelihood options prevailing in informal water economy

1.7 Need for the study

The notion of governance (as in effective water governance) is receiving increasing attention in public administration and policy science; "Governance in any society at any point is the sum of formal and informal organizations" (McKay, 2007b, p. 151). In these terms, there is very little of the literature in the areas of wastewater use and management that focuses on those issues, such as social interactions and community involvement that are important for projects into sustainable water reuse.

Since wastewater collection, treatment and effluent use span a wide range of interests at different levels of administration, the scope and success of any reuse scheme will depend largely on matters of institutional organization (Pescod, 1992). So the implementation of wastewater reuse schemes needs effective institutional arrangements, as well as community participation. An appropriate institutional structure provided with adequate resources is required for the development of this valuable resource. Moreover, we find that the hydrological dimension of water recycling is prominent in most of the existing literature while the institutional dimension is less evident (Colebatch, 2006). Further, drawing from experiences in water reuse around the world, institutional challenges to the successful development of this dependable resource include – conflicting agendas among water agencies, water rights issues, opposition to recycling or reuse, existing regulations that need modifying,

and the need for funding (Po, Julianne & Nancarrow, 2004; Po, et al., 2005; Mills, 2000, Kasower, 1998, Ritchie et al., 1998, all cited in Haddad, 2002).

In addition, as in the complex water economy, the largest element is the supply industry, which consists of publicly and privately owned systems, with varying organizational forms and sizes. This implies that the complex system may involve several organizations and relationships – some organizations are providers of water, others are producers of water, others may be both, and there are many provider-producer relationships. This demands that we understand the patterns of organizational development and of inter-organizational relationships (Blomquist, 1994) and that the social, institutional, and organizational aspects of effluent use must receive whatever attention is required to ensure long-term sustainability of the reuse schemes (Pescod, 1992; Asano, 2001; Po, Julianne & Nancarrow, 2004; Ensink et al., 2002; Rose, 1999). Further, the market for this valuable resource can be hard to balance, because of the complex institutional hurdles arising from the varying roles and responsibilities and overlapping concerns of the public agencies managing the resources (MacDonald & Dyack, 2004). As explained by Abu Madi et al., (2003, p. 115):

> "a growth on the supply side of the market, revealed by increasing number of wastewater treatment plants and stagnancy on the demand side revealed by the substantial proportions of the resource being discharged without proper utilization".

Moreover, in case of Australia, the Federal Government (in particular) is insisting that the States focus on capacity building in the Natural Resources Management domain, particularly with water, in order to achieve efficient and more productive water use.

Above all, most wastewater reuse studies in the past have adopted a scientific and biophysical approach (Buechler, 2004) and the dearth of institutional studies using a combination of social, quantitative and qualitative methodologies impedes the formulation of recommendations that could enhance the benefits and ease the concerns of all groups involved with wastewater reuse. In addition, these studies can be carried out at different levels – Macro, Meso and Micro levels. The meso-level includes the wastewater delivery or supply system, which is the largest element of the complex system, and the unit of analysis at the micro-level includes the beneficiaries/households and those local institutions that shape the wastewater use.

In consequence of these arguments, this research examines two innovative water reuse projects operating in South Australia, and one irrigation scheme in India. The study adopts an institutional approach and focuses at both the meso and micro-levels of analysis. The schemes selected for the study have varying governance or organizational structures and are examples of wastewater reuse that rely on cohesive local networks, and involvement of all three societal sectors - public, private, and community.

1.8 Research Contribution

The study endeavours to make some theoretical, analytical and methodological contributions; it will contribute to the field of New Institutional Economics (NIE), specifically to the existing theories of governance, partnerships, institutional change and collective action in relation to the water and wastewater management sector.

In the present scenario of increased demand for water, improvement in water use efficiency and effective management of the resource is drawing a great deal of attention. Along with this, water recycling is playing, and will continue to play, a greater role in the overall water supply in days to come. In this context, this study can provide policy makers with appropriate design principles to design institutions for the effective and efficient management of waste water resources. The policy contributions of this study will help develop strategies for institutional reforms within the water sector, particularly with respect to wastewater management. In addition, the outcomes from this comparative study could be used to draw lessons for both of these countries, which to a large extent have similar legal rules in relation to water.

While reclaimed wastewater has been proven to be a new and reliable water supply, the market for reclaimed wastewater is unbalanced. The findings of this study should provide valuable information on the potential market for reclaimed water and on community acceptance of recycled water, and thus lead towards reducing the gap between demand and supply. The findings should help in scaling up reclaimed wastewater schemes in Australia and will also provide policy makers in other water-scarce regions like India with the insights needed for thinking seriously about community participation and private sector involvement as an important strategy for successful implementation of sustainable and viable reuse projects. Thus, when understanding the shifting balance between private and public property rights is regarded as an important issue in the debate on the privatisation of water services, the findings from this study will provide answers to some of the questions such as – can private sector participation lead to sustainable waste-water management?

1.9 Research boundary

Considering the resource constraints, mainly time, the present study covers two cases in South Australia and one in India. Personal interviews with the irrigators were necessary to collect the data at all the sites. Details about the study methodology are furnished in Chapter Five, but some limitations of the study are mentioned here.

People from diverse cultural and ethnic backgrounds are associated with one of the schemes selected in South Australia – the Virginia pipeline scheme. So, to conduct personal interviews with these non-English speaking irrigators by it was necessary to hire interpreters, a time-consuming procedure compared with the telephone interviews adopted for the other case study in South Australia – the Willunga Basin pipeline scheme.

With respect to the Indian case study, selection of the study site was partly influenced by the Australian Centre for International Agricultural Research (ACIAR), which extended financial help for part of this study. Therefore, Andhra Pradesh state was selected so as to partly satisfy the requirement of the funding agency.

The study aims to compare the processes of governance and institution formation for urban wastewater management in Australia and India and therefore no data on the costs and benefits and economics of agricultural production were collected. Accordingly, willingness-to -pay and profitability analyses are beyond the scope of this study. Further, in the empirical context, the analytical tools and techniques used are based on the nature and amount of the data collected at each site.

1.10 Thesis presentation

The dissertation is organized into nine chapters. Chapter One sets the context and scope of the research study. The discussion in Chapters Two to Four is basically a review of the literature. Chapter Two examines the importance of urban wastewater as an alternative resource to augment freshwater supplies, with supporting case studies of wastewater reuse for agriculture in selected countries around the world. Chapter Three focuses on the concepts and issues related to water governance and institutional change. Chapter Four discusses various theories related to water governance and provides a theoretical background. It also examines the interrelationship between various theories, and provides a framework to analyse the institutional frameworks and regulations governing the use of urban wastewater for agriculture in Australia and India.

Chapter Five describes the research methods and statistical models used in this study; it introduces the case study sites in Australia and India and explains the criteria adopted to select the schemes, respondents, and key stakeholders.

Chapters Six through to Eight focus on the results of the study. Chapter Six focuses on the first case study in Australia – the Virginia Pipeline scheme, providing an overview of the scheme under study and then a discussion of the household survey results of the case study. It presents the socio-demographic features, and the perceptions of the respondents related to wastewater reuse, particularly the rules in use. It attempts to identify the key determinants for the success of the scheme and relates them to the overall sustainable development of the region in which the scheme is operating.

Chapter Seven presents the survey results of the second case study in Australia – the Willunga Basin Pipeline Scheme; it presents an overview of the scheme and attempts to identify the critical success factors for private sector involvement in implementing wastewater reuse scheme.

Chapter Eight discusses the results of the Indian case study – the Musi river irrigation scheme. This chapter discusses the irrigation reforms in India with a focus on Andhra Pradesh. Further, the chapter presents the case of wastewater reuse in informal water economies like India where it happens to be a source of livelihood for many communities. It also discusses the role that the Water User's Association plays in wastewater management.

Chapter Nine presents the conclusions that have been drawn from the analysis of the case studies in Australia and India; it covers the theoretical and empirical conclusions, followed by a number of recommendations and policy options for wastewater reuse in agriculture.

Chapter 2

Chapter 2: Urban wastewater reuse - a common reality

> As the drill is plugging downward at a thousand feet of level, if the Lord won't send us water, oh, we'll get it from the devil deeper down.
>
> - B. Paterson, 'Song of Artesian Water'

2.1 Introduction

Exponential growth of population, rapid industrialisation and urbanisation, higher cultivation intensities, and poor water management practices over the past century has made freshwater availability a limiting factor in agricultural development (Ray & Gul, 1999; Dupont, 2003). In addition, the options for increasing supply have become expensive and often environmentally damaging (Frederick, 2001). The United Nations World Water Development Report-2 (UNESCO, 2006) clearly states that:

> "the insufficiency of water is primarily driven by an inefficient supply of services rather than by water shortages. Lack of basic services is often due to mismanagement, corruption, lack of appropriate institutions, bureaucratic inertia and a shortage of new investments in building human capacity, as well as physical infrastructure"(UNESCO, 2006, p. 45)

The report further states that water crisis rest on how we as individuals, and as part of collective society, govern water resources and their benefits.

Therefore, we need to manage the available freshwater resources effectively and use water based on fitness-for-purpose criteria. Further, our actions to counter water scarcity challenges should be sustainable, without depleting the natural resources or harming the environment. For these reasons, water managers and policy makers around the world are forced to continually look for alternatives to supplement limited and depleting freshwater resources. In such

situations, ‘source substitution’ appears to be the solution as it allows higher quality water to be reserved for domestic supply and poor quality water may satisfy less critical uses (Hespanhol, 1997). Consequently, urban wastewater (treated) is now considered as a reliable alternative water source without compromising public health and wastewater management is prominent in the water management agenda of many countries (Asano, 2001; Hespanhol, 1997; Cullen, 2004).

With this background, this chapter provides an account of urban wastewater reuse and its applications. It also discusses the challenges facing policy makers and water managers as they implement wastewater reuse projects.

2.2 Source Substitution – response to freshwater scarcity challenge

Wastewater use, particularly for non-potable uses is an age-old practice and was mainly uncontrolled. Such practices went unreported because the norm then was that wastewater should be treated before use (Ensink et al., 2002). The earliest documented experiment of wastewater use is the large-scale cropland application of municipal wastewater in Western Europe and North America during the early 1900s, when flush toilets and sewer systems were being introduced into these cities (Asano & Levine, 1996; Asano, 2001; van der Hoek et al., 2002). Since then, there has been an increase in the extent of wastewater usage and applications and it is only recently that severe water shortages have pushed the idea of wastewater reclamation and reuse. The wastewater reuse experiments around the world presented in Table 2.1 demonstrate that wastewater reuse is not a new practice.

Table 2.1: Examples of water reuse experiments around the world

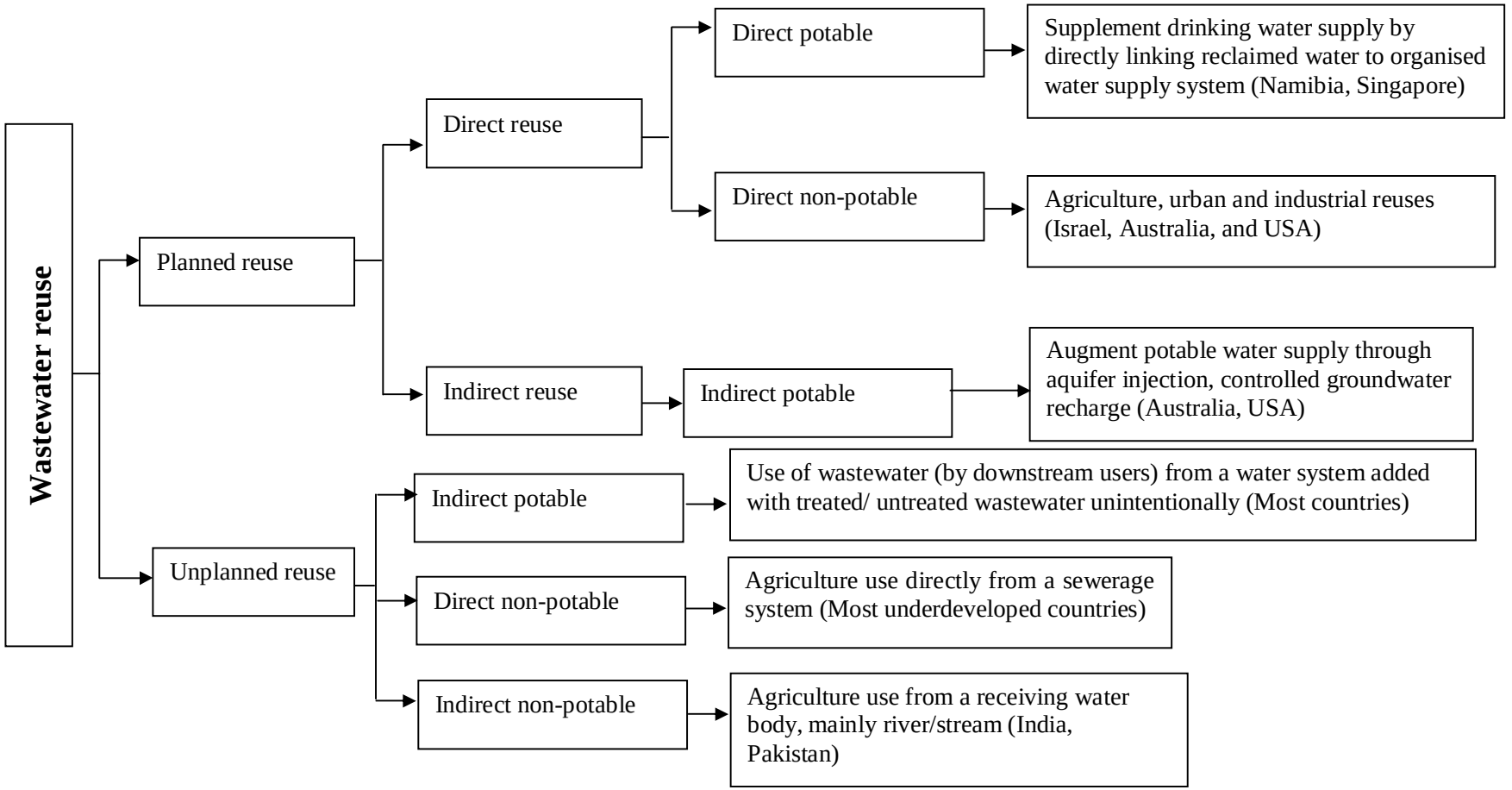
Year	Location	Purpose/Usage	Year	Location	Purpose/Usage
1912-1985	Golden Gate Park, San Francisco, California, USA.	Water lawns and supplying ornamental lakes	1977	Dan Region Project, Tel-Aviv, Israel	Groundwater recharge and unrestricted crop irrigation
1926	Grand Canyon National Park, Arizona, USA.	Toilet flushing, lawn sprinkling, cooling water, and boiler feed water	1984	Tokyo Metropolitan Government, Japan	Toilet flushing
1929	City of Pomona, California, USA.	Irrigation of lawns and gardens	1985	City of El Paso, Texas, USA.	Groundwater recharge by direct injection into aquifers, and power plant cooling
1942	City of Baltimore, Maryland, USA.	Metals cooling and steel processing at the Bethlehem Steel Company	1987	Monterey Regional Water Pollution Control Agency, California, USA.	Monterey Wastewater Reclamation Study for Agriculture – irrigation of food crops
1960	City of Colorado Springs, Colorado, USA.	Landscape irrigation for golf courses, parks, and freeways	1989	Shoalhaven heads, Australia	Irrigation of gardens and toilet flushing in private residential dwellings
1961	Irvine Ranch Water District, California, USA.	Irrigation, industrial and domestic uses, toilet flushing	1989	Consorci de la Costa Brava, Girona, Spain	Golf course irrigation
1962	La Soukra, Tunisia	Irrigation with reclaimed water for citrus plants, reduce saltwater intrusion into groundwater		Northern Adelaide Plains, South Australia	Class 'A' water used to irrigate horticulture crops
1968	City of Windhoek, Namibia	Advanced direct wastewater reclamation system to augment potable water supplies	1999	Willunga Basin, Adelaide, South Australia	Class 'B' waster used to irrigate premium quality grapes
1969	City of Wagga Wagga, Australia	Landscape irrigation of sporting fields, lawns, and cemeteries		Mawson Lakes reclaimed water scheme	A dual water reticulation system, recycled wastewater used for toilet flushing, and garden watering.
1970	Sappi Pulp and Paper Group, Enstra, South Africa	Industrial use for pulp and paper processes	2000	Rouse Hill Recycled Water Scheme	A dual water supply system, with the recycled wastewater used for toilet flushing, car washing and garden watering.
1976	Orange County Water District, California, USA.	Groundwater recharge by direct injection into the aquifers	2003	Singapore	The 'NEWater' project provides safe, reliable source of high quality drinking water (sewer water purified to drinking water standards) for Singapore's 4.3 million residents.

Source: Compiled from Asano (2001); US EPA (2004); Anderson (2003); Salgot and Tapias (2004) and van der Hoek (2004); NEWater, (2002).

2.3 Urban wastewater – reuse options and applications

Wastewater (re)use is not a new phenomenon although the concept is receiving greater importance recently because of the global water crisis. Urban wastewater reuse may be planned or unplanned; and planned reuse can be direct or indirect. At the same time, unplanned reuse is confined to non-potable uses, although we can find some cases of unplanned potable reuse. Figure 2.1 illustrates the typology of wastewater usage and applications with examples.

As already stated, planned reuse can be direct or indirect. Planned direct reuse can be for potable or non-potable purposes. Planned direct potable reuse is the deliberate use of treated wastewater for some beneficial purpose such as drinking. It is the use of reclaimed water straight from a wastewater treatment plant through a pipe-to-pipe system that connects the reclaimed water line directly to an established potable water supply system without intervening discharge to a natural water body. However, planned direct potable reuse (treated wastewater directly reused for drinking water) is very rare, because of the perception of increased potential risk to public health and because of negative public perception. In general, even though the technology is well proven, direct potable reuse has occurred only when there is no other option, as in the case of Windhoek, Namibia, which is currently the only place where direct potable reuse takes place on a municipal scale.



Source: Compiled from Anderson (2003); Salgot and Tapias (2004) and van der Hoek (2004)

Figure 2.1: Typology of wastewater usage for all purposes

Planned direct non-potable reuse is the use of treated wastewater where control exists over the conveyance of the wastewater from the point of discharge from a treatment plant to a controlled area where it is used for irrigation. Many countries in the Middle East and countries like Australia, the United States of America, and Israel have developed large-scale irrigation schemes delivering reclaimed water for agriculture use, using reclaimed water after it has passed through water bodies like storages or wetlands following treatment, or taken from a river, lake, or aquifer that has received sewage or sewage effluent.

Further, planned reuse can also be indirect potable reuse, by way of replenishment of ground water by the controlled addition of reclaimed water to the ground water basin through methods such as aquifer injection. Generally, planned indirect potable reuse is not thought to pose any health risk since it relies on natural treatment in surface water and aquifers, and the reclaimed water is diluted with 'ordinary' river or ground water before extraction, thus ensuring good drinking water quality (WHO, 2006). Nevertheless, this is still a new approach and is restricted mostly to the developed countries.

Unplanned reuse, on the other hand is largely for non-potable purposes that can be direct or indirect. Unplanned direct non-potable reuse is the supply of wastewater directly to the land from a sewerage system or other purpose-built wastewater conveyance system. Such situations are found in most of the underdeveloped nations facing water scarcity (Westcot, 1997). Unplanned indirect reuse for non-potable purposes is common in developing countries like India and Pakistan, where irrigation water is drawn from rivers

or other natural water bodies that receive wastewater flows, treated or not. However, unplanned potable reuse (common worldwide) is also practiced, largely unintentionally, when treated or untreated wastewater is added to a water supply system (reservoirs or rivers or streams) that is subsequently used by downstream communities as a water source for potable use, usually with additional treatment.

2.4 Urban wastewater reuse case studies

Use of urban wastewater has increased in many places mainly because of increasing demand by the agriculture sector. The best way of using treated wastewater is in agriculture (Pescod, 1992), and the use of wastewater for agriculture can definitely relieve a great deal of pressure on fresh water resources. Replacement of freshwater by treated or untreated wastewater is seen as an important conservation strategy contributing to agricultural production. Further, the communities depending on wastewater reuse for their livelihoods, particularly in the developing world, can derive substantial benefits from using nutrient-rich wastewater.

Although wastewater reuse occupies a prominent place in water management policies today, there is no regulation of wastewater reuse that is common across the world. This is mainly due to different economic and social conditions, and country or state-specific policies towards using wastewater. In developing countries like India, because of increasing water scarcity, lack of money for treatment and a clear willingness by farmers to use untreated wastewater, the practice of using untreated wastewater for irrigation is

still being practiced (Ensink et. al, 2002). Besides, the technology necessary to produce effluent of a required quality is often unavailable or not maintained, and the regulatory agencies can seldom enforce standards. Nevertheless, some developing countries including India have their own standards adapted from the leading standards set by the FAO or WHO (Achilleos, Kythreotou & Fatta, 2005). In developed nations, on the other hand, public health regulations and water pollution control requirements for treatment protect the agricultural workers and the consumers of crops irrigated with treated wastewater. So, wastewater reuse in developing countries is largely unplanned and uncontrolled whereas in developed countries it is controlled and planned (Parkinson & Tayler, 2003).

The terminologies of 'formal' and 'informal' are widely used in the literature on natural resource management in varying contexts. Similarly, this study uses these terminologies to distinguish the type of water economies and water institutions. Clarification of the terms will be made in the corresponding chapters where they are used. However, at this juncture, these terms are used to differentiate the type of wastewater irrigation.

Formal irrigation is one based on some form of fixed irrigation infrastructure, designed and possibly operated by the government or a donor agency, and used by more than one farm household. *Informal irrigation* is one that is practiced by individuals or groups of farmers, without an irrigation infrastructure planned, constructed or operated by a government or donor agency (Cornish, Mensah & Ghesquiere, 1999; van der Hoek, 2004; IWMI, 2007).

Accordingly, use of wastewater for irrigation differs across the world; so the following section provides an overview of water reuse criteria across the world and discusses country-specific experiences of urban wastewater reuse. The country-specific case studies cover planned, unplanned, potable, and non-potable applications.

2.4.1.1 Windhoek, Namibia

Namibia is the most arid country in Southern Africa; it faces severe water shortages due to uncertain rainfall and long spells of severe drought. The water supply of Windhoek, the capital of Namibia, used to be based on surface water and groundwater. However, these resources were fully exploited and consequently in 1994 the City Council of Windhoek approved an Integrated Water Demand Management Programme. The strategy consisted of policy issues, information campaigns, legislation and technical measures, and the major policy issues mentioned were maximum wastewater reuse and saving of water. The main objective of this programme was to remove luxury water demand and reduce the pressure and reliance on primary water sources (Magnusson, 2004; Lahnsteiner & Lempert, 2007).

The history of wastewater reuse in Namibia dates back to 1968, when the City Council of Windhoek was forced to implement direct reclamation of wastewater for potable use as the city was approaching the limit of its conventional drinking water sources (World Bank, 2003). The first water reclamation plant – The Old Goreangab Water Reclamation Plant (OGWRP) – after successful operation for more than 30 years was nearing the end of its viable life in the late 1990s. Therefore, the New Goreangab Water Reclamation

Plant (NGWRP) was built in 2002 through a 20-year operation and maintenance (O&M) contract between the City of Windhoek and the Windhoek Goreangab Operating Company Ltd. (WINGOC), which is a consortium of three international water treatment contractors (Lahnsteiner & Lempert, 2007). As a result, the city's total water supply is now met by three main sources – (i) surface water, (ii) ground water, (iii) reclaimed water from both the water reclamation plants.

Initially only 3 to 8% of reclaimed water was blended with premium water from other sources (bore holes and treated surface water). After several process improvements the portion of reclaimed water was raised gradually until it constituted up to 18 percent of the total potable water for the city (Lahnsteiner & Lempert, 2007). While there is opposition to use recycled water for potable purposes in many parts of the world (Hurlimann & McKay, 2006), the people of Windhoek derive pride from the fact that they are the only people in the world with potable reuse.

However, it should be noted that the potable reuse project in Namibia is successful because of the specific attitudes of the users, derived from a growing scarcity of water and a different set of cultural values (McKay, 2007a). In addition, a set of water institutional reforms in Namibia based on proper process design and quality management and effective public awareness programs, were also instrumental in making this project a reality (Lahnsteiner & Lempert, 2007; Heyns, 2005).

2.4.1.2 Singapore

Singapore has achieved a remarkable progress in water resource management as a result of efforts such as the creation of a comprehensive management system for the environment, the urban catchment and wastewater. Government support, institutional integration, integrated land use planning, effective enforcement of legislation, public education, and application of advanced technology are the critical factors for this success. The Four National Taps Strategy has resulted in diversification of Singapore's water sources (World Bank, 2006). The first tap is water from local catchments; the second tap is imported water; the third is NEWater, which is drinking-quality water produced by treating secondary effluent (see Box 2.1); and the fourth tap is desalinated water.

Box 2.1: The NEWater Initiative

NEWater is a recent, ambitious project of Singapore's Public Utilities Board aimed towards promoting potable use of wastewater. The NEWater initiative between Singapore's Public Utilities Board and Ministry of the Environment began in 1998 with the objective of assessing the appropriateness of treated wastewater as an additional water source.

The treated wastewater undergoes micro filtration and reverses osmosis to create NEWater, which is supplied directly to industry and to potable water treatment plants as a raw water source via surface water catchment reservoirs. Reports commissioned by the Public Utilities Board confirmed that NEWater meets the United States Environmental Protection Agency (USEPA) and World Health Organization drinking water standards.

Since 2002, when NEWater entered potable supply, it has only represented 1% of total daily water consumption and by 2011 it is expected to represent only 2.5%. The majority of NEWater is used for non-potable applications.

Source: NEWater Sustainable Water Supply, 2005.

The water institutions in Singapore provide favourable conditions for Integrated Water Resources Management (IWRM). Moreover, they have largely wiped away the administrative barriers facing the process of adopting the IWRM approach that exist in many other countries. Additionally, Singapore has comprehensive environmental

legislation and strict implementation of water resource related regulations. Table 2.2 presents the different water institutions and their duties, along with the important regulations that influence water and wastewater management in Singapore.

Table 2.2: Water management regulations, water institutions and their duties

Water management regulations	Water institutions	Main Duty
Environmental Pollution Control Act (Cap. 24), 2002	Water Supply	Production of public water and reused water, from treated secondary effluent and collective systems in Singapore
Environmental Public Health (Toxic Industrial Waste) Regulations	Water Reclamation	Treatment and reclamation of water from municipal sewage and sewer systems
Sewerage and Drainage Act (Cap. 294), 2001	Catchment and Waterways	Planning, management, construction and maintenance of catchment, reservoir, drainage systems, flood control, and discharge of rain water
Public Utilities Act (Cap. 261), 2002	3PN (Private-Public-People Networking)	Private participation in water infrastructure
Public Utilities (Water Supply) Regulations	Policy and Planning	Planning and development of water resource policy and pricing
Public Utilities (Central Water Catchment and Catchment Area Parks) Regulations	Best Sources	Exploration and identification of opportunities to outsource Public Utilities Board's work based on cost-effectiveness
	Technology and Water Quality	Planning, evaluation, testing and budget management for new technology and projects

Source: Compiled from World Bank, 2006

It is clear from the table that the Environmental Pollution Control Act, 2002 controls the production of public water and reused water from treated effluents and collective systems in Singapore. The Environmental Public Health (Toxic Industrial Waste) Regulations regulates the treatment and reclamation of water from municipal sewage and sewer systems.

Apart from these special and innovative cases of potable reuse, the general trend around the world is that communities are apprehensive about direct potable reuse mainly due to the increasing chance of health risk associated with potable reuse. Additional factors such as the 'yuck' factor, source of wastewater, trust and knowledge, public awareness are also responsible (Po, Juliane & Nancarrow, 2004). Box-2.2 presents a recent opposition to the use of recycled water for consumption in Australia.

Box 2.2: Recycled water for drinking- 'NO' says Toowoomba

After a series of devastating droughts, communities across Australia are looking at innovative ways to try and preserve and recycle water. One such community is Toowoomba in South-East Queensland where the water situation is so grim that there is a complete ban on garden hoses, apart from anything else.

Toowoomba, located to the west of Brisbane, has no major river nearby and its water has to be pumped uphill. Dam levels are less than a quarter capacity and the 140,000 residents of Toowoomba and surrounding areas have endured tough water restrictions for the past two-and-a-half years. The bore water has been decreasing over the last 30 to 40 years. The Mayor of Toowoomba thought that the city had no choice but to recycle its own sewage for drinking water.

The plan and technology was there but the major hurdle was public acceptance. The proposal of the City council met fierce opposition from the community. The proposal frightened many Toowoomba residents, fearing their city might loose its reputation. Since the proposal was referred as water from 'toilet-to-tap', some even thought the town will be called 'Poowoomba'. Thus, the town was split firmly in two groups –'No' and 'Yes' vote proponents.

To arrive at a decision, the plan was put to a referendum. The council held numerous public forums, run an advertising campaign, organised taste tests while the 'No' vote proponents organised their own meetings, letterbox drops and television advertisements. A total of 60,231 people were eligible to vote in the referendum. The outcome of the voting held on July 29, 2006 was a resounding victory for the 'NO' campaign as 61.62 per cent of residents opposed the proposal. Therefore, the proposal was shelved. Residents of Toowoomba have cited everything from health to tourism as reasons for shelving the proposal.

Source: The Source (2006) ; The Sydney Morning Herald (2006)

2.4.1.3 United States of America

In the United States, urban wastewater management strategies can be categorised as centralised or decentralised. However, from the end of the nineteenth century to the present day, centralised management has remained the preferred urban wastewater

management method (Burian et al., 2000). Reclaimed water use in the United States is well established and ranges from pasture irrigation using partially treated reclaimed water to augmenting potable water supplies with highly treated reclaimed water. However, there are no federal regulations governing wastewater reuse, and the regulations and guidelines are developed at the State level (Crook & Surampalli, 2005). The first regulation of wastewater reuse for irrigation was developed in 1918 (Asano & Levine, 1996) and is comprehensive with regard to public health. Since regulations and guidelines are developed at State levels, they vary across states. Table 2.3 presents water reuse criteria for non-potable applications in some selected states in the USA.

Table 2.3: Water reuse criteria for non-potable applications in the United States

	Arizona	California	Florida	Nevada	Texas	Washington
Treatment	Secondary treatment, filtration, disinfection	Oxidised, coagulated, filtered, and disinfected	Secondary treatment, filtration, high-level disinfection	Secondary treatment, disinfection	NS[1]	Oxidised, coagulated, filtered, and disinfected
BOD[2]	NS	NS	20 mg/l	30 mg/l	5 mg/l	30 mg/l
TSS[3]	NS	NS	5 mg/l	NS	NS	30 mg/l
Turbidity	2 NTU[4] (Avg) 5 NTU (Max)	2 NTU (Avg) 5 NTU (Max)	NS	NS	3 NTU	2 NTU (Avg) 5 NTU (Max)
Coliform	23/100 ml (Max)	23/100 ml (Max)	25/100 ml (Max)	400/100 ml (Max)	75/100 ml (Max)	23/100 ml (Max)

Note: [1]NS - not specified by state regulations; [2] BOD - Biochemical Oxygen Demand; [3] TSS - Total Suspended Solids; [4] NTU - Nephelometric Turbidity Units
Source: Achilleos, Kythreotou and Fatta, 2005

2.4.1.4 Europe

When compared to other regions of the world, Europe has plentiful water resources. However, droughts experienced in the early 90s and in 2003 changed the situation in Europe, resulting in growing water stress, both in terms of quantity and quality (Hochstrat et. al, 2005; Bixio et. al, 2006). To counter water scarcity challenges the

European Union and its member states have enacted the Water Framework Directive (WFD[1]) which highlights an integrated approach to water resources management. Further, the WFD favours municipal wastewater reclamation and reuse to augment water supply and decrease the impact of human activities on the environment (Bixio et. al, 2006).

Water reuse is a growing field and many projects have been proceeding throughout Europe in the last fifteen years (Angelakis, Bontoux & Lazarova, 2003). Wastewater reuse in Europe is mainly for agriculture, industry, urban, recreational and environmental uses. As compared to the early 1990s, when wastewater reuse in Europe was limited and incidental, at present there are more than 200 fully operational water reuse projects, with many others in an advanced planning phase (Hochstrat et. al, 2005). Nevertheless, there are no regulations for wastewater reuse at a European level and the only reference made by the European Union on the matter of wastewater is in the Urban Wastewater Treatment Directive (UWWTD). The UWWTD spells out the implementation of decentralised treatment so as to reduce pollution from households, apply strict sanctions on municipal wastewater treatment plants, and reduce the diffuse pollution from agriculture (Bixio et. al, 2006; Achilleos, Kythreotou & Fatta, 2005).

2.4.1.5 Israel

Due to a combination of severe water shortage, threat of pollution to its water resources and a concentrated urban population with high levels of water consumption and

1 EU Council Directive for community action in water policy-2000/60/EC of October 23, 2000.

wastewater production, Israel has devoted more effort to wastewater reuse than any other country. Israel's national policy aims to gradually increase the fraction of reclaimed wastewater used instead of fresh water for agricultural use (Brenner et al., 2000). This is reflected by the fact that Israel occupies second place in overall wastewater reuse after California and has the highest percentage of wastewater reused for agricultural irrigation in the world (Achilleos, Kythreotou & Fatta, 2005). It is estimated that by the year 2020, 50% of agricultural water consumption will be provided by treated wastewater (Brenner et al., 2000). Understandably, the large-scale wastewater reuse schemes in Israel are mainly for agricultural irrigation. Though modern treatment technology can produce reclaimed water meeting drinking water quality, because of public acceptance considerations the focus in Israel is directed towards maximising saving or replacing freshwater for consumptive uses other than drinking. The Ministry of the Environment determines recommendations for effluent quality standards for various purposes.

2.4.1.6 Australia

The scope for Australia to recycle water was first identified during 1977-78 in a report commissioned for the Victorian Government on the potential for water recycling (GHD, 1978). However, this failed to attract the attention of the policy makers and hence had little impact until the 1980s, when issues of environmental health, sustainability, water availability and water quality for consumptive uses emerged as significant political issues (Taylor & Dalton, 2003). Furthermore, Australia is currently experiencing the highest ever amount of pressure on its water resources. Additionally, it has been stated that "substitution of water used in agriculture and urban irrigation with reclaimed water will

free up water and help make appropriate allocations to the environment, thus ensuring good environmental condition for stressed water supplies" (Hamilton et al., 2005, p. 185). This means that reclaimed water can definitely become a major resource for the agriculture sector, since irrigated agriculture accounts for around 67% of Australia's total water usage (ABS, 2004).

Water recycling was given impetus, starting in the early 1990s when the States established Environment Protection Authorities (EPA) which imposed compositional standards on the discharge of treated effluents from sewage treatment plants (STPs) to the oceans. As a result the interest increased in recycling for productive purposes on land as an alternative to installing expensive biological nutrient removal plants. Further, the Water Sector Reforms of 1994, in the form of Council of Australian Governments (COAG) reforms, provided policy direction and gave momentum to water recycling in Australia. The droughts of 2001-3 reinforced the need for more effective water management, with recycled wastewater, urban stormwater and rainwater being seen as resources rather than problems. A recent review on Water Recycling in Australia, by the Australian Academy of Technological Sciences and Engineering, reports that by 2001-2002, over 500 wastewater treatment plants were recycling some or all of their treated wastewater (Radcliffe, 2004).

Water recycling was brought within the National Water Reform Framework in 2003. This framework is an intergovernmental agreement aimed to encourage water conservation in cities through better use of storm water and recycled water (Hurlimann & McKay, 2006).

The subsequent signing of the Intergovernmental Agreement on the National Water Initiative (NWI), and the creation of the Australian Government Water Fund, laid the foundation for encouraging innovation and the use of recycled water in Australia's cities and towns. Thus, a series of events in the late 90's provided powerful incentives for cities and town to consider including water recycling in their water development plans and ultimately converged to accelerate implementation of water recycling (Dillon, 2000). Given that the current fresh water resource status in the country is bleak, water recycling certainly has a role to play.

Australia is today a world leader in the use of treated wastewater (Dimitriadis, 2005). According to ABS (2004) data for 2000-2001, around 27.8% (511.3 GL) of the total volume of effluent produced (1,837.2 GL) was reclaimed. However, because of differences in definitions, these estimates of reclaimed water use sometimes vary considerably (Hamilton et. al, 2005). With reference to South Australia, the state where this study is carried out In South Australia, water scarcity problems have had a profound impact on policy development (McKay, 2007). With around 18% of water being directly reused (Radcliffe, 2004), South Australia stands second after Victoria (45.2%) in the country (ABS, 2004), and, per capita, has the highest level of wastewater reuse in the country (Dimitriadis, 2005).

Table 2.4 gives a summary of some of the successful reuse projects in Australia.

Table 2.4: Water reuse projects operating in Australia

Project	Annual Volume (ML)	Water Quality[1]	Application
Virginia (S. Aust.)	**22,000**	**A**	**Unrestricted irrigation of horticultural crops**
South East Queensland	100,000+	A and C	Class A to horticultural crops, Class C to cotton and Cereal farms
Hunter Water	Up to 3,000	C and B	Coal washing, electricity generator cooling
Eastern Irrigation Scheme	10,000	C	Horticulture, public spaces, golf courses, household gardens and toilet flushing
Barwon Water Sewer Mining	Up to 1,000	-	Agricultural and industrial uses
McLaren Vale	**Up to 8,000**	**C**	**Application to vines for producing premium quality grapes**
Rouse Hill	Up to 1,500	A	Dual reticulation system to 15,000 households
Georges River Program	15,000 to 30,000	Varying standards based on application	To serve existing potable water customers and new residential developments
Other projects[2]	-	All class B or A	Application include horticulture, wine grapes, pasture, fodder, public spaces, golf courses, household gardens and recreational area

Note: [1]States have to treat the water to standards that meet EPA and Department of Health requirements
[2] Includes more than 50 schemes
Source: US EPA, 2004

Apart from the schemes under study (marked Bold) and the other schemes mentioned in Table 2.4, Australia has several other schemes that are operating successfully, as most state governments and water authorities have policies on reuse and are devoting efforts to develop new applications. Therefore, it is worth mentioning some of these schemes, which are mostly irrigation schemes and formal wastewater reuse schemes. The schemes are formal in the sense that the arrangements between different parties/stakeholders (governments, local councils, and private companies) involved in implementing these schemes are formal and clear. Boxes 2.3 and 2.4 highlight a couple of formal wastewater

irrigations schemes operating in Australia, as well as the schemes under study. In addition to wastewater irrigation schemes, Australia has successful examples of dual distribution systems and planned potable reuse practices, usually referred to as Aquifer Storage and Recovery (ASR). A dual distribution system is a situation where there are two water supply lines: one for potable water and another for reclaimed water. Aquifer Storage and Recovery (ASR) is a method of enhancing water recharge to underground aquifers by gravity feeding or pumping excess water into the aquifers for later use in times of peak demand, using excess surface water, including urban storm water runoff, and treated wastewater (Dillon et al., 1999; Martin & Dillon, 2002).

Box 2.3: Brighton Irrigation Scheme, Hobart

Brighton is a dry area near Hobart, with significant broad acre farming. In an attempt to drought proof the area, Brighton Council is now recycling all its wastewater (800 to 900 ML per year), which is reclaimed from residential properties connected to sewerage in the areas Old Beach, Gagebrook, Bridgewater, and the Brighton township itself.

The Brighton Lagoon recycling system was established in 1996 and since then treated effluent has been used for irrigation of poppies, cereals and pasture on the neighbouring farm. In 1997, the Council formed a joint venture with the local pulp mill at Boyer to establish an irrigated pine plantation of 17 hectares. The success of the Brighton Lagoon recycling system enabled Council and local farmers to secure funding to establish infrastructure required to also recycle treated effluent from the Green Point Waste Water Treatment Plant. Participating farmers agreed to install and pay for suitable storage and irrigation infrastructure. The Brighton Council, with the help of a NHT Coasts and Clean Seas program grant of $788,000, paid for the recycled water distribution network. Farmers were irrigating with recycling water twelve months after project funding had been announced, which led to an initial reduction of the demand for potable water by 20 percent. Apart from the recycled water being an important and affordable source of water to local farmers, the scheme also led to a significantly reduced discharge of nutrients (nitrogen and phosphorus) into the river Derwent, thereby, helping farmers save on fertiliser.

Sources: Radcliffe (2004); naiad™

Box 2.4: Hawkesbury Water Recycling Scheme, Richmond, New South Wales (NSW)

The Scheme builds upon an established partnership with Sydney Water Corporation, and a project to harvest and treat stormwater supported by the NSW Stormwater Trust and the Natural Heritage Trust, in collaboration with Hawkesbury City Council, Clean up Australia, and a number of industry supporters. Situated near Richmond on the Hawkesbury Campus of the University of Western Sydney (UWS), the Hawkesbury Water Recycling Scheme is a practical demonstration of the environmental and economic benefits of water recycling.

Two resource streams, treated effluent and harvested stormwater, are strategically utilised. The upgraded Richmond sewage treatment plant supplies approximately 600 ML annually. Advanced biological tertiary treatment is used to produce high-quality recycled water suitable for a range of non-potable applications. In addition, approximately 250 ML per year of stormwater is harvested from the urban and peri-urban areas of Richmond, polished in constructed wetlands, and utilised as a complementary resource.

While, historically, the UWS Dairy was the main user of recycled water, a range of water users now draw upon this resource and new commercial agreements are being established. Current uses include pastures for cattle, sheep, deer, and a commercial horse unit, as part of the UWS outdoor laboratories and grazing unit; and a range of horticultural crops for commercial, research and teaching purposes by UWS. The multi-faceted aspects of the Scheme are coordinated through management systems which incorporate developing approaches to entitlements, differential securities, and risk communication strategies; approaches of great potential relevance to emerging water recycling schemes in Western Sydney and elsewhere.

Source: Attwater et. al, (2005); naiad^{TM}

Against this background, this study focuses on two wastewater irrigation (for agriculture) schemes operating in South Australia – the Virginia pipeline scheme and the Willunga pipeline scheme. Details of these schemes will be discussed in subsequent Chapters. The State of South Australia has a favourable regulatory and policy regime for wastewater reuse; the State Water Plan-2000 has a commitment to water reuse projects (Keremane &

McKay, 2006b); and the government has a policy to phase out all sewage discharge to the marine environment (Cullen, 2004). As a result, South Australia currently outdoes all other Australian States with 18 percent of water being directly reused (Radcliffe, 2004). At this point of the study we must note that in India (the other study region), wastewater use for irrigation purposes is largely uncontrolled and informal, as the case in all other developing nations; so a brief account of wastewater reuse in India is presented to set the scene. Wastewater reuse in India is mostly indirect non-potable applications, although there are cases of direct non-potable reuse.

2.4.1.7 India

The idea of wastewater as a source of irrigation is gaining popularity worldwide, including in India, which has a long history of the use of untreated or partially treated wastewater. For ages, marginalised communities in India have used domestic wastewater as well as industrial effluent to grow vegetables, fruits, cereals, flowers and fodder (direct non-potable reuse). Currently in India, as a result of rapid population growth, massive industrialization, and the growing number of cities, large amounts of sewage are disposed into bodies of water. According to UNDP's World Water Development Report (2003), 70 percent of industrial wastes in developing countries are dumped into waters without treatment, polluting the usable water supply.

Table 2.5 summarises wastewater usage in some of the major cities across India.

Table 2.5: Wastewater use in the some of the major cities across India

City	Direct use (ha)	Indirect use (ha)	Crops grown
Ahmedabad	890	-	Rice, other cereals and fodder
Bhilai	607	-	Vegetables and cereals
Calcutta	-	13	Vegetables, rice and fish
Gwalior	202	-	Vegetable, rice and other cereals
Hyderabad	**110**	**40,500**	**Vegetable, Rice, Fodder, Fruit trees, Cotton, Fish**
Jamshedpur	113	-	Other cereals, fodder
Lucknow	150	-	Vegetables, rice
Madras	133	-	Fodder

Note: Bold indicate the scheme under study; Source: Juwarkar, et al., 1988; Buechler and Devi, 2002.

Unlike in the developed world, where wastewater irrigation is controlled and carefully planned, in many parts of the developing world wastewater use is indirect and unregulated, which means that the wastewater is disposed of in rivers from where the contaminated river water is then used for irrigation (van der Hoek et al., 2002). The common practice observed is that, untreated urban wastewater is used downstream for uncontrolled, unrestricted irrigation. The water from the rivers that receive wastewater flows is diverted via anicuts (weirs) to canals and often to tanks, and then channelled to the fields for irrigation. Accordingly, most wastewater irrigation in India occurs along rivers, and if it was not for these continuous wastewater flows, many of the rivers of the Indian peninsula would have run dry throughout the year. In some other cases many people irrigate their crops by extracting the wastewater from the nallas (open drains) or the underground sewer pipes. Box 2.5 presents a case of unregulated wastewater reuse. These practices are more common in the semi-arid regions where the monsoon rains are erratic and unreliable, and hence wastewater is a valuable resource for farmers. The Musi

river case selected for this study is one such example where untreated urban wastewater is used downstream for uncontrolled, unrestricted irrigation.

Box 2.5: Unregulated Irrigation with Wastewater in Hubli-Dharwad, Karnataka, India

Within the twin city of Hubli-Dharwad 60 million litres of wastewater is generated every day which flows untreated into the natural watercourses. In the semi-arid climate where the monsoon rains are erratic and unreliable, wastewater is a valuable resource for farmers. Many extract it from the *nallas (open drains)* and underground sewer pipes to irrigate their crops, and this is considerably cheaper than constructing a borehole and hence the practice is more accessible and attractive to small farmers. Wastewater also provides an irrigation source during the dry season, enabling farmers to sell their produce for five times the monsoon prices, while its high nutrient load reduces the need for costly fertilizer inputs.

While this practice alleviates poverty for many farmers, it simultaneously places them, the consumers, and environment at risk. Untreated wastewater is a major source of pathogens, water-borne parasites and also contains potentially injurious bio-medical waste (including disposable needles and syringes), creating serious health concerns. Continuous irrigation with wastewater also leads to environmental problems such as salinisation, phytotoxicity (plant poisoning) and soil structure deterioration, which in India is commonly referred to as 'sewage sickness'. Therefore, such wastewater irrigation practices reveal a range of associated problems that threaten to outweigh the benefits.

Source: Bradford & et.al, 2003.

Over the past two decades wastewater use in agriculture has increased significantly. And with the growing population and increased industrial use of water, use of wastewater for irrigation is going to increase even further. But, these unregulated wastewater irrigation practices reveal a range of associated problems that outweigh the benefits. This highlights the failures of policies and lack of agricultural extension services. Nevertheless, some Non-Governmental Organisations (NGOs) have taken initiatives to address these issues (see Box 2.6)

Box 2.6: Decentralised wastewater treatment system and usage, Bangalore, India

Gram Swaraj Samithi (GSS), a non-government organization (NGO), partnered with Bremen Overseas Research and Development Association (BORDA) with funding from European Commission and the Federal Ministry for Economic Cooperation and Development, Germany built sanitation complexes fitted with Decentralised Wastewater Treatment System for the population of Ullalu Upanagara, on the outskirts of Bangalore.

It is the first community-based sanitation (CBS) project in India that treated wastewater and harvested rainwater. This made the wastewater suitable for reuse in toilets, bathrooms and for laundry. The facility is operated by the women's Self Help Group (SHG), which is nurtured by GSS. The amount earned from the two units is used for the operation and maintenance of the facility. Surplus amounts are transferred to the SHG's bank account.

At the outset, GSS involved the local government (*Panchayat*) from the very beginning and initiated education and awareness programmes on critical issues like health, environmental hygiene and sanitation. Community members mobilised contributions from the people of the area for the project. Community needs assessment, revealed the willingness to own and run the sanitation project. BORDA undertook a technical feasibility study. Concurrence from the community on the proposed CBS facility was taken and important stakeholders from the community were sent for a hands-on experience which enhanced the community's practical understanding of such units and their supplementary benefits.

Source: http://cbhi-hsprod.nic.in/

The above country-specific case studies establish that different countries have developed different approaches for wastewater reuse to protect public health and the environment. Developed countries have established conventionally low-risk guidelines based on a high technology/high-cost approach, while in developing countries the strategy is to adopt a low technology/low-cost approach based on WHO recommendations (Achilleos, Kythreotou & Fatta, 2005). Nevertheless, the objective behind all the guidelines is to

achieve better health protection by implementing stringent water quality limits and by defining other appropriate practices, depending on the type of reuse (USEPA, 2004).

So in the context of this study, it is important to understand the guidelines and mandatory criteria for reclaimed water use in South Australia, the State where the Australian schemes selected for this study operate. Table 2.6 shows the classification of reclaimed water for use in South Australia. On the other hand, wastewater use in India is unregulated and each individual state develops its own strategy for wastewater management based on the WHO recommendations for wastewater reuse; but the way these regulations are enforced is debatable. Nevertheless, these case studies from around the world highlight the potential of this valuable resource. However, given the nature and characteristics of this resource, and the regular concerns raised about its use as an alternative source, managing this resource encounters a number of challenges.

The section following Table 2.6 highlights the important hurdles facing wastewater management around the world, and ways to surmount them.

Table 2.6: Classification of reclaimed water for use in South Australia

Class	Uses	Microbiological criteria (*E. coli*/100ml)	Chemical/physical criteria	Typical treatment process
A	Residential non-potable (garden watering, toilet flushing, car washing, path/wall washing); Municipal use with public access; Unrestricted crop irrigation	< 10 Specific removal of viruses, protozoa and helminths may be required	Turbidity ≤ 2NTU BOD <20mg/L Chemical content to match the use	Full secondary plus tertiary filtration plus disinfection Coagulation may be required to meet water quality requirements
B	Municipal use with restricted access; Restricted crop irrigation; Irrigation of pasture and fodder for fodder animals	< 100 Specific removal of viruses, protozoa and helminths may be required	BOD <20mg/L SS <30mg/L Chemical content to match the use	Full secondary plus disinfection
C	Municipal use with restricted access; Restricted crop irrigation; Irrigation of pasture and fodder for fodder animals	< 1000 Specific removal of viruses, protozoa and helminths may be required	BOD <20mg/L SS <30mg/L Chemical content to match the use	Primary sedimentation plus lagooning OR Full secondary (disinfection if required to meet microbial criteria only)
D	Restricted crop irrigation; Irrigation for turf production; Silviculture and non food chain aquaculture	< 10 000 Helminths need to considered for pasture and fodder	Chemical content to match the use	Primary sedimentation plus lagooning OR Full secondary

Source: South Australian Reclaimed Water Guidelines (Treated Effluent), 1999; Note: NTU= Nephelometric turbidity unit; BOD= Biochemical Oxygen Demand; SS= Suspended Solids

2.5 Challenges for wastewater management

Water resource management in the past was largely shaped by an engineering approach (Pahl-Wostl, 2002). However, given the transformation the water sector is undergoing at all levels, water resource management in general is encountering new challenges that call for fresh strategies and institutional arrangements. According to Pahl-Wostl (2002), 'institutions and rule systems can enable and facilitate necessary transformation processes'. Likewise, when we think of wastewater management, we find various obstacles. Despite all the potential that (treated) wastewater offers for augmenting freshwater supplies, implementing sustainable wastewater reuse schemes encounters many impediments.

Experiments of wastewater reuse projects around the world suggests that human health, economic prosperity, property rights, and a general responsibility to the natural environment are the important components of accomplishing effective wastewater solutions (Jones, 2005). Furthermore, the "multidimensional character of this valuable resource - time, space, multidiscipline, and stakeholders- make it important to consider a large number of parameters in the decision making processes. The parameters include: "sustainability issues, legislation and health issues, techniques and technology, political and institutional issues, socio-economic impacts, and historical and cultural issues" (Thomas & Durham, 2003, p. 24). According to Livingston et al., (2004, p. 581), "successful implementation of new approaches to wastewater management is a multi-faceted challenge requiring input beyond mere technical". Societal and institutional adaptation is therefore critical to ensuring long-term sustainability of reuse schemes (Asano, 2001; Po, Juliane & Nancarrow, 2004; Po et al., 2005; Mills, 2000, Kasower, 1998, Ritchie et al., 1998, all cited in Haddad, 2002; Livingston et al., 2004). Therefore, like any other decisions about natural resource management policy, implementation of wastewater

projects too depends on policies and regulations and encounters various impediments. These issues are discussed here under several headings – institutional challenges; public perceptions and acceptance; market imbalance; community participation and willingness to pay.

2.5.1.1 Institutional Challenges

Wastewater collection, treatment and effluent use normally encompass a wide range of interests at different levels of administration. So the scope and success of any reuse scheme will depend to a large extent on the institutional organization (Pescod, 1992). In any natural resource management regime, coordination complexity results in problems, due to varying roles and responsibilities and overlapping concerns among the public agencies managing the resources (MacDonald & Dyack, 2004, McKay, 2007b). Previous studies related to wastewater use (Asano, 2001; Po, Juliane and Nancarrow, 2004; Po et al., 2005) have identified similar conflicting agendas among water agencies: addressing water rights issues; dealing with opponents to recycling or reuse; modifying existing regulations; and acquiring funding, are the institutional challenges facing successful development of this dependable resource. Therefore, appropriate institutions with adequate resources are required for development of sustainable wastewater reuse schemes. More about institutions is presented in Chapter Four.

2.5.1.2 Public perceptions and acceptance

For successful implementation of reuse schemes, public acceptance is a very important (Asano, 2001; Po, Juliane & Nancarrow, 2004; Marks, 2004; Marks, Martin & Zadoroznyj, 2006; McKay & Hurlimann, 2003). Generally, the tendency of people to be motivated by a set of long-term goals, but to act in the short term towards those things that they control, is what

affects wastewater reuse projects (Jones, 2005). Therefore, understanding public perceptions and community acceptance of water reuse is very important. Failure to gain public acceptance has led to vocal opposition and, at times, has resulted in schemes being stalled. According to Robinson, Robinson and Hawkins (2005), public concerns about real or perceived risks are weighted against the use of reclaimed water.

There are very few studies that have tried to investigate the factors influencing public perceptions of water reuse and their influence on individuals' decision-making processes. It is only in the recent past that public perceptions and acceptance of water reuse have been considered important for successful implementation of reuse schemes. While reviewing the existing international and Australian literature on water reuse, Po, Juliane and Nancarrow (2004) have identified the following factors to influence community's acceptance of a reuse scheme: disgust or 'yuck' factor, the perception of risks associated with using recycled water, the specific uses and cost of recycled water, the sources of water to be recycled, issues of choice, trust and knowledge, attitudes toward the environment, and socio-demographic factors.

If wastewater resources are to become an integral component of water and waste management policies, the acceptance of reclaimed water must be comprehensively tackled; this is more critical if the application is for potable uses. However, this challenge can be systematically addressed through effective educational, policy, and management strategies, as in case of the Windhoek Water Reclamation Project, Namibia. Failing to do so will result in controversies that ultimately lead to the project being stalled (see Box- 2.2).

2.5.1.3 Community participation

Wastewater reuse history is marked with failure of reuse schemes mainly because of lack of community involvement (Po, Juliane & Nancarrow, 2004, 2005; Hurlimann & McKay, 2006). According to Jones (2005), 'working with a community that does not have wastewater as a highest priority requires building participation through a combination of discussions about community outcomes, and more detailed action steps of technology identification, design work, and management'. The author further suggests that lack of community participation results in a wide gap between what is desired from wastewater reuse and what is necessary to get there, and inability to bridge this gap is the primary reason for failure of locally driven wastewater projects.

Since it is the public who will be served by and pay for them, the policies on wastewater use and management must include the human dimension (Robinson, Robinson & Hawkins, 2005). For a reuse scheme to be sustainable, community involvement and/or participation are very important. Asano (2001) suggests that water reuse project(s) should be built upon three principles:

- providing reliable treatment of wastewater to meet strict water quality requirements,
- protecting public health, and
- gaining public acceptance.

2.5.1.4 Market imbalance

The best application for the use of wastewater after treatment is in agriculture (Pescod, 1992) and use of this water for agriculture purposes can relieve a great deal of pressure on fresh water resources. This implies that the largest market for reclaimed water is in the agriculture

sector. In addition, use of wastewater, mainly for non-potable purposes is also increasing. Although there is market for this valuable resource, it is imbalanced, as is explained by Abu Madi et al., (2003, p. 115):

> "the market for reclaimed water is unbalanced and it is due to a growth on the supply side of the market, revealed by increasing number of wastewater treatment plants and stagnancy on the demand side revealed by the substantial proportions of the resource being discharged without proper utilization"

The reason for this imbalance is once again the institutional challenges facing implementation of reuse schemes and lack of community involvement in the implementation of those schemes. Success or failure of reclaimed water schemes largely depend on institutional factors, such as federal and/or state financial support, devolution of sufficient authority to local authorities, and development of innovative resource management institutions (Mills, 2000; Kasower, 1998; Ritchie et al., 1998, all cited in Haddad, 2002).

2.5.1.5 Financial feasibility and technicality

In addition to the above-mentioned impediments, financial feasibility is also important while implementing water reuse projects. Financing a reuse scheme is a challenge because acquiring funds to develop a water reuse scheme is an onerous task. Users' willingness to pay for the resource in question (wastewater in this case) to a large extent also influences the implementation of reuse schemes. According to Tsagarakis and Georgantzís (2003, p. 112), "more often than is usually believed, individually rational behaviour is compatible with socially desirable outcomes". Therefore, public perceptions and acceptance of wastewater, community participation and willingness to pay are all interlinked.

Willingness to pay for reclaimed water is also influenced by the tariff structure adopted in a particular scheme. The general tendency observed in case of water reuse schemes is that users might not be willing to pay more for this resource because it is considered as waste, so why pay for it? Therefore, the tariff structure should be such that the community being served should perceive it to be appropriate, as well as taking into account the long term viability of the service provider.

Sound technicality is another factor to be considered while implementing reuse projects. This is important because the effluent should be treated to a quality acceptable to the end user and matched to particular application. In the present context reclaimed water used for agricultural irrigation must be of very high quality to meet the process needs of the agriculture industry and to minimize the potential impacts on human health by inadvertent exposures. Therefore, the acceptability of reclaimed water for different uses is dependent on the specific application and is highly variable. See Table 2.6 for classification of reclaimed water for use in South Australia. In developing countries like India, treatment facilities are either not available or not implemented on the grounds of cost. In such situations, farmers using wastewater should be encouraged to adopt safer approaches. This can be achieved through participatory approaches such as farmer's field schools and public health education.

All the above-mentioned challenges facing wastewater management highlight the need to develop wastewater guidelines constituting a common vision and direction for wastewater management.

2.6 Conclusions

Irrigation with wastewater (treated and untreated) is a widespread reality. In developing countries, the use of untreated or partially treated wastewater for informal irrigation is common practice. However, the health risks associated with such practices is not receiving the attention it needs from policy makers in these countries. The developed countries like Australia rely on technical solutions (wastewater treatment) and have strict regulatory measures to manage the use of wastewater for irrigation or other purposes. On the other hand, in developing countries like India these treatment technologies are not available or often considered unaffordable. However, this issue can be addressed effectively through community and/or private sector participation, as demonstrated in countries like Australia (Thiyagarajah, 2005). Tsagarakis and Georgantzís, (2003, p. 105) in their study show that "well informed people, and especially users, have been proved useful to gain public acceptance and support for water recycling projects and increase their willingness to pay for them". The need is for an integrated approach to water resources management (IWRM), combined with locally appropriate and sustainable risk reduction measures, and the active involvement of stake holders from different sectors.

Chapter 3

Chapter 3: Water governance and institutional change

> Water is the true wealth in a dry land; without it, land is worthless or nearly so. And if you control water, you control the land that depends on it.
>
> *-Wallace Stegner, 1954*

3.1 Introduction

Water, both as a scarce natural resource and a good has always been regulated by societal entities exerting their social and political interference in different ways. General assumption is that public agencies possess all the necessary resources, expertise, and authority to manage water resources. Consequently, in most countries water is administered by a government department, or as a part of a ministry, or treated as a nationalised industry. It is estimated that nearly 95 per cent of water and wastewater services worldwide are provided by public water enterprises (Wolff & Palaniappan, 2004).

Organising the water sector is largely influenced by a country's overall standard of governance, its customs, mores, politics and conditions (Rogers & Hall, 2003; UNESCO, 2006). So variations can be seen in the ways the water sector is organised around the world. For many years, 'governance' was discussed and debated extensively in the context of society and development as a whole. But, in recent times, the notion of good governance has attracted the attention of water managers, planners, and policy makers because water crisis is seen as a crisis of governance (Rogers & Hall, 2003). This chapter discusses the concept of governance, particularly water governance and the features of effective water governance.

3.2 Water governance – concept and definitions

Governance and management are interdependent in the sense that effective governance systems should enable practical management tools to be applied correctly (UNESCO, 2003). Generally, the terms governance and government are used as synonyms, but in reality they differ. Therefore, before discussing water governance, a summarizing review of the literature on governance is presented.

3.2.1 Governance

The phrase 'governance' can be used in several contexts; characterised in a number of ways; and has a range of definitions. Likewise, it is presented in many forms in the development literature: 'global governance' (Keohane, 2002), 'self-governance' (Ostrom, 1990; Tang 1992), 'modern governance' (Gaudin, 1998), 'water governance' (Rogers & Hall, 2003), 'distributed governance' (Townsend & Pooley, 1995). However, because the term has been widely used since the early 1990s in economics and political science, the general impression is that 'governance' is a relatively recent term (Cleaver & Franks, 2005). Some of the definitions of governance are given below.

The UNDP (2006) defines governance as:

> "an exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences" (pp. 35-36).

Keohane (2002) defines it as, the making and implementation of rules and the exercise of power, within a domain of activity. As mentioned earlier, governance and government are

sometimes considered equivalent, whereas in reality they are different concepts. Rogers and Hall (2003, p. 4) bring out this difference while defining governance:

> "Governance is a more inclusive concept than government *per se;* it embraces the relationship between a society and its government. Governance generally involves mediating behaviour via values, norms, and, where possible, through laws……it also relates to government policies and actions".

McKay's (2007b, p. 150) definition of governance will help us to differentiate clearly between the concepts of governance and government. According to this author,

> "Governance is the process of decision making in the community involving both formal and informal actors at all levels. Government is just one of the formal actors in governance" (p. 150)

According to Stoker (1998), governance is ultimately concerned with creating the conditions for ordered rule and collective action and his five complementary propositions appropriately sums up the above-cited definitions:

- Governance refers to a set of institutions and actors that are drawn from but also beyond government.
- Governance identifies the blurring of boundaries and responsibilities for tackling social and economic issues.
- Governance identifies the power dependence involved in the relationships between institutions involved in collective action.
- Governance is about autonomous self-governing networks of actors.
- Governance recognizes the capacity to get things done which does not rest on the power of government to command or use its authority.

Further, governance is usually seen to entail "doing things right" (Cleaver & Franks, 2005), and therefore governance can be bad or detrimental, as it is in the case of the water resources sector. So, what are the features of good governance?

3.2.1.1 Attributes of good governance

Good governance is now the new mantra within the water sector. There is no single definition for good or effective governance. However, review of the development literature helps us to identify certain characteristics. Box 3.1 highlights some of the basic attributes that are likely to represent some of the features of good/effective governance.

Box 3.1: Attributes representing the features of good governance

Participation: all citizens, both men and women, should have a voice – directly or through intermediate organizations representing their interests – throughout processes of policy and decision-making. Broad participation hinges upon national and local governments following an inclusive approach.

Transparency: information should flow freely within a society. The various processes and decisions should be transparent and open for scrutiny by the public.

Equity: all groups in society, both men and women, should have opportunities to improve their well-being.

Accountability: governments, the private sector and civil society organizations should be accountable to the public or the interests they are representing.

Coherency: the increasing complexity of water resource issues, appropriate policies and actions must be taken into account so that they become coherent, consistent and easily understood.

Responsiveness: institutions and processes should serve all stakeholders and respond properly to changes in demand and preferences, or other new circumstances.

Integrative: water governance should enhance and promote integrated and holistic approaches.

Ethical considerations: water governance has to be based on the ethical principles of the societies, in which it functions, for example by respecting traditional water rights.

Source: UNESCO (2003, p. 373)

Grindle (2002) structures good governance around six principles: participation, fairness, decency, accountability, transparency, and efficiency. Likewise, the World Bank, Asian Development Bank (ADB), Global Water Partnership (GWP), United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) have all identified similar characteristics of good governance. Some of these characteristics, such as open and transparent, inclusive and communicative, equitable and ethical, are related to the approaches used by a governance system. The others, like accountability, efficient, responsive and sustainable are related to its performance and operation (Rogers, 2002; Rogers & Hall, 2003).

In Australia, the document "Good Governance Principles" (Australian Standard AS8000-2003), developed by Standards Australia International, provides a design for developing and implementing a generic system of governance suitable for a wide range of entities. These principles follow the Organization for Economic Co-operation and Development (OECD) "Principles of Corporate Governance" and are intended to "provide a system that is flexible enough to reflect each entity's individual circumstances" (AS 8000-2003, p. 13). The term 'entity' here can refer to a company, government department, government body, or not-for-profit organization. These principles cover five areas: (1) the role, powers and responsibilities of the Board; (2) disclosure and transparency obligations; (3) the rights and equitable treatment of shareholders; (4) the responsibilities of shareholders; and (5) the role of stake holders in corporate governance.

However, it must be remembered that these attributes are of an ideal model, difficult to achieve in its totality. Nevertheless, to ensure sustainable human development, actions must be taken to work towards the ideal model with the aim of making it a reality. In relation to water

governance, this can be achieved only when the institutions produce results that meet the needs of society by making the best use of resources at their disposal, thus leading to the sustainable use of natural resources and the protection of the environment. The term sustainability here implies providing the best outcomes for both human and natural environments, now and into the indefinite future. More detailed discussion on the concept of 'sustainable development' is discussed in the next chapter.

With this background on governance and features of good governance, the next section focuses on the concept of 'water governance' and its importance

3.2.2 Water governance

Within the water sector, the concept of governance is commonly used as a synonym for management, defined as the collective allocation of resources to achieve specific objectives (Cleaver & Franks, 2005). These authors further suggest that management implies managers interacting with stakeholders in the process of achieving outcomes, while governance describes the interactions between stakeholders to achieve them. Thus, water governance is concerned with the ongoing processes of extracting, distributing and using water within the present institutions. According to Rogers and Hall (2003),

> "Water governance is a range of political, social, economic and administrative systems that are in place to **develop and manage** water resources, and the delivery of water services, at different levels of society" (p. 12).

So, water governance can be viewed as a framework of political, social, economic, and legal structures within which societies choose and accept to manage their water related affairs. It

includes governments, the market forces that help to allocate resources, and any other mechanisms that regulate human interactions.

3.2.2.1 Importance of water governance

The UN World Water Development Report-2 (2006), while reporting on the state of global water governance observed that:

> "in many countries water governance is in a state of confusion: in some countries there is a total lack of water institutions, and others display fragmented institutional structures or conflicting decision-making structures" (UNESCO, 2006, p. 44).

The World Panel on financing global water infrastructure, in its report Financing Water for All (Winpenny, 2003), reported that serious defects in the governance of the global water sector are at the root of all the problems. The report highlights that:

> 'Water is not being sufficiently developed and conserved. Physical infrastructure is lagging behind need. Sector management is deficient; services are deteriorating, and deficits growing. Allied to this is a shortage of financial resources going into the sector' (p. 8).

For these reasons, water planners and policy makers agree that governance is one of the biggest challenges within the water sector.

So governance can be looked upon as processes of decision-making, involving both formal and informal actors in society at all levels – government is just one of these actors – and based on the outcomes of these processes, governance can be 'good' or 'bad'. For a governance system to be good or effective it should exhibit certain characteristics that are often difficult to achieve completely. Moreover, the policy shifts with respect to water management across the world support the view that water crisis is a crisis of governance. In view of that, during the

past decade, the natural resource management domain (the water sector in particular) has observed a major policy shift, as management responsibilities are transferred to users' groups or private utilities. With respect to irrigation systems, the focus has switched successively from on-farm improvement, to farmer involvement through Participatory Irrigation management (PIM), to Irrigation Management Transfer (IMT) and to quality service-oriented organizations (Prefol et al., 2006). Several factors such as inefficiency of the public agencies to manage the resource effectively, pushes from international lending institutions and the World Bank for community and private sector participation (mainly in the developing world), and demonstrations that users' groups could manage the resources more effectively than public agencies, were instrumental in this shift (Meinzen-Dick & Knox, 1999; Agarwal & Ostrom, 1999; Gyasi & Engel 2004; Tang, 1992; Meinzen-Dick & Sullins, 1994; Ostrom, 2000a; McCarthy, Dutilly-Diane & Drabo, 2002; Holm-Muller & Zavgorodnyaya, 2003).

Clear and efficient governance arrangements are critical to managing and delivering water services sustainably in any part of the world. So there is need for a new approach to govern the water resources with clearer roles for organizations, increased accountability, and more innovative service delivery. It is apparent that these days water governance has taken over from earlier ideas such as "managing water wisely" and is much broader than government (Cleaver & Franks, 2005) as it includes a range of actors and organisations such as private companies, co-operatives, and users' group or Water Users Association (WUAs).

The following section presents the shift in water resource management paradigm across the world.

3.3 Paradigm shift in global water resources management policy

With the global population growing rapidly, rapid industrialization and urbanisation, the traditional water systems around the world are coming under pressure (Dirksen, 2002). In most countries, irrigation is a major consumer of water. In developing or less-developed countries, the dominance of agricultural water use is the driving force for policy reforms, while in the industrialised countries, it is urban, industrial and environmental water demands that have spurred them (Turrall, 1998). As a result of reforms there has been a paradigm shift in water resources management policy around the world. What follows is a brief discussion about policy shifts, with emphasis on Australia and India, because these countries have a long history of water resource development and management.

3.3.1 United States of America

In the US, although water is a state resource there has been substantial federal influence through massive federal funding (Turrall, 1998). Until the enforcement of the Environmental Protection Act (EPA) of 1969, water development in the United States was heavily promoted by the Federal government through positive incentive programmes, although the states were able to finance local works such as water supply. With respect to inter- and intra-state water management there are three institutional, legal and political interests: (i) the constitution of the United States and the division of powers it makes between the Federal and the State governments; (ii) the federal system of political representation; and (iii) environment protection legislation (Turrall, 1998). State water legislation tends to be more regulatory, particularly in environment and water quality. The process of water resources development in the United States can be characterised for different periods as shown in Table 3.1.

Table 3.1: Different phases in United States water resources development

Period	Phase
1900–20	private versus public water exploitation
1921–32	growing federal role in water development
1933–44	reshaping the nation's waters for economic development
1945–69	encountering economic and environmental limits
1970–90	meeting future water needs

Source: (Frederick 1991, cited in Turrall, 1998)

In the United States the Federal government has left the regulation of water to the States, which develop their own codes of allocation and use, conservation and beneficial use. Different legislations have influenced the policy changes in the water sector over time; Table 3.2 gives a chronological account of the policy changes in the United States water sector.

Table 3.2: Legislation influencing policy change in the United States water sector

Year	Legislation related to water resources management
1902	The Reclamation Act; United States Bureau of Reclamation (USBR) became responsible for major hydroelectricity projects.
1917	Flood control programme begins
1933	Tennessee Valley Authority (TVA) set up; construction of an integrated system of 32 multi-purpose dams
1935	Soil Conservation and Domestic Allotment Act, authorised the Conservation Technical Assistance Programme
1936	Flood Control Act; US Army Corps of Engineers took a more active role in dam construction, Agricultural Conservation Programme (ACP) provided direct subsidies for the adoption of soil conservation technologies.
1954	Watershed Protection and Flood Prevention Act broadened provisions of the Flood Control Act to agricultural land.
1960	Flood Control Act recognizes need for a broader approach to flood management
1968	Wild and Scenic Rivers Act introduced to preserve habitats and amenities from development. Congress passes legislation for the National Flood Insurance programme (updated in 1973)
1969	National Environmental Policy Act; requires federal agencies to give full consideration to environmental impacts of all projects
1972	Clean Water Act (Federal Water Pollution Control Act Amendments) empowers states to impose minimum stream-flow requirements to protect water quality.
1973	Endangered Species Act (ESA) becomes the single most influential piece of legislation affecting water control Flood Disaster Protection Act of 1973, stressed non-structural responses to flood problems.

Year	Legislation related to water resources management
1974	Safe Drinking Water Act makes water quality rather than water supply the driving force behind the nation's water-related investment.
1977	Clean Water Act amendment introduces incentives for land based treatment of wastewater. Second national water assessment completed
1978	US Water Resources Council creates 18 water resources regions: nine covering 31 states in the east and nine covering 18 states in the west.
1982	Reclamation Reform Act signals removal of subsidies for irrigation development, and initiates the process of transforming the USBR into a regulatory, monitoring and planning agency.
1985	Food Security Act authorises the Conservation Reserve Programme (CRP), designed to meet goals for agriculture supply control, water quality and wildlife habitat in addition to farm income and soil erosion reduction.
1987	Clean Water Act amended to manage non-point source pollution and includes a 50 percent grant to implement state-level groundwater protection activities.
1988	Modifications to Central Arizona Project (CAP) to encourage tree planting in catchments in order to improve water quality.

Source: Turrall, 1998

3.3.2 Europe

Water resources management is largely determined by the national environment policy of the states in continental Europe. The framework legislation of the European Union (EU) is the basis for the orientation and the arrangement of subsidiary tasks assigned to national water management in western and southern European states (Dirksen, 2002, p. 201). The focus of the new EU water policy is on an integrated water resource management approach that takes into account the legitimate claims of society and nature. The most recent development in this regard is the enforcement of the Water Framework Directive (WFD) in December 2000, whose objective is to use and control ground and surface waters in such a way so as to strike a balance between human needs and nature conservation, by sustainable planning and public participation (Dirksen, 2002). The Directive is legally binding for all 15 Member States and has the following objectives (Blooch, 2000, cited in Dirksen, 2002):

- expanding the scope of water protection to all waters, surface and groundwater
- achieving "good quality status" for all waters by a certain deadline

- water management based on river basins
- ‘combined approach’ of effluent emission limit values and quality standards
- getting right the prices charged to water consumers
- getting the citizens involved more closely.

European countries have a long history of water resource development and management (Turrall, 1998), and along the way these countries have developed an enormous diversity of institutional and organizational structures for water management (Dirksen, 2002). So when it comes to water institutions and organizational structures, no two Member States of the EU are identical (Correia, 1998, cited in Dirksen, 2002). Despite this diversity there is an agreement among these states that “sustainable management of water resources requires an organizational structure, which is responsive to the needs of society and the users, and is financially autonomous” (Dirksen, 2002, p. 203).

As mentioned earlier, water legislation in EU is a part of environmental legislation and is a complex and graded system. Each administrative level (state, region and municipality) has to fulfil the specific tasks assigned. Further, the organizational structures in European states are characterised by attributes of self-governance and private initiative, and can be water boards, river commissions, and/or user associations. The scientific and professional associations are complementary organizations, responsible for preparing technical standards, guidelines, recommendations, and handbooks.

3.3.3 Israel

Water policy in Israel has always been tied up with agricultural policy, since agriculture is the major consumer of water resources. This is evident from the fact that in 2001, of the 1800.4 million m^3 of water allocated among urban, industrial and agricultural uses, approximately 1021.9 million m^3 (56%) was used for agriculture (Water Commission, 2002). Though the industrialisation and post industrialisation processes in recent years has resulted in a reduced role for agriculture, water policy is still a part of agricultural policy (Menahem, 1998). Development of water policy in Israel can be separated into three periods, as illustrated in Table 3.3.

Table 3.3: Periods in development of water policy and the highlights

Period	Highlights
1st period 1948-1967	Extensive governmental activity in water policy domain; Enactment of Water Law, 1959 to regulate production & water allocation Financing and implementing National large scale projects Water shortage perceived to be a problem of accessibility
2nd period 1967-1990	Completion of the National Water Carrier that carries water from the north of the country to the centre and south 1967 War-occupation of territories in the West Bank and Gaza Water shortage was seen as one of scarcity and not accessibility Prevalence of the policy paradigm of priority of agricultural expansion over preserving scarce water resources even under acute water crises. Cost of water for agriculture heavily subsidized
3rd period 1991-till present	Increased public debate and controversy over the direction of water policy Need to introduce changes in Israel's water policy was acknowledged Water pricing structure was altered, reassignment of water pricing from the parliamentary Water Committee to the Finance Committee Focus was shifted to green house crops and other crops which are not water intensive Appointment of a committee in 1994 to develop recommendations for the reform of water management and supply in Israel Committee recommended reduce involvement of public sector; increase private sector involvement in operating water production and supply systems; separation of the water and agriculture policies Recommendations met with total rejection by the Water Commissioner, pressure to offer alternative policy solution Called upon the old proposals for water desalination, large scale desalination became a favoured policy solution for those representing the agricultural interests.

Source: Modified from Menahem, 1998

The first period was characterised by extensive governmental activity in the water policy domain and water shortage was then perceived to be a problem of accessibility. During the second period the notion changed and water shortage was seen to be due to water scarcity; however, the policy paradigm of the priority of agricultural expansion over preserving scarce water resources still prevailed, even during acute water crises. In the third period there was increased debate over the direction of water policy, which resulted in some changes in water pricing, and crop selection; yet the policy changes still favour those representing agricultural interests.

So at present, although agricultural interests have been marginalized due to changing economic and political structures in Israel, water policy and agricultural policy are still intertwined, because of the organizational and personal affiliations of those who represent agricultural interests. Furthermore, recurrent acute water crises in Israel, have made necessary a national policy that recommends reuse of all municipal wastewater, along with desalination of seawater and brackish groundwater (Brenner et al., 2000). Thus, large-scale desalination has become the policy solution favoured by those representing agricultural interests.

3.3.4 Australia

The water industry in Australia operates under the State laws, since the Constitution of the Commonwealth of Australia, drafted at the close of the 19th century, clearly intended that natural resource policy, including that relating to water and water quality, would remain a responsibility of the States. One section of the Constitution specifically restricts the role of the Commonwealth in relation to water; according to Section 100, Chapter IV "The Commonwealth shall not, by any law or regulation of trade or commerce, abridge the right of

a State or of the residents therein to the reasonable use of the waters of rivers for conservation or irrigation" (http://www.constitution.org/cons/australia.txt). Even so, the Federal Government has the capacity to indirectly influence any area of public policy in Australia, and the Federal Government has indirectly influenced the water sector by developing national policies through agreement with the State and Territory Governments.

In view of Australia's Federal structure, the path of actual reform is left to the judgment of the States. As a result, different States and Territories have introduced such reforms at different rates and in different ways (Srivastava, 2004). Because of power sharing, each State Government has created its own unique system for the allocation and use of water, and the bodies providing water, gas and power became powerful in each State, while not working together (McKay & Halanaik, 2003). This led to a crisis in this shared resource, which in turn has forced the States to form agreements, such as the Murray Darling and Border Ranges agreements (McKay, 2002). This has led to a further set of reforms within the Australian water sector, which are discussed in a later section, on institutional change.

3.3.5 India

India is a Union of States and the constitutional provisions with respect to allocation of responsibilities between the State and the Centre fall into three categories: The Union List, the State List, and the Concurrent List. As most of the rivers in the country are inter-State, the regulation and development of waters of these rivers is a source of inter-State differences and disputes. Therefore, in the Constitution, water is a matter included in Entry 17 of the State List. This entry is subject to the provision of Entry 56 of the Union List which confers powers on the Central Government to regulate and develop inter-State rivers and river valleys to the

extent declared legally by the parliament to be expedient in the public interest (http://wrmin.nic.in/).

Water governance in India is a complex issue, with several water institutions (ministries and departments) assigned different roles and responsibilities; however the Ministry of Water Resources (MoWR), Ministry of Rural Development (MoRD), and Ministry of Environment and Forests (MoEF) are the three major ministries directly concerned with water management. When we speak of water sector reforms in India, it is evident that these ministries have shown a clear policy shift from a supply-driven to a demand-driven approach, characterised by decentralisation and user participation (Joshi, 2004). The Common Guidelines for Watershed Development developed by the MoRD highlight these principles and most of its programmes are based on the principle of user participation (Shah, 2001). Likewise, in the irrigation sector, there is a clear trend to user participation in Operation and Maintenance (O&M) of the irrigation systems, particularly in medium and minor irrigation schemes. This has been achieved by promoting a Participatory Irrigation management (PIM) programme, which has been incorporated as an important component into water resources management by the MoWR.

Thus, the shift in water governance paradigms clearly reveal that water governance has now taken over from earlier ideas of "managing water wisely," and includes a range of actors and agents that is much broader than government (Cleaver & Franks, 2005). As pointed out by Dirksen (2002, p. 200), "a comprehensive and balanced water policy has to satisfy the demands of all water users, assigning suitable roles to the participating actors, i.e. government,

administration, public and private enterprises as well as consumers". The following points highlight the features of the changed water policies around the world:

- Recognize water as a social and an economic good
- Recognising the importance of user contributions
- Recognize the need for decentralisation and community management, and
- Recognize the need for inclusion of historically marginalised sections in water management initiatives.

To sum up, "most major water policies in India have gradually and at different paces evolved towards recognising water as a social and an economic good and the importance of user contributions; the need for decentralisation and community management; and the need for inclusion of historically marginalised sections in water management initiatives." (Joshi, 2004, p. 6-7).

The foregoing discussions reveal that the ways of organising the water sector vary across countries, since they reflect local political, cultural, and administrative traditions (Rogers & Hall, 2003). Given the variations in water resources management, most researchers and policy makers in the water sector today agree that there is an urgent need to make a transition from a water resource development mode to a water resource management mode, by embracing Integrated Water Resources management (IWRM) (Shah & van Koppen, 2006). The United Nations World Water Development report-2 (2006) views IWRM as a comprehensive approach to the development and management of water. Allan (2001) argues that the next water resource management paradigm is when water users can assimilate IWRM as a political

process and not just as a technical, investment, or information sharing process. According to Gleick (2000) the new paradigm for water planning places a high value on maintaining the integrity of water resources and the flora, fauna and human societies that are built around them. He indicates that, in addition to increasing the efficiency of water use and allocation, non-traditional sources of supply (reclaimed or recycled water) will play an increasing role in the water management agenda. Easter and Hearne (1995) describe this paradigm shift well when they discuss the new World Bank policy on water management. According to them:

> "the new Bank policy has two key components. First, is the adoption of a comprehensive management framework, which calls for water to be treated as an economic good. Second, is a great decentralization of service delivery, greater reliance on pricing, and finally autonomous service entities, along with a much fuller participation of water users in the management of water resource systems" (Easter and Hearne 1995, p. 13)

Consequently, the way in which water is managed has changed considerably over the years, which can be attributed to continuously evolving technologies, altered understandings and perceptions of water, new lifestyles, and economic development (Huitema & Meijerink, 2007). Water governance today involves a range of stake holders- the government, civil societies, and the private sector, each with their own responsibilities. It is concerned with how institutions rule and how regulations affect political action and the prospect of solving societal problems, such as efficient and equitable allocation of water resources (UNESCO, 2003, p. 372). Huitema and Meijerink, (2007) rightly argue that in the past decades water management has undergone fundamental changes. Therefore, it is imperative to understand the dynamics surrounding the development, introduction, and implementation of such institutional change, and how it occurs.

3.4 Institutional change and water transition

A literature review on institutional change comes up with a number of definitions of institutional change. According to scholars like North and Ostrom, institutional change focuses more on the rules and processes that govern relationships between organizations and the public, and different organizations (North, 1990; Ostrom, 1990). Hargrave and Van de Ven (2006, p. 866) define institutional change as "a difference in form, quality, or state over time in an institution".

According to Hobley and Shields (2000, p. 15), "institutional change refers to change in the architecture and relationships between agencies and organizations. It addresses issues in the wider environment such as policy, laws, governance structures as well as issues of co-ordination between agencies (for example, contracting-out services)". The authors further identify the main instruments of institutional change as:

- Pluralistic delivery systems (e.g. privatisation of State roles, explicit roles for NGOs and private companies, new organizations);
- The strengthening of civil society by creating or supporting new civil organizations (e.g. Users Associations and other community-based organizations); and
- Newly defined, often contractual, relationships between organizations (e.g. increased provision of services through contracting and service agreements, competitive tendering arrangements) or, in the present case, partnership agreements between State, private company and the community.

It appears that most of the above definitions do not consider norms and values. However, in the present context, a definition of institutional change not only refers to a change in the relationships between agencies and organizations but also incorporates the changes in value systems, informal and formal norms and rules of behaviour between agents, and also between agents and organizations (Wegerich, 2001). The next question is – what brings about this (institutional) change?

3.4.1 Types of institutional change and reasons for them

Baez and Abolafia (2002), based on their data and readings of institutional change literature suggest that:

> "Institutional change in organizations rests on three assumptions. First, organizational actors make sense of, or interpret their organizations and environmental contexts in order to simplify the world they live in….. Second, environmental pressures change in sometimes unpredictable and unexpected ways, and actors are affected by these shifts….. Third, the degree to which actors take their context for granted varies with environmental pressure… (Baez and Abolafia, 2002, p. 527).

The authors further illustrate how institutions change over time by using metaphors from the field of music – keying, improvisation, and reprise – as indicated in Table 3.4.

Table 3.4: Metaphors for institutional change

Music themes	Institutional change context
Keying	Pursuing change practices that leave arrangements essentially unchanged
Improvisation	Using creativity, intuition, and flexibility to fundamentally change a relatively structured situation
Reprise	Reasserting a former sense of order by stabilizing and internalising improvised routines

Source: Baez and Abolafia (2002, p. 528)

Lin (1989) argues that institutional change can be induced or imposed and explains these two different types of institutional change as follows:

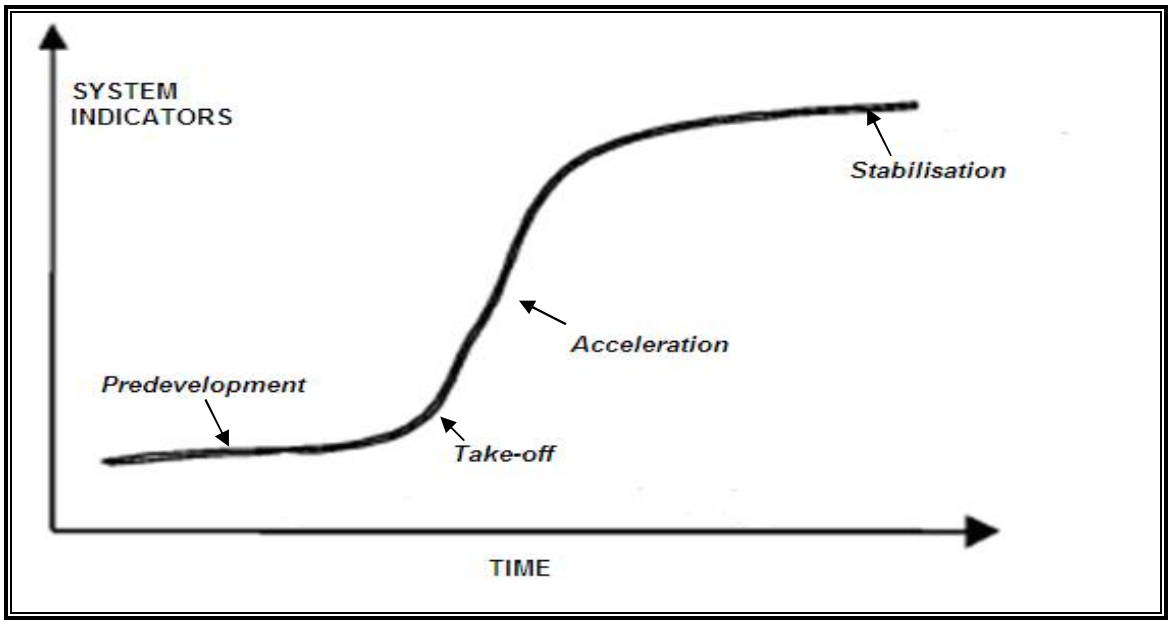
> "An *induced* institutional change refers to a modification or replacement of an existing institutional arrangement or the emergence of a new institutional arrangement that is voluntarily initiated, organised, and executed by an individual or a group of individuals in response to profitable opportunities. An *imposed* change, in contrast, is introduced and executed by governmental orders or laws" (Lin, 1989, p. 13).

In addition, in the New Institutional Economics (NIE) literature we come across two different approaches – demand and supply induced – to explain institutional change (see Wegerich, 2001). Moreover, there is an extensive interdisciplinary literature on institutional change and it is difficult to arrive at a single theory of change. Therefore, Van de Ven and Hargrave (2004) present four distinct perspectives of institutional change – institutional design, institutional adaptation, institutional diffusion, and collective action – each of which addresses different questions and relies on a unique generative mechanism to explain change.

However, in the present context, the last perspective of institutional change/collective action perspective is more relevant, described by Van de Van and Hargrave (2004) as processes of institutional change initiated by social movements, and entrepreneurs pursuing technological innovations. In addition, Lin (1989, p. 3) argues that institutional changes often require collective action, since the change from an existing institutional arrangement to an alternative is a costly process and 'free-riders' are an innate issue in institutional change.

3.4.2 Water transition

A transition can be described as "a set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology, and belief systems" (Rotmans, Kemp and van Asselt, 2001, p. 2). Further the authors distinguish four different transition phases that are illustrated in Figure 3.1.



Source: Rotmans, Kemp and van Asselt (2001, p. 3)

Figure 3.1: The four phases of transition

According to Rotmans, Kemp and van Asselt (2001, p. 3) these different phases can be characterised as follows:

- *Predevelopment phase*: the status quo does not visibly change;
- *Take-off phase*: the process change gets under way, because the state of the system begins to shift;
- *Acceleration phase*: visible structural changes take place through an accumulation of social-cultural, economic, ecological and institutional changes that react to each other;

- *Stabilisation phase*: the speed of social change decreases and a new dynamic equilibrium is reached.

Therefore, like any other sector or domain, the water sector has also experienced transition. As observed by the World Bank Water Resources Sector Strategy (2001) a series of transitions are under way in meeting the water resource challenges that have major implications for water management. These transitions are:

- From development, or management, to development and management
- From local to regional and international management.
- From disputes to cooperation.
- From public to public-private partnership

These transitions have been conceptualized by Hoekstra and Huynan (2002), cited in Lotze-Campen, Lucht, and Jaeger (2002), who distinguish the three phases of a water transition and explain them as follows:

> "In a *first* phase, increasing water withdrawals and rates of pollution disturb the original near-equilibrium of the water system. This disturbance is self-reinforcing…. which in turn prompts further exploitation of, and thus pressure on, the water system. In a *second* phase, increasing water scarcity and rising water supply costs induce competition between water users. Water supplies become less reliable, which leads to temporary shortfalls…. In a *third* phase, water consumption reaches a level at which people are forced to increase water-use efficiency and reduce pollution" (cited in Lotze-Campen, Lucht, and Jaeger, 2002, p. 294).

3.4.3 Water transitions in Australia

Australian water sector reforms were the result of a broader reform agenda initiated during the 1980s and 1990s (Srivastava, 2004). Between 1960 and 1992, Australia slipped from being the third richest developed nation in the world to the fifteenth position. This drove successive

governments to initiate a package of reforms, particularly infrastructure reforms, including the water infrastructure. Since 1992, the Australian Government has embarked on two phases of ambitious reform of state laws and policies for water management. The first, in 1994, is known as the Council of Australian Government (CoAG) reforms, and the second, in 2004, is known as the National Water Initiative reforms (McKay, 2006, p. 115).

These water sector reforms were prompted by a number of domestic environmental and social issues and international processes, and were targeted at reducing government activity in water management. However, initiation of the reforms in the water, gas, electricity, and transport industries that were adopted in the form of the National Competition Policy (NCP) in 1995 is seen as the driver of change in the Australian water industry. The water sector reforms in Australia can be explained as follows:

> "The NCP and the CoAG Water Reform Agenda are the two principal pillars of government policy stimulating reform in the water industry at the national level. The National Water Quality Management Strategy (NWQMS), which provides guidelines to regulate issues related to public health and the environment, and the National Environment Protection Council (NEPC) are the two other elements of the reform framework" (Srivastava, 2004, p. 3)

Nevertheless, the purpose of the reforms was to achieve efficient and customer-oriented service by restructuring the public water utilities (McKay & Halanaik, 2003). McKay explains these reforms or shifts as 'four paradigms of formal water resources laws and policies since 1788' (McKay, 2006 p. 115). As a result of these reforms, every State in Australia has introduced its reforms in a different way, and consequently the water services industry in Australia provides examples of a variety of models for water service provision, a variety of regulatory regimes, and some examples of private sector participation.

Borrowing Rotmans, Kemp and van Asselt's (2001) expression of transition, it is evident that while moving towards a stabilisation phase the water sector in Australia is currently in the acceleration phase.

3.4.3.1 Institutional arrangements and regulatory regimes

Across Australia, South Australia (SA), Western Australia (WA) and the Northern Territory (NT), and the Australian Capital Territory (ACT) each have a single state-owned utility with the primary responsibility for water supply and sewerage services. The local governments or local boards are vested primarily with the responsibility for water and sewerage services in New South Wales (NSW), Queensland (QLD), and Tasmania (TAS). The state of Victoria (excluding Melbourne) offers the only example of regional utility model in which more than one utility exists and each of them services multiple local-government agencies. However, this is a very recent evolution.

With respect to ownership and operations, State or local governments own all the water utilities in Australia. With the exception of some irrigation schemes, there has been little privatization in the water sector. However, there has been restructuring and institutional role separation within the public sector departments. The public sector departments have been transformed to corporations, subject to the same laws that govern the private sector, and with clear commercial objectives (Srivastava, 2004). Further, a number of water utilities have contracted out their design, construction, and various operational roles to the private sector through service or management contracts. This process is usually termed corporatisation

wherein government owns the assets but contracts out the management (McKay & Halanaik, 2003). This has been achieved through various models available for private sector participation, which will be discussed in Chapter Four. Likewise, Australia has a variety of regulatory regimes: health regulation, environmental regulation and economic regulation.

An economic regulator has the responsibility both for prices and for customer service standards. The emerging trends and practices in Australia with respect to economic regulation show a clear shift towards independent regulation, and most of the States and territory jurisdictions favour a multi-sector approach. For health regulation, in almost all the states the health department controls compliance with national water and sewerage quality standards. Environment regulation comes under an Environment Protection Authority/Agency (EPA) in all states, except in Western Australia and the Northern Territory, where it is the responsibility of a department. Proper pricing of rural and urban water is one of the key issues for reform in the Australian water industry; as a part of the COAG reforms, the 'pay for use' principle was adopted, which provides for water services to earn fair rate of return, ensuring that their business is financially viable and sustainable. All states have adopted a two-part tariff for water provision, consisting of a fixed access fee and a charge for usage. Sewerage charges are generally fixed.

Water management in Australia is a complex process and Table 3.5 shows the principal water management agencies for each jurisdiction, the principal legislation relating to water management, the institutional model for water service provision and the authority responsible for price setting in each state.

Table 3.5: Water management agencies and institutional arrangements for water service provision across Australia

State/Territory	Lead jurisdictional body for water management	Principal legislation relating to water management	Institutional model for water service provision			Price- setting
			State-owned utility	Local government	Regional utility	
Western Australia	Department of Water	Rights in Water and Irrigation Act 1914, amended in 2001	√	X	X	Government
Victoria	Department of Sustainability and Environment	Water Act 1989; Groundwater (Border Agreement) Act 1985	X	X	√	Regulator
Queensland	Department of Natural Resources, Mines and Water	Water Act 2000; Wild Rivers Act 2005; Integrated Planning Act 1997	X	√	X	Local bodies
New South Wales	Department of Natural Resources	Water Management Act 2000; Water Act 1912	X	√	X	Regulator
South Australia	Department of Natural Resources, Mines and Water	Natural Resources Management Act 2004; Groundwater (Border Agreement) Act 1985	√	X	X	Government
Tasmania	Department of Primary Industries and Water	Water Management Act 1999	X	√	X	Local bodies
Australian Capital Territory	Environment ACT	Water Resources Act 1998	√	X	X	Regulator
Northern Territory	Department of Natural Resources, environment and the Arts	Water Act 1992	√	X	X	Regulator

Source: Modified from Srivastava (2004) and http://www.water.gov.au/WaterAvailability/Water Management/;

Note: This table does not cover the regional licensing authorities for each state, urban authority or catchment management authorities, which have powers for water management that are delegated under various Acts.

√ = Model currently exists and X= model does not exist

3.4.4 Water transitions in India

As with water transitions all over the world, India too has experienced a water transition; the current water management regime advocates community participation. There has been a major shift in water management, where the Government of India (GoI), through its Sector Reform Programme (SRP), aims to create a sense of ownership and control by local communities of assets created through partial contributions (Joshi, 2004). This is true for other programmes for managing the commons, such as participatory watershed development, participatory irrigation management (PIM), and joint forest management (JFM). Although these programmes have been initiated in response to the incapacity of public sector to effectively operate and maintain the resource systems (Nicol, 2000, cited in Joshi, 2004) and the failure of supply-driven approaches to deliver these services to the rural poor, the major thrust for institutionalising and implementing these programmes has been from the World Bank, through its various projects (Joshi, 2004). Although, under the Indian Constitution, provision of water is the responsibility of the State governments, the Union Ministry of Water Resources, at the central level, is responsible for development, conservation and management of water as a national resource. It also oversees the regulation and development of inter-state rivers through various Central organizations. Urban water supply and sewage disposal is the responsibility of the Ministry of Urban Development, while rural water supply is handled by the Department of Drinking Water, under the Ministry of Rural Development. Hydroelectric power is the responsibility of the Ministry of Power, while pollution and environment control comes under the Ministry of Environment and Forests.

3.4.4.1 Institutional Arrangements

As mentioned earlier, since water is a state matter, the State governments have primary responsibility for its use and control. At the State level, major and medium-sized irrigation projects are handled by irrigation departments, while minor irrigation is looked after partly by water resources departments, minor irrigation corporations, Zilla Panchayats, and other departments such as agriculture. Urban water supply is the responsibility of Public Health Departments and rural water supply is taken care of by Panchayats. Hydropower is the responsibility of the State Electricity Boards.

Adopting Rotmans, Kemp and van Asselt's (2001) idea of transition, in India, water sector has yet to reach the acceleration phase. It can be said that, with the passing of National Water Policy 2001, India has entered the take-off phase, but more needs to be done to move towards the stabilisation phase. However, the journey up to now, the history of institutional development of water resources that dates back to the pre-independence period, can be illustrated by listing events since 1855 (Table 3.6).

Table 3.6: Chronological list of events in the development of water institutions in India

Year	Event
1855	Irrigation & Power made the responsibility of the Public Works Department (PWD)
1858	Extensive canal construction and appointment of Inspector General of Canals
1863	Decision to place irrigation under the charge of an irrigation expert designated as Inspector General of Irrigation, under the administrative control of Secretary, PWD
1919	Under the Government of India Act 1919, irrigation became a provincial subject and Government of India's responsibility was confined to advice, co-ordinate and settlement of disputes over right on water of inter-provincial rivers.
1923	PWD was merged with the Department of Industry into the Department of Industries and Labour which looked after the subject of Irrigation and Power
1927	A Central Board of Irrigation was constituted
1937	Department of Industry and Labour was split into the Department of Communication and Department of Labour. The latter looked after the work relating to Irrigation and Power. Later, on the recommendation of the Secretariat, Reorganization Committee, Department of Works, Mines and Power was created to look after the subject of Irrigation and Power.

Year	Event
1951	A new Ministry of National Resources and Scientific Research was set up which took over the subjects of Irrigation and Power from the Ministry of Works, Mines and Power.
1952	A separate Ministry of Irrigation and Power was set up to look after irrigation.
1969	An Irrigation Commission was set up to address the question of future Irrigation development programme in the country in a comprehensive manner.
Nov 1974	A separate Department of Irrigation was set up under the re-constituted ministry of Agriculture and Irrigation to help implementation of Irrigation and Command Area Development projects
Jan 1980	Department of Irrigation came under the new Ministry of Energy and Irrigation
Jun 1980	Ministry of Energy and Irrigation was bifurcated and the erstwhile Department of Irrigation was raised to the level of Ministry
Jan 1985	Ministry of Irrigation was once again combined under the Ministry of Irrigation and Power.
Sep 1985	Ministry of Irrigation of Power was bifurcated and the Department of Irrigation was re-constituted as the Ministry of Water Resources.
Sep 1987	The National Water Resources Council (NWRC) was constituted under the Chairmanship of Prime Minister and the NWRC adopted the National Water Policy
Sep 1990	National Water Board was constituted
Apr 2002	The National Water Resources Council adopted the revised National Water Policy -2002

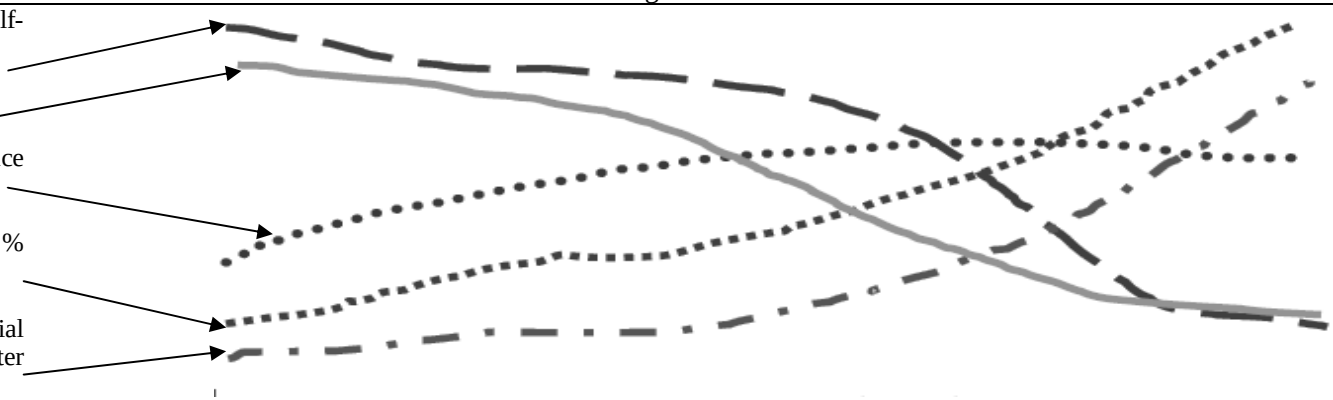
Source: Compiled from http://wrmin.nic.in/

Focusing on the discussions about water governance and water transitions in Australia and India, it is clear that the water governance regime and institutional environment are different in both countries. The difference can be attributed to varying social, economic, and political settings. Moreover, both countries have different water economies in the sense that water economy in Australia is formal while in India the water economy is informal. The next section briefly explains the concept of formal and informal water economies.

3.5 Formal and Informal Water Economies

Water economies around the world are generally grouped under two broad categories: Formal and Informal. The distinction between a formal and informal water economy is based upon the stage of "**formalisation**" of the water economy in a particular country which means "the

proportion of the economy that comes under the extent of direct regulatory influence" (IWMI, 2007, p. 2). According to (Fiege, 1990, cited in Shah and van Koppen, 2006), an informal economy is that part of the economy that remains outside formal mechanisms of governance-law, policy and administration. Shah and van Koppen (2006) categorise the water economies around the world into four stages: (I) Completely Informal; (II) Largely Informal; (III) Formalizing; and (IV) Highly Formal. The authors focus more on the dominant mode of water service provision and related institutional arrangements. However, looking at the shift in water governance paradigms, the transformation in water economies can be extended to Stage V, where the formal institutional arrangements governing water are supported by active involvement of informal actors or institutions (see Figure 3.2).

	Stage I: Completely Informal	Stage II: Largely Informal	Stage III: Formalising	Stage IV: Highly Formal	Stage V: Highly Formal + engage Informal institutions
% of users in the formal sector	< 5 %	35%	35-75%	75-95%	> 90 %
Dominant mode of water service provision	Self-supply and informal mutual help community institutions	Partial public provisioning but self supply dominates	Private public provisioning; attempts to improve service and manage the resource	Rise of modern water industry; self-supply disappears	Rise of modern water industry, cooperation at a levels; self-supply disappears
% of total water use self-supplied % rural population Cost of water service provision Cost of domestic water as % of per caput income Human, technical financial resources used/km of water diversion					
Institutional arrangements	Self-help, mutual help, and feudal institutions dominate	Informal markets, mutual help and community management institutions	Organised service providers, self supply declines, informal institutions decline in significance	Self supply disappears, all users get served by modern water industry	All users get served; engage informal institutions integrate policy and activities at all levels- national, regional, local and the individual to achieve Ecologically Sustainable Development (ESD)
Examples	Sub Saharan Africa	India, Pakistan, Bangladesh	Mexico, Thailand, Turkey, eastern China	USA, Canada, Western Europe, Australia	Australia, Canada, Singapore

Source: Modified from Shah and Barbara van Koppen (2006) and McKay (2007b)

Figure 3.2: Formal and informal water economies and the transition stages in water management

However, it should be recognised that while dealing with water governance and the water supply industry, it is difficult to sketch a clear distinction between the terms 'formal' and 'informal' mainly because "in practice, there is an extensive range from the fully formal to the totally formal activities involved in water management" (Devas, 1999, p. 18). For example, Moretto, (2005) gives an account of how the word 'informal' is used in different contexts within the water sector (see Table 3.7).

Table 3.7: Types of informality in water services

Informalities	Definitions
Informal **providers**	small independent providers from household vendors of water, small network providers, and private entrepreneurs to cooperative. In some cases they are primary suppliers, and in others they supplement the formal providers
Informal **suppliers**	tanker and cart carriers intermediaries
Informal **system/practices**	water as a gift; secret connections; public provisions distorted by bribery; informal sector vendors; water sold from privately owned wells
Informal **activities**	are those which do not have full, official recognition or do not comply in some way or other with official procedures and rules
Informal **arrangements**	informal institutional arrangements understood here as rule-enforcing mechanisms, including customs, norms and values, religious benefits and social and solidarity networks
Informal **networks**	such informal organizational networks have no social, legal or political status.

Source: Moretto, (2006): p. 11

This study adopts the classification of formal and informal economies by IWMI (2007) according to which water economies in the developing countries are largely informal while they are more formal in developed countries. In developing countries like India water users depend largely on self-supply, informal exchanges and local community institutions while in developed countries like Australia most users are served by public or private service providers (IWMI, 2007; Shah & van Koppen, 2006). In the context of this study, Australia has formal arrangements to govern wastewater use for irrigation and other purposes while in India it is still uncontrolled, and unregulated.

3.6 Conclusions

Water has always been regulated by societal entities exerting their social and political interference in different ways. General assumption is that public agencies possess all the necessary resources, expertise, and authority to manage water resources. During the past decade however, the water sector has observed a major policy shift as management responsibilities are transferred to users' groups or private utilities due inefficiency of the public agencies to manage the resource effectively, pushes from international lending institutions and the World Bank for community and private sector participation, and demonstrations that users' groups could manage the resources more effectively than public agencies. It is apparent that these days water governance has taken over from earlier ideas such as "managing water wisely" and is much broader than government; includes a range of actors and organisations such as private companies, co-operatives, and users' group or Water Users Association (WUAs).

To sum up, governance can be looked upon as processes of decision-making, involving both formal and informal actors in society at all levels – government is just one of these actors – and based on the outcomes of these processes, governance can be 'good' or 'bad'. Clear and efficient governance arrangements are critical to managing and delivering water services sustainably in any part of the world. So there is need for a new approach to govern the water resources with clearer roles for organizations, increased accountability, and more innovative service delivery.

Having discussed the concepts of water governance and institutional change it now becomes necessary to understand the theories related to water governance and management, particularly when IWRM is seen as the appropriate management tool for sustainable use of our water services and for improved delivery of water services. In line with this, Chapter Four is devoted to discussions on theories related to water governance and management in the present scenario. The theories deal with the following:

- Institutions,
- Collective action,
- Social sustainability and social capital,
- Public governance, and
- Distributed governance and Strategic alliance.

Chapter 4

Chapter 4: Theoretical framework

> Beautiful hands are those that do work that is earnest and brave and true, moment by moment, the long day through.
>
> -A.P.J. Abdul Kalam

4.1 Introduction

The arguments presented in previous chapters (2 & 3), have shown that the concepts of water governance and institutional change have a number of dimensions, span diverse disciplines, and are related to various theories. This makes it difficult to integrate them into a single perspective. In addition, in the context of this study we have to deal with concepts such as strategic alliances and partnerships between the public and private sector, and the role of self-governing institutions such as the Water Users Associations (WUAs). Taking account of these points, this chapter will examine the theories and concepts relevant to the present study.

4.2 Theory of institutions

Institutions are part of our daily life and the term 'institutions' in everyday use often refers to ministries, departments, associations, and unions that are actually 'organizations' (Bandaragoda, 2000). The two terms 'institutions' and 'organizations' are so common in usage that they are often used as synonym. But it should be realized that they have some distinct meanings. Therefore, a clear understanding of these terms is important. It is more important in the present context when the objective is to analyse the institutional arrangements governing the urban wastewater use for agriculture in Australia and India. What follows is a clarification of the two terms.

4.2.1 Institutions and organisations defined

In general sociology, an institution depends on organized, established procedures that are represented as constituent rules of society, or 'rules of the game' (Jepperson, 1991, cited in Bandaragoda, 2000). We find a similar interpretation by North, who defines institutions as the rules of the game in a society, or the humanly devised constraints that shape human action (North, 1991). According to MacDonald and Dyack (2004), institutional arrangements include both administrative arrangements, and the ways that rules regulating water use and reuse are defined. Adopting various definitions of institutions from the literature, Bandaragoda (2000) sums up an institution as:

> "a combination of policies; laws, rules and regulations; organizations, their bylaws; operational plans and procedures; incentive and accountability mechanisms; and norms, traditions, and practices" (p. 5).

Institutions, therefore, set the ground rules for resource use and establish the incentives, information, and compulsions that guide economic outcomes. They are the sets of the users' rights in relation to the resource in question, and the rules that define what actions they can take in using it. According to Davis and North (1997, pp.6-7), institutions can be differentiated as those related to the political, legal and social environment of an economic system, and those related to arrangements between economic units that govern the ways in which these units can cooperate and/or compete.

Organisations on the other hand, are groups of individuals with defined roles and bound by some common purpose and rules and procedures to achieve set objectives. Merrey (1993, p.8) describes organizations as "structures of recognized and accepted roles". North (1990, p.73) defines organizations as "purposive entities designed by their creators to maximize wealth,

income, or other objectives defined by the opportunities afforded by the institutional structure of the society." According to Cernea (1987 cited in Bandaragoda, 2000) organizations are networks of behavioural roles arranged into hierarchies to elicit desired individual behaviour and coordinated actions obeying a certain system of rules and procedures; and the hierarchical arrangement is referred to as the 'organizational structure'. Organisations can be government agencies, companies, political parties, churches or non-governmental organisations.

Nevertheless, institutions and organizations are interlinked and this interaction can be perceived in two ways:

1. Evolution of organizations is influenced by the institutional framework. Eg: In Australia, the creation of NRM Boards or Water Boards followed the articulation of natural resources or water-related policy, and the enactment of water law.
2. Organizations represent a set of norms and behaviours and are in fact institutions. Eg: Water Users Associations (WUAs) in India

From the view point of this study, the focus is on the governance mechanisms, which are comprised of formal and informal institutions and support organisational forms for the production and/or exchange of assets (Bandaragoda, 2000; Zenger, Lazzarini & Poppy, 2001)

4.2.2 Formal and informal institutions

Institutions can be both formal and informal because apart from written laws, rules and procedures, informally established procedures, norms, practices and patterns of behaviour also form part of the institutional framework. This is largely because informally established procedures and norms become 'rules' in their own right, when they are accepted by the society

after years of practice. For example, rotational irrigation systems (Ostrom, 1990) and contracts, implicit or explicit (Nabli & Nugent, 1989, cited in Herath, 2002) are institutions because they embody rules and regulations that govern specific activities of the irrigators or the parties involved. However, lack of proper enforcement or disregard of the written laws can make them ineffective, and as a result they replaced by a set of practices referred to as 'rules-in-use' (Bandaragoda, 2000). These rules are "prescriptions that define what actions (or outcomes) are required, prohibited, or permitted, and the sanctions authorized if the rules are not followed" (Ostrom, Gardener & Walker, 1994, p. 38). It is "the final element that structures an action arena" (Schlager & Blomquist, 1998, p. 4).

These formal and informal institutions define the behavioural roles of individuals and groups in a given context of human interaction, aiming at a specified set of objectives – like the use of urban wastewater for irrigation in the present case. Since the study involves two nations with different socio-economic and political settings it is important that we realise that in many developing societies, informal rules have a tendency to override formal rules, making the enforcement of formal rules very difficult and thereby affecting performance (Bandaragoda & Firdousi, 1992). Zenger, Lazzarini & Poppo (2001, p. 2) distinguish the terms formal and informal institutions as follows:

> "Formal institutions are the rules that are readily observable through written documents or rules that are determined and executed through formal position, such as authority or ownership. Formal institutions, thus, include explicit incentives, contractual terms, and firm boundaries as defined by equity positions. Informal institutions, in turn, are the rules based on implicit understandings, being in most part socially derived and therefore not accessible through written documents or necessarily sanctioned through formal position. Thus, informal institutions include social norms, routines, and political processes".

However, for the purpose of institutional analysis in this study both, the underlying institutions and the organizations as agents of institutional change will be considered. Accordingly, this study uses a broad interpretation of institutions as suggested by Saleth and Dinar (1999). This interpretation covers all three important elements in the institutional framework, namely policies, laws and organizations, and is particularly chosen for the study, because it is more easily amenable to institutional analysis aimed at effective water governance.

4.2.3 Functions of institutions

Institutional arrangements or rules-in-use serve as instruments for human cooperation (North, 1991) and they can minimize vulnerability, scarcity and conflict; thus enhancing sustainable management of water resources (Marothia, 2003). They are applied to resolve conflicts, to maintain a coordinated flow of action and transactions in the society, to indicate what individuals can, must, or may or may not do, and are enforced by collective sanctions (Commons, 1931; Marothia, 2003; Marothia, 2002; Herath, 2002; Gonce, 1971, cited in Marothia, 2003). Therefore, institutional arrangements can be subdivided into two sets: (i) operational rules and (ii) collective choice rules (Tang, 1992), who points out that operational rules stipulate who can participate as appropriators and providers; what participants may, must, or must not do; and how they will be rewarded and punished, while collective choice rules stipulate the conditions for adopting, enforcing, and modifying the operational rules. Operation rules generally include boundary, allocation, input and penalty rules, which coordinate irrigators in allocation and maintenance activities and collective choice rules interpret the content of institutional arrangements favouring collective action.

Institutions also shape the incentives for individuals to take certain actions such as cooperate, engage in collective action, and/or coordinate activities to achieve desired outcomes. Hence, the incentives individuals have to be involved in group activities also influence the success or failure of the collective action initiatives. This is why some communities succeed while others fail to sustain cooperative behaviour. More on collective action will be discussed later in this chapter. However, in the present context, institutions generally include the operation and maintenance of systems, designing cropping patterns, allocation and scheduling of water, enforcing the rules (or changing them if needed), and regulations governing access to irrigation water by individual farmers (Saleth, 1994; Marothia, 2003).

Institutions affect individual behaviour and resource management (Kuks, 2005). According to Schlager and Blomquist (1998, p. 9), "institutional arrangements are devised to solve shared problems that resource users experience and they are evaluated on the basis of effectiveness – how well the arrangements addressed dilemmas; fairness – how the arrangements addressed distributional issues; ease of monitoring and enforcement – how the arrangements addressed issues of commitment and monitoring; and efficiency".

However, while dealing with Natural Resources Management (water in this case), the focus on institutional regime should be both from a public governance perspective (policy theory) (Kuks, 2005; Bressers & Kuks, 2005) and a perspective of private property and usage rights (property rights theory) (Ostrom, 1990; Bromley, 1991). Policy theory concentrates on the effects of resource policies and applied instruments, while property rights theory focuses on bundles of rights and their sustainable management of water resources (Kuks, 2005). Further, the institutional arrangements in the context of water resources management are multi-

dimensional and there are numerous types of arrangements, characterised by hundreds of different combinations of rules (Ostrom, 1990). Nevertheless, these diverse institutional arrangements share at least one thing in common, in the sense that they attempt to address and resolve similar types of issues (Schlager & Blomquist, 1998). Ineffective institutional arrangements lead to a crisis situation which is the case within the water sector.

Crisis situations can be best dealt with by cooperation or collaboration between different stakeholders and by evolving appropriate institutional arrangements or institutions. Likewise, in the context of the present study, institutional and social dimensions cannot be overlooked in the implementation of resource conserving alternative wastewater technologies. The adoption of an alternative technology is dependent directly on the level of acceptance it gains from both the household user and the institutional framework (Frijns & Jansen, 1996; Khouri, Kalbermatten & Bartone, 1994; Veenstra & Alaerts, 1996). Further, Frijns and Jansen (1996) have pointed out that although alternative technologies may be less expensive per capita, they often require community efforts and resources from residents. This leads us to the next section(s) which focuses on concepts such as collective action, social capital, partnerships and strategic alliances.

4.3 The theory of collective action

Collective action is mostly discussed in relation to the “tragedy of the commons” and therefore before moving further, here is a brief note on this. Hardin (1968), through a seminal article, made this notion popular. According to him:

> "There is the tragedy. Each man in locked into a system that compels him (her) to increase his (her) herd without limit – in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believe in the freedom of the commons" (p. 1244).

Overcoming the tragedy of the commons in the real world situation is a difficult task, since much of the world is dependent upon resources that are subject to the possibility of a tragedy of the commons (Ostrom, 1992). However, there is a growing consensus among scholars of the commons that collective, community–based efforts hold out the best prospects for efficient management of the Common Pool Resources (Ostrom, 1990; Ostrom, 1999; Ostrom, 2000a; Baland & Platteau, 1998; Ostrom, Gardner & Walker, 1994; Ostrom & Gardner, 1993), leading to the emergence of the concept of 'collective action', a response to deal with the tragedy of the commons.

4.3.1 Concept of collective action

The term collective action refers to activities that need coordinated efforts by two or more individuals (Meinzen-Dick & Knox, 1999; Agarwal & Ostrom, 1999; Meinzen-Dick & Monica, 2004; Dantiki, 2005). For example, Wade (1979) points out that, in areas where water is problematic for virtually all irrigators, they tend to form a corporate body to deal with common irrigation and cultivation problems.

Collective action is mostly discussed in the context of Common Pool Resource (CPR) management and rightly so, because the literature on the commons is full of instances of collective regulation for natural resource management (Ostrom & Gardner, 1993; Schlager & Ostrom, 1992; Schlager, Blomquist & Tang, 1994; Feeny et al., 1990; Lam, 1996a; 1996b;

2001; Morrow & Hull, 1996; White & Runge, 1995; Meinzen-Dick, Raju & Gulati, 2002; Agrawal & Gibson, 1999; Ostrom, Walker & Gardner, 1992). In the event that the state fails to govern the CPRs in an efficient and sustainable way, collective action is seen as an institutional response to the tragedy of the commons.

4.3.2 Reasons for collective action

The reasons for collective action vary depending on the circumstances and local conditions. Evidence suggests that people come together when there is a widely acknowledged crisis; one that multiple groups concede is affecting their core interests (UNDP, 1999). Individuals may organize due to State failure to govern the CPRs efficiently (Chopra & Gulati, 1997). Furthermore, the literature demonstrates that variables such as group size (Baland & Platteau 1999), economic benefits, fairness, trust, and reciprocity (Schmidt et al., 2001) are likely to affect the collective action and cooperation in a given institutional setting. Bardhan (1993) argues that local information can act as an incentive to cooperation or collective action. According to Ostrom (1990; 2000), a key attribute of collective action is that members invest resources in monitoring and sanctioning the actions of one another, to reduce the probability of free-riding. In addition, the physical and group attributes of the communities influence collective action (Ternstrom, 2001; Agarwal, 2001; Anand, 2003; Mukhopadhyay, 2005). Baland and Platteau (1996, cited in Anand, 2003, p. 234) provide a comprehensive list of conditions for communities to sustain cooperative behaviour:

> "…user groups must be small, live close to CPRs, and be free to set access and management rules in their own way; the CPRs must be clearly defined and people must have high level of dependence on them; rules as well as techniques of control must be simple and fair; there must be well-established schemes of punishment; costs of monitoring must not be too high; well-known and low cost conflict-resolution mechanisms must be available; crucial decisions must be taken publicly; and some record-keeping and accountability must be provided for"

However, mere presence of a crisis is not the only reason for cooperation. Since such action involves multiple groups, separate uncoordinated actions can only lead to missing opportunities to optimise the use of the resource. Therefore, leaders or champions, through their personal motivation, can make partnerships happen (UNDP, 1999). Besides, collective-action situations demand participation by all the parties involved.

4.3.3 Community participation and leadership

Community participation is not new to the water sector, as the governments of several countries, the World Bank and other multinational financing agencies, and donors are promoting the concept of decentralization for managing water resources (World Bank 1993; Mody 2004). According to Blomquist, Dinar and Kemper (2005, p. 4), "decentralization has two components. One is organizing management responsibilities at the river basin scale, which often involves devolution of authority from a central government. The other is involving stakeholders within the basin in decision making and/or operations concerning water resource management activities".

In this context, community ownership and participation are essential components of the implementation and success of any large-scale project, whether centralised or decentralised. But it can be seen that decentralised, alternative sanitation strategies offer the opportunity to extend services in an incremental fashion. In line with this, Marks (1993) has noted that incremental sanitation schemes encourage self-help whenever this is possible. Thus, effective collaboration and rewards, both economic and environmental, can be realised if strong relationships can be developed among the community, the construction and servicing groups (or community maintenance members), and supporting institutions. However it is important

that an institutional framework should guide responsibilities among stakeholders (Frijns & Jansen, 1996), who go on to state that partnerships among community level users, private sector contractors and government officials must be equitable and pre-determined.

In any action that involves participation of multiple actors or stakeholders, leadership plays an important role, however; as Sinha and Suar (2005, p. 127) rightly argue:

> "effective leadership can augment collective action by inspiring people, enforcing institutional norms, resolving conflicts, networking with development partners and assuring expected benefits to people".

The literature on leadership offers a great deal of information from different perspectives. Despite their differences, many writers actually emphasize similar points, which Carter (1997) contextualises as the 'Leadership Cube$^{(TM)}$', which represents at least 20 different perspectives on leadership and has the following dimensions: (1) five domains of leadership, (2) two contexts of leadership and (3) two orientations of leadership (see Table 4.1).

Irrespective of their different domains, leadership qualities are very important, particularly in the context of leading others – individuals, groups, or communities. These qualities sometime determine the leadership styles, as in case of Indian forest management where four leadership styles – manipulative, authoritarian, participative and charismatic – have been suggested (Sarin, 1996; Singh, Ballabh & Palakudiyil, 1996; both cited in Sinha & Suar, 2004).

Table 4.1: Different dimensions of leadership

Domain	Relevant Leadership skills
Leading yourself	Time management, stress management, assertiveness, et
Leading other individuals	Coaching, mentoring, delegating, etc.
Leading other groups	Meeting management, facilitation skills, etc.
Leading organizations	Strategic planning, Balanced Scorecard, etc
Leading communities	Community organizing, political skills, etc.
Context	**Focus of Context**
Roles	Board Chair, Chief Executive Officer, executive roles, etc.
Traits	Charismatic, influential, ethical, etc
Orientation	**Leadership Values**
Results-oriented	Timeliness, efficiency, work direction, authority, etc.
Relationship-oriented	Participation, empowerment, relationships, etc.

Source: Adapted from Carter McNamara (http://www.managementhelp. org/ldrship/ldrship. htm) accessed 29/3/07

However, the perception of which leadership traits would induce greater participation varies from individual to individual. Sinha and Suar (2005) argue that participative style would evoke more participation, while Conger and Kanungo (1987) and Shah (1991) (both cited in Sinha & Suar, 2005) are of the opinion that charismatic leaders possess all the abilities to pursue desired goals and that participative style, with the addition of some charisma works better in rural institutions.

Participation is a broad term with many variations in its meaning and interpretation; in simple terms it can be expressed as nominal membership, while in a broader sense it can be defined as a process in which people have voice and influence in decision-making (White, 1996). In the

political sense, it is a principle that allows citizens to take part in the political process (Heyd & Neef, 2004). According to Sinha and Suar (2005) there are two dimensions to participation – direct and indirect – while other scholars like Pretty (cited in Heyd and Neef, 2004) give a more detailed classification with seven forms of participation. Compiling the information from recent literature on participation Eberlei (2001) argues that participation is/or can be discussed under four and seven stages (Table 4.2).

Table 4.2: Stages of participation

Four	Five	Six	Seven
Information-sharing	Information-sharing	Information-sharing	Information-sharing
Consultation	Consultation	Consultation	Consultation
Joint-decision making	Joint-decision making	Joint-decision making	Participation
Initiation and control by stakeholders	Collaboration	Collaboration	Co-determination
	Empowerment	Empowerment	Joint responsibility
		Control by stakeholders	Partnership
			Control by stakeholders

Source: Adapted from (Eberlei, 2004)

However, it is also argued that several structural and administrative lacunae, especially in institutional arrangements, sometimes result in failure of such collective efforts (Pollnac, 1988; Pollnac & Crawford, 2000). Therefore, institutional arrangements are the crux for collective-action problems, as they can make collective action more efficient for some tasks (Tang, 1992; Meinzen-Dick, Raju & Gulati, 2000; Marothia, 2003). Apart from institutions or rules, Social Capital is also very important for organizing groups to take a collective action. In addition this study also aims to investigate the institutional arrangements (both formal and informal institutions), that will help in implementing sustainable water reuse and participation

of the community in this process; so understanding the concept of sustainability and social capital is indispensable for this study.

4.4 Sustainability and the theory of social capital

In recent times, 'sustainability' and 'sustainable development' has become the catchphrase among politicians, bureaucrats, academics and researchers. Nevertheless, the concept tends to be rather vague and confusing to be used in a wide variety of contexts and without empirical validation (Copus and Crabtree, 1996). As defined in the Brundtland report sustainable development is,

> "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

This implies that, sustainable development is about ensuring a better quality of life for everyone, now and for future generations to come. Although the concept of sustainability has become popular in recent years, it is interpreted differently by specialists in different disciplines. For example, social scientists say a lot about social sustainability; economists deal with economic sustainability and environmentalists deal with environmental sustainability. However, a holistic approach to understand sustainability is to deal with all the three dimensions (Sullivan, 2003). However, this study focuses more on social sustainability and the role of social capital to attain sustainability.

4.4.1 Social sustainability

Social sustainability is focused on the development of programs and processes that promote social interaction and cultural enrichment. Social sustainability is related to how we make choices that affect other humans in our global community – 'the Earth'. It covers the broadest aspects of business operations and the effect that they have on employees, suppliers, investors, local and global communities and customers. Social sustainability is also related to more basic needs of happiness, safety, freedom, dignity and affection.

Social sustainability emphasizes protecting the vulnerable, respecting social diversity and ensuring that we all put priority on social capital. For the purpose of this study 'Social Sustainability' as described by Leviten-Reid (2000) is used which is as follows:

> For a community to function and be sustainable, the basic needs of its residents must be met. A socially sustainable community must have the ability to maintain and build on its own resources and have the resiliency to prevent and/or address problems in the future. There are two types or levels of resources in the community that are available to build social sustainability (and, indeed, economic and environmental sustainability) - individual or human capacity, and social or community capacity. Individual or human capacity refers to the attributes and resources that individuals can contribute to their own well-being and to the well-being of the community as a whole. Such resources include education, skills, health, values and leadership. Social or community capacity is defined as the relationships, networks and norms that facilitate collective action taken to improve upon quality of life and to ensure that such improvements are sustainable. To be effective and sustainable, both these individual and community resources need to be developed and used within the context of four guiding principles - equity, social inclusion and interaction, security, and adaptability.

According to Cooper (2006), social sustainability can be understood to be made up of three required components and four guiding principles. The three components are: (1) basic needs, (2) individual capacity, and (3) community capacity. The four guiding principles are: (1) Equity (2) Social inclusion and interaction (3) Security, and (4) Adaptability (see Box-4.1).

Box 4.1: Components and principles of Social Sustainability

Components of Social Sustainability

(1)Basic needs of residents can continue to be met through:

- Locally produced, nutritious food that is affordable
- Jobs that enable people to be productive and utilize their skills and abilities
- Sufficient income for people to be able to financially support themselves and their families

(2) Individual capacity can be maintained and enhanced through:

- Opportunities to develop and upgrade skills
- A variety of local employment opportunities throughout the region
- Appropriate, affordable formal and informal life-long learning
- A range of opportunities for individuals to contribute to the health and well-being of the community

(3) Community capacity can be maintained and enhanced through:

- Support and encouragement for community economic development
- Community "identity" is reflective of community diversity
- Involvement in public processes and their results, and in government
- Opportunities and places for social interaction throughout the community
- Support and encouragement for community organizations and networks

Guiding Principles of Social Sustainability

(1) Equity – when individuals have access to sufficient resources to participate fully in their community and have opportunities for personal development and advancement and there is a fair distribution of resources among communities to facilitate full participation and collaboration.

(2) Social inclusion and interaction – both the right and the opportunity to participate in and enjoy all aspects of community life and interact with other community members; where the environment enables individuals to celebrate their diversity and react and act on their responsibilities.

(3) Security - individuals and communities have economic security and have confidence that they live in safe, supportive and healthy environments. People need to feel safe and secure in order to contribute fully to their own well being or engage fully in community life.

(4) Adaptability is a process of building upon what already exists, and learning from and building upon experiences from both within and outside the community.

Source: Cooper (2006)

In line with this discussion and the argument that wastewater reuse history is marked with failure of reuse schemes mainly because of lack of community involvement (Po, Juliane & Nancarrow, 2004; Hurlimann & McKay, 2006) it is important that the policies on wastewater use and management must include the human dimension because it is the public who will be served by and pay for the services (Robinson, Robinson & Hawkins, 2005). So, for a reuse

scheme to be successful community involvement and/or participation are very important and social infrastructure provides a framework for building shared solutions to a joint problem through negotiation and dialogue processes (Woolcock, 2004; Flora and Flora, 1993). Success here implies meeting the desired outcomes for all the parties involved, to all the parties' satisfaction. Since implementing a water reuse project involves an entire community the term 'community social infrastructure' is used in this study.

4.4.1.1 Community Social Infrastructure – meaning and dimensions

Success or failure of a wastewater reuse project largely depends on community participation and involvement. Therefore, it is important to measure the social capital at the community level and maintaining social capital means social sustainability (Keremane and McKay, 2007). Putnam (1993) has measured indicators of social capital on provincial and national level; Coleman (1988) has addressed social capital on an individual and household level. This study adopts the concept of 'Social Infrastructure' (Flora and Flora, 1993) which is an important mechanism of institutional analysis as a basis for change. According to the authors social infrastructure means that communities begin to look at making slots rather than fitting into slots; entrepreneurial social infrastructure means communities begin to look at risk, both collectively and individually, in a different way (Flora and Flora, 1993, p. 58), and it has three major dimensions:

- *Symbolic diversity* implies a collective or community level orientation toward inclusiveness rather than exclusiveness,
- *Resource mobilisation* implies that communities must be ever more dependent on their own resources if development is to occur, and

- *Quality of linkages* or networks means that networks, formal and informal, within the community and with the outside, facilitate the flow of resources, and so broad linkages are important.

The foregoing discussions reveal that 'social capital' is an important factor in achieving social sustainability. So, what is Social Capital and how to measure it?

4.4.2 Social Capital – meaning and forms

The role of social capital is vital in policy studies, yet planners and policy makers often fail to understand this concept. There is a growing body of literature that examines the importance of social capital in organising groups to take a collective action and couple social capital with development (Paldam, 2000; Carroll & Stanfield, 2003; Coleman, 1988; Coleman, 1996; Putnam 2004; Ostrom 1990; Dietz, Ostrom & Stern, 2003).

In the social capital literature we come across various definitions for social capital. Social capital is a person's or group's sympathy towards another person or group that may produce a potential benefit (Robison, Schmid & Siles, 2002). According to Putnam (2004; 1993), social capital includes networks, norms and trust. While discussing social capital we come across many perceptions about the concept; some scholars focus on dense networks (Dietz, Ostrom, & Stern, 2003); some on values and connections (Sen, 1995); and some argue that citizen engagement, interpersonal trust, and effective collective action are what form social capital (Rohe, 2004). Irrespective of the variations in the perception about social capital, it is apparent that the social capital theory encompasses three aspects: (i) groups and networks, (ii) trust and solidarity, and (iii) cooperation.

Social capital provides a framework for building shared solutions to joint problem through negotiation and dialogue processes that are necessarily and inherently social (Woolcock, 2004, p. 188). In innovative and participatory human resource management arrangements, all workers communicate more widely to solve operating problems, thus workers have much richer communication networks, representing higher levels of social capital compared to traditional human resource management systems (Gant, Ichniowski & Shaw, 2002). Further, trust is one of the most frequently encountered elements in definitions of social capital and is an indication that social capital plays some important role in sustainable development (Hutchinson, 2004; Danchev, 2005).

As argued by Danchev (2005, p. 26), " there is no evidence that deterioration of social capital can be compensated for by the rise of other forms of capital; on the contrary, when we observe the worsening of social capital, all other forms of capital including development deteriorate". Therefore, building social capital can be a powerful mechanism for planners who seek to promote greater equity in and across cities (Vidal, 2004 p. 164). Thus, social capital makes a difference in terms of a community's ability to solve its own problem (Flora, 1995).

4.5 Water governance - Public vs. Distributed Governance

Traditionally, water has been managed and controlled by many societal entities, with substantial government involvement. Accordingly, Kuks (2005), discussing water governance, regards it as a collective action with respect to water issues that is not restricted to government action, but includes the involvement and participation of non-public stakeholders. Water governance deals with extracting, distributing, and using water within current institutions, and

must address the complexity of the institutional context in which collective action is being pursued. Since this study aims to analyse waste-water governance structures in Australia and India, an attempt will be made in this section to identify the dimensions which relate to them.

The governance of water is generally linked to public governance since the common perception is that public agencies possess all the required resources, expertise, and authority to manage water resources. However, the situation is different today and it is not enough to understand a policy sector (water policy in this case) in terms only of policy goals and instruments. This is because public authorities and target groups, and consequently their actions, are influenced by their administrative capacity for policy implementation, different perceptions of the problems at stake, the positions and linkages of the actors in the policy network, and the relations between different stakeholders (Bressers & Kuks, 2005), who further argue that governance structure can be analysed along five dimensions:

i. levels and scales of governance;
ii. actors in the policy network;
iii. problem perceptions and policy objectives;
iv. strategy and instruments; and
v. responsibilities and resources for implementation.

Thus, successful, sustainable, cooperative water resources management is clearly a challenge, and it is believed that integrated water resource management (IWRM) can overcome it.

Integrated Water Resource Management (IWRM) is a comprehensive approach that involves organizing management responsibilities and involvement of stakeholders at different levels in decision making and/or operations related to water resource management. Stakeholders include a wide array of individuals and organizations. Blomquist, Dinar and Kemper (2005, p. 4), while discussing institutional arrangements for river basin management state that:

> "Some stakeholders are individual water users, and others are organizations or groups of water users (e.g., utilities, industries, irrigation associations). Also, there are nongovernmental organizations that may not be directly involved with water use but have related interests in environmental protection, community development, and so on. Still other stakeholders in a basin are governmental bodies with water resource management responsibilities and authority, or with responsibilities for related concerns such as public health, environmental protection, economic development, land use, etc."

In addition, while discussing water governance and public governance, it is imperative to understand the concept of Corporate Social Responsibility (CSR) (Australian Standard AS 8003-2003), which states, "Corporate Social Responsibility (CSR) is a mechanism for entities to voluntarily integrate social and environmental concerns into their operations and their interaction with the stakeholders, which are over and above the entity's legal responsibilities" (Australian Standard AS 8003-2003, p. 4). The Standard further states that the concept of CSR is applicable equally to public and private entities, government departments and not-for-profit organizations.

4.5.1 Distributed Governance

The shift in water resources management paradigm has changed the general perception about governing water resources and services. Experiences around the world clearly indicate that, acting alone, neither the public nor the private sector can meet the continually growing demand for water, waste, and energy services (UNDP, 1999). New approaches that involve

collaboration among an increasing number of stakeholders are urgently needed and hence, governance of water resources is now discussed with reference to different institutions such as state, community, market or individual (Pradhan, 2000; Marothia, 2002). Therefore, compared to the traditional water governance system, the general perception on governing water resources and services has changed over time. It is now believed that water governance is more effective with broader participation by civil society and private enterprise, and consequently concepts such as distributed governance and partnerships are gaining popularity among water managers and policy makers. Nevertheless, there is always an ongoing debate between the policy makers, planners, and researchers involved about the pros and cons of partnerships and not all partnerships have been a success (Grimsey & Lewis, 2004). Like any other sector, a number of strategic alliances between the private and public sectors to provide improved delivery services have been seen in the water sector. It becomes imperative to understand strategic alliances and partnerships.

4.6 Understanding strategic alliances

Over the past 25 years, collaborative activities have become more prominent and extensive in all sectors in many nations. As a result, we have witnessed a surge in strategic alliances among competing firms or companies located in the same country or across national boundaries (Murray, 1995). This rapid growth since the 1980s is viewed as further evidence of globalisation (Narula & Hagedoorn, 1999).

Strategic alliances often represent a variety of collaborative agreements among competing firms that are more than standard customer-supplier relationships or venture capital

investments in nature (Terpstra & Simonin, 1993). One type of collaborative engagement often observed at a domestic level is partnerships between business, government, and civil society to address social issues and causes (Selsky & Parker, 2005). These authors further point out that such partnership are formed to address challenges such as economic development, education, health care, poverty alleviation, community capacity building, and environmental sustainability. The following section establishes the what, why and how aspects of Strategic Alliances.

4.6.1 What, why and how about strategic alliances

In his seminal paper entitled "Symbiotic Marketing", Alder first recognized the possibilities of forming strategic alliances (Murray, 1995); since then, there has been a rapid growth in domestic and international alliances. So what exactly is meant by strategic alliances?

Parkhe (1993) perceives strategic alliances as innovative and interesting forms of relationships between organizations, which differ from the traditional interactions of organizations. Wheelen and Hungar suggest that a strategic alliance is "an agreement between firms to do business together in ways that goes beyond normal company-to-company dealings, but fall short of merger" (Wheelen & Hungar, 2000, p. 125). Narula and Hagedoorn, (1999), argue that the terms strategic alliance, collaborative agreement, and network are often used as synonyms. They further specifically define strategic alliances as, "inter-firm cooperative agreements which are intended to affect the long-term product market positioning of at least one partner" (Narula & Hagedoorn, 1999, p. 284).

In summary, as stated by Harbison and Pekar (1999), a strategic alliance is defined as a cooperative arrangement between two or more companies where:

- A common strategy is developed in conformity and all parties adopt a win-win attitude.
- The relationship is reciprocal, with each partner prepared to share specific strengths with each other, thus lending power to the enterprise.
- Pooling of resources, investment, and risks occurs for mutual (rather than individual) gain.

In general, these alliances are intended to allow the parties involved to attain common goals in a more efficient and timely manner than if they were acting alone and, in some cases, to attain goals that they would not be able to achieve using only their own resources. A review of current relevant literature and empirical studies indicates the most common reasons for forming strategic alliances. Some of these are mentioned below.

Alliances are formed to obtain technology, gain access to specific markets, reduce financial and political risks, and achieve competitive advantage (Wheelen & Hungar, 2000). According to Likhi and Sushil (2005), strategic alliances are formed for a variety of reasons, which include entering new markets, reducing manufacturing costs, developing and diffusing new technologies, accelerating product introduction, and overcoming legal and trade barriers. Kanter (1994) suggests that organizations create alliances in their quest to compete against fast and agile competitors. Rai, Borah and Ramaprasad, (1996) are of the opinion that strategic alliances provide an effective means to improve on both the economies of scale and scope offered by traditional modes of organization.

The above discussion makes it clear that companies may form alliances in order to gain access to the management strengths or regulatory expertise of another company. Alliances may provide sources of raw materials and can be a means to overcome legal and trade barriers. In some cases, a company with a product may form an alliance with another company that has an established distribution system that the first company cannot create for itself without incurring great cost and delays in market penetration.

However, strategic alliances do not always achieve their desired results. As pointed out by Hamel, Doz and Prahalad, (1989), uncertainty about the behaviour of partners can be a cause for concern, leading to unstable and conflicting relationships. Parkhe (1993) attributes the failure of strategic alliances to a significant dearth of theoretical and empirical research on the topic.

In the context of this study, the focus is on strategic alliances at the domestic level, among Private, Public, and the community organisations– the three main societal sectors. One such type is public-private partnerships, meaning working arrangements based on a mutual commitment between a public sector organization and an organization outside the public sector (Bovaird, 2004). But, before discussing the nature and forms of partnerships within the water sector, a brief note on the three main societal sectors - **Privat**e, **Public**, and the **Community organisations.**

4.7 Public, Private and Community Organisations

Generally, public sector means the 'Government' and any other entity that is non-governmental is the private sector. However, it is difficult to say precisely and thoroughly what we mean by 'public' and 'private' because in literature we find a number of methods or approaches to handle the issue namely common sense approach, practical definitions, analytical definitions and denotative approaches (see Rainey, Backoff & Levine, 1976 for detailed discussion about these methods). According to Lachman (1985, p.671),

> "profit making business firms commonly represent the private sector, and nonprofit service or government regulatory agencies commonly represent the public sector".

The author reminds that this difference is been attributed to the differences that have frequently been observed to organizations' affiliations with the presumably different sectors. Within the water sector, public sector means the 'Government' while, private sector may include private businesses, non-governmental organizations (NGOs) and community-based organizations (CBOs). Some researchers argue that, ownership and management by user cooperatives or the community is also included under private sector (Turral, 1995). However, this study sees the water users co-operatives or water users associations (WUAs) as a third category – 'self governed organisations' (Ostrom, 1992).

But, again these self-governed organisations (for example the WUAs in India) may be categorised into two groups: (1) those which own the irrigation system and are fully responsible to control and manage the system, and (2) those which have partial control over the control and management of irrigation systems with the government agencies owning the system. The focus of this study is on the second category which includes systems that have

been turned over by the government to user groups for management. This category is also known by other terms such as 'irrigation communities', 'communal irrigation', and 'farmer-managed irrigation systems" and there is considerable variety in the size, technology, and organization of these self-governing systems (Merrey, 1996).

4.8 Public-Private Partnerships (PPP) in the water sector

According to Grimsey and Lewis (2004, p. 2), "any relationship involving some combination of the private, and public sectors is prone to be labelled a partnership". Sharing of responsibility and/or authority between the parties involved is an essential ingredient of partnership (Townsend & Mooley, 1995). According to Caplan et al., (2001), a partnership is just a means for delivering the project objectives; therefore, the need today is to implement and enforce the rules under which private or public agencies are made efficient and responsive to social needs and desires (Wolff & Palaniappan, 2004). Worldwide, numbers of examples of this cooperation or collaboration in various forms exist (see Grimsey & Lewis, 2004); one of the most promising forms of partnership is the Public-Private Partnership (UNDP, 1999). In the water sector, the pressing need for more investment in water infrastructure, coupled with constrained government resources, is the main reason behind the emergence of Public-Private Partnerships.

Public-Private Partnerships, popularly known as PPPs, describe a spectrum of possible relationships between public and private actors for the cooperative provision of infrastructure services (UNDP, 1999). Grimsey and Lewis (2004, p. 2) see PPPs as a "contract for a private entity to deliver public infrastructure-based service". In line with this definition, in the context

of the water sector, PPPs refer to “public entity entering into a contractual agreement with private sector to take over some or all of its activities related to water management” (UNDP, 1999; OECD, 2003; ADB, 2000). Thus, through PPPs, the social responsibility, environmental awareness, and local knowledge of the public sector can be combined with the innovation, access to finance, technology, managerial efficiency, and entrepreneurial spirit of the private sector in order to solve urban problems (UNDP, 1999).

Generally, PPPs are misunderstood as ‘privatisation’, but they differ from privatisation. Grimsey and Lewis (2004) state that two major differences – regulation through contract and the lack of government disengagement in case of the PPPs – differentiate them from privatisation. In privatisation, the management and ownership of the water infrastructure are completely transferred to the private sector, while, in the case of a PPP, the ownership of the assets of the water utility remains with the government, and only the management is contracted out to professional management, which is held accountable and has appropriate incentives to ensure effective delivery and reduce waste (OECD, 2003; ADB, 2000). The only essential criterion with respect to PPP is some degree of private participation in the delivery of traditionally public-domain services. However, as stated by Grimsey and Lewis (2004, p. 55), “PPPs might still be seen as privatisation in all but name, as they are by many public sector unions.”

4.8.1 Options for public-private partnerships

Options for PPPs can be tailored to satisfy very specific needs, however, for PPP to work to the advantage of the concerned country, it is always important to ensure that social and environmental issues are taken into account (Requena & Lamrani, 2002). The literature

provides us with a wide range of options for involving the private sector that might be applicable to the water (irrigation) sector (OECD, 2003, UNDP, 1999; Finlayson, 2002; Requena & Lamrani, 2002). According to Pierson and McBride (1996), cited in Grimsey and Lewis (2004, p. 2), the mechanics of the arrangements can take many forms and may incorporate some or all of the following features:

- the public sector entity transfers land, property or facilities controlled by it to the private sector entity (with or without payment in return) for the term of the arrangement;
- the private sector entity builds, extends or renovates a facility;
- the public sector entity specifies the operating services of the facility;
- services are provided by the private sector entity using the facility for a defined period of time (usually with restrictions on operations standards and pricing); and
- the private sector entity agrees to transfer the facility to the public sector (with or without payment) at the end of the arrangement.

Table 4.3 illustrates the different forms of PPP and the allocation of public/private responsibilities across these forms.

Table 4.3: Options for private sector involvement in water sector and allocation of responsibilities

Model → / Responsibilities ↓	Service Contract	Management contract	Lease/affermage	Concession	Divestiture
Asset ownership	Public	Public	Public	Public	Private
Capital investment	Public	Public	Public	Private	Private
Commercial risk	Public	Public	Shared	Private	Private
Operations/ maintenance	Private/ Public	Private	Private	Private	Private
Contract duration	1-2 years	3-5 years	8-15 years	20-30 years	Indefinite
Description [a]	Short-term agreements for a specific task	Government transfers certain O&M responsibilities but retains other	Government transfers all O&M responsibilities	Private agency manages the entire utility and government retains the ownership of assets	Government transfer the water business to private agency including infrastructure on a permanent basis

Source: Modified from Budds and McGranahan, 2003
Note: [a] See Budds, J. and McGranahan, G. (2003) for further description of the models

4.9 Conceptual framework

This study examines the institutions managing wastewater reuse for agriculture in Australia and India, which have different socio-economic and political situations. According to Blomquist, Heikkila and Schlager (2004), the focus of institutional research should be on how institutions affect management options and outcomes, rather than being a mere observation about the importance of institutions in water resource management. Accordingly, the focus of this study is to understand how institutions actually affect wastewater management options and outcomes. So, based on the literature review presented in previous chapters and keeping in mind the focus of this study, a modest attempt is made here to develop a conceptual framework for examining wastewater management institutions in Australia and India (see figure 4.1 on page 125).

The conceptual framework developed to examine the wastewater management institutions in Australia and India has two parts: (1) water governance and (2) the urban wastewater market. Specifically, the focus of this study is the third component of wastewater market: market control and monitoring, basically the regulatory and institutional framework. This is nothing but governing the use of the resource – (waste) water governance, the upper part of Figure 4.1. What follows immediately is a discussion on the second of these: the urban wastewater market.

4.9.1 Urban wastewater market

Currently, wastewater utilisation for non-potable applications is increasingly being recognized as a valuable non-conventional resource; however, its utilisation is on the low side in many countries. This is despite factors such as severe water scarcity, high agricultural water demand, a growing need for additional water supplies, and technological

advances in wastewater collection and treatment (Abu-Madi, 2004). This implies that there is still a need to maximise the contribution of wastewater reuse to total water availability. This will be possible if there are comprehensive wastewater collection systems; well-operated wastewater treatment facilities and users for the treated effluents (Oron et. al, 1999; Mills & Asano, 1996; Abu-Madi, 2004). Thus, collection, treatment, and use are the three pillars of wastewater utilisation (Asano, 2001). Further, urban wastewater is a commodity whose market consists of three major components: (1) a supply side; (2) a demand side; and (3) market control and monitoring. It is generally agreed that imbalance in this market is one of the impediments to implementation of wastewater reuse schemes (Abu-Madi et al., 2003; Abu-Madi, 2004; Asano, 2001; Mills & Asano, 1996).

In addition, since public or user participation is very important in wastewater reuse projects, the study aims to examine the mechanisms used to include public input in the management of wastewater. This further needs understanding of users' perceptions about various issues related to wastewater management; trust and reciprocity; and participants' understanding of the issues related to wastewater usage. Further, since wastewater usage generally involves different stakeholders, it is important that the partnership between these stakeholders is effective and well planned. So the approach of this study spans different theories, discussed in previous chapters, and it is evident that these theories are interrelated (see Figure 4.1). The interrelationships between the different theories and their link to water governance as depicted in the upper part of Figure 4.1 are already discussed in the Chapter 1 through 4.

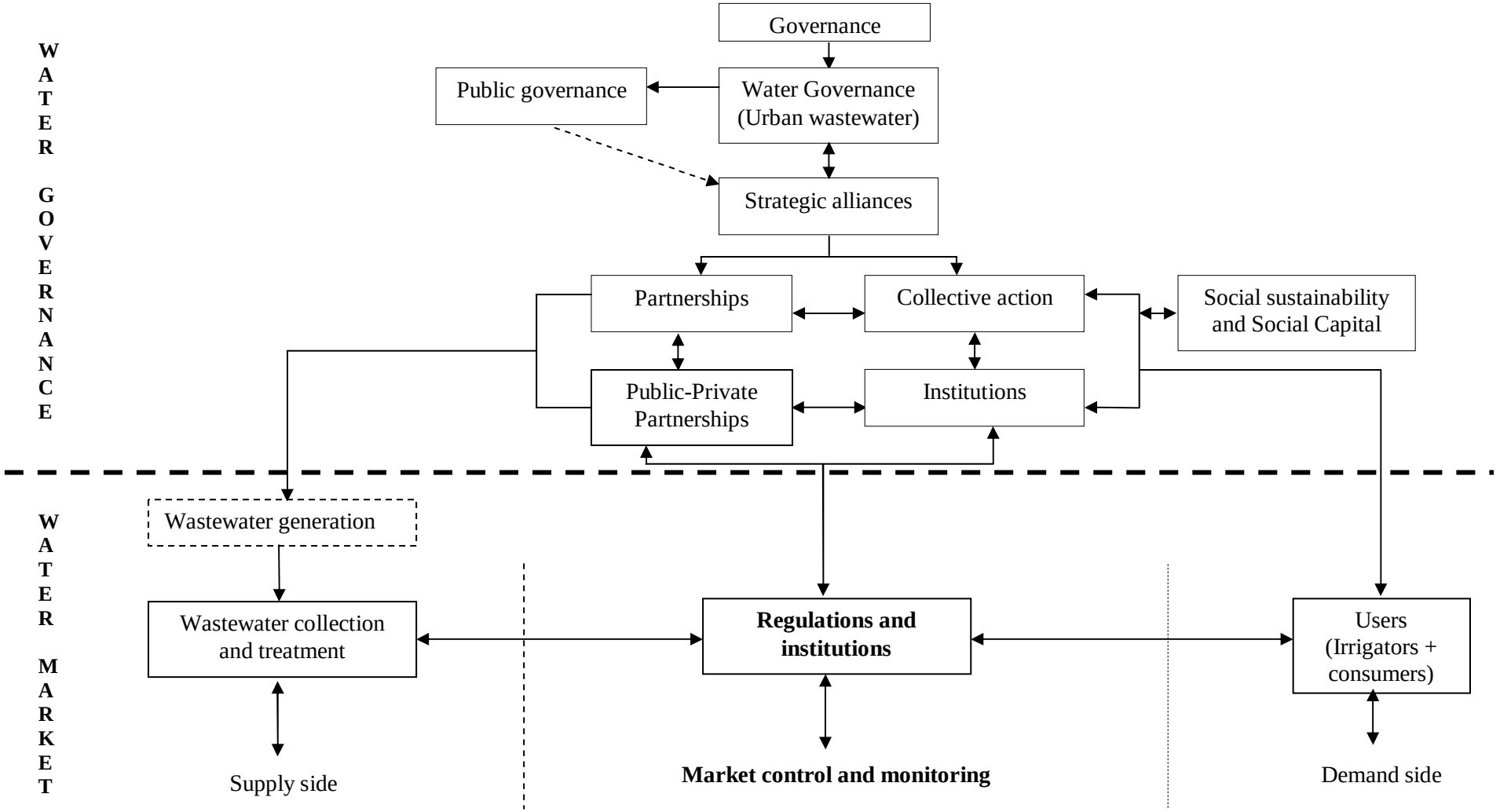


Figure 4.1: A conceptual framework for analysis of wastewater management institutions in Australia and India Source: Wastewater market adapted from Abu-Madi (200

The conceptual model depicted in Figure 4.1 includes perception-based variables to capture the attitudes towards various issues in urban wastewater management. These variables will be examined and analysed using a variety of statistical techniques, which will be discussed in Chapter 5.

4.10 Conclusions

Knowing that "water crisis is essentially crisis of governance", concepts like governance and water governance are receiving wider importance. 'Governance' often implies 'good governance', and in achieving it there has been a major policy shift in the natural resource management domain in the form of transfer of management responsibilities to users' groups or private utilities.

As a result, governance of water resources is now discussed with reference to institutions such as state, community, the market or the individual. And concepts like 'distributed governance' and 'partnerships' are becoming popular in the water sector. One cannot ignore the fact that partnerships help to pool resources and reduce risks; evidence suggests that people come together when there is a widely acknowledged crisis, a crisis that multiple groups acknowledge to affect their core interests – the concept of collective action. The reasons for collective action vary depending on the circumstances and local conditions.

Irrespective of who owns and manages the resource in question, the role of institutional arrangements or working rules is extremely important. Institutions also shape the incentives for individuals to take certain actions such as cooperating, engaging in collective action,

and/or coordinating activities to achieve desired outcomes. Water crises can be best dealt with by cooperation or collaboration between different stakeholders; effective collaboration and rewards, both economic and environmental, can be realised if strong relationships can be developed among the community, the governments, and supporting institutions.

Chapter 5

Chapter 5: Study Design and Methods

> Water, water everywhere, and all the boards did shrink. Water, water everywhere, nor any drop to drink.
>
> - S. T. Coleridge – The Rime of the Ancient Mariner

5.1 Introduction

Although the problems of water scarcity are widely recognized, the question – how to formulate the water laws, policies and institutions that can achieve sustainable management of water – remains unanswered. This, in fact, is the modern natural resources management problem. There are wide arrays of sectors, environmental, and social factors including the nature of the policies, laws, and institutions themselves that need to be examined to achieve sustainability. In line with this, the present study seeks to evaluate water laws, policies, and institutions related to urban wastewater reuse in South Australia, which is largely formal, innovative, and involves some form of bureaucratic entrepreneurship. This research study also includes a case study in India, typified by its informal and unregulated use of wastewater for irrigation, thereby allowing comparison of formal (regulated) and informal (unregulated) use of urban wastewater for agricultural irrigation. This chapter describes the research design and methodologies adopted for the study. A brief description of the case study sites in both countries and the analytical tools and techniques used to analyse the data are also presented.

5.2 Study design

A case study research strategy is adopted for the study. The case study is one of several ways of doing social science research and its use as a research strategy spans different disciplines including psychology, sociology, political science, history, anthropology and economics. It is

also used extensively in practice-oriented fields such as urban planning, public administration, public policy, management science, social work, and education. Moreover the method is found frequently in thesis and dissertation research in all the above-mentioned fields and disciplines (Yin, 1994).

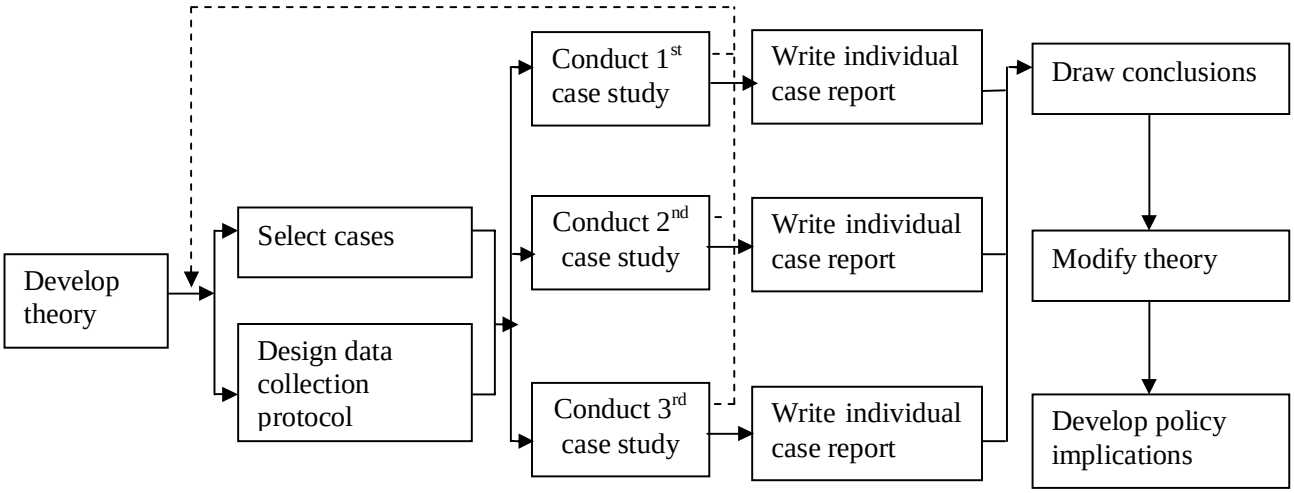
Case studies illustrate the general trends of the events leading to success or failure of an effort. Case study evaluations can cover both process and outcomes; they can include both quantitative and qualitative data (Tellis, 1997). According to Yin (1994):

> "case studies are the preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context"(p. 1)

Case studies therefore, have a beneficial influence on learning and for motivating others in similar situations. In addition, a case study method is considered appropriate where the situation in question represents an extreme or unique case (Yin, 1994).

Case studies can be exploratory, descriptive or explanatory and use of each of these strategies depends on three conditions: (i) the type of research question posed, (ii) the extent of control an investigator has over actual behavioural events, and (iii) the degree of focus on contemporary as opposed to historical events (Yin, 1994, p. 4). In the present case, the focus is on finding how the community has managed the use of urban wastewater for agricultural irrigation by means of formal or informal arrangements. Therefore, following Yin's (1994) argument, a case study approach can cope better with the technically distinctive situation, can rely on multiple sources of evidence, and can benefit from the prior development of theoretical propositions to guide data collection and analysis.

Case study research can include single and multiple case studies. In this instance, since the study includes three wastewater irrigation schemes (2 in Australia and 1 in India), the situation is that same investigation will include multiple case studies. In addition, the study strives for a holistic understanding of the systems under study. According to Yin (1994), any use of multiple-case designs should rely on either literal or theoretical replication. Figure 5.1 illustrates the case study research method used in this study.



Source: Adapted from Yin (1994)

Figure 5.1: The case study research design

5.3 Sampling Design

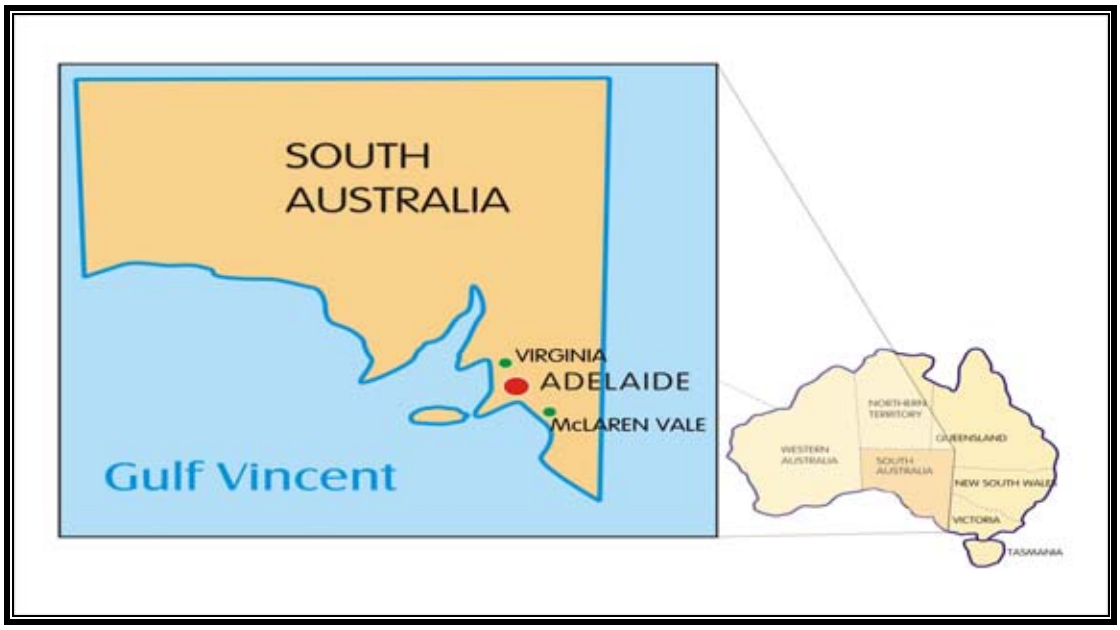
The major method of sampling employed in this study is purposive sampling. In addition, the snow-ball sampling method, a sub-set of purposive sampling, is used to select sample households for interview survey (particularly in the case of the Virginia pipeline scheme in South Australia).

Purposive sampling is a form of non-probability sampling (Polit & Hunglar, 1999, p. 284). Probability sampling is based on the idea that people or events are chosen as the sample because the researcher has some notion of the probability that these will be a representative cross-section of the whole population being studied. In contrast, non-probability sampling is conducted without any knowledge about whether those included in the sample are representative of the overall population.

In purposive sampling, we sample with a purpose in mind. According to Trochim (2006), purposive sampling can be very useful for situations where the need is to reach a targeted sample quickly, and where sampling for proportionality is not the primary concern. With a purposive sample, you are likely to get the opinions of your target population, but you are also likely to overweight those subgroups in your population that are more readily accessible.

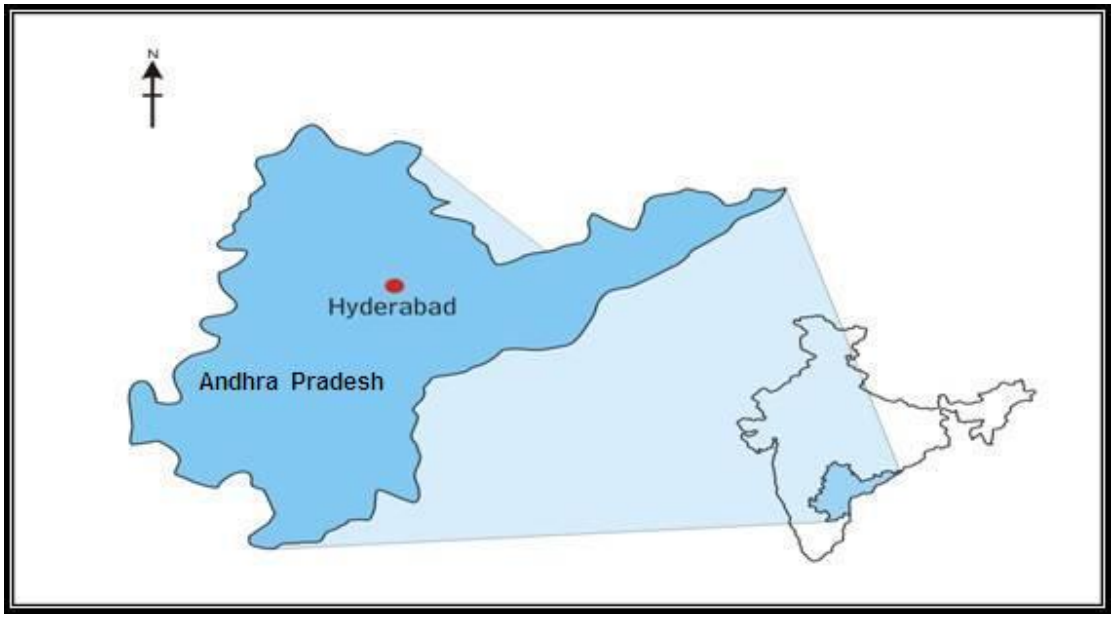
5.3.1 Selection of the schemes

The universe of inquiry for this study comprises two reclaimed water irrigation schemes in South Australia, with their communities, and a third case study, in Andhra Pradesh, India. Figures 5.2 and 5.3 indicate the location of study sites in Australia (Virginia and McLaren Vale) and India (Hyderabad).



Note: Figure not to scale; Source: http://www.worldatlas.com/webimage/countrys/oceania/au.htm

Figure 5.2: Location of the study sites in South Australia



Note: Figure not to scale; Source: http://www.mapsofindia.com/maps/india/outlinemapofindia.htm

Figure 5.3: Location of the study area in Andhra Pradesh, India

In the case of the Australian case studies, an initial exploration of the study area was conducted well before the surveys were initiated. The objective of this exercise was mainly to enable the researcher to familiarize himself with the study area and the schemes.

5.3.1.1 Initial Exploration

Initial exploration of the study area in Australia comprised secondary data reference and key informant interviews. Key activities done during the process were: looking for available documents on scheme service and performance, identifying key informants for future interviews and stratifying the schemes on the basis of organizational setup. The following information was gathered as the major findings of the initial visits at both the research sites in South Australia:

- The schemes are performing well since their inception (particularly with reference to the schemes in Australia)
- The schemes were unique and innovative in their own right. Although all schemes are related to wastewater irrigation schemes they are innovative when it comes to the organizational setup.

Detailed description of the organizational setup will be given in subsequent chapters. It was observed that the schemes differed in one more aspect, and that was in the class of reclaimed water being used for irrigation. The VPS scheme (Virginia pipeline scheme) used 'Class A' water to irrigate the market gardens while the WBPS (Willunga Basin Pipeline Scheme) used 'Class B' water to irrigate the vineyards. In India, partially treated water released to the river was being used for irrigating crops. Further, in one of the schemes in Australia (Virginia

pipeline scheme), the irrigators were people from different ethnic backgrounds, such as Vietnamese, Cambodians, Greeks or Italians. These irrigators could be broadly classified as English-speaking (Greek and Italian) and Non-English-speaking (Vietnamese and Cambodian) communities. Table 5.1 presents the attributes of the schemes under study.

Table 5.1: Attributes of the two schemes selected for the study in Australia

Attribute	***Virginia Pipeline Scheme***	***Willunga Basin Pipeline Scheme***
Location	Northern Adelaide Plains region	McLaren Vale region
Date of commissioning	1999	1999
Governance model	Public Private Partnership	Divestiture
Main source of reclaimed water	Bolivar Sewage Treatment Plant (BSTP)	Christies Beach Wastewater Treatment Plant (CBWWTP)
Number of contracts	252	80
Capacity	120 mega litre/day	46 mega litre/day
Cost of construction	$22 million	$7.2 million
Length of pipeline	100kms	13.2kms
Water class	'A'	'B'
Used for	Irrigate market gardens	Irrigate vineyards

Source: John Gransbury, 2004 and WRSV, 2005

5.3.2 Case studies in Australia

Increasing pressure on water resources and technology advances in wastewater treatment has increased the opportunities for water reuse. Since public perceptions of reuse are very important in implementing reuse projects, involving the community prior to the inception becomes very important. Generally, water reuse for non-potable applications is widely accepted by Australian community as a concept for water management. This is evident from the fact that Australia (South Australia in particular) has been a world leader with respect to successful implementation of innovative cooperative or user-owned and managed reclaimed wastewater projects. With this backdrop, the present study is carried out in South Australia,

which currently tops all Australian States in the percentage (18%) of water directly reused (Radcliffe, 2004). Moreover, a couple of innovative wastewater irrigation schemes operate in the state, which are the cases selected for this study. These schemes were selected following discussions held with key informants, and observations made by the researcher during the initial exploration study. Some of the reasons for selecting the schemes are:

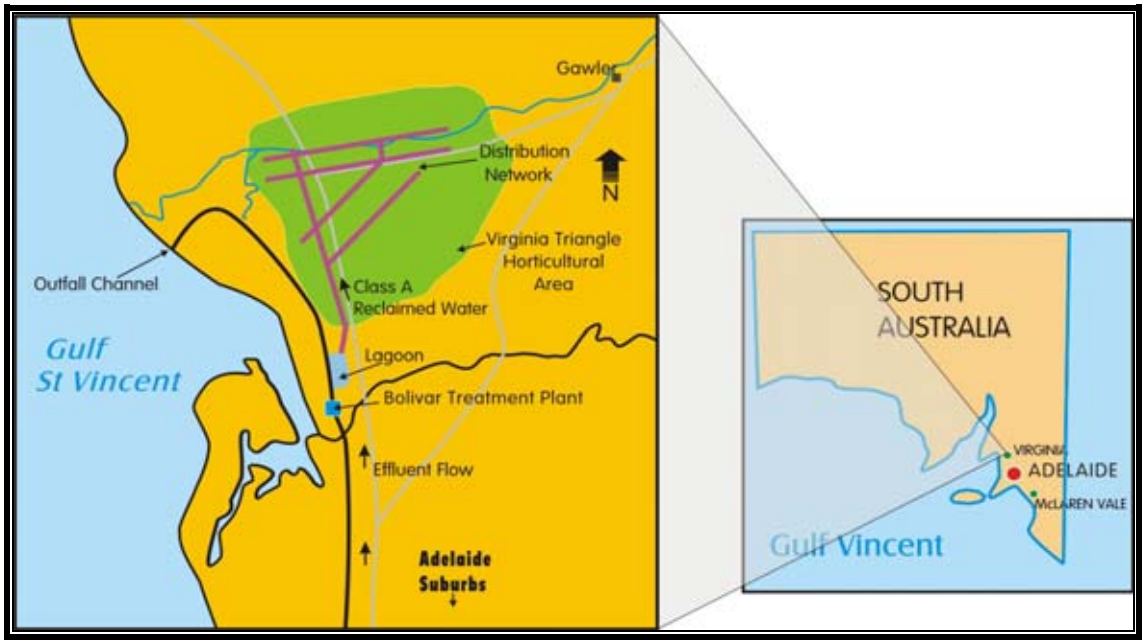
- Both schemes are innovative in their own right.
- Even though both schemes are reclaimed water irrigation schemes they differ in the governance structure, thus providing an opportunity to analyse similar schemes with varying organizational structures.
- The first scheme – Virginia pipeline scheme – is the first and the largest reclaimed wastewater project in the whole of Australia.
- The second scheme – Willunga basin pipeline scheme – is also the fist of its kind, in the sense that it is the first scheme to be owned and operated by the water users (grape growers and wine makers in the region) themselves.

In addition to these points, the two schemes were chosen on the basis of their long service experiences (both with more than five years' service) in reclaimed water use and distribution. Moreover, the schemes have operated successfully since their inception. What follows is a brief description of the schemes under study.

5.3.2.1 Virginia Pipeline Scheme (VPS) in Northern Adelaide Plains region

Overuse of the groundwater resources to irrigate horticultural crops resulted in the decline of water levels in the aquifers of the northern Adelaide plains. Each year about 18,000 megalitres

of groundwater are used for irrigation in the Virginia region. This usage is beyond the sustainable limits of supply, which is estimated at between 6,000 to 10,000 megalitres per year (Kracman, Martin & Sztajnbok, 2001; Marks & Boon, 2005). In order to supplement the declining groundwater supplies, many growers used Class 'C' reclaimed water to irrigate their crops by pumping from the Bolivar wastewater treatment plant out-fall channel. Growers were thus aware of the potential this new source had to offer towards meeting the growing demand for water supplies. This realisation by the growers, along with the environmental, economic and social pressures led to the commissioning of the Virginia Pipeline Scheme (VPS) in 1999 (Thomas, 2006). Since then the VPS has provided highly-treated reclaimed water for irrigation to approximately 250 growers operating within an area of 200 square kilometres in the Northern Adelaide plains. A schematic layout of the scheme with its distribution network is presented in Figure 5.4.



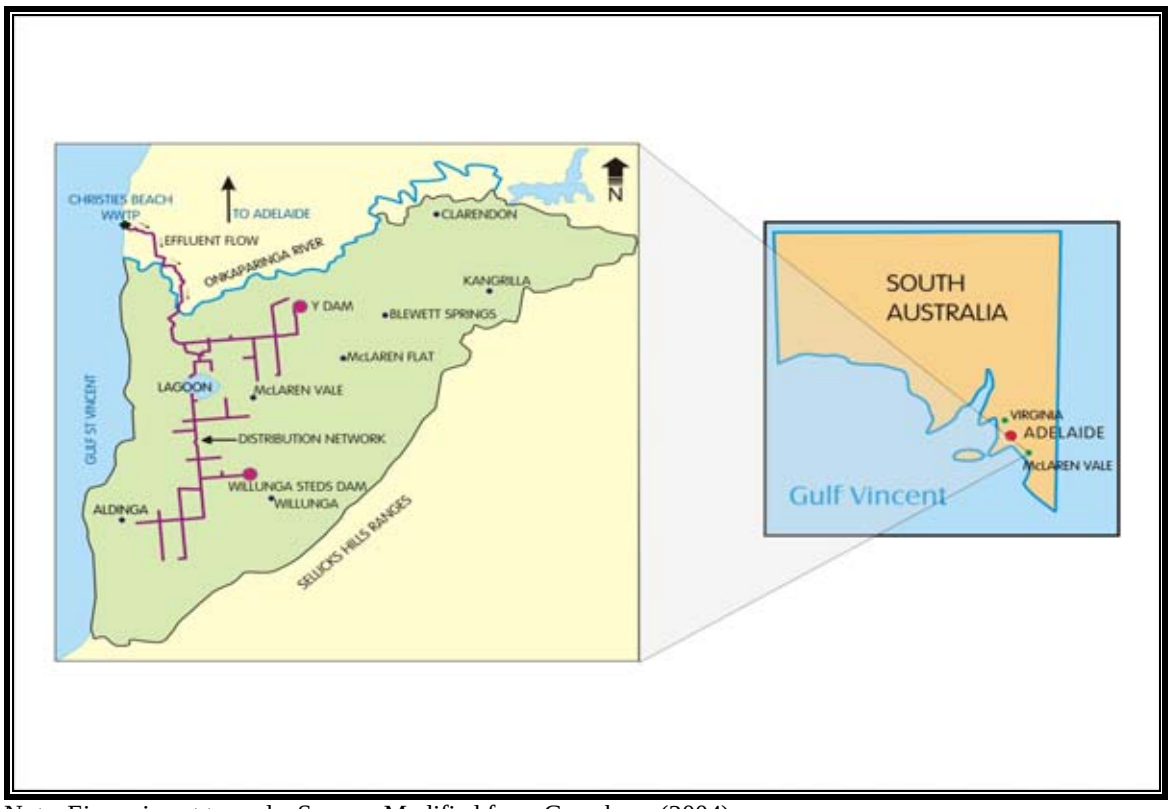
Note: Figure is not to scale; Source: Modified from Radcliffe (2004)

Figure 5.4: Schematic layout of the Virginia pipeline scheme, Northern Adelaide Plains

5.3.2.2 Willunga Basin Pipeline Scheme (WBPS) in McLaren Vale region.

Willunga Basin is home to the world-renowned McLaren Vale wine region and over 50 wineries. Because of dwindling water supplies, excessive groundwater extraction and imposition of a water extraction licensing regime by the government of South Australia, the iconic McLaren Vale region was left out of the boom in wine exports during the mid to late 1990s. The situation was that when the rest of Australia was going through a planting boom, this prime grape growing region had ample land available but no water (Gransbury, 2004). Water had obviously become a scarce and valuable resource for the vineyards located in the basin, leading to declining crop yields and falling land values. The situation demanded that the irrigators look for alternatives to augment the depleting water supplies. One alternative that was thought about was to develop a viable and reliable water 'production' project and the result was the conceptualization of the Willunga water reuse scheme. Figure 5.5 is a schematic layout of the Willunga basin pipeline scheme.

The Willunga water reuse scheme was commissioned in 1999 after negotiating a licensing agreement between SA Water and the Willunga Basin Water Company (WBWC) to access reclaimed water from Christies Beach wastewater treatment plant. The WBWC is a joint venture company formed by growers, which owns and operates the scheme. More details on the scheme are given in Chapter Seven while discussing the results of the Willunga case study.



Note: Figure is not to scale; Source: Modified from Gransbury (2004)

Figure 5.5: Schematic layout of Willunga basin pipeline scheme, McLaren Vale Region

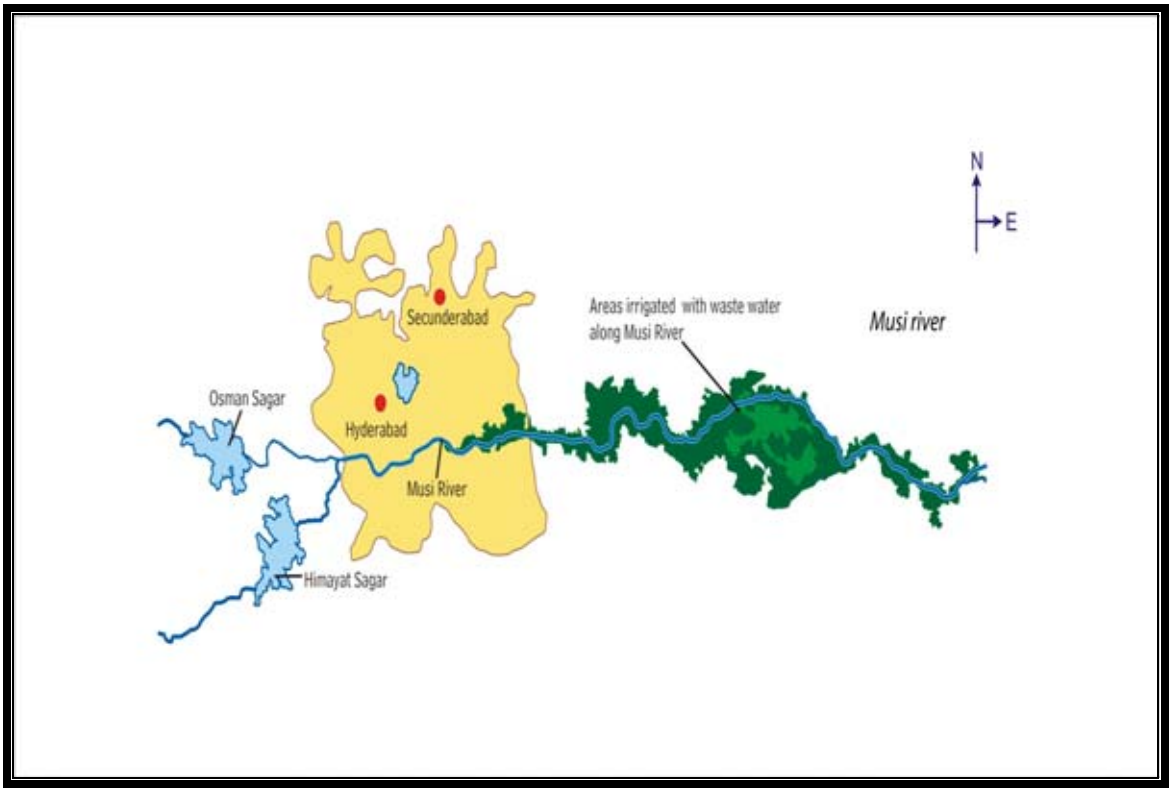
5.3.3 Case study in India

In similar ways to many other developing countries, the marginalised communities in India have been using wastewater irrigation for ages (using domestic wastewater as well as industrial effluent) to grow vegetables, fruits, cereals, flowers and fodder. Unlike the case studies in Australia, wastewater use in India is indirect, which means that wastewater is disposed of in rivers, and the contaminated river water is used for irrigation (van der Hoek et. al, 2002). Most of this reuse occurs along the many Indian peninsular rivers for agricultural irrigation, and the Musi River, flowing across Andhra Pradesh, is one of these. This was selected as the third case study mainly as it provides an opportunity to compare formal and informal wastewater reuse for agricultural irrigation and partly to fulfill the project

requirements of ACIAR (Australian Centre for International Agricultural Research), since this part of the study is funded by the ACIAR.

5.3.3.1 Musi irrigation system in Hyderabad, India

The study was conducted along the Musi River, which runs through the city of Hyderabad in the state of Andhra Pradesh, South India. See Figure 5.6 for a schematic layout of the wastewater irrigation along Musi River. The region is located in the semi-arid tropics, with eight months of dry weather, while the rainy season prevails during the monsoons, from June to September. Hyderabad, the state capital of Andhra Pradesh, is the fifth largest metropolis in India with a population of approximately six million.



Source: IWMI, 2004

Figure 5.6: Schematic layout of Musi irrigation scheme, Hyderabad, India

The focus of this study is the Musi River, which rises a few kilometres upstream from Hyderabad in the Anantha Giri Hills and flows from west to east across Andhra Pradesh. Upstream of Hyderabad, a reservoir was constructed in the 1922, designed to be a flood moderator and to supply Hyderabad with drinking water. There is no water in the river as it enters the city, except during the monsoon season. Downstream, however, the river is perennial, due to the vast amounts of wastewater disposed; this is indicated by the green portion in the figure, which is the area under wastewater irrigation. There is only one wastewater treatment plant with primary and secondary treatment and another that only has primary treatment facilities. The treated and untreated wastewater are diverted to the Musi River and only 40% of the sewage is clarified beforehand (Buechler, Devi & Raschid, 2002; Buechler, 2004).

5.3.4 Selection of respondents

Apart from their geographic locations, the irrigation schemes under study differed in the composition of the irrigators receiving water from the schemes. Therefore, selection of respondents varied between these schemes; the actual processes adopted in each case are explained below.

5.3.4.1 Virginia pipeline scheme

The selection of sample population for household interviews for the Virginia pipeline scheme was carried out through snowball sampling, one of the strategies for data gathering within the purposive sampling frame. The initial visits to the study sites and discussions held with the concerned authorities had revealed that, due to the privacy policy and confidentiality issues, it

was difficult to obtain a list of the irrigators using water from the scheme. Given that situation, snowball sampling appeared to be the most suitable technique.

Snowball sampling is an approach for locating informants in the case of certain hard-to-reach subgroups of the population (Patton, 1990). The basis here is that an initial contact from the hard-to-reach subgroup may then introduce the researcher to a network of further informants. Using this approach, a few potential respondents are contacted and asked whether they know of anybody with the characteristics that the researcher is looking for in his/her research. However, snowball sampling is not a stand-alone tool – it is simply a way of selecting participants – then other tools, such as interviews or surveys, are used by the researcher to gather the required information. This method is also referred to as chain referral sampling or network sampling.

Since the water users on the Virginia pipeline scheme constituted people from different ethnic communities it was difficult to get the exact composition of irrigators associated with the scheme due to privacy policies. So it was decided to obtain the overall composition of the population in the region. According to the Playford City Council Community Profile (http://www.id.com.au/playford/commprofile/Default.asp?bhcp=1), the total population in Virginia Township consists of people from Vietnam, Cambodia, Greece, Italy, Serbia, Turkey and Macedonia. However, for this study the total population was broadly classified into two groups: (1) English-speaking, and (2) Non-English speaking. The profile further indicated that the non-English speaking group was dominated by the Vietnamese and Cambodian community. Therefore, interpreters were employed to interview the Vietnamese and

Cambodian irrigators. The procedure for household interviews is explained later in this chapter.

The sample size was based on the researcher's intention to include at least 50% of the irrigators who were using reclaimed water from the Virginia pipeline scheme. According to the WRSV sources (Collins, Personal communication, 2005), the total number of irrigators using reclaimed water from the scheme was around 250 and 50 percent of these users comes to 125. However, given the limited resources (time, money and availability of the interpreters) along with factors such as irrigators' refusals to participate in the study, and unavailability of the irrigators for interview, the researcher found it more practical to visit as many farms as possible instead of taking the exact calculated figures. Accordingly, 165 farms were visited and the total sample size was 128 irrigators (includes both English speaking and non-English speaking communities). The total sample size for the household interview survey, and sample allocation are summarized in Table 5.2.

Table 5.2: Total sample size for household interview survey and sample allocation

Group	Total number of farms visited	Total Respondents
Non-English speaking	120	91
Vietnamese	85	68
Cambodian	35	23
English speaking (Greek, Italian, Serbian, Turkish)	45	37
Total	165 (65.48)	128 (50.79)

Note: Figures in parentheses are percentages of the irrigators (252) using reclaimed water from the scheme.
Source: Field survey

5.3.4.2 Willunga Basin Pipeline Scheme

Unlike the Virginia pipeline scheme, the Willunga basin pipeline scheme is entirely owned and operated by the growers, who have formed a private joint venture company. Most of the irrigators associated with this scheme are grape growers and/or wineries. For privacy reasons the Willunga Basin Water Company was not ready to supply the list of irrigators associated with the pipeline, which made obtaining the list of irrigators a difficult task. As an alternative, it was decided to approach the Phylloxera Board, which maintains a register of all the wineries in South Australia, and seek its assistance in sending a letter and a consent form to all the irrigators receiving reclaimed water from the scheme, to inform them about the objectives of the study and find out whether they would participate.

Accordingly, a meeting with the Phylloxera Board staff was set up to discuss the possibilities; this revealed that it was difficult to distinguish grape growers receiving reclaimed water from the scheme from those using fresh water resources. Nevertheless, letters were sent to around 100 irrigators who had their land within the operational area of the pipeline despite knowing that the scheme supplied reclaimed water to only 80 growers (Templeman, Personal Communication, 2006). The result was not encouraging – no consent forms were received.

Following this effort, more attempts were made to convince the management of the Water Company about the purpose of the research and to seek their help in sending the letter of information. This time there was some success, as the management agreed to send the letters to its beneficiaries, but were doubtful about the response rate. The expectation was to receive consent from at least 20 irrigators (25% of total irrigators) to participate in the research. At the

end of all this, 23 irrigators volunteered to participate in the telephone interviews. However, only 19 growers (24 % of total growers) were interviewed, as the remaining four were not available for interview, despite repeated calls and messages left on their telephones. Table 5.3 provides the break up of the sample.

Table 5.3: Total sample size for telephone interview survey at Willunga basin pipeline

Particular	Number of growers
Total letters posted	80
Consent forms received	23 (28.75)
Total growers interviewed	19 (23.75)

Note: Figures in parentheses are percentages of total irrigators (80) ; Source: Telephone survey

5.3.4.3 Musi river basin

Here, Water Users' Associations (WUAs) have been formed to manage the canals/tanks both downstream – where water flow is adequate due to wastewater inflows, and upstream – where there are serious water shortages. This has resulted in the upstream WUAs being silent passive bodies, with no active role in water management, while the downstream WUAs are more active. To make comparisons between them, the users' groups at both locations along the Musi River are included in the study.

Accordingly, 30 WUA leaders: Presidents, or TC (Territorial Constituency) or DC members, were selected after discussions with key officials in the Irrigation Department and officials of the Institute of Resource Development and Social Management (IRDAS), Hyderabad, which also helped in conducting the interviews. Out of 30, 15 were located upstream and the other 15 were located downstream. Considering the time constraints it was decided to interview only

Presidents of the WUAs. In their absence, any member of the TC was interviewed. Table 5.4 presents the distribution of the sample across the Musi river basin.

Table 5.4: Distribution of sample across the Musi river basin

Particulars	WUAs downstream (with drainage)	WUAs upstream (without drainage)
Total number of WUA leaders interviewed	15	15
No. of Presidents interviewed	7	11
No. of TC members interviewed	8	4
Number of villages covered	15	15
Number of Mandals covered	5	3

Source: Field Survey

5.3.5 Selection of key stakeholders

Key stakeholders were selected for interview, with a focus on better understanding the workings of the schemes. The interviewees in Australia included people who were involved in the planning, operation and management of the reuse schemes and also represented different parties associated with in the scheme. In India, key stakeholders included officials from the Irrigation Department, researchers at the International Water Management Institute (IWMI) and people at local non-government organizations. The stakeholders were selected on the basis of their knowledge and perspective; the interviews were not highly structured and they took shape according to the individual's experience and time constraints.

5.4 Data Collection Methods

Both primary and secondary data have been gathered and used for the study. The secondary data included information, mainly from formal sources, such as SA Water, water companies

and literature from a range of sources. The primary data sources included a household interview survey and interviews with key informants.

5.4.1 Household interview survey

The household interview survey consisted of face-to-face and telephone interviews with the irrigators associated with the reuse schemes. Face-to-face interviews were conducted in two cases – the Virginia pipeline scheme in Australia and the Musi irrigation scheme in India – while telephone interviews were carried out with irrigators associated with the Willunga pipeline scheme.

5.4.1.1 Face-to-face interviews

As observed during the initial exploration survey, irrigators associated with the Virginia pipeline scheme were from different ethnicities. For the sake of this study, these groups were broadly classified as English speaking and non-English speaking communities. Greeks, Italians and Australians constituted the English speaking communities while Vietnamese and Cambodians constituted the non-English speaking communities. Apart from the researcher himself, to gather survey data, eight interpreters (5 Vietnamese and 3 Cambodians) were recruited on the basis of their command of Vietnamese or Khmer and the English language, as well as relevant knowledge of the survey methods and study theme. The interpreters were further trained how to handle their jobs and the actual interviews were carried out under the researcher's supervision.

In case of the Musi irrigation scheme in India, trained interpreters who were also trained staff of a local non-governmental organization – the Institute of Resource Development and Social

Management (IRDAS) in Hyderabad – were recruited for gathering household interview survey data. These interpreters were recruited on the basis of their command of the local language (Telgu), as well as of their relevant knowledge of the study area, survey methods and the study theme.

5.4.1.2 Telephone interviews

Unlike the Virginia pipeline scheme, irrigators at the Willunga pipeline scheme came only from English-speaking communities, and hence it was decided to rely on telephone interviews with them. Professional interviewers at the Marketing Science Centre, University of South Australia, were employed for the interviews.

5.4.2 Stakeholder interviews

Apart from the initial discussions held with the key stakeholders a second round of interviews were conducted at each scheme. The key stakeholders interviews were qualitative, in-depth interviews of knowledgeable sources, selected for their first-hand knowledge about each topic of interest. The interviews were loosely structured, and relied on a list of issues to be investigated and hence allowed a free flow of ideas and information. According to USAID (1996), key stakeholder interviews are useful in the following situations:

- When there is a need to understand motivation, behaviour, and perspectives of parties involved.
- When quantitative data collected through other methods need to be interpreted.
- When preliminary information is needed to design a comprehensive quantitative study.
- When a main purpose is to generate recommendations.

- When qualitative, descriptive information is sufficient for decision-making.

Similarly, in the present case the stakeholder interviews were conducted to gather information about the issues pertaining to the theme of the study, like the history of the schemes (before and after implementation) and management practices, perceptions of the customers and partners of the reclaimed water irrigation schemes and so on. Further, I also aimed at augmenting the information gathered through the household and telephone interviews with some relevant information provided by the key informants.

5.5 Survey Instruments

A structured interview survey questionnaire and a semi-structured interview questionnaire with sufficient room for probing, organized in a logical order of presentation, were used as instruments for data collection. The structured questionnaire was used for the household interview survey, while the semi-structured interview questionnaire was used for key informant interviews.

The household interview survey questionnaire was designed after considerable literature survey, consultation with key informants and local researchers. It used a mix of question types: multiple choice, numeric open-ended, rating scales and agreement scales. In the case of the Virginia pipeline scheme, the questionnaires were translated from English into Vietnamese and Khmer by professional translators to facilitate the interview process and, in some cases, to allow the respondents to easily mark the document themselves.

For the Musi irrigation scheme, the questionnaires were modified partly to satisfy the requirement of a larger research project and translated from English into Telgu by professional translators. This facilitated the interview process and also allowed the respondents to easily mark the document themselves, in some cases.

A shortened version of the questionnaire (with some irrelevant questions deleted) was used for the telephone interviews. A semi-structured interview questionnaire, with sufficient room for probing with second-order questions, was used for key informant interviews. All the versions of the questionnaire, mail-outs, consent forms, and letters of information used in the study will be found in Appendices 2 to 15.

5.6 Research ethics

Application was made to University of South Australia Human Research Ethic Committee (UniSA HREC) for approval to conduct interviews with the irrigators in each scheme. The actual interviews were conducted only after receiving the clearance from the UniSA HREC. Documents submitted for ethical consideration included the survey questionnaire, letter of information and consent form for interview (see Appendices).

5.7 Data Analysis

The data gathered have been analyzed in terms of the study objectives, and the analysis was carried out, using qualitative descriptions and descriptive statistics. The portion of data that is readily quantifiable (information from the close-ended questions of the questionnaire) was

entered into the SPSS program and the output has been analysed using tabulations and cross-tabulations of variables, and with percentage values for the descriptive statistics. Readily non-quantifiable data (information from open-ended questions, key informant interviews, and focus group discussions) have been processed through qualitative description. In addition, statistical and econometric models are used to analyse the field data. The following sub-section describes these techniques and models.

5.7.1 Statistical tools and econometric models

The current study aimed at collecting perception–based qualitative data to understand the institutional arrangements that govern the reclaimed water use and management in the schemes under study. Therefore, a number of statistical techniques were considered to analyse the association of institutional aspects, type of rights, and social capital and socio–economic and demographic attributes of the irrigators. For this purpose, non-parametric tests, such as Chi–square ($\chi 2$) tests were conducted. Factor analysis was employed to identify the critical success factors for partnerships in the implementation of the water reuse schemes. Regression models were used to examine the primary relationships between socio–economic and demographic attributes and perception-based variables that are assumed to influence the success or failure of water reuse schemes. These methods and techniques are briefly explained in the following sections.

5.7.1.1 Chi-square Test (χ^2)

One of the exploratory procedures in any research is reviewing or analysing the distribution of each variable (data) in question in a sample data set. Frequency tables are widely used for this

purpose. Similarly, in this study frequency tables are used to summarise the field data pertaining to various aspects of institutional arrangements in the schemes under study. To further test the data for statistical significance, the Chi-square (χ^2) test was used, because of its utility in a variety of situations.

Chi-square (χ^2) is a non-parametric test of statistical significance for bivariate tabular analysis (also known as cross-tabs). Any test of statistical significance tells us the degree of confidence we can have in accepting or rejecting a hypothesis. In the case of Chi-square (χ^2) the hypothesis tested can be formulated as: there is no significant relationship between two variables or categories (Null hypothesis); and there is a significant relationship between two variables or categories (Alternative hypothesis).

5.7.1.2 Factor Analysis: Principal Component Analysis

Factor analysis is a statistical approach that can be used to analyse interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions (factors). It is a statistical approach that involves finding a way of condensing the information contained in a number of original variables into a smaller set of dimensions (factors) with a minimum loss of information (Hair et. al, 1992). It enables the researcher to determine interrelationships (correlations) among a larger number of variables by defining a set of common underlying dimensions, known as factors. The choice of a component and factor analysis method is not clear, because there is disagreement among statistical theorists about when they should be used (Costello & Osborne, 2005, p. 2).

However, Principal Component Analysis (PCA) is the most popular method and has been widely employed by researchers (Velicer & Jackson 1990, p. 1), mainly because it is the default method of extraction in many popular statistical software packages like SPSS and SAS (Costello & Osborne, 2005). In this study, principal component analysis (PCA) is used to identify the critical success factors for partnerships in the implementation of the water reuse scheme. The analysis was performed using the SPSS software package. More details about the actual analysis will be found in the results chapter.

5.7.1.3 Regression Analysis

Logit regression models are used to evaluate the effects of principal components on the performance of the reclaimed water scheme. The two indicators used are satisfaction (SATISFCT) and water security (WTRSECUR) based on the rationale that these reflect the performance of the scheme in the sense of indicating how satisfied and secure the irrigators feel in participating in the reclaimed water scheme. This is important, given that the regions where the schemes are operating face severe water scarcity problems. The details on how these variables are measured are discussed in Chapter Six. Generally, the logit model takes the following form:

$$Ln\left\langle \frac{P}{1-P} \right\rangle = \alpha + \beta x_i + \varepsilon$$

Where,

α is the constant (intercept),

β is the coefficient (slope),

x_i is the independent variables (i=1,....,n), and

ε is the error term.

The individual models used to evaluate the effects of independent variables (factor scores) on the dependant variables (SATISFCT and WTRSECUR) are explained later.

5.7.2 Methodological and Analytical Limitations

Although a proper attempt was made to collect the required field data there were some limitations.

The sample size plays a significant role in interpretation and generalisation of the results. In the present study, the sample size in each of the case studies varied. For the Virginia pipeline scheme, a reasonable number of farm households (124) were interviewed. This accounted for 51% of the total number of irrigators associated with the VPS. For the Willunga basin pipeline scheme, the sample size was rather small (19) which accounted for 26% of the total number of irrigators associated with the scheme. Specific limitations for obtaining data have already been explained earlier in this chapter.

In India, 30 leaders (Presidents or members of the Territorial Constituency) of the Water Users Associations were interviewed. The idea here was to have equal number of WUAs from both upstream and downstream locations on the Musi River. Accordingly, 15 WUAs from each location were selected and their leaders were interviewed.

The study depended mostly on the perception based qualitative information and therefore some limitations remain, such as (i) the nature of the information, (ii) its interpretation, and (iii) its suitability for statistical analysis. Further, the elicitation of subjective information based on the perceptions of the individuals is limited to the knowledge that they possess at the

time of interview. However, it is hoped that the subjective information, which is based on a respondents' experience in the real world situation and their expectations of desirable change, would provide some insights, in the context of water governance in general and wastewater management in particular.

Since this study aims to examine the processes of governance and institution formation for urban wastewater management in Australia and India and therefore no data on the costs and benefits and economics of agricultural production were collected. So, willingness-to -pay and profitability analyses are beyond the scope of this study.

Chapter 6

Chapter 6: Public-Private Partnership Model for Wastewater Management – The Virginia Pipeline Case Study[2]

> So you cut all the trees down; you have poisoned the sky and the sea. You've taken what's good from the ground; But you've left precious little for me.
>
> -Mid Night Oil, 1990

6.1 Introduction

The first case studied is the Virginia pipeline scheme operating in the Northern Adelaide plains, South Australia. The scheme is the result of effectively designed partnerships and collective community efforts. In addition, effective regulatory and policy measures related to wastewater management in Australia, particularly South Australia have also been instrumental. Following its inception, the scheme is operating successfully and has resulted in the sustainable development of the region. This chapter is based on the household survey results conducted at Virginia, a township in the northern Adelaide plains, South Australia. The chapter elicits the irrigators' points of view on various issues related to wastewater usage and the rules-in-use governing wastewater management within the scheme under study. It also examines the factors that have led to the success of this scheme, which in turn has contributed to the sustainable development of the region.

Before moving ahead with the experimental results, an outline of the scheme under study is provided to set the scene for discussion.

[2] Parts of this chapter have been published as research articles in refereed journals.

6.2 Background of the Virginia pipeline scheme (VPS)

The Virginia Pipeline Scheme is named after the township of Virginia, South Australia, which is the focal point of the Northern Adelaide plains. The region is described as South Australia's 'Vegie Bowl' because of its reputation for delivering high quality horticultural produce to local, interstate and overseas markets.

The Virginia horticulture industry has historically relied on ground water resources for its irrigation water supply. However, as a result of over-use of these resources for irrigating horticultural crops, the water levels in the aquifers have declined and groundwater has become a really scarce resource. The groundwater resource has provided about 18,000 megalitres per year, which is beyond sustainable limits (Kracman, Martin & Sztajnbok, 2001). Because of the depletion of ground water resources in the region, several growers have been using Class 'C' reclaimed water to irrigate their market gardens, by pumping reclaimed water from the Bolivar wastewater treatment plant out-fall channel through reticulation pipelines they installed themselves. Thus, these growers had already realised the potential of this new source of water in providing a secure supply for irrigating their croplands. This realization and environmental, economic and social pressures led to the development of the Virginia Pipeline Scheme (Thomas, 2006).

6.2.1 Project structure

The scheme is built on the build-own-operate-transfer (BOOT) model, and is the largest of its type in the whole of Australia. The main elements of the scheme consist of a treatment plant at Bolivar, a storage reservoir, and 150 kilometres of distribution pipe work (Collins, 2005).

The scheme is a co-operative undertaking of the VIA, representing market gardeners and other irrigators; SA Water and WRSV (Water Reticulation Services Virginia), a private company. The proposal for developing the VPS was envisioned when the SA Water Corporation, as part of its Environment Improvement Program (EIP), constructed a filtration/disinfection plant (DAFF) costing AUD 30 million to treat lagoon effluent from the Bolivar wastewater treatment plant. This resulted in the production of Class A reclaimed water, which instead of being disposed of to the receiving waters, could be used for irrigation of the market gardens in the region, whose groundwater resources were already over-used. A private water company, WRSV, won a contract from the SA Water Corporation to access the output from the treatment plant, and also signed up clients for the reclaimed water and built the water distribution system. Since the project is built on the BOOT model, the project will be returned to the ownership of SA water by WRSV in 2019, at the end of the contract term. The total cost of the project (AUD 55million), including the DAFF plant and the reticulation system, was shared between a Commonwealth Government contribution from the Building Better Cities funds (AUD 10.8 million); a Landcare contribution (AUD 574,000); private investors' contributions (AUD 7 million); SA government funds (AUD 7 million); the remainder was contributed by SA Water. As a result of the effective partnerships between the public and private entities, along with the collective efforts of the community, the scheme was finally commissioned in 1999, and since then has been operating successfully. As of 2005, the scheme supplies Class-A treated water (Table 6.1 gives the classifications of reclaimed water for use in South Australia) to around 252 growers in the township of Virginia. Success here implies meeting the desired outcomes for all the parties involved, to all the parties' satisfaction – SA water attained the desired environmental outcomes, users received a secured water supply, and the private company made its profits.

Table 6.1: Classification of reclaimed water for use in South Australia

Class	Typical treatment process	Microbiological, chemical & physical criteria	Uses
Class A	Full secondary plus tertiary filtration plus disinfection. Coagulation may be required to meet water quality requirements	< 10(*E. coli*/100ml); ≤ 2NTU(Turbidity); <20mg/L(BOD); Chemical content to match the use	Residential non-potable; Municipal use with public access; Unrestricted crop irrigation
Class B	Full secondary plus disinfection	< 100(*E. coli*/100ml); <20mg/L (BOD); <30mg/L(SS); Chemical content to match the use	Municipal use with restricted access; Restricted crop irrigation; Irrigation of pasture and fodder for fodder animals.
Class C	Primary sedimentation plus lagooning OR Full secondary (disinfection if required to meet microbial criteria only)	< 1000(*E. coli*/100ml); <20mg/L(BOD); <30mg/L(SS); Chemical content to match the use	Municipal use with restricted access; Restricted crop irrigation; Irrigation of pasture and fodder for fodder animals.
Class D	Primary sedimentation plus lagooning OR Full secondary	< 10 000(*E. coli*/100ml); Chemical content to match the use	Restricted crop irrigation; Irrigation for turf production; Silviculture and non food chain aquaculture

Note: NTU=Nephelometric turbidity units; BOD=Biochemical Oxygen Demand; SS=Suspended Solids
Source: South Australian Reclaimed Water Guidelines (Treated Effluent), 1999

6.3 Results and Discussion

The data collected were analysed using SPSS software, and the results are presented in terms of frequencies and percentages. What follows is the discussion of the results.

6.3.1 Socio-demographic profile of the respondents

The socio-demographic profile of the respondents for the Virginia pipeline scheme is presented in Table 6.2.

Table 6.2: Socio-demographic profile of the irrigators associated with the VPS

Variable	Percentage
Gender	
Male	89.8
Female	10.2
Age group	
Young (<24 years)	1.6
Middle (25-44 years)	48.4
Old (45 years and over)	50.0
Ethnicity	
Non-English speaking	71.1
English speaking	28.9
Education level attained	
Up to primary school	40.6
Secondary school	32.0
High school	18.0
University	7.8
Others (TAFE/Diploma)	1.6
Farming experience	
0-5 years of experience	27.3
6-10 years of experience	45.3
11-15 years of experience	21.9
>15 years of experience	5.5

Source: Field Survey

Out of the total of 128 respondents interviewed, 89% were male while 10% were female. A majority of the respondents belonged to either the middle age group or the old age group. One interesting fact about this scheme is the diverse cultural backgrounds of the irrigators. However, as explained earlier, in this study they have been grouped simply as English speaking and Non-English speaking communities. The majority (71%) were in the non-English speaking community, which is also true for the total population in the region. The

respondents were literate, as they all had attained education at no less than primary school level. Most of the respondents (47%) had farming experience, ranging from 6 to 10 years while around 5% of the irrigators had the experience of farming for more than 15 years.

6.3.2 General awareness of wastewater usage and the scheme

The respondents were asked whether they had any knowledge about reclaimed water use prior to the implementation of the scheme (Table 6.3). The idea was to examine the extent of knowledge possessed by the respondents regarding wastewater use. About 57% said they had some knowledge while 4% said they knew quite a lot. About 37% said they did not know anything about reclaimed water use.

Table 6.3: Did you have any knowledge about water reuse before implementation?

Degree of knowledge	Percentage
No knowledge at all	37.5
Some knowledge (little to very little)	57.0
Quite a lot	4.7

Source: Field Survey

Since most of the irrigators knew about wastewater use, they were asked about the source of this information (Table 6.4). Thirty-six percent said it was the water authorities, 26% said that they heard about wastewater reuse through community networking, while 23% reported that the private water company was the main source of information. Around 13% said they knew about reclaimed water use from their own personal experience of using the resource.

Table 6.4: What was the source of information?

Source of information	Percentage
Water authorities	36.7
Private water company	23.4
Community	26.6
Personal experience	13.3

Source: Field Survey

Irrespective of the sources, the figures in Table 6.3 and 6.4 indicate that the community was aware that wastewater can be a useful and reliable alternative source of water to augment groundwater supplies, which is very important when implementing a water reuse scheme (MacDonald & Dyack, 2004). In order to support this argument and check whether the community was involved in the implementation of the scheme, the irrigators were asked about the time when they first heard about the scheme (Table 6.5). Most of the respondents (54 %) reported that they first came to know about the scheme after implementation, i.e., they joined the scheme once it had started operation. About 23% said they knew before implementation indicating that a considerable proportion of the respondents were involved right from the planning stage, which is once again a very important factor for any irrigation scheme to be successful, particularly wastewater reuse schemes.

The idea of community participation is being promoted and practiced in most parts of the world, particularly with respect to common pool resources management; the case with water reuse schemes in Australia is no different. Moreover, among other things, the National Water Initiative (NWI), signed by all Australian State Governments in 2004, promises better and more efficient management of water in urban environments through the increased use of recycled water and stormwater. In addition, under one of the objectives of the NWI ('community partnership and adjustment'), the "government are to engage water users and other stakeholders in achieving the objectives of the Initiative by improving certainty and building confidence in the reform processes; transparency in decision making; and ensuring sound information is available to all sectors at key decision points" (National Water Commission, 2004, p. 20).

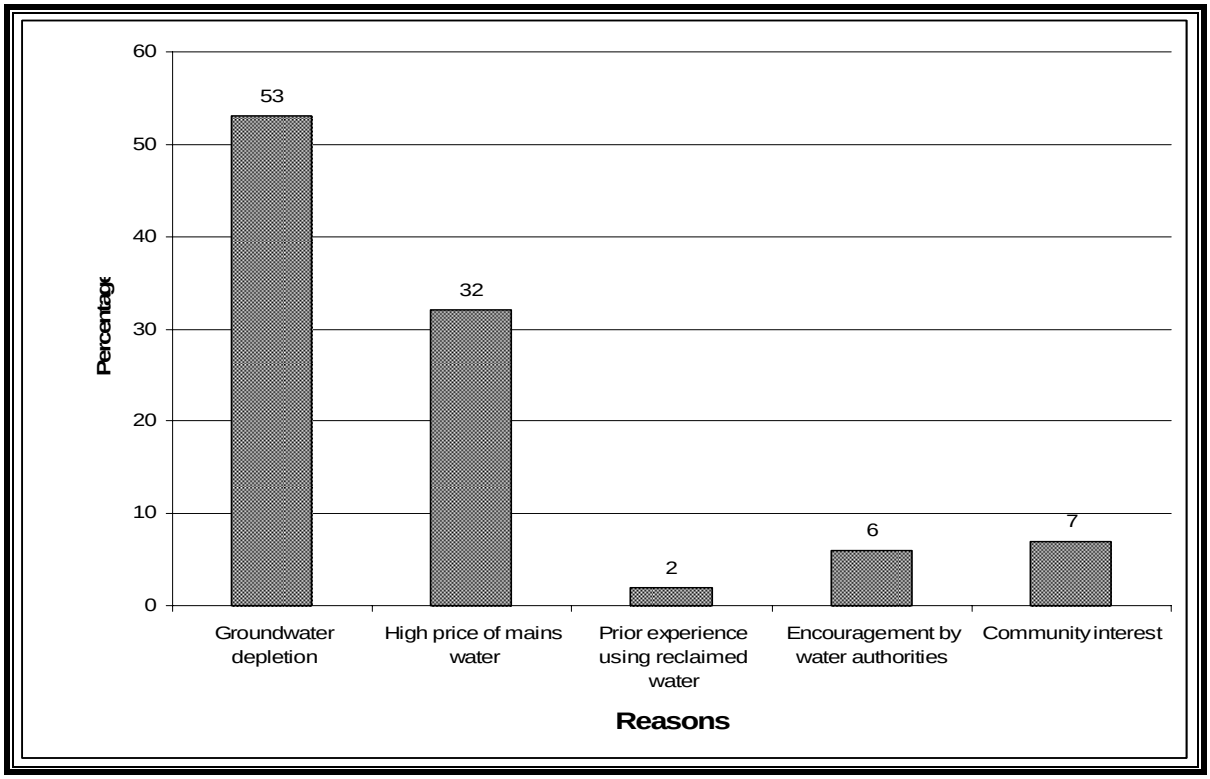
Table 6.5: When did you first hear about the reclaimed water irrigation scheme?

Particulars	Percentage
Well before the implementation of the scheme (Planning stage)	23.4
Just before the implementation of the scheme (Implementation stage)	22.7
After implementation of the scheme (Operational stage)	53.9

Source: Field Survey

6.3.3 Factors prompting implementation of the scheme

Generally, whenever individuals face problems unsolvable on their own they tend to come together to find solutions, so that when there is a crisis that several groups acknowledge is affecting their core interests, collective action is possible (OECD, 2003). Collective action then becomes an immediate necessity rather than a choice. According to Wade (1979), when water is problematic for almost all of a group of irrigators, they tend to co-operate to deal with irrigation and cultivation problems. An initial exploration study and discussions with key stakeholders had revealed that the region faced serious groundwater shortages and that reclaimed water was the only alternative available to meet the water demands. The setting up of VPS was seen as a way to attain the desired environmental outcomes and meet the challenge caused by these shortages (Kracman, Martin and Sztajnbok, 2001; Thomas, 2006). This was possible only because of the organised collective efforts of the irrigators, and so the respondents were asked what motivated them to organise collectively and to mention the most important reason that prompted development of the Virginia pipeline (see Figure 6.1).



Source: Field Survey

Figure 6.1: Irrigators' perception of reasons prompting development of the VPS

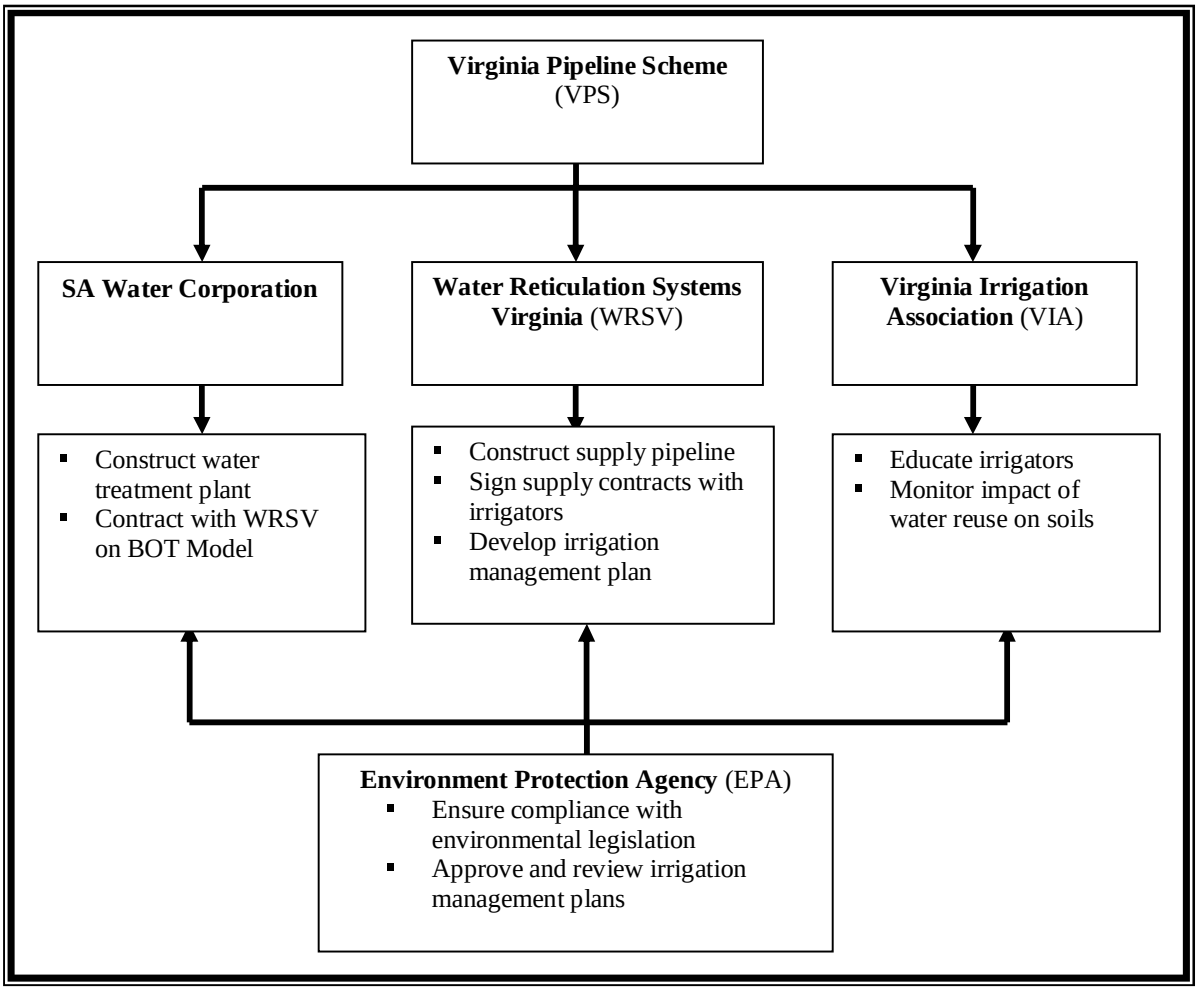
Around 53% of the respondents nominated groundwater depletion as the most important reason; 32% cited the price of mains water, while 7% said community interest in the use of reclaimed water was the important reason. About 6% mentioned encouragement by water authorities as the important reason, while only 2% said that previous experience of using the reclaimed water was instrumental in implementing the scheme. However, these are only the perceptions of the irrigators. In field settings, the scheme is the result of a combination of all these factors; as well as the factors perceived by the respondents, there were others, such as increasing public concern about the environmental damages caused by discharge of nutrient-rich effluents into the ocean; government initiatives such as the Building Better Cities Environment Improvement Program, were also instrumental in initiating this scheme.

The other important aspect of the VPS is the innovation with respect to the partnerships developed for achieving a common goal. It represents a case of well-designed 'public-private partnership' that has led to the success and sustainability of VPS. So a brief note on the framework of partnerships is provided below.

6.3.4 Framework of partnerships

In the context of the water sector, a public-private partnership amounts to 'a public entity entering into a contractual agreement with the private sector to take over some or all of its activities related to water management' (OECD, 2003). In general, public-private partnerships (PPPs) promoted within the water sector are concession-based contracts in which a private firm obtains from the government the right to provide a particular service under conditions of significant market power (Kerf et al., 1995, cited in Braadbaart, 2005). Such contracts come in three flavours: franchise contracts, concession contracts and build-own-operate-transfer (BOOT) contracts (Braadbaart, 2005).

Implementation of the VPS was largely possible because of the enhanced participation of the stakeholders in effectively designed partnerships through contractual agreements between the stakeholders (see Appendix 18). As a part of the contractual agreement this scheme follows the Build Own Operate Transfer (BOOT) model. Figure 6.2 shows the contractual agreements signed by the stakeholders involved in the scheme.



Source: WRSV documents and Field Survey

Figure 6.2: Contractual agreements between key stakeholders in VPS

In a BOOT project, a private company is given a concession to build and operate a facility, that would normally be built and operated by the government, and at the end of the contract period it is transferred back to the government (UNIDO, 1996, cited in Braadbaart, 2005). So in this case a private consortium (WRSV) is responsible for building and operating the Virginia pipeline scheme, until the whole scheme is returned to the ownership of SA water at the end of the BOOT period (Keremane & McKay, 2007). Under this form of partnership, capital investment, designing and building, and operation of the scheme is the responsibility of the private sector, while the responsibility for setting performance standards, asset ownership,

user fee collection, and oversight of performance and fees rests with the public agency; in the present case, SA water. The private company (WRSV) is responsible for designing, building and operating the scheme, as well as capital investment with contributions from SA water, State and the Federal governments in the proportions described at the beginning of this chapter.

To ensure that the irrigation of the agricultural land is sustainable, an Irrigation Management Plan (IMP) is developed. The responsibility for reporting deviations, if any, from the plan is assigned to WRSV. Ensuring that all environmental legislation is complied with is the responsibility of the Environment Protection Agency (EPA), which is also responsible for approving and reviewing the irrigation management plans on an annual basis. The irrigation association (VIA), representing the community/irrigators, is assigned the responsibility for managing an education programme for growers in relation to water reuse. Through this programme the VIA educates the irrigators about the impact of the enhanced nutrient levels on soils and natural groundwater due to the use of reclaimed water. It also closely monitors the effects of the reclaimed water on the soils. In addition, these arrangements also helped tackle the impediments – legal, policy, institutional, financial and social – that usually face the implementation of any reuse scheme.

As already mentioned, commencement of VPS can be seen as the outcome of an organised collective effort of the irrigators who wanted to find solutions to the water scarcity crisis caused by depleting groundwater resources. So, the study attempted to assess the irrigators' perceptions on collective action and participation by using 11-point Likert scale items to

measure these within the community. Respondents were asked to agree or disagree with the scale items, and the results are presented in the following sections.

6.3.5 Irrigators' perception of collective action and participation

The concept of collective action has emerged as a response to deal with the tragedy of the commons. We recall that the phrase 'collective action' refers to activities that require the coordination of efforts by two or more individuals (Agarwal & Ostrom, 1999). Individuals associate in collective action to face uncertainties and search for solutions wherever possible. The commons literature has ample evidences of collective regulation for natural resources management (White & Runge, 1995; Lam, 1996; Ostrom, 1992; 2000a). In the present case, an organised collective effort of the irrigators led to the implementation of VPS ultimately helping the irrigators to solve the problem of depleting groundwater resources.

Respondents were presented with scale items on collective action and participation and were asked to agree or disagree with these items. The results are presented in Tables 6.6 and 6.7. More than 75% of the respondents agreed that 'most people in the community are willing to help when in need'. When asked about their perception of community prosperity over the last five years, around 76% believed that the community had prospered because of cooperation among its members. Keeping in mind their variations in cultural background and ethnicity, the respondents were asked if they felt accepted as a member of a community. More than 70% agreed that they felt accepted. When specifically asked about cooperating during a water crisis, about 59% agreed that people cooperate in such situations.

The responses in general indicate that the community has a strong sense of cooperation and is community orientated. However, it is to be noted that a considerable percentage of people remained neutral (point five on the scale) in response to these propositions. Field observations matched the responses.

Table 6.6: Irrigators' perception about collective action and cooperation

Statements	Agree	Neutral	Disagree
People in the community will cooperate when there is water supply problem	58.6	14.1	27.3
Most people in the community are willing to help when in need	78.9	18.0	3.1
This community has prospered in the last five years	75.8	21.9	2.3
I feel accepted as a member of this community	77.3	20.3	2.3

Source: Field Survey

Mere presence of a crisis does not always bring out collective action, participation of all the actors involved is equally important. According to Ostrom (2000b, p. 138), "individuals in all walks of life and all parts of the world voluntarily organize themselves so as to gain the benefits of trade, to provide mutual protection against risk, and to create and enforce rules that protect natural resources". This author, while highlighting the 'free rider' problem associated with collective goods, suggests that self-organized resource governance regimes can reduce its probability (Ostrom, 1990; 2000b). Social cohesion, evidenced by a sense of community pride and identification, may convince individuals that working for a communal benefit is to their advantage (Meroka, 2006) and therefore participation that addresses other factors that affect the likelihood of success is very important.

Participation is a broad term with many variations of meaning and interpretation. However, in its narrowest sense, it can be defined in terms of nominal membership, while in the broadest

sense it can be defined as a process in which people have voice and influence decision-making (White, 1996). Here, the focus is 'community participation' and to examine the extent of community participation the study proposed three statements to the irrigators (Table 6.7).

Table 6.7: Irrigators' perception about statements regarding participation

Statements	Agree	Neutral	Disagree
I have worked with others in the past for the benefit of the community	59.4	31.3	9.4
Most likely, the people who do not participate in communal activities are criticised.	10.9	26.6	62.5
Everyone in the community make a fair contribution to communal activities	42.2	41.4	16.4

Source: Field Survey

When asked if they worked with others for the benefit of the community, almost 60% of the respondents agreed with the proposition. When asked whether people who do not participate in communal activities are criticised, more than 60% disagreed. About making fair contribution towards communal activities around 42% of the respondents thought that everyone in the community did so (the term 'contribution' here meant contributing in terms of money or kind); almost an equal percentage of respondents remained neutral. Around 75% of the respondents agreed that the community had prospered over the previous five years.

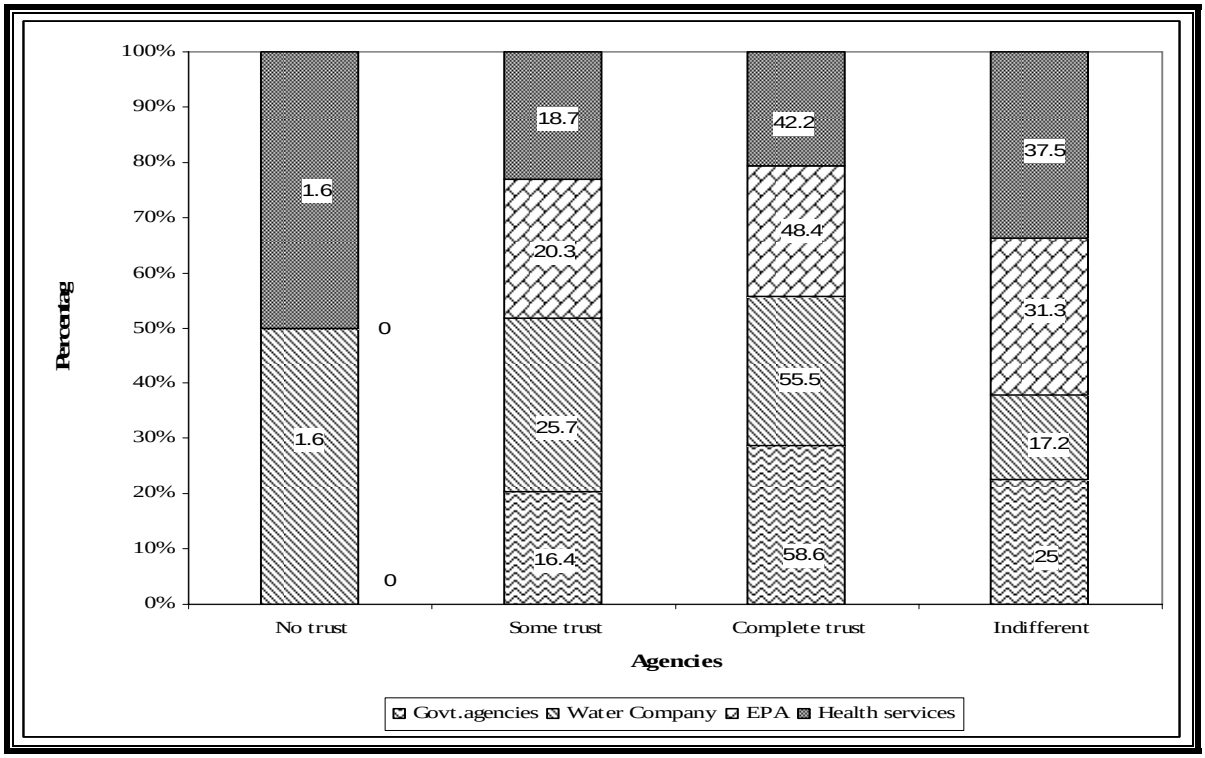
Chi-square (χ^2) estimates were calculated to test whether irrigators' perception about collective action and participation varied with age, education level, or ethnicity. The estimates were not significant, confirming that irrigators' perceptions were similar across different age groups, education levels, and ethnicities.

Generally, reuse schemes span different agencies and, in this case too, the VPS is a co-operative undertaking and involves different agencies. Therefore, according to social capital theory, the irrigators' level of trust in these agencies is a very important measure of social capital which is an important ingredient of social sustainability.

6.3.6 Irrigators' perception of trust and solidarity

Various agencies are involved in the functioning of the VPS, and trust in these agencies plays an important role in decisions about participation in the scheme. Respondents were asked about their level of trust in the agencies: government, EPA, health department and the water company. Figure 6.3 shows the level of trust that irrigators have in various agencies.

The irrigators had either complete trust or some level of trust in these agencies to perform their duties effectively. Around 58% of the respondents had complete trust in the government agencies, while another 16% had some level of trust. As for the water company, more than 55% had complete trust while around 26% more had some level of trust. About other associated agencies, like the EPA and the Health Department, more than 40% had complete trust in them. However, the percentage of respondents who were indifferent is considerable, particularly with respect to EPA and Department of Health. This may be due the lack of awareness among the irrigators of the roles of these agencies in relation to the scheme.



Source: Field Survey

Figure 6.3: Irrigator's level of trust in different agencies associated with the scheme

The chi-square estimates for age group (χ^2=18.11) and ethnicity (χ^2=41.78) in respect of trust in the water company were significant, indicating that irrigators with English speaking background and in the young and middle age groups had more trust. Similar results were obtained in case of trust in the health department where the estimates for age (χ^2=23.82) and ethnic groups (χ^2=71.32) were significant.

It is evident from the success of the scheme that, despite different ethnicities and cultural backgrounds, the irrigators have demonstrated a high degree of networking; without this there might have been problems. This contradicts the argument on collective action that divisions between irrigators due to cultural and/or other social differences affect their capacity to communicate with one another (Tang, 1992). Thus the findings of this study suggest that

relatively heterogeneous community groups can be effective at provision of irrigation services (Kurian & Dietz, 2005). It also demonstrates a high level of trust among the members of the community.

6.3.7 Irrigators' perception of the 'rules-in-use'

Institutional arrangements are described using different terminologies by researchers studying common pool resources management and collective action (Tang, 1992). However, in this case, we consider it to be the rules-in-use that stipulate who can participate in the scheme as appropriators and providers; what participants may, must or must not do; and how they will be rewarded or punished. These rules are conceptualised in the commons literature as "operational rules" (Tang, 1992, p. 81).

In order to elicit the perceptions of the irrigators about these rules-in-use they were presented with propositions and asked to indicate their degree of agreement with each of them. The responses are presented in Figure 6.4.

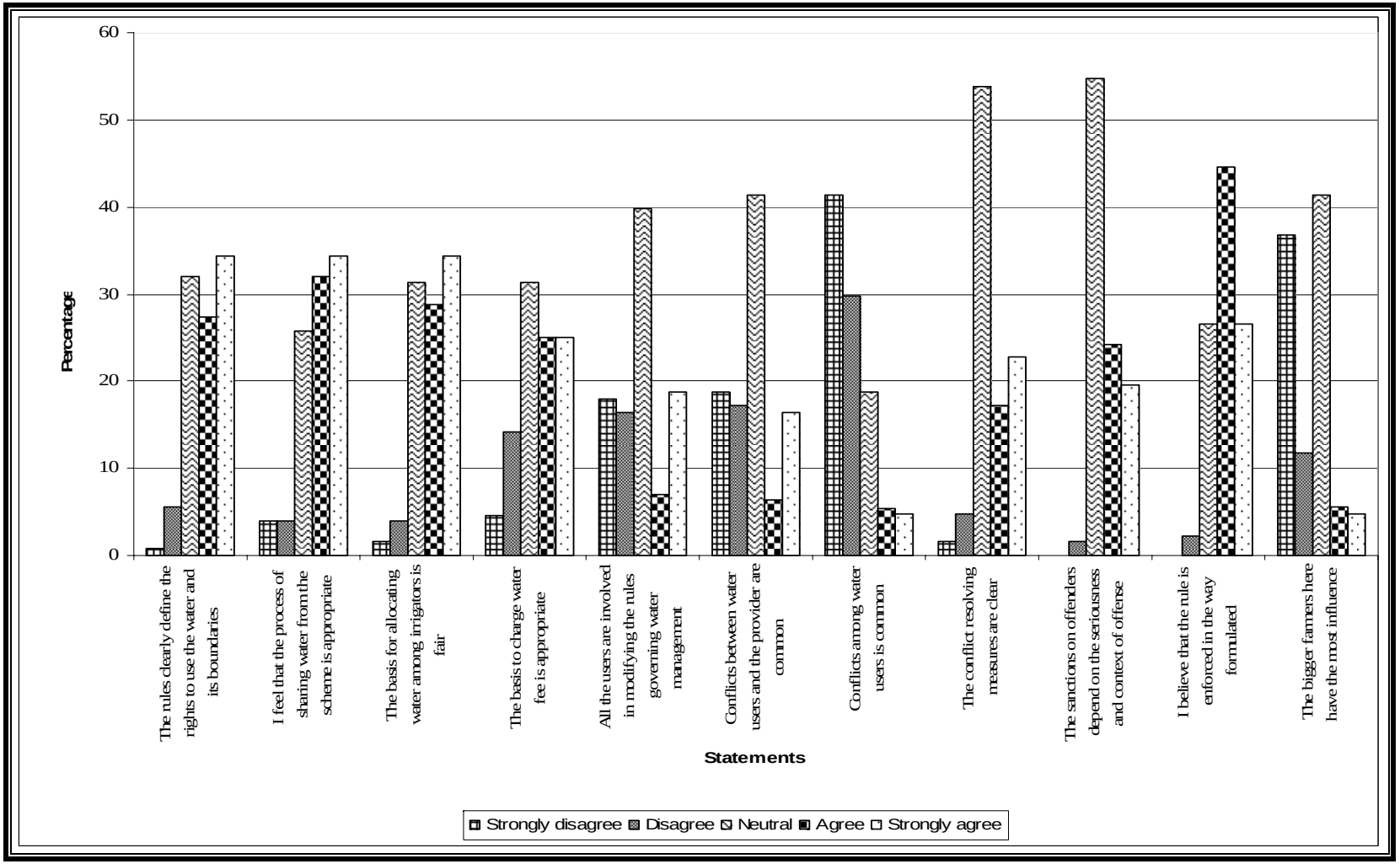


Figure 6.4: Irrigators' perceptions about the operational rules in the VPS

Source: Field survey

When asked whether the rules governing water distribution were clear, around 60% of the irrigators agreed that the rules were clearly defined, with 34% strongly agreeing with this. About the process of water sharing or distribution within the scheme, more than 65% agreed that the process was appropriate and the results were similar when asked about the basis for allocating the water from the scheme, when more than 65% agreed that the allocation was fair. However, a significant number (31%) of the irrigators were neutral on this proposition. When they were asked about the water use charges and the basis of fixing them, most growers (50%) generally understood the price structure and were happy with the current price of the water (Marks & Boon, 2005). Nevertheless, a significant percentage of the irrigators remained neutral. Perhaps this reflected their dissatisfaction with the 'take or pay' policy, as they were concerned about paying for an allocation whether or not they used the water.

The survey went on to ask further whether all the irrigators were involved in decision making processes, particularly in modifying the rules governing the use of wastewater from the scheme. Around 34% disagreed with this proposition, stating that not all the irrigators were involved. It was observed that unlike some other self-governed institutions managing common pool resources, where the users create and modify the rules (Keremane & McKay, 2006; McKay & Keremane, 2006a; Keremane, McKay & Narayanamoorthy, 2006), in this case the contractual agreement between the irrigators and the water company took care of these issues. This might have been the reason for the irrigators being neutral about water allocation and fees.

Generally, in natural resource management, conflicts arise due to disagreement over access, control and use of natural resources (Matiru, 2000). It is more so with water

because it has become a scarce resource in limited supply. So in this study the irrigators were presented with some propositions related to conflict and its management (see Figure 6.4).

When asked if conflicts between the water company and the irrigators was common (common implying frequently occurring), around 41% of the irrigators remained neutral, around 35% disagreed, while about 22% agreed with the statement. This indicated some conflict; when the water company was asked about this, they said otherwise and also claimed there was no chance for conflict, as “everything is clearly mentioned in the contractual agreement and they adhere to it”. Earlier results had shown that there was a strong sense of cooperation within the community; however the irrigators were asked if there were any conflicts with neighbours on water use; the results supported the previous observations, as 70% of the irrigators disagreed that there were conflicts between the water users. Although the water company had insisted there was no scope for conflict, the survey went on to ask the irrigators whether there were any conflict resolution measures mentioned in the agreement in case they should occur. More than 50% of them were neutral, indicating that they were not aware of any such measures. There was a similar response when they were asked about sanctions on offenders.

On a more general note, when the irrigators were asked if they believed that the rules were enforced as formulated, around 70% agreed that they were. Furthermore, over 40% felt that there was no influence from large farmers, which could be true, given that most of the farmers associated with the scheme were market gardeners.

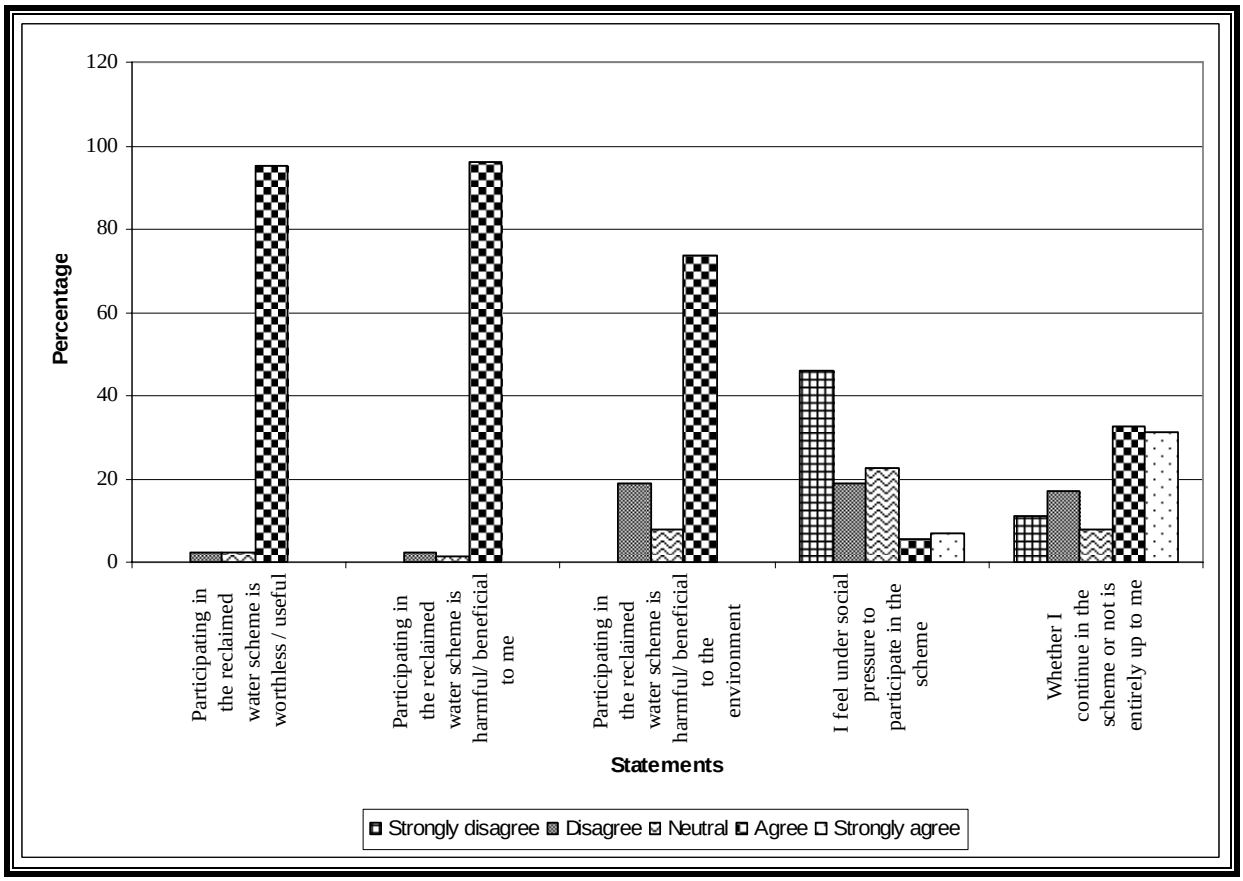
The survey further tried to elicit what the irrigators thought the scheme had to offer, for them and for the environment. The following section discusses these issues.

6.3.8 Irrigators' perceptions of the benefits of the scheme

Wastewater use in agriculture has both positive and negative impacts. The fact that wastewater contains nutrients can provide significant benefits to farming communities and society in general as these nutrients can used for crop production and other agricultural enterprises including aquaculture (Hussain et al., 2001). However, humans place pressure on coastal and marine environments in many ways, a major one is pollution due to discharge of stormwater and treated wastewater, which has detrimental effects on the health of the coastal and marine environment. By reducing the level of pollutants entering the ocean we can benefit the environment. Wastewater use also has negative impacts on communities using this resource, most of it related to health, since the widespread use of wastewater containing toxic wastes or bacteria is likely to cause an increase in the incidence of water-borne diseases (Hussain et al., 2001). With this in mind, the irrigators were presented with some statements on perceived behaviour to examine their view about participating in the scheme. The results are presented in Figure 6.5.

When asked whether participating in the reclaimed water scheme was useful or worthless, more than 95% agreed that it was useful. Next, the survey asked whether by participating in the scheme the irrigators saw any harm to themselves, more than 95% said that it was beneficial to them. When asked if they saw that by participating in the scheme they can cause harm to the environment, more than 70% believed that they were not causing any damage to the environment; however, around 18% thought they might cause harm in the

long run, since widespread use of reclaimed water can cause degradation of the environment.



Source: Field Survey

Figure 6.5: Irrigators' perceptions about participating in the scheme

Next the irrigators were asked if they were under any sort of social pressure to participate in the scheme; more than 60% felt they were not under any social pressure. More than 60% agreed that deciding to continue in the scheme was entirely up to them. However, around 20% thought otherwise, since they had an agreement with the water company that influenced their decision.

Having examined the irrigators' perceptions of perceived benefits, rules-in-use, and level of trust they have in the regulatory authorities, the study set out to identify the factors

responsible for the success of the VPS and how the scheme has contributed towards achieving sustainable development.

6.4 Factors influencing the success of the VPS

This section discusses the effects of irrigators' socio-economic and demographic characteristics on the success of the Virginia pipeline scheme. Success of the scheme is represented by the irrigators' perception of satisfaction with the services of the scheme and water security. The study used two methodologies to arrive at the results: (1) Factor analysis (Principal Component Analysis), and (2) Regression Analysis (logit).

6.4.1 Principal Component Analysis (PCA)

The present study uses a series of either Likert-type or dichotomous scales in the survey questionnaire for obtaining information on human knowledge, attitudes, and behavioural preferences. However, traditional statistical methods for analysing survey responses, like frequency analysis, t-test, and measures of central tendency, do not account for correlation occurring at or between scale level responses, thus omitting the more important aspect of being able to detect and evaluate unobservable patterns (Santos & Clegg, 1999). One approach to analysing subjective perceptions and gaining insights from survey responses is factor analysis (Kim & Muller, 1978), which requires no pre-existing theory of functional relationships, can handle masses of diverse data relating to a large number of social and economic characteristics and communities, and is not sensitive to the scale chosen for the quantitative specification of the variables (Adelman & Dalton, 1971).

Factor analysis and Principal Component Analysis (PCA) share a common goal: to investigate interrelationships among a large number of variables and to explain these

variables in terms of their common underlying factors (Hair et. al, 1992). However, the choice between component or factor analysis is not clear, because there is disagreement among statistical theorists about when each should be used (Costello & Osborne, 2005; Gilley & Uhlig, 1993). Nevertheless, PCA is the more popular method and has been widely employed by researchers (Velicer & Jackson 1990, p. 1) mainly because it is the default method of extraction in many popular statistical software packages like SPSS and SAS (Costello & Osborne, 2005). Consequently this study uses SPSS software to perform the analysis, while the factors are extracted using principal component analysis with Varimax rotation and Kaiser Normalisation process.

6.4.2 Criteria for model fit and inclusion of variables

During PCA, the models' fit is guided by two criteria: (1) the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, and (2) Bartlett's test of sphericity. The KMO explains the proportion of variance in the variables that might be caused by underlying factors, and the rule of thumb is that a value of more than 0.50 indicates a good fit. The Bartlett's test of sphericity is a Chi-square test and a significant chi-square value implies a good model fit, while an insignificant value indicates lack of good fit.

The extraction of factors or components was guided by the magnitude of the Eigen value. In practice, factors with an Eigen value of greater than unity are considered (Gilley & Uhlig) and in SPSS it is a default setting for factor extraction. Inclusion of a variable in definition of a factor varies according to the context of the research. For instance, common social science practice uses a minimum cut-off of 0.3 or 0.35, while another rule-of-thumb terms loadings as "weak" if less than 0.4, "strong" if more than 0.6, and otherwise as "moderate" (Mulaik, 1972 cited in Anton, Balkou & Vobecky, 1984). However, in this

study a loading of 0.5 or more was considered appropriate for including a variable in the definition of a factor.

6.4.3 Results of Principal Component Analysis

In this case study, three rounds of factor analyses were carried out, since some of the variables had lower factor loadings than the cut-off of 0.5 or more set for this study. During the third round of analysis, all the variables used to define each factor had a loading of more the 0.5 (Table 6.2). Hence the results of the third round are presented here and the factors extracted from this analysis are used for logit analysis. The results of initial rounds of analyses are presented in Appendices 16 and 17.

6.4.3.1 Model fit

As explained above, the model fit is guided by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, and Bartlett's test of sphericity. Table 6.11 presents the details of the KMO and Bartlett's test. The KMO value for the variables considered in this case is 0.723. This implies that 72.3% of the variance is explained by the underlying factors. Bartlett's test of sphericity indicates that the Chi-square value is 771.392, with 153 degrees of freedom. Its consequent significance is 0.000, implying that the variables are related and suitable for factor structure detection and so factor analysis is useful for the data under consideration.

Table 6.8: KMO and Bartlett's test for model's fit

Kaiser-Meyer-Olkin measure of sampling adequacy		0.723
Bartlett's test of sphericity:		
	Chi-square (approx.)	771.392
	Degrees of freedom (df)	153
	Significance	0.000

6.4.3.2 Extraction of factors

The extraction of factors or components was guided by the magnitude of the Eigen value, factors with an Eigen value of greater than unity being considered. Further, a variable with a loading of 0.5 or more was included in the definition of its respective factor (Table 6.12).

Table 6.12 shows that the total variance explained by the model is around 67% which implies that the extracted principal components explain around 67% of the total variance of the variables used in factor analysis. Thus, these factors represent certain characteristics of the respondents with a loss of around 33% of the information. Further, the communalities are high in this case, indicating that the extracted components or factors represent the variables well. For instance, the communality of INATTUD (initial attitude regarding the reclaimed wastewater scheme) is 0.704. This means that 70% of the variation in the initial attitude about the scheme under study is associated with the six components extracted from the total variables included in the analysis. Communality denotes the proportion of the total variance explained by all factors taken together, and is similar to R^2 in a regression analysis.

The PCA extracted six components or factors (see Table 6.12) and these factors (Factor 1 to Factor 6) are explained below:

Factor 1 (F_1): Factor one accounts for around 23% of the overall variance in the variables considered in the analysis. The variables with highest loadings on this factor are perception-based variables related to enforcement of rules, collective action and cooperation. It is also the factor with the highest loading for the perception of fair distribution of water within the scheme. Irrigators with the highest loadings tend to agree with the propositions on collective action, rule enforcement and fair water distribution.

Table 6.9: Rotated factor loadings for socio-economic, demographic and perception-based variables

Variables	F_1	F_2	F_3	F_4	F_5	F_6	R^2
INATTUD	-.020	-.439	.055	**.612**	-.068	-.359	0.704
PRATTUD	-.061	.144	-.023	**.803**	-.164	-.180	0.729
WTRFAIR	**.614**	.155	.020	.090	.099	.303	0.511
CONFMEMCOM	.272	**.815**	-.022	.194	.133	-.014	0.794
CONFMEMB	-.136	.102	-.094	-.012	**.832**	.066	0.734
CONFRSLCLR	**.614**	.312	-.024	-.150	.060	-.145	0.522
RLENFRCD	**.683**	-.040	-.151	-.184	-.044	.159	0.552
NGBRTRST	**.836**	-.184	.029	-.080	.050	.013	0.743
ACCPTCOMMUN	**.816**	-.202	-.035	.033	-.103	.017	0.720
COMMFAIRCONTR	**.766**	.226	.058	.040	-.125	-.026	0.659
COMCOOPWTR	**.833**	-.068	-.023	.001	.252	.127	0.779
AGEGRP	-.258	.132	-.137	.101	**-.726**	.223	0.690
EDNLEVEL	.115	-.278	-.051	.051	-.198	**.552**	0.440
FMNGINCOME	.060	-.044	-.176	**-.676**	-.087	-.222	0.550
FMGEXP	.100	.127	.007	-.113	.037	**.764**	0.624
ETHNGP	.438	**-.703**	.009	.104	.281	.033	0.777
GOVTRST	-.132	.076	**.889**	.082	-.043	.098	0.832
WTRCOMTRST	.062	-.104	**.879**	.076	.049	-.135	0.814
% of variance	**23.72**	**9.81**	**9.22**	**9.09**	**8.37**	**7.43**	**67.63**

Notes: Extraction method=Principal Component Analysis with Varimax rotation; F1-F6=Factor 1 to Factor 6; R^2=communalities; N= 128

Factor 2 (F_2): Two variables have high factor loadings under this factor. The variables are ethnic group and a perception-based variable about conflict between the irrigators and the water company. Irrigators with the highest scores belong to different ethnic groups (negative sign of factor loading for ETHNGP). This factor explains around 9% of the overall variance.

Factor 2 (F_2): Two variables have high factor loadings under this factor. The variables are ethnic group and a perception-based variable about conflict between the irrigators and the water company. Irrigators with the highest scores belong to different ethnic groups (negative sign of factor loading for ETHNGP). This factor explains around 9% of the overall variance.

Factor 3 (F_3): Factor three characterises trust in the government and the water company. Irrigators with highest scores have high levels of trust that the government and the water company will fulfil their duties. This factor accounts for around 9% of the overall variance.

Factor 4 (F_4): This factor represents the attitude of the irrigators (both initial and present) towards the scheme under study. Irrigators with the highest scores have a positive attitude towards it. This factor also includes farming income, and irrigators with the highest loadings derive less (negative sign) of their total income from activities depending on irrigation using wastewater. This factor explains around 9% of the overall variance.

Factor 5(F_5): This factor includes age and a perception-based variable related to conflicts. Irrigators with high factor loadings on the perception-based variable agree with the proposition on conflicts between the members. Irrigators with highest loadings consisted of middle- and old-aged groups. The factor explains 8% of the total variance in the variables included in the analysis.

Factor 6 (F_6): This factor accounts for around 7% of the total variance and reflects the social characteristics of the irrigators. Irrigators with the highest loading had attained education of more than primary school and also had the experience of farming for more than five years.

6.4.4 Regression Analysis

Regression analysis was used to examine the relationship between the performance measures of the reclaimed wastewater scheme and the set of principal components obtained by factor analysis. A logit regression model can test whether the sample irrigators

are satisfied with the performance of the scheme and feel secure with the present wastewater supply system. As indicated above, the two performance measures are SATISFCT and WTRSECUR, which are used as the dependant variables in the regression models fitted separately. Before moving to the results of the logit regression, here is a note on how the performance indicators were measured for the purposes of this study.

6.4.5 Specification of regression models

For the purposes of this study two indicators were used to measure the performance of the scheme. The rationale is that these indicators reflect irrigators' level of satisfaction and security in terms of water distribution. Separate regression models were fitted to arrive at the results as indicated below:

Model-1: The logit model to evaluate the effects of independent variables (factor scores) on the probability of irrigators' level of satisfaction was specified as follows:

$$P(Y) = \frac{1}{\{1 + \exp[-(\alpha + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \beta 5x5 + \beta 6x6)]\}}$$

Where,

P(Y) = probability of satisfaction,

Y = SATISFCT (1=agree, 0=disagree),

x1 to x6 = Factor 1 to Factor 6,

α= constant, and

β = coefficients of the independent variables.

Model-2: The logit model to evaluate the effects of independent variables (factor scores) on the probability of irrigators' level of security with respect to water distribution was specified as follows:

$$P(Y) = \frac{1}{\{1 + \exp[-(\alpha + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \beta 5x5 + \beta 6x6)]\}}$$

Where,

P(Y) = probability of water security,

Y = WTRSECUR (1=agree, 0=disagree),

x1 to x6 = Factor 1 to Factor 6,

α= constant, and

β = coefficients of the independent variables

6.4.6 Measurement of variables

The factor scores from this analysis were used in the regression analysis as independent variables. As explained earlier in this chapter, these factors represented socio-economic, demographic, and perception-based variables. The performance measures of the scheme considered for this study: satisfaction (SATISFCT) and water security (WTRSECUR) were used as dependent variables in the regression analysis. These variables were recoded into binary variables as explained below:

Satisfaction (SATISFCT) attempts to measure irrigators' level of satisfaction with the services provided by the scheme under study. The extent to which irrigators agree or disagree with the statement 'I am satisfied with the present services of the water provider' reflects the level of satisfaction. A recoded binary variable with 1= agree and 0=disagree is used as a dependant variable.

Water security (WTRSECUR) attempts to measure the extent to which irrigators feel secure with the water allocation plans under the scheme. This is reflected by the irrigators' responses (agree or disagree) to the proposition 'I feel secure with the current water

distribution plan'. A recoded binary variable with 1= agree and 0=disagree is used as a dependant variable.

6.4.7 Results of regression analysis

The study aimed to understand the factors influencing the performance of the scheme under study. As explained earlier in the chapter, satisfaction with the services of the water provider (SATISFCT), and how secure the irrigators felt with the present water distribution system of the scheme (WTRSECUR) were used as the performance measures. The results of logit regression for SATISFCT and WTRSECUR are presented separately in Tables 6.10 and 6.11. It should be noted that the factor scores developed by the principal component analysis are used for the logit analysis.

Table 6.10 presents the results from the logit regression analysis of the likelihood of the irrigators being satisfied with the services provided by the water provider, Water Reticulation Services (WRSV), in this case. The results indicate that the likelihood of correctly predicting the level or degree of satisfaction using this model is 81.3%.

The coefficient for factor 1 is significant, indicating that those irrigators, who agree that the rules are enforced in the way they are formulated, and that there is cooperation within the community, are more likely to agree that they are satisfied with the services of the water provider. It means that having a high score on factor 1 significantly increases the probability of correctly predicting the degree of irrigators' satisfaction to 1.492. Similarly, factor 5, which represents age group and conflicts between the members, has a negative and significant impact on the degree of irrigators' satisfaction with the services of the water provider. This implies that irrigators who belong to the middle age and old age groups and say that there are conflicts between the members (irrigators) within the scheme

are less likely to agree that they are satisfied with the services. However, the probability of this happening is less than one (0.703).

Table 6.10: Logit regression results for performance of the VPS (SATISFCT indicator)

Predictors	β coefficients	Exp (B)
Factor 1	0.400*	1.492
	(0.236)	
Factor 2	-0.287	0.751
	(0.262)	
Factor 3	-0.316	0.729
	(0.221)	
Factor 4	0.206	1.229
	(0.246)	
Factor 5	-0.352*	0.703
	(0.217)	
Factor 6	0.134	1.143
	(0.233)	
Constant	1.513**	4.539
	(0.247)	
Log-likelihood	119.08	
Pseudo R^2	0.76	
Model χ^2	10.12	
N	128	
Overall correct prediction (%)	81.3	

Notes: β coefficient= effect of factor on log-likelihood of Y; Exp (B) = effect of factor on probability; *=significant at 10%; **= significant at 1%; Figures in parentheses are standard errors

Factor 2, which represents the ethnicity of the irrigators and perception about conflicts between the irrigators and the water company, has a negative impact, but not significantly so. However, the probability is less than 1 (0.751). The rest of the factors (factors 3, 4 and 6) have a positive impact. This implies that irrigators who have high level of trust in the government and water company (factor 3); positive attitude towards the scheme, both

initially and at present (factor 4); and irrigators with high level of education and more experience in farming are more likely to agree that they are satisfied with the services of the water provider.

The results imply, therefore, that trust, education and awareness about the use of wastewater, as well as community attitude in general, are important for successful implementation of the water reuse scheme. These findings accord with the results presented in the previous chapter, which states that trust among the community and trust in all the stakeholders is a very important component for the success of any wastewater irrigation scheme.

The results from the logit regression analysis of the likelihood of the irrigators feeling secure with the present water distribution system within the scheme are presented in Table 6.11. It is clear that the likelihood of correctly predicting the level or degree of satisfaction using this model is 84.3%.

In this case, factor 1, representing the perceptions of irrigators about rule enforcement, collective action and cooperation among the community has a positive and significant impact on the probability of the likelihood of irrigators feeling secure. Therefore, a high score on factor 1 significantly increases to 2.587 the probability of correctly predicting that the irrigators feel secure with the present water distribution system. Similarly, factor 5, which represents age group and conflict between the members, has a negative and significant impact on the degree of irrigators' satisfaction with the services of the water provider. This implies that irrigators who belong to the middle and old age groups who say there are conflicts between the members (irrigators) within the scheme are less likely to

agree that they are satisfied with the services. However, the probability of this happening is less than one (0.703). Further, apart from factor 3 (representing irrigators' trust in the government and water company) and factor 6 (representing irrigators' level of education and farming experience), others have a positive impact. However, the probabilities of these factors are less than one.

Table 6.11: Logit regression results for performance of the VPS (WTRSECUR indicator)

Predictors	β coefficients	Exp (B)
Factor 1	0.950**	2.587
	(0.282)	
Factor 2	0.010	1.010
	(0.317)	
Factor 3	-0.313	0.731
	(0.218)	
Factor 4	0.121	1.129
	(0.245)	
Factor 5	0.443	1.558
	(0.284)	
Factor 6	-0.006	0.994
	(0.237)	
Constant	1.814**	6.133
	(0.297)	
Log-likelihood	103.44	
Pseudo R^2	0.145	
Model χ^2	20.09**	
N	128	
Overall correct prediction (%)	84.4	

Notes: β coefficient= effect of factor on log-likelihood of Y; Exp (B) = effect of factor on probability; **=significant at 1%; Figures in parentheses are standard errors

6.5 Water reuse scheme and sustainable development

In recent times, 'sustainability' and/or 'sustainable development' has become a buzz-word among politicians, bureaucrats, academics and researchers. However, the concept tends to be rather vague, and too confusing to be used in a wide variety of contexts without empirical validation (Copus & Crabtree, 1996). As defined in the Brundtland report sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). For the purpose of this study, sustainable development is seen as any development that simultaneously meets environmental, economic, and social objectives. In line with this, the ways that the VPS has contributed to the sustainable development of the region (Northern Adelaide Plains) is discussed below.

Before applying the principles of sustainable development to the Virginia pipeline scheme, it would be helpful to look into the details of how the impediments that face the implementation of any reuse scheme were tackled in this particular case. It is only because these issues were effectively addressed, that today VPS has been able to contribute to the sustainable development of the region.

6.5.1 Impediments encountering implementation of reuse schemes

In a situation where competition for high quality freshwater is manifold, reclaimed water is increasingly being recognized as a new and reliable water source that does not compromise public health. All the same, developing successful and sustainable wastewater irrigation schemes faces various difficulties, among which legal, policy, institutional, financial and social impediments occupy a prominent place.

These problems arise due to coordination complexity resulting from the varying roles and responsibilities and overlapping concerns of the public agencies managing the resources (MacDonald & Dyack 2004). As well, wastewater collection, treatment, and usage span a wide range of interests at different levels of administration, so the success and long-term sustainability of any reuse scheme depends largely on institutional organization. My field observations and discussions with the key stakeholders associated with the VPS revealed that these issues can be effectively addressed through community participation and partnerships between the public and private entities.

Legal and policy issues were addressed effectively, because South Australia has a favourable regulatory and policy regime for wastewater reuse. The government policy "to phase out all sewerage discharges to the marine environment where it is economically and environmentally sustainable" has significantly influenced the development of water reuse programs in South Australia (Thiyagarajah, 2005). The inclusion of reclaimed water in the South Australian Government's State Water Plan 2000 demonstrates the State's commitment to wastewater reuse projects. Above all, the state has several regulatory controls that need to be complied with before implementation of any scheme, including comprehensive guidelines on reclaimed water; the Water Resources Act; approval by the Public and Environmental Health Service, and approval by the Environment Protection Authority (EPA).

The financial, institutional and social issues were addressed through contractual agreements between the stakeholders – SA Water, VIA, and the WRSV. As a part of the agreement, SA water constructed the DAFF water treatment plant. The WRSV built the distribution system and delivers water to dams on individual growers' properties, from

which they pump the water into their own irrigation systems. All properties using recycled water need to have signs on fencing reading ‘Reclaimed water – do not drink’. The supply contracts with the irrigators are with the water company, who owns the scheme at present and will transfer it to SA Water in 2019, by the terms of agreement.

As for financial aspects, the total cost of the project, including the DAFF Plant and the reticulation system, was shared between the Commonwealth Government, Landcare, private investors, the SA government, and the SA Water Corporation.

6.5.2 Applying the principles of Sustainable Development

Although the concept of sustainability has become popular in recent years, it is interpreted differently by specialists in different disciplines. For example, social scientists say a lot about social sustainability, economists deal with economic sustainability and environmentalists deal with environmental sustainability. However, a holistic approach to understand sustainability should deal with all three dimensions (Sullivan, 2003).

In the present context, we use a definition that is best related to the agricultural use of reclaimed water. This definition states that “sustainability is the ability of an agro-ecosystem to maintain productivity in the face of stress or shock” (Conway, 1997, cited in Abdel-Dayem, 1999). The definition is appropriate, since it considers an agro-ecosystem that consists of the land, plants, animals, environment, together with the people who husband them in order to produce food and other agricultural products. Thus, this dissertation adopts a systems approach in which economic profit, social benefits to the farm family and community and environmental conservation are taken as the measures of economic, social and environmental sustainability respectively.

Table 6.12 is a sustainability matrix for the Virginia region, based on growers' perceptions and field observations.

Table 6.12: Socio-economic and environmental sustainability matrix for Virginia region

Economic Sustainability **(++)**	Social Sustainability **(++)**	Environmental Sustainability **(+-)**
Production volumes (++)	Social capital (++)	Groundwater mining (++)
Purchase of off-farm fertilizers (+-)	Farming income (++)	Marine environment (++)
Market value of land (++)	Job opportunities (++)	Soil quality (+-)
Markets for produce (++)	Community cohesion (++)	Health concerns (+-)

Note: ++ Indicative of more sustainable; +- Indicative of less sustainable
Source: Field Survey

6.5.2.1 Economic sustainability

A widely accepted definition of economic sustainability is maintenance of capital, or keeping capital intact (Goodland, 2002). However, in the present context, we have used production volumes, purchase of fertilizers, land values and markets for the produce grown with reclaimed water as the sustainability indicators, mainly because we are dealing with the use of reclaimed water for agricultural purposes (Table 6.12). It is clear from the table that the growers were very pleased about the growth in production volumes since the inception of the scheme. Although exact production figures are not available, the relative resource use data indicate an increase in the delivery of water to the region. In 1999-2000 6000 ML of reclaimed water was used, which increased to 12100 ML in 2004-05 (Thomas, 2006), meaning an increase of 6100ML over a period of five years. The scheme managers expect that the use of reclaimed water will further increase as the horticulture industry continues to expand. Thus, the increase in water availability and usage definitely indicate an increase in the related horticulture production.

As for the second indicator, growers agreed that the nutrients in reclaimed water provide fertilizer value in crop production, and thus limit the purchase of off-farm fertilizers. However, excessive use of the resource in question might sometimes result in excessive vegetative growth, delayed or uneven maturity, or reduced quality that is not sustainable, indicated by (+-) in Table 6.12. There is no doubt that water allocations add value to the land, meaning that land with water has higher market value than land without. In the present case, the growers stated that good land for horticulture without water and improvements costs AUD 15,000 per hectare, which doubles, to around AUD 30,000 per hectare, when a water allocation is supplied with the land (2003-04 prices). They further claimed that "reclaimed water has the same influence on land values as groundwater" and that consequently the reclaimed water allocations have benefited the lands in the region in terms of their market value. Regarding the market for the produce grown with reclaimed water, the growers reported that this produce is well accepted at all levels of the retail chain. This has been achieved through communication campaigns carried out at different levels to train and educate the key stakeholders – industry, retailers, and the public. In addition, wholesalers were kept informed of the development of the scheme and were reassured that product quality would not be compromised. Moreover, endorsement of the scheme by the South Australia Department of Human Services and the Environment Protection Agency was also helpful in building up the confidence level of the consumers with respect to product quality. Currently, with the domestic market being well supplied with fresh vegetables, and increased water supplies leading to increased production there is scope for development of export markets in the area. Plate 6.1 shows the packed vegetables produced using reclaimed water, ready to be sold in local markets in South Australia.



Source: Field Survey

Plate 6.1: Produce grown using reclaimed water ready for the markets

6.5.2.2 Social Sustainability

Social sustainability means maintaining social capital. According to Goodland (2002), "social capital is investments and services that create the basic framework for society. It lowers the cost of working together and facilitates cooperation". In this case, despite the varied ethnic and cultural backgrounds of the growers associated with the VPS and the different stakeholders involved in partnerships, the scheme has been operating successfully since commissioning. This in itself demonstrates the presence of high social capital within the community.

In addition, the families in the region derive most of their income from activities dependant on irrigation; the horticulture industry supports almost all the families in the community. Moreover, with the industry bound to expand in coming years there is no doubt that more

people will be taking up farming. The commissioning of the scheme has resulted in expansion of the horticulture industry, in turn resulting in the creation of more jobs for the region. Horticulture being a labour intensive industry, this has resulted in increased labour force for the agricultural sector in the region. The Australian Bureau of Statistics census data from 1996 and 2001 shows a 7.5% increase in the labour force. Further, more jobs will be created as downstream opportunities in the packing, processing and marketing industries. This highlights a strong link between increased horticultural production and job opportunities.

Social sustainability also relies on good communication, trust, and mutual support (Sullivan, 2003); community cohesiveness promotes social sustainability (Goodland, 2002). A general argument about collective action is that divisions between irrigators due to cultural and/or other social differences affect their capacity to communicate with one another (Merrey & Wolf, 1986; Lowdermilk, Clyma & Carly, 1975, both cited in Tang 1992). In the present case, despite different ethnicities and cultural backgrounds the irrigators associated with the scheme have demonstrated a high degree of networking, evident from the success of the scheme. Therefore, the findings of this study, while contradicting previous studies, suggest that relatively heterogeneous community groups can be more effective at providing irrigation services (Kurian & Dietz, 2005) and promoting social sustainability.

6.5.2.3 Environmental sustainability

Groundwater was the predominant water resource for the Virginia horticultural region until the development of the VPS. This resource was providing about 18000 ML per year, which was beyond sustainable limits (Kracman, Martin & Sztajnbok, 2001). As a result of over use, the groundwater resources in the region were seriously depleted, ultimately resulting

in increased bore and pumping costs, and the quality of the groundwater was adversely affected by incursions from adjacent saline aquifers (Thomas, 2006). However, with the commissioning of the VPS, the use of groundwater in the area has been reduced, evidenced by increased water levels of the two aquifers (Tertiary 1(T1) and Tertiary 2(T2)) beneath the region.

Discharge of effluents degrades the quality of the freshwater and, hence, adversely affects the water's beneficial uses, as well as the health of its aquatic ecosystem. The Bolivar Wastewater Treatment Plant, from which the VPS draws the reclaimed water, discharges an average 40000 ML of sewage effluent per year to St Vincent Gulf (Kracman, Martin & Sztajnbok, 2001). Therefore, by using reclaimed water from the Bolivar, the VPS has decreased the volume of nutrient-rich treated effluent entering the Gulf. Currently, the scheme has reduced the outfall by around 30%, since 12100 ML per year of the flow from the Bolivar plant is used for irrigation. This could be further increased to more than 50% at the scheme's capacity of 23000 ML per year. Thus, the scheme has helped improve the marine environment and reduced the impact of the nutrients discharged on the sea grass of the Gulf.

Use of reclaimed water in agriculture might result in adverse environmental hazards. Soil salinisation is the most serious potential environmental hazard, since high sodium content in the irrigation water may reduce soil permeability and create an unsustainable environment for plant growth (Abdel-Dayem, 1999). Therefore, in the present case, to ensure that irrigation applied to the soil cover does not affect the soil's physical and chemical properties, an Irrigation Management Plan has been developed, including and addressing the following specific items: water balance; subsurface drainage; and overall irrigation strategy. However, the growers still have some concerns about the impact of

reclaimed water on the soil quality in the long run, which is indicated as (+-) in Table 6.12. In addition, from a health point of view, pathogenic micro- and macro-organisms present in the reclaimed water are the contaminants of greatest concern, since in every reuse scheme there is some risk of human exposure to these contaminants. In the case of the VPS, despite the training and awareness programmes carried out by the Virginia Irrigation Association, an agreement to pump reclaimed water in lilac-coloured pipes and to display signboards to warn about the use of reclaimed water (Plate 6.2), the growers were still sceptical about the potential health hazards from the use of reclaimed water.



Source: Field Survey

Plate 6.2: Lilac pipes and sign board display used in the Virginia pipeline scheme

From Table 6.12 it is clear that the scheme has been able to achieve high level of economic and social sustainability while regarding the environmental sustainability there is still scope for improvement. Having said this, we cannot just ignore the overall benefits the scheme has brought in to the region. This is evident from the fact that in October 2005, the South Australian Government and the Commonwealth Government agreed to co-fund an

extension of the Virginia pipeline via the National Water Commission. The extension project involves an additional 18 km of pipelines to be laid, extending into neighbouring Angle Vale. This will allow up to a further 3000 megalitres of treated water to be supplied to the region every year.

6.6 Conclusions

Development of successful and sustainable water reuse projects will definitely provide solutions to water scarcity problems. However, we cannot overlook the impediments facing implementation of any reuse scheme. Conflicting agendas among water agencies; addressing water rights issues; dealing with opponents to recycling/reuse; modifying existing regulations and acquiring funding are some of the challenges to successful development encountered by reuse schemes.

Experience from the VPS suggests that, through collective action, enhanced community participation and well-designed partnerships, it is possible to coordinate individuals' activities; develop rules for resource use; impose sanctions on violators and mobilize the necessary financial, labour and material resources (Agarwal & Ostrom 1999). By providing knowledge and information on current best practice and communicating this information in a form that is understandable to the different stakeholder groups, it is possible to implement sustainable reuse schemes. This also influences the user's willingness to pay; the study found that willingness to pay for reclaimed water is influenced by various factors, such as the perceived benefits of the new facility, trust in the regulatory authorities, perception of ownership and understanding about the use and management of reclaimed water.

Fresh water scarcity and its associated problems are acknowledged world-wide. On the other hand, use of reclaimed or low quality water for potable and non-potable use has emerged as an innovative alternative option to augment continuously depleting freshwater supplies. However, for the latter option, use of this valuable resource imposes concerns about its suitability to sustain development, because of various issues related to wastewater usage and application. But as evidenced in the case of the Virginia Pipeline scheme, it can be said that by providing knowledge and information on current best practice, and communicating this information in a form that is understandable to the key stakeholder groups, any form of reuse can achieve sustainability, with its economic, social and environmental dimensions. Therefore, with sound policies, proper planning and management, sufficient financial commitments, and public awareness, support and participation it is possible to attain sustainability. Here are few suggestions from the VPS experience for the development of reclaimed water irrigation schemes in the future:

- Specific guidelines for wastewater use and management should be located and prepared.
- Awareness programmes regarding the legal, social, economic, environmental, and health issues related to waste water should target all key stakeholders.
- The private sector should play a key role in wastewater treatment and management.
- Enhanced community participation is crucial to achieving sustainability.

Chapter 7

Chapter 7: Private Sector Participation in Wastewater Management – The Willunga Pipeline Case Study[3]

Give us the tools, and we will finish the job.

-Winston Churchill, 9 February 1941

7.1 Introduction

The Willunga pipeline scheme is the second reclaimed water scheme selected for this study. The scheme is built by a joint venture company formed by grape growers and wine makers, which also owns and operates the scheme. Since inception, the scheme has been successfully supplying Class 'B' reclaimed water for growing grapes in the McLaren Vale region. This chapter is based on information collected through telephone interviews with the grape growers and wine makers associated with the scheme; it presents an outline of the project structure and the socio-economic and demographic characteristics of the respondents, and then examines the perceptions of the irrigators on institutional aspects of the scheme. It also elicits the critical factors for implementing successful water reuse scheme through private sector participation.

7.2 Project background

The Willunga basin is home to the world-renowned McLaren Vale wine region and over 50 wineries. The McLaren Vale Wine Region is located just to the South of Adelaide, the capital of South Australia. The Region is bounded to the south by the Sellicks Hill Range, extends to the eastern side of Clarendon and includes the area around the Mount Bold Reserve, extends just to the north of Reynella, and is bounded to the west by the waters of

[3] Parts of this chapter have been presented at refereed conferences.

Gulf St Vincent. The region is named after the township of McLaren Vale, which is a premium winemaking area.

However, during the mid to late 1990s the region missed out on the boom in wine exports because of dwindling water supplies, excessive groundwater extraction, and imposition of a water extraction licensing regime by the State government. The situation was that this prime grape growing region had ample land available, but no water to meet its irrigation needs (Gransbury, 2004). Water had obviously become a scarce and valuable resource for the vineyards located in the basin, which had other associated problems such as declining crop yields and dropping land values. The situation demanded that the irrigators look for alternatives to augment the depleting fresh water supplies and this search led to the implementation of the Willunga pipeline scheme.

7.2.1 Project outline

The Willunga pipeline scheme was commissioned in 1999, when the Willunga Basin Water Company (WBWC) negotiated a licensing agreement with the SA Water Corporation to access reclaimed water from the Christies Beach wastewater treatment plant for 40 years. The WBWC is a joint venture company formed by a consortium of grape growers and winemakers, which owns the pipeline and is responsible for its operation and maintenance. Unlike the Virginia pipeline scheme, this scheme did not receive any kind of financial support or subsidy from the public sector (State or Federal governments). All the costs incurred were met by the Water Company. Since the scheme started its operations it has benefited the company, community and environment.

One of the important drivers in initiating the scheme was the South Australian Environment Improvement Program (EIP) that completed in 2004. The EIP had the

following aims: (1) increase the effectiveness of our metropolitan wastewater treatment plants (2) reduce the amount of treated wastewater entering Gulf St Vincent and (3) recycle high quality treated wastewater for irrigation purposes. So when the Willunga Basin Water Company (WBWC) approached South Australian Water Corporation (SA Water) to gain permission to use the treated water from Christies Beach Waste Water Treatment Plant (CBWWTP) SA Water agreed to permit access for no charge. It was a win-win situation for SA Water, since without any investment it could comply with the EPA guidelines that wanted a reduction in the amount of treated effluent being discharged into the sea. Furthermore, the growers were able to get the alternative source of water that they were desperately seeking to expand their vineyards.

However, SA water had a different explanation of the entire implementation process. People at SA water who were involved in implementing the reclaimed water schemes (key players) claimed that the scheme was the brainchild of the SA Water Corporation. They further suggested that SA Water had already done a feasibility study of this project well before the Water Company approached them; but could not implement because of some ongoing work and prior commitments at the time. It was observed during the interviews that personnel at SA Water were not happy with the current arrangement as they believed SA Water now has to depend on a third party (WBWC in this case) to achieve the environmental outcomes. Further, SA water claims that the current beneficiaries (about 80) mostly comprise of the new vineyards that were established to take advantage of the boom in wine exports and there are irrigators in the region who still live with the prevailing water resource problems.

Irrespective of all the difference in opinions, the scheme is now seen as a successful example of private sector participation in wastewater management. The Willunga pipeline is a triple-bottom-line role model: it does not draw on public funds, it delivers high value to the community, and it reduces nutrient discharge to the ocean while replacing water consumption from aquifers and the river Murray. The scheme is an excellent example of how private sector participation backed up by favourable regulatory regime may well lead to solving water resource problems.

The next section presents a brief discussion on private sector participation in water sector with reference to the scheme under study.

7.3 Private sector participation in the water sector

The global trend for governments to move major projects into the private sector is growing, mainly in the construction industry (Angeles & Walker, 2000). The trend is similar in the water sector, particularly where operation and maintenance responsibilities, are passed by governments to the private sector, through various contractual arrangements. Reasons such as inefficiency, corruption and lack of funding of public utilities to extend access to services within the water and sanitation sector, has prompted this shift.

Although private sector participation was strongly promoted on the water and sanitation policy agenda for the South, during the 1990s (Budds & McGranahan, 2003), its prominence in the water sector remains limited. Private sector participation in general refers to contractual agreements involving a public agency and a private company. Within the water and sanitation sector, the non-government institutions or private agencies can range from large water companies (often multinationals) to small-scale informal operators

or civil societies. Likewise, the forms or models of private sector involvement vary, based on the allocation of responsibilities, so experts form varying opinions about water privatisation. The concept of public-private-partnerships and options for partnership has already been discussed in Chapter 4. The focus here is on the divestiture model of partnership.

7.3.1 Private sector involvement and the Willunga pipeline scheme

According to Turral (1995), ownership and management by profit-oriented companies, joint ventures, or non-profit organizations like user cooperatives, can all be included under the heading of privatisation. In this instance, the scheme under study is owned by a joint venture company – Willunga Basin Water Company (WBWC). According to Budds and McGranahan (2003, p. 90), "a joint venture is an arrangement whereby a private company with the participation of private investors signs an agreement with the public sector whereby the private company takes a contract for utility management". In this case, the WBWC (private company) formed by a consortium of grape growers and winemakers (private investors) who signed an agreement with SA Water (public sector) to build, own, operate and maintain the pipeline. Table 7.1 presents the allocation of responsibilities under the divestiture model in case of the Willunga scheme.

Table 7.1: Allocation of responsibilities unde divestiture model in Willunga scheme

Responsibility	Sector
Asset ownership	Willunga Basin Water Company
Capital investment	Willunga Basin Water Company
Commercial risk	Willunga Basin Water Company
Operations/maintenance	Willunga Basin Water Company
Contract duration	40 years

Source: Budds and McGranahan, 2003

The scheme has been a success since its inception, and this study attempts to examine the critical success factor for private sector participation, adopting a divestiture model.

7.4 Results and Discussion

The data collected was analysed using SPSS software, and the results were obtained in terms of frequencies, percentages and simple tabulations.

7.4.1 Socio-demographic profile and irrigation details of the respondents

The socio-demographic profile of the respondents is shown in Table 7.2, while Table 7.3 presents the respondents' sources of irrigation.

Table 7.2: Socio-demographic profile of the respondents

Particular	Percentage
Age group	
Young (25-34 years)	21.0
Middle (35-54 years)	31.6
Old (55 years and more)	47.4
Education level attained	
Up to primary school	0.0
Secondary school	15.8
University (Undergraduate)	31.6
Postgraduate	36.8
Others (TAFE/Diploma)	15.8
Farming experience (viticulture)	
0-5years of experience	0.0
Up to 10 years of experience	31.6
Up to 25 years of experience	31.6
>25 years of experience	36.8

Source: Field Survey

About age group, majority of the respondents (47.4 %) belonged to 'old' age group and as for the respondents' education level, the survey indicated that the respondents were highly educated, since around 67% of the respondents had attained University degrees (see Table 7.2). For experience in farming, all the respondents had at least 10 years of experience in

farming, with irrigators having more than 25 years of experience accounting for 36% of the total respondents.

Looking at the respondents' source of irrigation (Table 7.3) it can be seen that around 32% used a mix of groundwater, mains water/dam water and reclaimed water for irrigation purposes, while around 32% used only reclaimed water for irrigation. Twenty one percent of the respondents used a combination of reclaimed water and groundwater for irrigation purposes, while around 16% used a mix of mains/dam water and reclaimed water.

Table 7.3: Irrigation details of the respondents

Particular	Percentage
Source of irrigation	
Groundwater only	0.0
Mains/Dam water only	0.0
Reclaimed water only	31.6
All the above sources	31.6
Groundwater + Reclaimed water	21.0
Mains/Dam water + Reclaimed water	15.8
Proportion of reclaimed water used	
< 50% of total water usage	31.6
51-75% of total water usage	31.6
> 75% of total water usage	36.8 (31.6) [a]
Acreage under irrigation using reclaimed water	
Up to 20 acres	42.1
21- 45 acres	21.0
46 acres and more	36.8

Note: [a] Figures in parenthesis is percentage of respondents using 100 % reclaimed water
Source: Field Survey

Since a significant amount of reclaimed water was being used for irrigation, the survey went on to ask the respondents about the proportion of reclaimed water in the total water used to irrigate vineyards (see again Table 7.3). Around 37% said that reclaimed water bought from the company was more than 75% of the total water used. Out of this, around

31% used 100% reclaimed water to irrigate their vineyards. About 32% said they used less than 50% of reclaimed water while a similar percentage of respondents said that the proportion of reclaimed water being used ranged between 50 and 75%. In terms of acreage (area irrigated using reclaimed water), around 42% of the respondents used reclaimed water to irrigate up to 20 acres of their land, while about 37% had more than 45 acres of land under reclaimed water irrigation (see Table 7.3).

It is clear from the responses received that reclaimed water is a major source of irrigation for the respondents in the study area. According to a recent report, the use of ground water in the McLaren Vale area has declined by more than two-thirds in just over a decade. Some recent figures from the Adelaide and Mount Lofty Natural Resources Management Board show that 2,900 ML of groundwater were used in the 2005-2006 season compared with 9,100 ML in 1994-1995. A trend of wetter spring months, along with changing land use and irrigation practices, maturing vines and greater use of reclaimed water is credited for the decline.

7.4.2 Reason for implementation of the scheme and general awareness

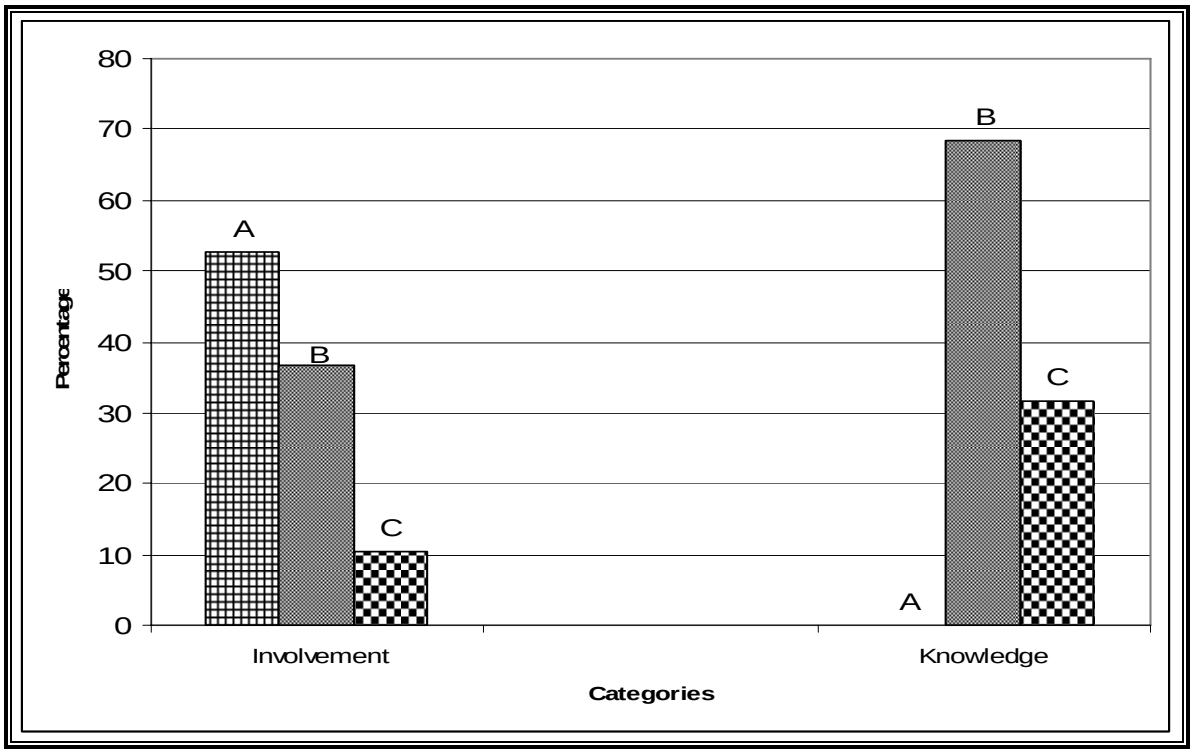
Many factors as discussed in section 7.2.1 have led to the development of the Willunga pipeline. However, from irrigators' point of view groundwater depletion was the major driving force behind the implementation as indicated by majority (73.6%) of the growers. There were other reasons too that contributed to the start of this scheme, such as the high price of mains water, encouragement by water authorities, and community interest (Table 7.4).

Table 7.4: Important reasons to join the reclaimed water irrigation scheme

Reasons	Percentage
Groundwater depletion	73.6
High price of mains water	10.5
Encouragement by water authorities	5.3
Community interest	5.3
Refused	5.3

Source: Field Survey

An important factor in the success of any water reuse scheme is community involvement and awareness. This is evident for the Willunga pipeline scheme, in the sense that more than 50% of the respondents had been involved with the scheme since the planning stage (Figure 7.1). Around 36% of the respondents were involved during the implementation stage, while 10% joined during the operational stage. In addition, it was noticed that the respondents had some knowledge (68.4%) or knew quite a lot (31.6%) about water reuse even before the scheme was implemented.



Notes: A, B, C for Involvement indicates three stages: planning, implementation, and operational. A, B, C for Knowledge indicates three levels: no knowledge, some knowledge, and quite a lot. Source: Field Survey

Figure 7.1: Irrigators involvement and level of knowledge

A query about the source of information further supported this observation about the knowledge and awareness among the community. It was observed that general knowledge (47.4%), followed by the personal experience of the growers (21%), were the major sources of information (Table 7.5).

Table 7.5: Irrigators' sources of information

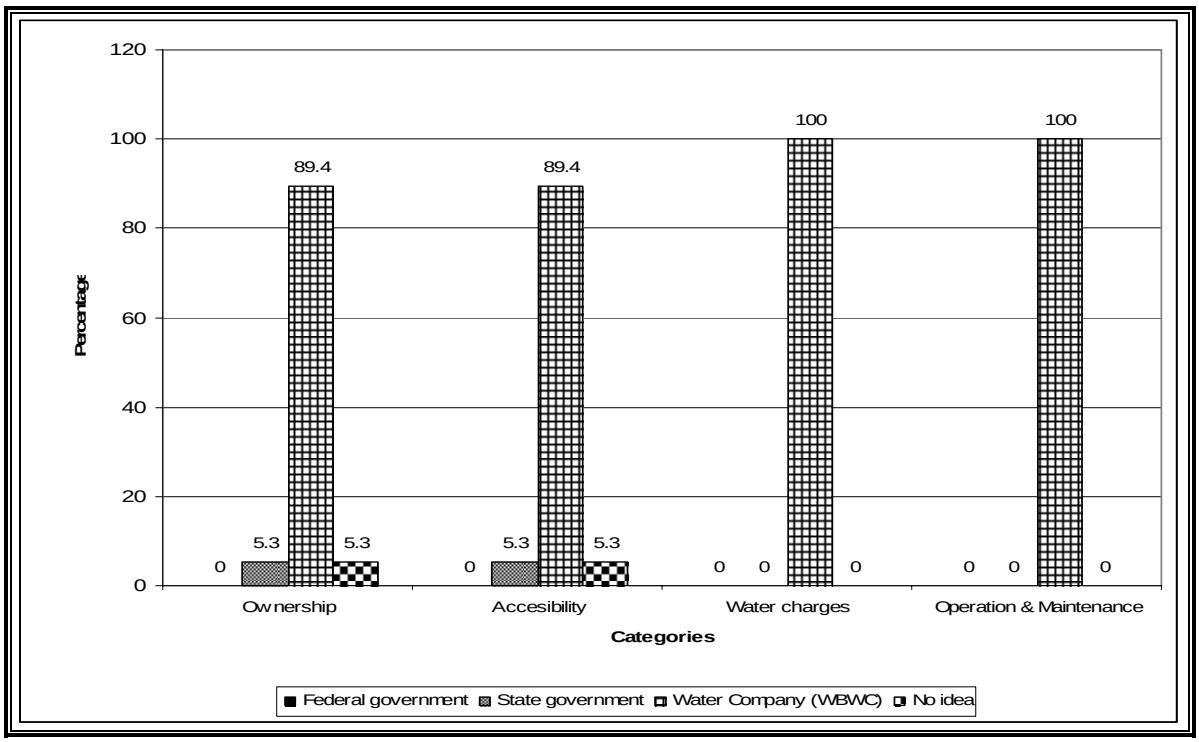
Reasons	Percentage
Water authorities	10.5
Water company	10.5
Community	5.3
Personal experience	21.0
General knowledge	47.4
Don't know	5.3

Source: Field Survey

These results indicate that the community was aware of the advantages of reclaimed water reuse in general, and of the scheme in particular. Further, it also shows that the community was involved right from the planning stage in the development of the Willunga pipeline scheme. Thus, it was these realisations by growers and the interest of SA Water Corporation in preventing discharge of nutrients to the bay that led to implementation of the scheme. Over and above all these factors, a favourable regulatory and policy regime for wastewater in South Australia and several aligned regulations, such as reclaimed water use guidelines, the approval of Public and Environmental Health and the EPA were also instrumental in the commencement of the scheme (McKay, 2007a).

7.4.3 Irrigators' knowledge of the operational details of the scheme

The survey went on to investigate the irrigators' perceptions about the operational details of the scheme: ownership of the scheme, the authority for deciding the water charges and accessibility to the scheme, and the operation and maintenance of the scheme (Figure 7.2).



Source: Field Survey

Figure 7.2: Irrigators' perceptions about the operational details of the scheme

The irrigators were agreed in their responses. About ownership, around 89% thought that the scheme is owned by the Water Company, 5.3% of the irrigators believed the State government owned the scheme, while an equal percentage had no idea. The results were quite similar when the irrigators were asked: "Who has the authority to decide about accessibility to reclaimed water from the scheme?" All the irrigators (100%) were of the opinion that the water company had the authority to decide upon the water charges and was entrusted with the responsibility for the operation and maintenance of the scheme.

When asked about the basis for determining the accessible volume of reclaimed water from the scheme, the majority of the irrigators (58%) said it was an individual requirement; in reality it depended on field conditions. However, it was interesting to note that a few (21%) thought it was land area, while around 15% had no idea. This indicates that the

irrigators are not informed about the basis for determining the accessible volume of reclaimed water from the scheme (see Table 7.6)

Table 7.6: What is the basis for determining accessible volume of reclaimed water?

Basis	Percentage
Land area	21.0
Individual requirement	57.9
Number of irrigators	5.3
No idea	15.8

Source: Field Survey

When asked about the basis for fixing the reclaimed water charges, around 79% said it was based on the volume of the reclaimed water, while about 10% of the irrigators felt it was both time and volume that were used to determine charges. An equal number (10%) of irrigators had no idea (Table 7.7). In reality, volume was the basis to fix the water charges.

Table 7.7: What is the basis for fixing water charges?

Basis	Percentage
Volume	79.0
Time and volume	10.5
No idea	10.5

Source: Field Survey

Knowing that the Willunga scheme was developed to meet the water requirement of the grape growers and wine makers in the region, the survey asked the irrigators if the area under grapes had increased after the implementation of the scheme. All the irrigators said there had been an increase in the acreage under grape cultivation in the region. More than 70% felt that the increase was significant, while around 16% felt the increase was normal. A small number (10%) of irrigators felt there was an increase but it was negligible (Table 7.8). According to the Water Company (WBWC) records, the total area covered by the pipeline is more than 1500 hectares and, in the opinion of Norm Doole (WBWC, 2006a),

who heads the water company, “use of the wastewater through this scheme has given the opportunity to ‘drought-proof’ an industry which is heavily reliant on water”.

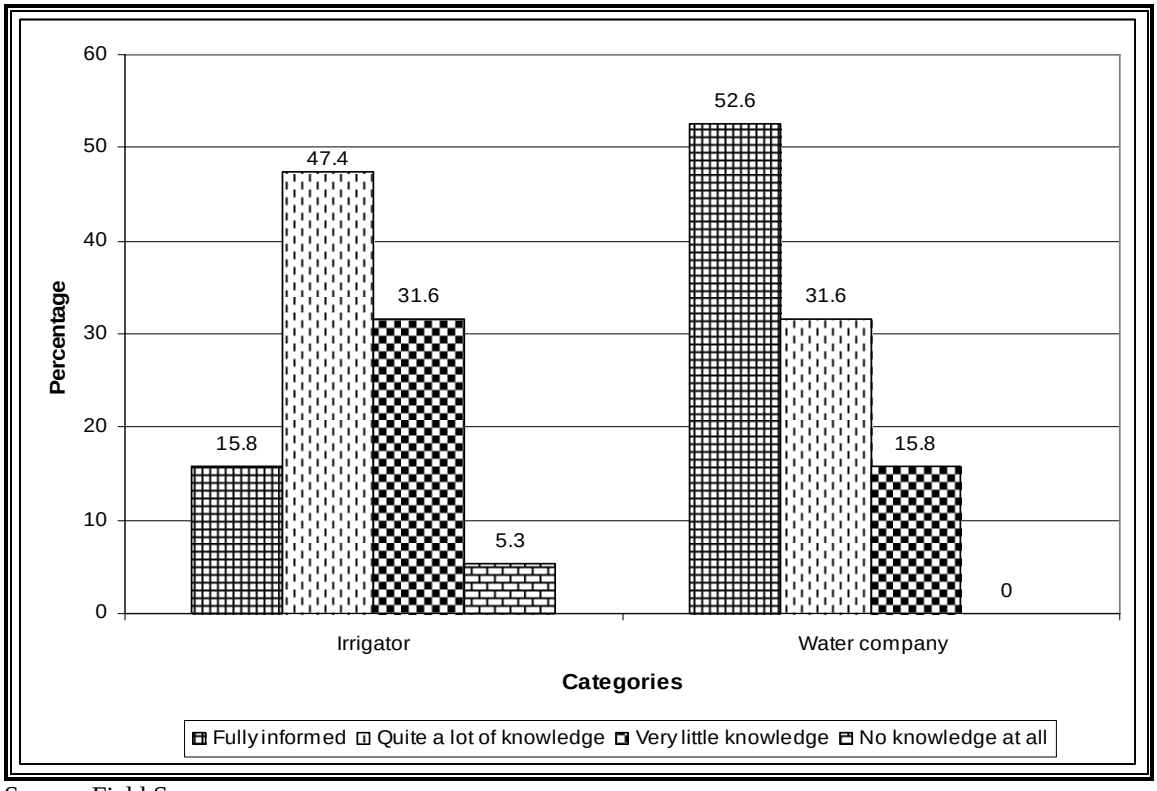
Table 7.8: Influence of the scheme on acreage under grape cultivation in the region?

Has the area under grapes increased after implementation of the scheme	Yes (%)	No (%)
	100.0	0.0
What do you think about this increase in the area under grapes?	Percentage	
Significant	73.7	
Normal	15.8	
Negligible	10.5	

Source: Field Survey

7.4.4 Irrigators’ knowledge and level of trust

The survey tried to examine the extent of knowledge that the irrigators and the water company had regarding wastewater treatment and usage, since this is important when it comes to community involvement. To a certain extent it also implies the level of trust the users have in the resource (reclaimed water) and the water providers’ ability to deliver the goods. Figure 7.3 presents the perceptions of the irrigators.



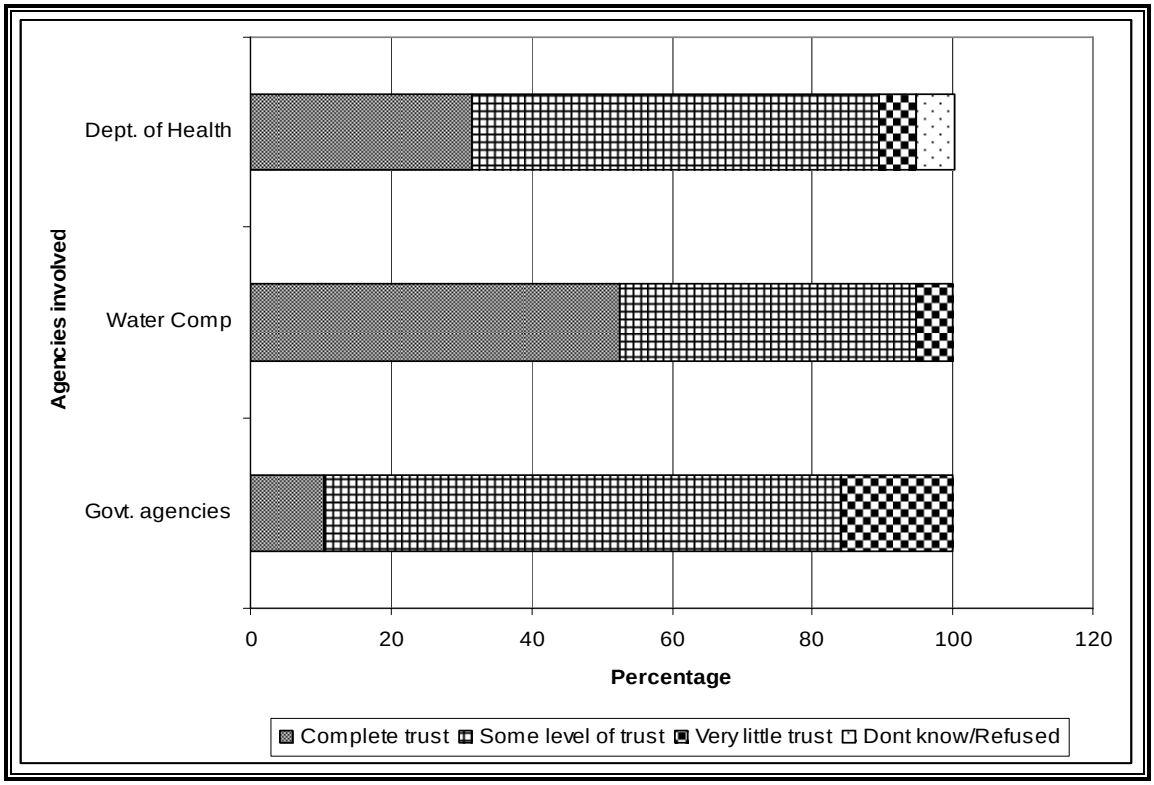
Source: Field Survey

Figure 7.3: Irrigators’ and water company knowledge of wastewater treatment and use

Irrigators were asked about the knowledge they had regarding wastewater treatment and usage. The results indicate that more than 90% had this knowledge. However, the extent of their knowledge varied, as a majority of the irrigators (47%) knew quite a lot about wastewater treatment and usage, while around 15% said they were fully informed. About 31% said they had some knowledge, while a small number (5%) of the irrigators said they had no knowledge at all.

When they were asked about the extent of knowledge that the Water Company had regarding wastewater treatment, all the irrigators (100%) said the water company was knowledgeable. More than 50% said it was fully informed, around 31% said the water company knew a lot about wastewater treatment and usage, and about 15% said the water company had some knowledge.

The results clearly show that the community is aware of wastewater treatment and usage. Also, the community has full faith in the water company to deliver the goods, as it perceives the Water Company to be knowledgeable about the processes, a very positive sign for the success of any reuse scheme. However, the survey tried to ask some direct questions to examine the level of trust the community (irrigators) had in the different agencies that are involved, directly or indirectly, with the scheme – the Government agencies, Water Company, and the Department of Health. Their responses are presented in Figure 7.4.



Source: Field Survey

Figure 7.4: Irrigators' level of trust in various agencies associated with the scheme

Generally, the irrigators had trust in all the agencies involved with the scheme. However, the level of trust was higher in the Water Company, compared with the government agencies and the Department of Health.

As illustrated in Figure 7.4, around 70% of the irrigators said they had some level of trust in the government agencies, and only 10% said they had complete trust; about 15% said they had very little trust. In the case of the Water Company, more than 50% of the irrigators said they completely believed the Water Company would perform its duties, and around 42% said they had some level of trust in the water company.

As any reuse schemes raises health concerns, trust in the agencies involved in defining the health requirements (Department of Health in this case) is equally important. When asked about this, more than 55% of the irrigators had some level of trust in the department, while

31% had complete trust; the least number of irrigators (5%) had no trust. An equal number of the irrigators refused to answer (Figure 7.4)

Further, 'trust' is one of the most frequently encountered elements in definitions of social capital (Hutchinson & Vidal 2004) and maintaining social capital means social sustainability (Keremane & McKay, 2006b). According to Goodland (2002, p. 490), "social capital is investments and services that create the basic framework for society. It lowers the cost of working together and facilitates cooperation". In this case, it is important to note that the Water Company is a consortium of the grape growers and the wine makers who are the 'community' in the study region, and hence there is high level of trust within the community. Thus, the presence of high social capital within the community is one of the factors contributing to the successful functioning of the Willunga scheme.

7.5 Critical success factors for private sector participation

The Willunga pipeline scheme is innovative in its own right, in the sense that it is totally owned and operated by the users without any support from the public sector. In this case it is the grape growers' and wine makers' consortium (a private joint venture company) that owns the scheme and is responsible for its operation and maintenance. Therefore, taking the Willunga pipeline scheme as a case in point, the study tried to identify the critical factors that facilitate private sector participation in implementing water reuse schemes, adopting the Critical Success Factor (CSF) method to arrive at results.

7.5.1 Critical Success Factors Method

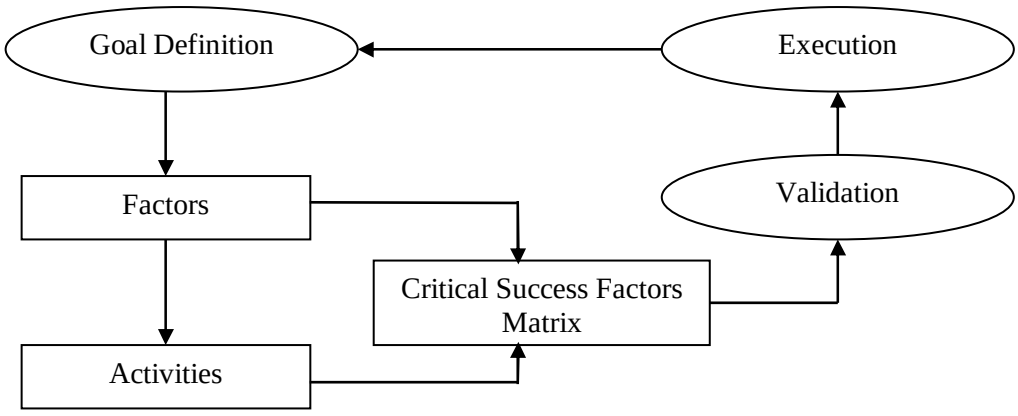
The phrase 'Critical Success Factors' (CSF) was first used in the context of information systems and project management; the concept was developed by Rockart and the Sloan

School of Management (Jefferies, Gameson, & Rowlinson, 2002). According to Rowlinson (1999) (cited in Jefferies, Gameson, & Rowlinson, 2002, p. 354), critical success factors are those fundamental issues inherent in the project that must be maintained in order for team working to take place in an efficient and effective manner. The CSF method provides an easy way of keeping an overview about all relevant activities needing to be executed, and of eliminating redundant activities in order to solve a problem (Wasmund, 1993).

According to Wasmund (1993), the CSF method is basically a process of creating a project out of a problem definition. The author further explains the process as follows:

> "the process includes decomposing a well-defined goal into a comprehensive list of sub-goals, called as factors. From there a list of activities follows, whose purpose is to obtain the factors and eventually accomplish the specified goal. The activities are executed in a project context, leading to the solution of the original problem" (p. 596).

The CSF method therefore consists of four steps: (1) defining the goal, (2) decomposing goals into factors, (3) defining activities, and (4) building the CSF matrix and validation. See Figure 7.5 for a diagrammatic illustration of the CSF method.



Source: Wasmund (1993)

Figure 7.5: Steps of the Critical Success Factor (CSF) method

7.5.2 Critical Success Factors and the Willunga pipeline scheme

Wastewater management spans a wide range of institutions and stakeholders, with various responsibilities, and diverse political and economic priorities. So coordination of policies and regulations governing the resource is very important. The presence of an effective institutional network is a prerequisite for coordinating these and developing a successful reuse scheme. Apart from an effective institutional network, a favourable regulatory and policy regime for wastewater management is also essential. These regulatory controls help in improving the acceptability of the scheme and delivering high value to the community and to the environment. In addition, since developing such schemes involves large investments, a strategy to minimise the technical and investment risks should be thought of during the planning stage. Further, the engineering design should be reliable and simple. Also, the risks should be appropriately allocated between the entities involved in the scheme through proper arrangements; only this can ensure the commercial sustainability of the scheme.

In the present instance, implementation of the Willunga pipeline scheme faced several impediments, social, institutional, financial, and regulatory and policy. However, these issues were effectively addressed through private sector participation by adopting the divestiture model. What follows is an account of the application of the CSF methodology to the Willunga pipeline scheme. The aim here is to identify the critical success factors for private sector participation in implementing a successful water reuse scheme, so as to provide insights for those policy makers and planners in water-scarce regions who are thinking of developing schemes on similar lines for their own regions.

7.5.2.1 Application of the CSF method to the Willunga pipeline scheme

Step 1: Setting up a goal: For the Willunga water reuse scheme, the goal was to 'develop an alternative water production (water reuse) project to replace water consumption from groundwater aquifers, whilst reducing nutrient discharge to the ocean'. The rationale behind this was to deliver high value to the community and the environment.

Step 2: Decomposing the goal into a set of factors: To achieve the above-mentioned goal it would be necessary to develop and implement a successful water reuse scheme without any public sector involvement. It is clear from the literature that implementing a reuse scheme faces various obstacles, among which legal, policy, institutional, financial and social impediments occupy a prominent place (Jones, 2005; Thomas & Durham, 2003; Po, Juliane & Nancarrow, 2004; Po et al., 2005; Livingston et al., 2004). This implies that six factors, by and large, are considered to be critical for the success of any reuse scheme: (1) social, (2) institutional, (3) financial (4) regulatory and policy (5) risk allocation and (6) technical. Thus, for the Willunga pipeline scheme, these six factors were identified as critical for achieving the stated goal.

Step 3: Defining the activities: The third step is defining activities to address the factors previously identified; that is, the work to be performed to satisfy one or several factors. The activities determined in the present case are outlined in Table 7.9.

Table 7.9: Critical Success Factors and interrelationship with supporting activities

Critical Success Factors						Activity
Social	Institutional	Regulatory & Policy	Financial	Risk allocation	Technical	
√		√				1. Community acceptance : information dissemination, discussions, seminars
√		√				2. Monitor and control the water quality and soil conditions
√		√				3. On-farm warning signs (safety measures)
√		√				4. Issue operating manuals
	√	√				5. Approvals from various government organizations, departments and local council
	√	√				6. Comply with the Water resources Act
	√	√				7. Prepare annual Irrigation Management Plans
	√	√				8. Approval of the Public and Environmental Health Service
	√	√				9. Approval of the Environment Protection Authority (EPA)
	√	√				10. Comply with the Reclaimed Water Guidelines issued by the Department of Human Services and EPA
			√			11. Shareholdings
			√			12. Feasibility study
√			√			13. Tariff structure
	√			√		14. Contractual agreements
√				√	√	15.Demand management – self ordering
			√	√	√	16. Staged construction
√		√			√	17. Drip irrigation
√					√	18. Expansion capacity – third party access

Note: √ indicate the factors satisfied by the respective activity.

Source: Project reports and field work

It is possible for one activity to satisfy more than one factor; in this present case all the activities defined satisfied one or more factor. For example, from Table 7.9 it is clear that activity 1, related to information and awareness, satisfies factor 1 (social) and factor 3 (regulatory and policy). In total, 18 activities were listed to satisfy the six factors which are critical for developing and implementing a sustainable water reuse project.

Step 4: Build and validate the CSF matrix: Once the activities are defined, the next and final step is to validate the interrelationship between the set of factors and the supporting activities. Developing a critical success factor matrix (Table 7.9) helps this step. The following discussions bring out the interrelationship between the set of factors and the supporting activities, which ultimately led to implementation of the Willunga pipeline scheme. Since more than one activity has been identified to satisfy each particular critical factor, the discussions will focus on the activities rather than on the factors. However, an effort has been made to include all the factors, and the activities that satisfy each one which are discussed in the following sections.

7.5.2.2 Social factors

Among the social factors, community perceptions about the use of wastewater are very important. A review of experiences around the world on this point reveals that users' apprehension, about the quality of wastewater and its impact on health and the environment, can result in a project being stalled. Therefore, community acceptance is very critical in implementing a water reuse scheme. However, with proper measures to

create awareness among the community, backed up by suitable regulatory regimes, some of these concerns can be alleviated.

Further, they are also important since they influence the users' willingness to pay. Previous studies on willingness to pay for recycled water show that community involvement from the start of the project, and knowledge and understanding in the community regarding wastewater use and management, will increase the willingness to pay for reclaimed water. In this particular case, it was observed that there had been community involvement ever since the planning stage, and the community had the necessary knowledge about wastewater use and applications.

However, for the Willunga pipeline scheme, creating awareness among the community was not initially so important, since this scheme was different from other typical reuse schemes built with private sector intervention. Unlike most water reuse schemes, where a private independent company retails the reclaimed water to individual growers based on certain contractual agreements with the public sector and the customers, in the case of the Willunga pipeline scheme it was the initial efforts of a committed and motivated group of grape growers (who later formed a joint venture and company), driven by an individual champion, which gave momentum to the launch of the project. So, it was more self-motivation, or self-interest that prompted the implementation of the scheme in first place.

All the same, since the Willunga scheme did have a provision for third party access, creating awareness among the community that would be affected by the scheme, and

ensuring their involvement was always on the project agenda as the. According to water company records, the number of customers benefiting from the scheme today (apart from the first investment cohort of 16 growers and wine makers) is around 80 (Templeman, 2006). So it is clear that proper information dissemination, discussions, and seminars helped to gain the confidence of growers and to ultimately increase the number prepared to sign up for the scheme. In addition, appropriate measures to monitor and control the water quality and soil conditions improved the comfort level of these second wave customers. None the less, the fact that the region had strict groundwater restrictions and the irrigators wanted to expand the vineyards also prompted them to sign up for the scheme.

It is also important to note that community participation and involvement has now become a policy requirement. The signing of the National Water Initiative (NWI) by all Australian State Governments in 2004 has made community participation and involvement very important to water resources management in Australia. According to the 'community partnership and adjustment' objective of the NWI, "governments are to engage water users and other stakeholders in achieving the objectives of the Initiative by improving certainty and building confidence in the reform processes; transparency in decision making; and ensuring sound information is available to all sectors at key decision points" (National Water Commission, 2004, p. 20). Thus, community involvement in water and wastewater management is now a policy requirement.

7.5.2.3 Institutional, regulatory and policy factors

Irrespective of who owns and manages the resource in question, the roles of institutional arrangements or working rules are extremely important. Although the definitions of institutions and the way we interpret them vary, in the present context they are viewed as administrative arrangements that regulate water use and reuse, as well as the way these rules are defined (MacDonald & Dyack, 2004).

In the context of water management irrigation systems in particular, institutions generally include operation and maintenance of the systems, conjunctive use of surface and groundwater, designing cropping patterns, allocation and scheduling of water, enforcement of the rules (or changes to them, if needed), and regulations governing access to irrigation water by individual farmers (Saleth, 1994; Marothia, 2003). Institutions also shape the incentives for individuals to take certain actions, such as to cooperate, engage in collective action, and/or coordinate activities to achieve the desired outcomes (North, 1991). Thus, institutions affect individual behaviour and resource management (Kuks, 2005) and can be formal or informal.

In the case of the Willunga scheme, it is more that the formal arrangements result from regulatory pressures on the water authorities. The setting up of the Natural Heritage Trust (NHT) in 1997, to help conserve and restore Australia's natural resources, helped many organizations and community groups to attract funding for environmental and natural resource management programs. The NHT has many programs and the Coasts and Clean Sea Initiative (1996-2002) is one of these. The Clean Seas Program under this initiative

aimed to tackle coastal pollution by encouraging wastewater reuse and promoting ecologically sustainable development. One of the priorities of the program was to improve the quality of coastal, marine and estuarine waters, by reducing the amount of pollution from wastewater and storm water discharges, by constructing on-ground pollution control infrastructure, accompanied by measures to address pollution at its source. The NHT funded such projects through two mechanisms: (1) the Commonwealth component that funded large, nationally significant projects; and (2) the local component that funded regionally significant projects. However, unlike the previous case (Virginia Pipeline) which benefited from this program, the Willunga pipeline is entirely funded by the growers. Nevertheless, these policy reforms might shed some light on the claim by SA Water to have done the feasibility study before WBWC approached them but could not implement the scheme due to some reasons. But, the South Australia Environment Improvement Program aimed at increasing the effectiveness of metropolitan wastewater treatment plants, reducing the amount of treated wastewater entering Gulf St Vincent, and recycling high quality treated wastewater for irrigation purposes might have compelled SA Water to permit access to the treated effluent from CBWWTP for no charge.

The favourable policy regime for water reuse in South Australia has made it the leader in water reuse in Australia. South Australia is a national innovator in the use of recycled water and SA Water is committed – through the Water Proofing Adelaide strategy – to exploring further opportunities to deliver recycled water for community uses. In 2004-2005, about 21% of Adelaide's treated wastewater was recycled and delivered for use in

the irrigation of crops, parks, gardens and the recycled water system at Mawson Lakes, which includes toilet flushing (ABS, 2004).

Regulation of water recycling is a state responsibility (Stevens, 2006) and the legislative instrument, the Environment Protection (Water Quality) Policy, is embedded in the South Australian Environment Protection Act 1993. The Water Quality Policy uses codes of practice and guidelines to describe how activities can comply with the general environmental duty of care. The South Australian guidelines related to the water quality policy "establish acceptable levels of constituents of reclaimed water for a variety of uses and describes the means for assuring reliability in production so that reclaimed water does not impose undue risk to health and the environment", (South Australian Reclaimed Water Guidelines – Treated Effluent, 1999).

7.5.2.4 Health, safety and financial risks

Implementation of reuse scheme faces several risks, among others, perceptions of heath and safety risk and financial risks are prominent. According to the National Water Quality Management Strategy (2000), "The major risk of human contact with wastewater is infection from viruses, bacteria, protozoa and Helminths, as well as chemical toxicants such as poisons, or carcinogens … after prolonged … exposure". Through the implementation of multiple barriers, and treatment processes and disinfections, these risks can be controlled. Moreover, safeguards such as signage, and public access controls in the implementation plan will add to health safety. In case of the Willunga basin water reuse scheme, the concerns raised about negative impacts of water reuse were addressed

by regular monitoring and control of the water quality and soil conditions. The reclaimed water is pumped in lilac-coloured pipes, and growers are required to use signage stating “reclaimed water, do not drink” on their properties, where reclaimed water is being used. The growers are also provided with operating manuals that have detailed information on the standard operating procedures.

Further, following the South Australian regulatory and policy regime related to wastewater treatment and use, all entities involved in the implementation of the scheme (in this case it is only the private water company) need to get approvals from various government organizations, departments and local council. The water company is required to prepare an annual Irrigation Management Plan that complies with the Reclaimed Water Guidelines issued by the Department of Human Services and Environment Protection Authority (EPA) and the Water resources Act, 1997. This is to ensure sustainable use of this resource without damaging soil quality. The IMP is to be reviewed and approved by the Environment Protection Authority (EPA). To ensure health safety, approval of the Public and Environmental Health Service is also essential. This makes trust in these different regulatory agencies an important factor. In the present case it is established that there is high level of institutional rust and trust in the regulatory agencies like the EPA and the Department of Health Services. The State reuse guidelines have helped, by taking care of the heath and safety related risks.

The other risk is finance in such schemes, because acquiring funds to develop a water reuse scheme is an onerous task. However, in the case of the Willunga scheme, the initial

investment required for laying the pipeline was handled by the Willunga Basin Water Company – the first investment cohort of 16 motivated grape growers and wine makers. Initial feasibility studies were conducted to determine the financial (and technical) viability of the scheme. The studies indicated that it was potentially attractive to both the landowners and the Willunga Basin Water Company (WBWC) that was set up to build and operate the Scheme. The shareholders of the scheme, all of whom were growers, made contributions through shareholdings to take care of the initial investment cost of AUD7.2 million for constructing a 24 kilometre main pipeline from the Christies Beach WWTP. The first investment cohort of 16 growers shared the initial investment cost and the costs of their on-farm drip irrigation systems. No government subsidy/funding support was provided for the scheme. The WBWC was not charged for the effluent water by the South Australian Water Corporation (SA Water) 'producing' the effluent, as it had no alternative use or value for it.

Regarding the tariff structure, it is important to have appropriate tariff structure because the general tendency observed in case of water reuse schemes is that users might not be willing to pay more for this resource because it is considered as waste, so why pay for it? The tariff structure should be such that the community being served should perceive it to be appropriate, as well as taking into account the long term viability of the service provider. In the case of the Willunga reuse scheme the tariff is about half the price of mains water, while at the same time it has lower salinity and restrictions than the groundwater in the region. The tariff structure comprised two components: (1) a fixed tariff based on allocated water entitlement and (2) a variable tariff based on usage. The

Company charged approximately AUD 5000 per ML of entitlement (fixed tariff) and AUD 0.53 per KL of reclaimed water (variable tariff), which was cheaper than the mains water supplied by SA Water (MacDonald, 2004). According to the Water Company, "for irrigation, reclaimed water supplied by the WBWC is up to 40% cheaper per kilolitre than mains water and the establishment cost of WBWC water is typically cheaper than a groundwater license. The salinity of WBWC water compares favourably with the average salinity of groundwater in the region" (WBWC, 2006a). However, when compared to the Virginia pipeline scheme, the rates are relatively higher and the owners or the initial investment cohort pay a lower tariff, perhaps to compensate them for the initial investment cost. Further, to provide an incentive for customers to physically take their water entitlements or to on-sell them, a take-or-pay arrangement is adopted which implies an unused water tariff.

7.5.2.5 Technical factors

The technical side of the scheme is also partly responsible for the success of the scheme under study. By virtue of sophisticated engineering works, the Willunga scheme is very innovative. Water allocations are available to growers on demand, on a 24 hours/day, 7 days/week basis. The supply to those growers who take more water than their entitlement, is automatically cut off. The company recommends drip irrigation with filters as the appropriate method to irrigate the vineyards. As for the quality of water affecting the growth and yield of the grapes, the Water Company is confident that water quality has not been an issue since the inception. According to Glen Templeman, the operations manager, "the use of reclaimed water is a good news story for wineries. Since

vine roots are perfectly designed to extract pure water from reclaimed water, the use of reclaimed water on vineyards is an economically and environmentally smart way. It is safe and has no negative impact on the vines, grapes or resultant wine, which is proven by comprehensive research and testing. Therefore, using reclaimed water for irrigation is the way of the future".

The two-stage construction strategy adopted in case of the Willunga scheme helped to minimise technical and investment risks. In Stage 1 water was delivered to the shareholders of the scheme (the initial group of 16 growers), while in Stage 2 (one year later); the supply was extended to third-party growers. The scheme, which started with a small group of primary producers in the region, now has more than 80 users and the company is reliably providing water to irrigate more than 3,000 acres of prime grape-growing land.

Further, the technical design of the scheme also has reduced the probability of risks occurring. As the scheme supplies class B water to growers, which is not suitable for spray irrigation, and is not to be used for salad crops, the Willunga Water Company in its agreement with the grower asks them to adopt a drip irrigation facility, so that no grower comes in direct contact of the water. The company also recommends users to have a filter that will be the user's responsibility, to filter the water to a standard appropriate for their own on-farm drip irrigation system. As mentioned earlier, the operational manual has all the details. The signboards displayed on each property will help others (other than the customers using water) to stay away from the vineyards.

All these above activities, that satisfy the critical factors identified, were performed through various agreements. The agreements signed include: Shareholder agreements; water sales/supply agreements with third party users; pipeline construction contracts with the irrigation consultants who designed the pipeline and delivery system; and Water Reuse License with SA Water. The objective here was to ensure that commercially sustainable contractual structures were in place and the scheme would become a success story. Field observations reveal that the initial goal to "develop alternative water production (water reuse) project to replace water consumption from groundwater aquifers whilst reducing nutrient discharge to the ocean" has been achieved. This is evident from the fact that the scheme has been successfully operating since 1999, and after almost seven years from inception the scheme is still expanding.

7.6 Conclusion

Wastewater use in agriculture will definitely ease the pressure on available freshwater resources. But, successful development of reuse schemes encounters social, institutional, financial, regulatory, and technical impediments. Overcoming these hurdles will lead to implementation of a successful reuse scheme as evident from the present case study. 'How' is the question to be answered? This chapter endeavours to respond by adopting the Critical Success Factor (CSF) methodology. By aid of the CSF method six factors: social, institutional, financial, regulatory and policy, risk allocation, and technical, were identified that are critical in implementing water reuse scheme. Further, these factors were addressed by determining different 'activities' (work to be performed to satisfy one or several factors). In total, 18 activities satisfied the six factors ultimately leading to

developing and implementing a successful water reuse project. The case of Willunga pipeline scheme illustrates that considerable innovation and collective effort by a motivated group of individuals can yield positive results. Finally, the findings provide insights to develop similar schemes in the developing world, where private sector participation is in its infant stage provided the following areas receive proper attention:

- Appropriate arrangements and agreements between the government, the management company and the growers;
- Thorough financial and technical feasibility studies to ensure the scheme's long-term viability and to attract private sector funding;
- Competent technical design and appropriate safety measures and practices to avoid any occupational health and safety hazards;
- Regular water quality monitoring and control, best irrigation practice through soil surveys, regular soil and crop management reports, in order to ensure environmental sustainability;
- A tariff structure that is affordable to the users and also ensures the financial sustainability of the project;
- Above all, a favourable policy and regulatory regime for wastewater reuse, based on the local socio-economic and political situations.

Chapter 8

Chapter 8: Informal and uncontrolled use of wastewater for agriculture – Musi river case study, India

Whisky is for drinking, but water is for fighting over.

– Mark Twain

8.1 Introduction

The third case study is in India, where wastewater use for irrigation is unregulated and indirect, similar to the practices in many other developing countries. Wastewater reuse is not new to India, because there has been a history of untreated or partially treated wastewater use there for a long time. For ages, the marginalised communities in India have followed wastewater irrigation, using domestic wastewater as well as industrial effluent, to grow vegetables, fruits, cereals, flowers and fodder; the wastewater is discharged into rivers and then the contaminated river water is used for irrigation (van der Hoek et. al, 2002). Today, as a result of rapid population growth, massive industrialization, and the growing number of cities, indirect use of wastewater has increased even further as large amounts of sewage are discharged into bodies of water. Most of this reuse occurs along the Indian peninsular rivers for agricultural irrigation and it is important to note that these rivers would not have had any flow for most of the year if they were not used to funnel wastewater away from cities to peri-urban and rural areas (Buechler, Devi & Raschid, 2002; Buechler, 2004). The Musi River, which rises a few kilometres upstream from Hyderabad and flows across Andhra Pradesh is one of these many rivers, This chapter is based on the study carried out to examine wastewater reuse along the Musi River in Hyderabad, India.

8.2 Field settings

The river Musi has its origin about 50 km. west of the city of Hyderabad and passes through the middle of the city. It spreads over 8000 sq. km. and lies in a region receiving an annual rainfall ranging from 500-700 mm. The basin is drained by many small streams, and most of the water flows are diverted to a series of tanks and used for irrigation. However, these inflows are very limited; further on, as the river passes through the city of Hyderabad, with a population of around seven million, the wastewater from the drains passes into the Musi, almost throughout the whole year. Around 40,000 acres are irrigated with the wastewater of the Musi (IRDAS, 2006). Wastewater released into the river is untreated or partially treated; most of it is released from the two wastewater treatment plants operating in the region. One of these plants has primary and secondary treatment, while the other just has primary treatment facilities. According to estimates, only 40% of the sewage is clarified before it is dumped into the river (Buechler, Devi & Raschid, 2002).

The field situation is that, upstream of the place where the river enters the city, it has no water in it, except during the monsoons; while downstream, due to the discharge of vast amount of wastewater the river is perennial. The quantity of wastewater released into the Musi is estimated to be around 5200 litres per second (IRDAS, 2006). Figure 8.1 provides an aerial view of the area irrigated with wastewater downstream of the river Musi. The aerial shot clearly indicates the green patches along Musi River (yellow square in Figure 8.1) that represent the irrigated area referred as the 'Musi River Corridor' (Buechler & Devi, 2003).



Figure 8.1: Aerial view of the area irrigated with wastewater along the Musi

Note: Yellow Box = wastewater irrigated area downstream of Musi River, Source: Google Earth

8.2.1 Channeling of wastewater for irrigation

As explained earlier, the irrigation schemes along the Musi River depend primarily on urban wastewater from the city of Hyderabad, and these schemes are controlled by the Irrigation Department. However, the storage and channelling of wastewater for use in agriculture varies, and is diagrammatically represented in Figure 8.2.

Most of the wastewater discharged into the Musi (around two-thirds of the total discharge) is channelled via open sewage drainage canals. The remaining one-third is channelled through the sewage system to either of the two treatment plants, from where the partially treated wastewater is channelled downstream via a canal used for agricultural irrigation. In some cases the wastewater from the sewage treatment plant is

stored in a natural pond where the untreated and treated water mix. The water is then pumped from the pond and used for irrigation.

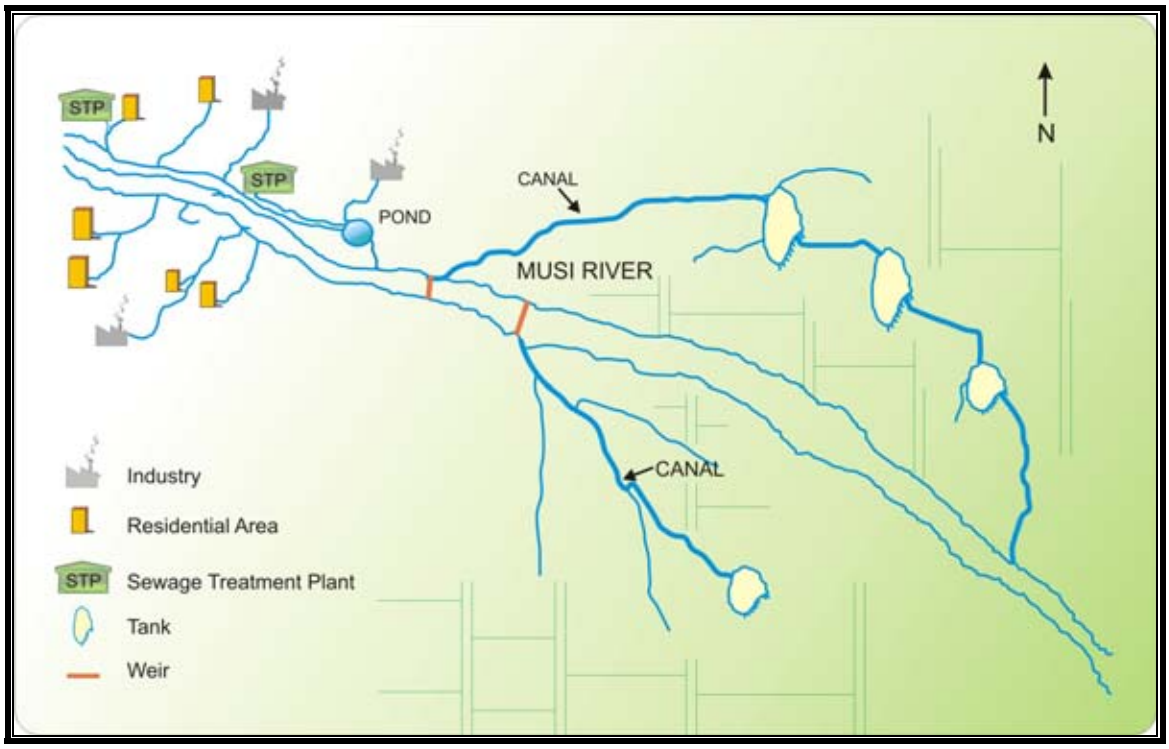


Figure 8.2: Methods of channelling wastewater for irrigation along the Musi River
Source: Modified from IWMI, 2001

The channelling methods used to irrigate the lands along the river vary depending on their location. Generally, wastewater from the river is first diverted via *anicuts* (local name for weirs) on both sides of the river to main canals that further feed the branch canals (Figure 8.2). There is direct irrigation from the branch canals or main canals in the case of the fields closest to the riverbanks. For fields located at higher altitudes, wastewater is pumped from the branch canals into underground pipes and later directed to smaller channels that go to the fields. In some other cases, the water from the weirs is channelled to tanks of varying sizes, where it is stored for irrigating the fields near the tanks. These tanks are controlled by the Water Users Associations (henceforth WUAs)

formed under the Andhra Pradesh Farmers Management of Irrigation System Act (APFMIS) enacted in 1997(IRDAS, 2006). This study focuses on these WUAs that were formed originally to manage surface irrigation systems, whereas at present they are managing the use of wastewater downstream of the river Musi.

Moreover, field observations and discussions with Irrigation Department officials revealed that the WUAs formed downstream performed better than the WUAs formed upstream. This was understandable, given that there was no water upstream except during the monsoons and downstream, due to wastewater discharges the river was perennial; so the WUAs downstream were functional. This provided an opportunity to compare the perceptions of the leaders of the WUAs at both locations – downstream and upstream.

However, it is important to note that unlike the previous two cases which represented planned and regulated wastewater reuse, the situation with the Indian case study is different, where wastewater use and management is largely unplanned and unregulated. Further, field observations and discussions with the Irrigation Department officials revealed that in India, different informal institutions and organizations are associated with wastewater use at different levels – macro, meso and micro. Accordingly, in Hyderabad, which is the study site, there were a number of informal institutions related to wastewater use along the river Musi. In urban areas, there was an Urban Farmers' Association, primarily composed of wastewater farmers who own land, while in the peri-urban and rural areas it was the WUAs that were composed of farmers with access to wastewater. Apart from these two there were different caste groups in these areas, which consisted of

mainly low-caste and landless labourers (Buechler, 2004). This study focuses the community organisations or the Water User Associations which are operating at the micro-level.

Before discussing the actual results of the study it is essential to understand the irrigation reforms in India, with special reference to the Andhra Pradesh Farmers Management of Irrigation Systems Act (APFMIS) enacted in 1997, which was the main reason for the formation of the Water Users' Associations.

8.3 Irrigation reforms in India and Andhra Pradesh

Irrigation management in India is generally dominated by public authority, the Irrigation Department (ID). Nevertheless, despite huge public investments in irrigation, water use efficiency has always been a major concern under public distribution and far below the acceptable level. Moreover, poor maintenance and the lack of effective control over irrigation practices by public authority management has led to sub-optimal use of water and undesirable practices, such as water theft and other social problems (Lele & Patil, 1994; Gyasi & Engel, 2004). The failure of public agencies has further resulted in a significant decline of total public expenditures and reduced lending for irrigation by international agencies (Rosegrant & Svendsen, 1993, cited in Sinha, 1994).

A common perception about the failure of public irrigation schemes is that there has been insufficient involvement of the farmers in the design and management of these

programmes. This forced the Government of India (GOI) to maximize the performance of existing irrigation schemes by providing new models to the donors and hence encouraging costly new investments. In this context, Irrigation Management Transfer (IMT) was seen as the way forward; having more involvement of farmers in the management of these schemes and accordingly complete or partial transfer of irrigation management to user groups, was seen as a panacea (Sinha, 1994).

Efforts in the direction of Irrigation Management Transfer (IMT) in the country began with the initiation of the Command Area Development (CAD) Programme in 1973 (Ministry of Water Resources, 2000), with the objective of increasing water use efficiency and productivity in irrigated agriculture. IMT in general, refers to involvement of farmers in all aspect of management of the irrigation system, such as planning and development, operation and maintenance (O&M), collection of water charges, allocation of water, and resolution of conflicts. The concept of IMT was first incorporated in the National Water Policy (NWP) adopted in 1987, and the latest release of NWP in April 2002 clearly highlights the role of farmers' participation in irrigation management:

> "Management of the water resources for diverse uses should incorporate a participatory approach; by involving not only the various governmental agencies but also the users and other stakeholders, in an effective and decisive manner, in various aspects of planning, design, development and management of the water resources schemes….. Water Users' Associations and the local bodies such as municipalities and *gram panchayats* should particularly be involved in the operation, maintenance and management of water infrastructures/facilities at appropriate levels progressively, with a view to eventually transfer the management of such facilities to the user groups / local bodies" (Ministry of Water Resources, 2002).

This institutional response at the national level to overcoming the ailments associated with large public irrigation schemes prompted many State Governments to formulate policies intended to facilitate the devolution process. Accordingly, Andhra Pradesh enacted the Andhra Pradesh Farmers Management of Irrigation System Act (APFMIS) in 1997 and has been a leader in the entire country in this respect.

8.3.1 The Andhra Pradesh Farmers Management of Irrigation System Act

The State of Andhra Pradesh is among the first batch of States in India to initiate the CAD programme and further, by passing the Andhra Pradesh Farmers Management of Irrigation Systems Act in 1997, the State laid pathways to irrigation sector reforms in India (Sivamohan, 2001). As a result of this act, Water Users Associations (WUAs) were formed in all areas served by irrigation systems in the entire State. A total of 10,292 WUAs were formed, which became functional immediately (Irrigation and Command Area Department, 2006). This reform is viewed as a 'top down' exercise and is lauded as 'special reform' in the South Asian context, since it was characterised by strong political support by the then state government, and there was no lack of the infamous 'political will' (Mollinga, Doraiswamy & Engbersen, 2000). Five years after its enactment, amendments were made to the APFMIS Act in 2004, to link the WUAs with local bodies such as gram panchayats (Irrigation and Command Area Department, 2006).

8.3.1.1 Features of the APFMIS Act, 1997

The need for irrigation reforms in India, and in Andhra Pradesh in particular, was essential due to five key factors: (1) low performance of the irrigation sector despite

massive investments; (2) declining irrigated area and poor condition of the irrigation infrastructure; (3) low agricultural productivity; (4) inadequate maintenance of infrastructure; and (5) restoring and sustaining irrigation and enhancing agricultural productivity (Oblitas et al., 1999). As a result, new policy initiatives were debated in the legislative assembly for improving the performance of existing irrigation systems. Enactment of the Andhra Pradesh Farmers Management of Irrigation Systems Act (APFMIS), 1997 was the outcome of these debates. All aspects of the Andhra Pradesh State irrigation policy revolve around user empowerment in irrigation management as the central theme. However, the key features of the APFMIS Act are as follows (Raju, 2001 p. 30; Svendsen & Huppert, 2003, p. 28):

- The Andhra Pradesh Farmer Managed Irrigation Systems Act came into effect in Andhra Pradesh in April 1997. The Act facilitates: (a) formation of WUAs (Water Users' Associations) on the basis of a hydraulic boundary; (b) the inclusion of landowners and tenants; (c) making a person eligible to become a member of more than one WUA; (d) the exclusive right of members to vote (either owners or tenants).
- The Act has provisions for the election of president and members of the managing committee for a period of three years at three levels: (i) WUA level, (ii) distributory level, and (iii) project level.
- The APFMIS Act has clearly underlined the objectives, functions and resources of WUAs. The Act also identifies the specific responsibilities and tasks of government officials and WUA leaders.

- The Act transfers control over field personnel of the state Irrigation Department to WUAs and makes membership in primary-level WUAs compulsory, along with obligations of membership, including fee payment.
- The Act requires annual budgets of WUAs be brought before the general body of the WUA for approval.
- The Act gives WUAs legal personalities and powers, including the right to levy taxes and impose fines, which are ultimately enforceable through the legal powers of the state.
- The Act separates WUAs from the local political establishments and allows the government to resume either governance or operational control from WUAs in the event that they fail to perform effectively.

Following the enactment of the APFMIS Act, water charges were increased three-fold without significant protest; WUAs were established throughout the state, and elections for leaders of WUAs and elections for Distributory Canal Committees were held. In addition a State-wide training programme was launched for WUA leaders who were given a trainer's handbook containing irrigation engineering, agriculture, and revenue subjects. Each WUA formed has a varying catchment size, ranging between 500 and 8,000 acres, and each WUA is divided into four or six Territorial Constituencies (TC), each with an area between 500 and 1,300 acres.

Table 8.1 gives the distribution of WUAs in the State by type of irrigation system.

Table 8.1: Distribution of WUAs by type of irrigation system

Type of Irrigation System	Number of WUAs
Major	1673
Medium	304
Minor	8315
Total	10,292

Source: Irrigation and Command Area Development Department, 2006

8.4 Results

The APFMIS Act, 1997 is seen as a visible example of how a seemingly impossible task can be made possible. However, there is still debate going on in the country, in other states, and in the world about the pros and cons of this big bang, one-shot approach to irrigation management reforms; however this is not within the purview of the present study. Therefore, without diverting from the focus of this study, the next section discusses the actual results of the study, preceded by a profile of the WUAs under study.

All the results discussed in this chapter are presented for the both sets of WUAs (upstream & downstream), with the help of simple tabulations and percentages. The SPSS software package was used to analyse the data.

8.4.1 Profile of the WUAs under study

Tables 8.2 and 8.3 present a brief profile of the WUAs selected for the study, both downstream and upstream of the river Musi.

Table 8.2: Profile of the WUAs selected at the downstream of Musi River, receiving wastewater inflows

Name of the WUA	Year formed	Village	District	Location of the WUA	
				On Main Canal	On distributory
Chowdari Kathwa WUA	1997	Pratapsingaram	Rangareddy	Middle reach	Head reach
Laxminarayana WUA	1999	Edulabad	Rangareddy	Tail reach	Middle reach
Bacharamkalwakatwa WUA	1999	Bacharam	Rangareddy	Middle reach	Middle reach
Gowrelly WUA	1999	Gowrelly	Rangareddy	Middle reach	Tail reach
Yerrakunta WUA	1997	Banda Raviryala	Rangareddy	Middle reach	Head reach
Pillayapally Nala	1998	Pillaipally	Nalgonda	Middle reach	Middle reach
Sangem Anikut WUA	1998	Dharmareddy pally	Nalgonda	Middle reach	Head reach
Dharma Reddy Pally Kathwa	1996	Sangem	Nalgonda	Head reach	Head reach
Ramasamudram Chervu WUA	1996	Gokaram	Nalgonda	Middle reach	Middle reach
Asif Nahar channel WUA	1998	Nagaram	Nalgonda	Tail reach	Middle reach
Akkachellalla Cheruvu WUA	1996	Valigonda	Nalgonda	Tail reach	Head reach
Bapanenu Cheruvu WUA	1999	Lingaraj pally	Nalgonda	Tail reach	Middle reach
Rudravelli Cheruvu	1995	Rudravelli	Nalgonda	Head reach	Tail reach
Alinagar channel WUA	1998	Juloor	Nalgonda	Head reach	Head reach
Chintala Cheruvu WUA	1996	Bhattu Gudem	Nalgonda	Head reach	Tail reach

Note: *Cheruvu* means tank in Telugu (local language). Source: Field survey.

Table 8.3: Profile of the WUAs selected at the upstream of Musi River, receiving no wastewater inflows

Name of the WUA	Year formed	Village	District	Location of the WUA	
				On Main Canal	On distributory
Pedda Cheruvu WUA	2001	Anajipur	Nalgonda	Head reach	Head reach
Ura Cheru WUA	2001	Thokkapur	Nalgonda	Tail reach	Head reach
Pedda Cheruvu WUA	1999	Nandanam	Nalgonda	Tail reach	Head reach
Pedda Cheruvu WUA	2001	Baswapur	Nalgonda	Head reach	Head reach
Pedda Cheruvu WUA	1999	Bolepally	Nalgonda	Tail reach	Middle reach
Pedda Cheruvu WUA	1996	Raigiri	Nalgonda	Head reach	Middle reach
Pedda Cheruvu WUA	1997	Veeravelly	Nalgonda	Head reach	Middle reach
Thumma Cheruvu WUA	1997	Sarvepally	Nalgonda	Tail reach	Tail reach
Akkamatti Cheruvu WUA	1997	Chada	Nalgonda	Head reach	Head reach
Veerla Cheruvu WUA	1997	Atmakur	Nalgonda	Head reach	Tail reach
Mogulla Cheruvu WUA	1997	Kurella	Nalgonda	Middle reach	Middle reach
Pedda Cheruvu WUA	2000	Mothkur	Nalgonda	Head reach	Head reach
Pedda Cheruvu WUA	1997	Paladugu	Nalgonda	Tail reach	Middle reach
Dacharam WUA	2000	Dacharam	Nalgonda	Head reach	Head reach
Pedda Cheruvu WUA	1997	Kotamarthy	Nalgonda	Head reach	Head reach

Note: *Cheruvu* means tank in Telugu (local language). Source: Field survey.

The WUAs along the Musi with wastewater inflows are comparatively old, as a couple of WUAs were formed in 1995 and 1996, even before the passing of APFMIS Act in 1997 (Table 8.2). These WUAs were located in two districts, Nalgonda and Rangareddy, and they represented different types of irrigation system: tank, canal or nala as indicated by their names. The majority of the WUAs (7) were located in the middle reach of the Main canal while four each were located on the head and tail reaches. On the distributory, six WUAs each were on the head and middle reaches respectively, and three were located on the tail reach. The WUAs formed upstream are comparatively new, as all these were formed following the passing of the APFMIS Act (Table 8.3). They were all concerned with canal irrigation and belonged to the Nalgonda district. As for the location of the WUAs on the main canal, most WUAs (9) were located on the head reach, five on the tail and one on the middle reach. On the distributory, the distribution of WUAs based on their locations was almost alike with eight WUAs located on the head, five on the tail and two on the middle reach respectively.

8.4.2 Socio-demographic profile of the respondents

Since the study aimed at looking into the perception of the irrigators across the WUAs located upstream and downstream of the river Musi, the results are presented accordingly. The socio-demographic profile of the respondents is presented in Table 8.4.

The figures indicate that irrespective of the location, the majority of the respondents (around 60% in both cases) belonged to the older age group. Almost all the respondents were literate, with the majority (about 40% in both cases) of the respondents having

primary education. Regarding farming experience, the percentage varied across the location. In the downstream section, where the river was perennial due to wastewater availability, a majority (60%) of the respondents had less than 25 years of farming experience, while a majority (80%) of the respondents upstream were engaged in farming for more than 25 years. This is because most of the farming downstream is along the peri-urban area and this picked up recently, with more sewage being discharged to the river Musi as a result of urbanisation and industrialization.

Table 8.4: Socio-demographic profile of the respondents

Particulars	Number of respondents	
	Upstream (without drainage water)	Downstream (with drainage water)
Age group		
Young (up to 34 years)	6.7	6.7
Middle (35-54 years)	66.6	60.0
Old (55 years and more)	26.7	33.3
Education level attained		
Up to primary school	40.0	46.7
Up to High school	33.3	33.3
College	13.3	6.7
University	6.7	0.0
Illiterate	6.7	13.3
Farming experience (viticulture)		
Up to 10 years of experience	0.0	13.3
Up to 25 years of experience	20.0	60.0
>25 years of experience	80.0	26.7

Source: Field survey

8.4.3 Irrigation details and water availability information

Although the main source of irrigation is canal water, the farmers in the region depend on other sources as well, as indicated in Table 8.5. General observation and discussions with

farmers revealed that generally the farmers upstream did not receive enough water from the canal, especially during summer. However, downstream, due to the sewage water inflows the case was different.

Table 8.5: Distribution of respondents based on source of irrigation

Particular	Number of respondents	
	Upstream (without drainage water)	Downstream (with drainage water)
Canal Water only	0.0	26.7
Groundwater only	26.7	0.0
Other sources (open well)	13.3	0.0
Canal + groundwater	13.3	0.0
Canal water + wastewater	0.0	53.3
Canal + groundwater + wastewater	0.0	20.0
Groundwater + other source (open well)	46.7	0.0

Source: Field survey

A majority of the respondents downstream (53.3%) were using both canal water and wastewater, while upstream around 47% used groundwater and open wells to meet their irrigation needs.

Table 8.6: Perceptions of WUA leaders about water availability in the Musi River basin

Particular	Number of respondents			
	Upstream (without drainage water)		Downstream (with drainage water)	
Is there sufficient water available for irrigation throughout the year?	YES	NO	YES	NO
	0.0	100.0	80.0	20.0
If no, what are the reasons for water scarcity?				
No Field Irrigation Channel (FIC)		0.0		6.7
Disturbed FIC		0.0		6.7
Land in the tail reach		100.0		6.7

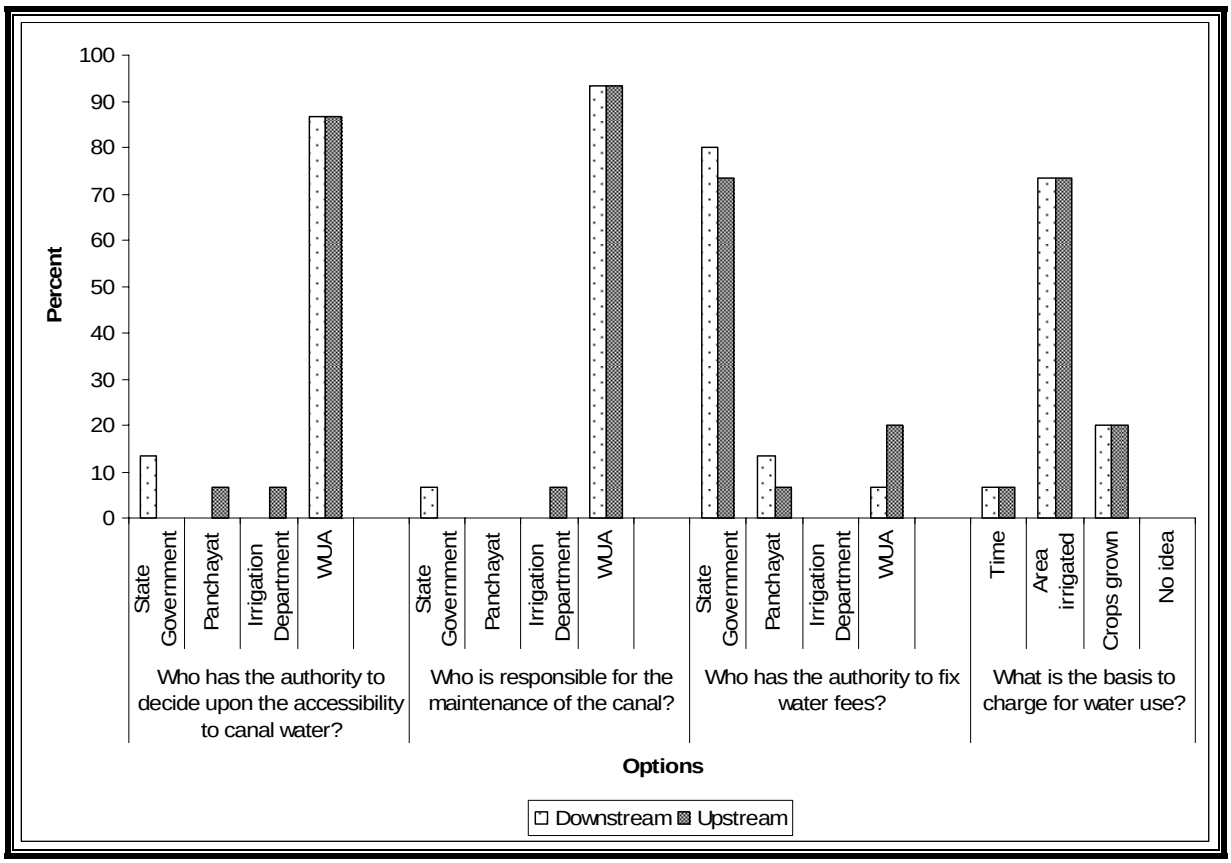
Source: Field survey

When the farmers were asked about the availability of water (Table 8.6), all the respondents upstream said there was not sufficient water available, while about 80% of the respondents downstream said that there was sufficient water. This difference is because of the wastewater flowing into the river Musi downstream. When asked for the reasons for insufficient water, all the farmers upstream claimed that it was because their lands were situated in the tail reach.

8.4.4 Perceptions of WUA leaders about water management

As discussed earlier, the WUAs under study were not formed to manage wastewater in particular. These were the WUAs formed under the APFMIS Act of 1997. It is important to note that in the study region, particularly downstream of Musi where the river is perennial; we can find other informal associations or users groups, such as the Urban Farmers' Association, different caste (low caste) groups in addition to the WUAs formed under the Act. However, this study focuses on the WUAs that were formed as a result of irrigation reform strategy in Andhra Pradesh.

The study interviewed the WUA leaders, who were either the President of the WUA under study or the Territorial Constituency (TC) Members. The idea was to understand the perceptions of these leaders regarding issues related to water management in their respective WUA. Figure 8.3 presents the perceptions of WUA leaders about issues such as operation and maintenance, water fees, and accessibility to water from the canal. The responses to the questions related to water management were similar at both locations, downstream and upstream.



Source: Field survey

Figure 8.3: WUA leaders' perceptions about water management issues

When asked who has the authority to decide upon the accessibility to canal water, more than 85% at both locations said it was the WUA's decision. Around 13% of the respondents representing the WUAs downstream of Musi said that the State government decided about accessibility. The respondents from WUAs located upstream believed it was the Irrigation Department (6.7%) and the Panchayat (6.7%) who decided about accessibility to canal water. More than 90% of the respondents at both locations believed that the WUA was responsible for the operation and maintenance of the canal.

It is interesting to note that, despite making separate mentions of the State Government and the Irrigation department, the respondents saw both as one and the same. Perhaps the respondents were not clear about the organizational setup within the state. However, the study assumes that when they say 'state government' it implies the irrigation department. The respondents were then asked who decides the water charges and what was the basis for charging for the water used? The respondents representing WUAs downstream thought that the state government (80%) decided the water charges. Around 13% felt it was the Panchayat, while 6% felt it was the WUA. The case upstream was almost similar as around 70% of the respondents indicated that state government fixed the water charges, around 6% felt it was the Panchayat, while 20% said it was the WUA that fixed water charges.

On the basis for fixing water charges, the responses at both locations were identical, with more than 70% saying that water fees were fixed based on the area irrigated with water accessed from the canal. Around 20% felt that the decision was based on the crops grown by the farmers.

The study went on to ask the respondents what they felt about the rules governing water use in their area. The leaders were presented with propositions representing various aspects of water distribution and rules within the WUA under study and they were asked to agree or disagree with the propositions. Table 8.7 presents the perceptions of WUA leaders about these rules.

Table 8.7: WUA leaders' perceptions of rules for water distribution

Scale Items	Upstream (without drainage water)			Downstream (with drainage water)		
	Disagree	Agree	Neutral	Disagree	Agree	Neutral
Water is shared fairly among every user in the scheme	40.0	40.0	20.0	0.0	100.0	0.0
Water distribution system is efficient	53.3	33.3	13.3	6.7	80.0	13.3
I feel secure with the present water distribution system	66.7	20.0	13.3	13.3	80.0	6.7
The basis for distributing water among irrigators is fair	53.3	20.0	26.7	26.7	66.7	6.7
The basis to charge water fee is appropriate	6.7	53.3	40.0	0.0	86.7	13.3
The way Executive Committee is formed is fair	6.7	80.0	13.3	13.3	66.7	20.0
The committee is fair in its processes	13.3	80.0	6.7	13.3	73.3	13.3
All caste members get an equal hearing during meetings	0.0	100.0	0.0	0.0	100.0	0.0
Bigger farmers are more influential	93.3	6.7	0.0	100.0	0.0	0.0
The rules are enforced as formulated	40.0	46.7	13.3	40.0	60.0	0.0

Source: Field survey

Although previous questions had not shown major differences among the respondents from WUAs upstream and downstream on the Musi, the scale item responses tend to give a clearer idea about the overall performance of the WUAs. Field observations and discussion with the Irrigation Department officials revealed that the WUAs located

upstream of Musi were not functioning properly, because of water scarcity. The study seems to support the field observations.

The scale items presented to the WUA leaders represented the normal activities of a WUA, including statements mainly related to operation and maintenance, and to the formation and performance of the Executive Committee (Table 8.7).

When asked if the water sharing among all the irrigators was fairly done, all the downstream WUA representatives (100%) agreed that it was fair, while around 40% of the upstream representatives thought it was unfair. When asked whether the water distribution system was efficient, again the response was on similar lines. A majority downstream (80%) agreed that the system was efficient, while more than 50% of respondents upstream disagreed. While 80% of respondents downstream felt secure with the present water distribution system, more than 65% felt they were not secure. Furthermore, more than 50% of respondents upstream disagreed that the basis for distributing water was appropriate, while it was the reverse downstream, with more than 65% agreeing with this statement.

However, the responses to statements representing the general administrative aspects of WUAs were almost alike at both locations. A majority of the respondents at both locations agreed that the Executive Committee was formed fairly and that it was fair in its processes (Table 8.7). They also agreed that there was not much discrimination based on caste or land holding. This is mainly because the majority of the respondents (83%)

belonged to the backward community and were marginal farmers (Buechler, Devi & Raschid, 2002).

The results clearly indicate that, compared to the respondents who represented the WUAs downstream, their counterparts upstream tend to disagree more with the proposed statements, meaning that the percentage of respondents disagreeing with the proposed statements was comparatively higher in the case of the WUAs located upstream. This is mainly because, upstream the Musi River runs dry throughout the year, except during monsoons, in contrast to downstream, which receives wastewater all year round. Hence the downstream WUAs performed better than those upstream, which is reflected in the responses of the WUA leaders. This also proves that wastewater is an important substitute source for meeting declining freshwater resources.

A very important issue in natural resource management is conflict over access to, control and use of natural resources and their management. In the case of irrigation systems, particularly in India, these conflicts arise over: unauthorized use of water, breaking the rotational sequence, illegal use of water, and wastage of water (McKay & Keremane, 2006).

The study examined this aspect of water management by self-governed institutions in the study region and Table 8.8 presents the results. The respondents were asked whether conflicts between water users and the executive committee was a common phenomenon. The word ‘common’ was used in the study to denote the frequency of the conflicts

occurring at a given period of time. It was interesting to note the differences in opinion at each location. More than 70% of the WUA representatives upstream disagreed that conflicts were common; while downstream 33% agreed that conflicts were common. When the respondents were asked about conflicts among water users, around 20% of the respondents upstream agreed that there were conflicts, while only 6% did so downstream. These results highlight two very different yet interesting aspects of water management.

Table 8.8: WUA leaders' perceptions about cooperation, conflicts and their resolution

Scale Items	Upstream (without drainage water)			Downstream (with drainage water)		
	Disagree	Agree	Neutral	Disagree	Agree	Neutral
Conflicts between water users and the management are common	73.3	6.7	20.0	53.3	33.3	13.3
Conflict between members is common	40.0	20.0	40.0	80.0	6.7	13.3
In case of any conflicts, the conflict resolution measures are clear and in place	40.0	26.7	33.3	26.7	73.3	0.0
Social pressure is the common conflict resolution mechanism practiced	40.0	46.7	13.3	40.0	53.3	6.7

Source: Field survey

The fundamental situation is that there is less water upstream than downstream. Therefore, judging by the responses of the WUA leaders at each location, it is evident that on the one hand, 'less water – fewer conflicts between the irrigators and the WUA' while on the other hand, 'there can be conflicts between users over limited water resources'. Nevertheless, it is clear that there were conflicts, as there are bound to be with

natural resource management (Matiru, 2000); so two more statements related to conflict resolution were presented to the interviewees (Table 8.8).

When asked if the conflict resolution mechanisms were clear and in place to resolve any conflicts that might occur, around 40% of respondents representing upstream WUAs disagreed, while for downstream WUAs, more than 70% agreed with the statement. Based on the researchers' previous experience of researching WUAs in India (Maharashtra) the respondents were asked if 'social pressure' was a common method of resolving conflicts. Subjecting the defendant to social pressure was found to be a common procedure employed to resolve conflicts among the WUAs in Maharashtra (Keremane & McKay, 2006a; McKay & Keremane, 2006). It appeared that the case was similar in the study region as well, since a majority of respondents in each location agreed with this statement.

8.4.5 Lashkars and water management issues

As explained earlier, Water Users Associations are responsible for the allocation and distribution of water to the users. However, due to the vast catchment area under each WUA, canal operators are appointed by the Irrigation Department to look after this. In some cases, the Government-appointed canal operators have to work alongside operators appointed by the respective WUA. These canal operators are referred by different names in different states across India. For example canal operators in Maharashtra are known as patkari, while in Andhra Pradesh they are known as lashkars. Since canal operators have a very important role in operating and maintaining irrigation systems, this study went on

to ask the WUA leaders their perceptions about the lashkars. What's more, in this particular case (in Andhra Pradesh), it was more interesting because of an ongoing court case with the lashkars.

8.4.5.1 The court case

A lashkar is a canal operator and water regulator for approximately 800 hectares. The number of lashkars within a WUA varies with the catchment area of that particular WUA. Originally (before passing of the APFMIS Act), the lashkars were employed by the Irrigation Department (State Government) and received salaries from them. However, since the passing of the APFMIS Act, the services of lashkars have now been transferred to the WUAs. Today, even though the lashkars continue to receive salaries from the government, they have come under the supervision of the WUAs. Moreover, some of the WUAs have appointed their own lashkars to oversee operation and maintenance activities. Around 3,500 lashkars in the state opposed a government order that made the government-appointed lashkars answerable to the WUAs. Following this development a legal battle is still going on in the state. Therefore, it was decided to ask the leaders of the WUAs being studied about the issues associated with the lashkars within their WUA.

8.4.6 Perception of WUA leaders' about government and private *lashkars*

Table 8.9 presents the perception of the WUA leaders about government appointed and private lashkars. The leaders were first asked whether the government appointed lashkars interacted with the WUAs on the operation and maintenance issues. The responses at each location varied. Downstream, 80% of the respondents said that lashkars interacted

with the WUA and 20% said they did not; the response upstream was the opposite. This supports the observation that WUAs upstream were not functioning properly, and hence the lashkars were not active in those WUAs.

Table 8.9: WUA leaders' perception about government and private lashkars

Particulars	Upstream (without drainage water)	Downstream (with drainage water)
Do the government *lashkars* interact with the WUA?		
Yes	26.7	80.0
No	73.3	20.0
Information about private lashkars		
No. of WUAs with private *lashkars*	2	6
Average number of private *lashkars* in these WUAs	1	3
Mode of payment to *lashkars*	In kind	Cash or in kind
Average area under the supervision of *lashkars*	85 acres	295.3 acres

Source: Field survey

The discussions further revealed that there were some WUA appointed lashkars (referred as private lashkars in this study) who worked along with the government appointed lashkars. The private lashkars were paid for their services by the WUAs. Unlike the government appointed lashkars who received salaries from the state government, the private lashkars were paid for their services either in cash or kind. Each lashkar upstream had an average area of 295 acres under his supervision, while for lashkars upstream it was around 85 acres.

The survey revealed that only some of the WUAs being studied had appointed private lashkars (Table 8.9). There were more WUAs with private lashkars downstream, where the WUAs functioned well. Six WUAs located downstream had appointed private lashkars, while only two upstream had done so. The average number of lashkars per WUA downstream was three, compared with one upstream. This again indicates that, compared to the downstream WUAs, the upstream WUAs were not functioning properly.

8.5 Wastewater – a source of livelihood for users along the Musi

In most of the informal water economies like India, where there is a severe scarcity of freshwater supplies, both ground and surface water, wastewater is the only alternative source of water available in sufficient quantities throughout the year. In addition, various groups of people, mostly living in rural and peri-urban areas, derive their daily sustenance from wastewater-related activities, so wastewater can be or is an important source of livelihood for them. This illustrates an integral connection between household income, wastewater-related livelihood activities and household food security, which is more evident in semi-arid areas where frequent periods of drought are a common phenomenon. The study area in Andhra Pradesh is one such area in India, and for many landed and landless households along the Musi, wastewater is a critical resource that supports a wide variety of livelihood activities. Thus, wastewater is important for the livelihood of various social groups using wastewater in the urban, peri-urban and rural areas along the river (Buechler & Devi, 2003).

This study focuses on livelihood activities in rural areas and its results are based on the field observations and on group discussions held with the WUA members, irrigation department officials and a voluntary organization operating in the study area, which also assisted in conducting the survey.

8.5.1 Wastewater use, food security and livelihood

The World Food Summit (1996) defined food security as a situation when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Moreover, food security is linked to livelihood, in the sense that unemployment and lack of access to assets such as land and water leads to poverty, which in turn leads to food insecurity (Nawani, 1994).

In line with this, it can be argued in the current case that wastewater contributes to food security by providing water for livelihood activities. In addition, this resource is reliable, sufficient and available on demand.

8.5.1.1 Wastewater and livelihood activities

Access to clean water for irrigation in the study region is problematic, due to the predominance of hard rock aquifers, which are subject to rapid drawdown. Further, as explained earlier in this chapter, as a result of industrialization and urbanisation there is a continuous flow of domestic and industrial wastewater into the river Musi. As a result, the river is perennial downstream, with water all year round. It is estimated that about

600 million litres per day of wastewater enters the Musi River and is subsequently used for irrigating around 40,600 hectares of land in the urban, peri-urban and rural areas along the river. In addition to agriculture, there are other types of economic activity that depend on the existence of this wastewater (Buechler & Devi, 2003).

Therefore, as a result of short and unpredictable monsoons, frequent droughts, and over exploitation of the groundwater resources, wastewater is the only water source available for farmers to use, for all of their activities. Accordingly, different groups of users depend on wastewater for a variety of different activities along the Musi River. Water for these activities is provided by channelling the wastewater that flows in the river into the fields by various methods, as explained earlier in this chapter (Figure 8.2).

Livelihood activities along the Musi River vary with the location of the area cultivated (urban, peri-urban or rural), further influenced by factors such as land area available, quality of the wastewater, proximity to urban markets, and the caste or class, gender and religious affiliations of the users (Buechler, Devi & Raschid, 2002). Yet a majority of those depending on the wastewater in the Musi River reside in rural areas and therefore this study focused on rural wastewater users and their livelihood activities.

8.5.1.2 Rural wastewater users and wastewater-dependant activities

For many decades people have been growing para grass, paddy and vegetables using wastewater irrigation (Buechler, Devi & Raschid, 2002). However, with the advent of pump sets and bore wells in the region people are mostly opting to grow paddy.

Vegetable cultivation on a commercial scale has decreased in recent times because it is seen as labour intensive. However, small farmers still use their land for vegetable cultivation for household consumption. As of February 2005, about 2,108 hectares of para grass in and around Hyderabad and 10,000 hectares of paddy along the 'Musi River Corridor' are irrigated with wastewater (IRDAS, 2006). Further, an additional benefit of using wastewater is its fertilizer value, which results in considerable savings in external supplies, translating into higher incomes (Buechler & Devi, 2003).

The other important activity dependent on wastewater is livestock rearing. Livestock reared in the region include water buffalos, cattle and goats. Since these animals are fed with wastewater these animals have year-round water, while sometimes animals in non-wastewater areas die from thirst. Further, the fodder that is fed to the livestock is para grass, again irrigated with wastewater. The para grass is usually grown on the residual moisture around the wastewater and rain-fed tanks. Sometimes, it is purchased from the grass market in the city, which receives the grass grown in wastewater-irrigated fields in all the urban, peri-urban and rural areas along the Musi River.

Fishing is another livelihood option for the wastewater users in the region. However, this is a subsidiary activity, as the major income of these farmers is derived from agriculture. Fishing is usually practiced in those tanks fed with wastewater as well some rain-fed tanks that often run dry during off-seasons. Therefore, the situation in the wastewater fed tanks is better than that in the rainfed tanks.

Field observations and discussions with the WUA leaders revealed that most of the rural wastewater users belonged to the backward community (mostly Gouda), whose traditional occupation is toddy tapping[4]. Generally, each individual toddy tapper needs to become a member of the toddy tappers society by paying certain fees. Only then, will he have access to a certain number of palm trees from which he can tap the toddy. Toddy is a beverage from a toddy palm tree that is often drunk fermented, and the palm trees used for toddy are grown all around the fields and the tank bunds using wastewater. This study focused on the institutions and their role in wastewater management, and therefore no cost and returns data were collected. However, findings of the IWMI study indicate that for one hectare of land, the annual income[5] is approximately Rs. 135,000 for para grass, Rs. 40,000 for leaf vegetables, Rs. 22,500 from one hundred banana plants, and Rs. 10,000 from 20 coconut palm trees (Buechler & Devi, 2003). These figures give us an idea of the income generated from wastewater dependant activities along the Musi River.

Despite these benefits, the quality of the wastewater used for irrigation is a major concern, because the farmers use the wastewater directly that was untreated or only partially treated. However, farmers in the study region were not too much concerned about the quality of wastewater, as most of them saw it as a panacea to water scarcity problems and they were able to fill their stomachs only because of this water. Moreover, it was free of cost for these farmers. According to a previous IWMI study (Buechler & Devi, 2003) the BOD and COD values (biological and chemical oxygen demands) were

[4] Toddy tapping is found in South Indian states of Tamil Nadu, Kerala, Karnataka and Andhra Pradesh. It is a specialized process where a person (usually from a backward caste) draws off the toddy.
[5] 1 Australian Dollar (AUD) = 30.85997 Indian Rupee (INR) as June 30, 2003

quite low for wastewater along Musi River. Total coliform values indicated high levels of faecal contamination that can be detrimental to farmers in direct contact with the wastewater. The electro conductivity (EC) and total dissolved solids (TDS) values were higher than those recommended by the FAO guidelines. Total Nitrogen was found to be higher than the limits suggested in the FAO guidelines. However, all heavy metals were within safe limits. Table 8.10 reports the water quality results along Musi obtained by IWMI in 2002.

Table 8.10: Musi river water quality, 2002

Areas	BOD (mg/l)	Total coliform (MPN)	EC (dS/m)	TN (mg/l)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)
Urban	105	$4.6x10^{10}$	2.1	25	0.04	0.13	0.07	0.32
Peri-urban	70	$2.4x10^{7}$	2.6	17	0.00	0.02	0.03	0.09
Rural	45	$4.0x10^{4}$	2.6	16	0.02	0.03	0.00	0.02

Note: Pre-monsoon water sample, May 2002; Source: Buechler and Devi, 2003

Wastewater irrigation is common in the region, despite the high risks to health associated with its use. This is mainly because of the fact that wastewater irrigation benefits the community dependant on wastewater for their livelihoods, through employment generation, increased farming income, savings in fertilizer costs, increased reliability of irrigation and access to water, and the proximity to urban markets (Buechler & Devi, 2003). Nevertheless, the economic and health related risks for those using this water directly cannot be denied and banning use of this resource cannot be the solution as wastewater is the only reliable source of irrigation for farmers in this region. Further, it was observed during field visits that the farmers have not received any agricultural

extension or awareness programmes on the safe use of wastewater for agriculture and ways of lessening the risks associated with its use.

8.6 Conclusions

In many developing countries such as India, the rapid expansion of urban development will bring opportunities in terms of increased water supply for irrigation in the form of wastewater. This is exactly the situation in the present case in Hyderabad. Nevertheless, the quality of wastewater will be a great concern if urbanisation takes place concurrently with increases in industrial, hospital and commercial effluents. Further, it is noted that most of the wastewater usage in the developing world including India is informal and indirect. This means wastewater is discharged into rivers and the contaminated river water is used for irrigation.

Therefore the need today is proper management of the resource, which implies cost-effective and appropriate treatments suited to the end use of wastewater, supplemented by guidelines for their application, as in the case of developed nations, Australia for example. Equally important is farmer and consumer education in risk management strategies as well as improved institutional coordination. Given the situation in India, where self-governed institutions – Water Users Associations – have been established to manage the use of water from the river or canal under the Participatory Irrigation Management programme this is achievable.

Findings from this study clearly indicate that wastewater flow in the Musi River downstream is largely responsible for the better functioning of the WUAs as compared to the WUAs upstream where the river runs dry, except during the monsoons. Therefore, the WUAs formed to manage the canal water can also be made responsible for wastewater management. Further, in India, effective wastewater management necessitates coordination between the urban authorities, water and sanitation agencies, health care agencies, agriculture ministries, urban and industry planning agencies, development and welfare agencies. Therefore, through the WUAs, which are well established and have already developed links with most of these agencies, it will be easy to co-ordinate the activities. This will also ensure participation of the users, which is supposedly a very important aspect of water and wastewater management policies around the world. However, one of the biggest obstacles in such cases is lack of clarity among the user groups regarding wastewater-irrigated agriculture.

The main risks and benefits are not well understood and wastewater is not a priority issue for policy makers. These issues hinder the process of designing an integrated solution. Some of the following initiatives may help in better (waste) water management in developing countries like India:

- Proper planning for wastewater treatment
- Preventing water pollution by proper management techniques and developing preventive and curative health care measures, and
- Designing farmer extension services for each category of wastewater dependent group and provision of incentives for wastewater use.

Chapter 9

Chapter 9: Conclusions and policy options

"Waste" water is not a problem. It is a resource!

9.1 Introduction

Water withdrawal statistics indicate a manifold increase in global water withdrawals over the past century, as a result of growing population, urbanisation and industrialisation. Inevitably, these unprecedented developments have resulted in shrinking freshwater supplies. The current signs indicate that the situation on the ground is getting worse, and not better. Hence, water managers, water planners and policy makers around the world face the challenge of finding new sources of supply to address perceived new demands. The challenge is more acute because the options for increasing the supplies have become expensive and are often environmentally damaging.

In recent decade and in situations where freshwater availability is a never-ending problem, source substitution is a suitable alternative to satisfy certain uses, allowing higher quality waters to be used for domestic supply. The search for a reliable alternative source of water has triggered the development of water reclamation and reuse projects. Accordingly, in many water-scarce regions, water reclamation, recycling and reuse have come to occupy a prominent place in water and wastewater management policies.

In many places the water crisis is a crisis of governance. Presentations in earlier chapters on institutions, collective action, social sustainability and social capital, distributed

governance, and public-private partnership give clear hints that more efficient participation of formal and informal organizations in the management and development of water is necessary and thus mandatory.

In line with this thinking, this research is concerned with the urban wastewater use for agriculture, and the different governance models for wastewater management in Australia and India. It attempts to grasp and analyse the ongoing multi-faceted problems of wastewater management with a focus on the role of the public sector, the private sector and the community. This research aims to generate a deeper understanding of the problems related to wastewater management in Australia and India. It selects three case studies representing different models of governance: the Virginia pipeline scheme (PPP model); Willunga Pipeline scheme (Divesture model); and Musi irrigation scheme (unsupported/informal wastewater reuse). From these studies, it thereby attempts to draw lessons from these experiences. For clarification it poses the questions: *What are the governance models that aid in implementing sustainable water reuse in formal and informal water economies? Does community social capital contribute to the implementation of a sustainable water reuse project, and in what ways*?

The following conclusions have been drawn based on the analysis of the selected case studies. The first part of the chapter covers the conclusions related to the theoretical discussions that have been presented throughout the thesis. The second part covers the discussions on the empirical results from the case studies in Australia and India.

9.2 Theoretical conclusions

Urban wastewater as a resource- Appropriately treated urban wastewater is a reliable alternative source of water that can ease the pressure on freshwater supplies. Concepts such as water reclamation, recycling and reuse have been receiving added significance and recognition as key components of water and wastewater management policies around the world. Use of treated urban wastewater for irrigation can augment freshwater supplies and is thus a response to the squeeze on water supply, particularly for the agriculture sector. This use also helps close the loop between water supply and wastewater disposal. Realising the potential benefits of water conservation and water recycling are two of the greatest challenges of our time.

(Good) Governance- Governance is about the interactions that involve the participation of public and private actors solving societal problems or creating societal opportunities. However, a good governance system should exhibit certain features, and very few countries and societies have come close to achieving good governance in totality. This demands that actions are taken towards making it a reality and thereby ensure sustainable human development.

Water governance- Water governance has taken over from earlier ideas such as 'managing water wisely' and includes a range of actors and agents that is much broader than government. Therefore, water governance is perceived as comprising all social, political, and economic organizations and institutions, and their relationships, as long as they are related to water development and management. The emphasis in this study is on

urban wastewater governance in Australia and India, two countries which have varying socio-economic and political settings.

Institutions and Organisations- Institutions can be understood as the rules of the games in a society or the humanly devised constraints that shape human interaction. These rules can be formal or informal. In the present case, the rules governing the use of urban wastewater for agriculture are more formal in Australia, while in India they are largely informal. Formal here indicates the rules that are readily observable through written documents or rules that are determined and executed through formal position. Informal implies the self-created rules based on implicit understandings, being in most part socially derived and therefore not accessible through written documents. Both institutions and organisations provide structures for human interaction, but institutions can be said to define the rules of interaction whereas organisations act within existing sets of rules and constraints. Institutions form 'the rules of the game' whereas organisations and other actors are 'the players in the game'. The institutional framework will determine what organisations come into existence and how they evolve over time, but organisations simultaneously influence how the institutional framework develops. The two are thus closely interlinked and interact.

Collective action- Collective action refers to activities that need coordinated efforts by two or more individuals and cooperation between different stakeholders. The case studies in Australia suggest that through collective action, enhanced community participation and well-designed partnerships, it is possible to: coordinate individuals' activities, develop

rules for resource use, impose sanctions on violators, and mobilize the necessary financial, labour and material resources. In case of India, people (mostly small farmers and the landless) have formed groups to deal with common irrigation and cultivation problems.

Social sustainability and social capital- Social sustainability can be understood to be made up of three required components: (1) basic needs, (2) individual capacity, and (3) community capacity; and four guiding principles: (1) equity, (2) social inclusion and interaction, (3) security, and (4) adaptability. And social capital is an important factor in achieving social sustainability. Irrespective of the variations in the perception about social capital, it is apparent that the social capital includes groups and networks, trust and solidarity, and cooperation. In all the three case studies the results suggest that the level of social capital was high which in turn led to the sustainable development of the region, particularly in the Virginia pipeline case.

Private sector participation- Over the years, water has been managed and controlled or governed by all the societal entities, with substantial involvement of governments, under the assumption that public agencies possess all the necessary resources, expertise, and authority to manage the resource. However, the general perception about governing water resources and services has changed over time, and it is now agreed that neither the public nor the private sector acting alone can meet the continually growing demand for water, waste, and energy services. Compared to the traditional water governance system, it is now believed that water governance is more effective within an open social structure and

with broader participation by civil society, private enterprises, and the community referred as ‘distributed governance’. The pressing need for more investment in water infrastructure, together with constrained government resources, has made Private Sector Participation (PSP) become popular within the water sector. There are many options for private sector participation. Public-Private Partnership (PPP) is one of those options.

Public-Private Partnership (PPP) - This refers to a kind of formal cooperation between the public and private sectors, supposed to harmonise the strengths and weaknesses of the two sectors, enhancing efficiency and sharing both profits and risks. In this study, a Public-Private Partnership is evident in the Virginia pipeline case in Australia. This partnership has resulted in implementing a successful wastewater reuse scheme, ultimately resulting in the sustainable development of the region. The second scheme in Australia the Willunga pipeline case is built on a different PPP option – the divesture model. In this case too, private sector participation has accompanied successful implementation of a wastewater reuse scheme. However, it is important to point out that strong regulatory mechanisms and strict enforcement of rules related to wastewater usage in Australia has contributed largely to these successes. The regulatory arrangements have enhanced the willingness of irrigators to accept and use treated wastewater, and made urban wastewater operators eager to find willing takers of their product.

In India, considering the economics of implementing a sophisticated wastewater reuse scheme, and PPP in its infancy stage, the Water Users Associations established to manage the river or canal water appear to play a vital role in managing the wastewater.

This is plausible considering that most of the wastewater usage in India occurs along the rivers which receive the wastewater all the year and the contaminated river water is then used for irrigation. In some cases like Musi River, the WUAs are functional just because of the wastewater flows in to the river.

9.3 Empirical conclusions

These conclusions are based on the findings from the three case studies selected for this study – Virginia pipeline scheme and Willunga Pipeline scheme (both in Australia) and Musi irrigation scheme (in India) and these are presented in Table 9.1 through 9.3. The aim is to understand the difference in the cases selected; explain environment for wastewater treatment and usage in both countries; and measure social sustainability with respect to the three cases.

9.3.1 Wastewater policy framework in Australia and India

With different systems of governance the water supply institutions in India and Australia work in two different domains. Likewise, the regulatory and policy framework for wastewater treatment and usage are also entirely different and therefore largely remained incomparable. However, this study attempts to compare the processes of governance and institution formation in these countries.

The aim of this section is to compare the wastewater policy framework in Australia and India based on some of the key features presented in Table 9.1. These key features help us to understand how each case differed from one another.

Table 9.1: Key features of the wastewater policy frameworks in Australia and India

Features	Virginia pipeline scheme	Willunga pipeline scheme	Musi irrigation scheme
Type of scheme	Wastewater irrigation scheme	Wastewater irrigation scheme	Surface water irrigation scheme
Regulatory and Policy framework for wastewater use	National Guidelines for Water Recycling, 2006 South Australian Reclaimed Water Guidelines, 1999	National Guidelines for Water Recycling, 2006 South Australian Reclaimed Water Guidelines, 1999	WHO Guidelines for the safe use of wastewater, excreta and grey water, 1973 WHO Health guidelines for the use of wastewater in agriculture and aquaculture, 1989
Governance model	BOOT model (Public-private partnership)	Divestiture model (Private company)	Self-governed institutions (WUAs)
Ownership of the scheme	State (Built on the BOOT model)	Willunga Water Company	State owns the Musi irrigation scheme, WUAs responsible for O&M of the scheme
Use of wastewater	Irrigating market gardens	Irrigating vineyards	'Source of Livelihood' Growing vegetables, rice
Quality of wastewater	Treated to Class A	Treated to Class B	Untreated/Partially treated
Beneficiaries	Heterogeneous group in terms of ethnicity	Homogenous group of grape growers	Heterogeneous group (small farmers & landless)
Access to wastewater	Users sign contract with the Water company	Users Sign contract with the Water company	Use in *defacto* illegal manner

It is clear from the Table 9.1 that while the schemes in Australia are identical except for the governance model whereas the Indian case differs in at least a dozen of issues. First and foremost is the type of scheme: the Virginia and Willunga scheme are exclusively wastewater irrigation schemes, Musi scheme on the other hand is originally a surface water irrigation scheme which over a period of time has turned into a wastewater irrigation scheme (particularly downstream). This is mainly due to the vast amount of urban and industrial effluents flowing into the river all the year round which will only increase given the current trend of increased urbanisation and industrialisation.

Secondly, the regulatory and policy framework for wastewater use: In Australia, wastewater reuse for non-potable applications is largely formal which means there are rules and policies that are written documents and are executed through formal position, such as authority or ownership. The two schemes studied in Australia had a strong regulatory and policy framework in the form of National Guidelines for Water Recycling, 2006 developed under the National Water Quality Management Strategy, 1992. At the State level, there is the South Australian Reclaimed Water Guidelines, 1999 prepared by the Environment Protection Agency (EPA) and the Department of Human Services (DHS) on behalf of the Environment Protection Authority (the Authority) and the Public and Environmental Health Council (the Council). On the other hand, India has no such clear guidelines and the nation still relies on the WHO guidelines for the safe use of wastewater, excreta and grey water, developed in 1973 and updated in 1989.

Another major difference observed in the cases studied is the ownership of the schemes. The Australian schemes are properly planned reuse schemes while the Musi case is the representation of how wastewater use and management occurs in developing countries like India. The Virginia pipeline is built under the BOOT contract wherein the State retains the ownership of the scheme. The other case in Australia – the Willunga pipeline is owned by a private company. In case of Musi, although the irrigation scheme (canal) is owned by the State/Irrigation Department the Water Users Associations (WUAs) are responsible for operation and maintenance of the scheme. Therefore, this makes WUAs responsible for managing the wastewater by default.

When it comes to the priority in use of wastewater, one thing common across all the schemes is that wastewater usage gained importance because of the depleting freshwater resources. A noticeable feature here is that, in Australian cases wastewater appears to be an alternative source to supplement the freshwater resources and the wastewater is treated to a quality matched to particular end uses. In Indian case, large numbers of small farmers and landless depend on wastewater for their livelihoods. This is a cause of concern because all the wastewater that is used In India is either untreated or partially treated, and complete prohibition or adoption of any stringent set of guidelines is not a practicable solution.

Further, the Virginia scheme sells Class A reclaimed water to a heterogeneous group of market gardeners who belong to different ethnicity and are either broad acre or glass house farmers. The Willunga scheme supplies Class B reclaimed water to a homogenous

group of grape growers who wanted to catch up with the boom in wine exports. In India, wastewater is either untreated or partially treated, nevertheless is a source of livelihood for small farmers and landless labourers.

The users in case of the Australian schemes need to sign a supply contract with the private water company to gain access to the water from the scheme and need to pay a fixed tariff for using the water and services of the company. On the other hand, wastewater use in India is done in a *defacto* illegal manner and it is free for the users. Needless to say it has associated problems which outweigh the benefits of using it. Apart from these points, the institutional and social environments for wastewater use in both countries are very different which is discussed in the following sections.

9.3.2 Institutional and social environments for wastewater use

This section discusses the institutional and social environments for wastewater usage in Australia and India. Table 9.2 compares and explains how the observations made in each case reflected institutional and social characteristics of that particular case. Institutional and social features shape the desire and decisions of:

1. Users who buy the reclaimed wastewater (in Australia) and use it for irrigation,
2. Water provider or water company who sell the water (in Australia), and
3. General public who buy the crops watered with reclaimed wastewater.

Having selected schemes with different governance structures, and considering that the study sites have varying socio-economic and political conditions, these findings will help draw lessons that can be useful for implementing wastewater reuse projects elsewhere.

Table 9.2: Regulatory, institutional, technical, financial and socio-cultural environment for wastewater usage in Australia and India

Environment for wastewater treatment and usage	Virginia Pipeline Scheme	Willunga Basin Pipeline Scheme	Musi river irrigation scheme
Regulatory and institutional			
Quality standards and regulations	Clear	Clear	Not clear
Freshwater availability at project level	Sever scarcity	Scarce with restrictions	Scarce
Institutional framework	Formal	Formal	Informal
Community, public, and private sector involvement	high level of community, public and private sector involvement,	high level of private sector involvement, no public sector involvement	high level of community involvement, no public or private sector involvement
Regulatory & Enforcement mechanisms	Strict and strong	Strict and strong	Weak
Technical			
Conveyance and distribution	Sophisticated infrastructure facilities	Sophisticated and innovative infrastructure facilities	Local or primitive conveyance methods
Reliability of reclaimed water supplies	High	High	High
Quality of reclaimed water	Class Á	Class B	Untreated and/or partially treated
Impact on crop yield and use of fertilisers	Positive	Positive	Positive
Health risks	Minimal	Minimal	High
Financial			
Financing the scheme	Pooled effort	Users	No cost
Willingness to pay	Increased WTP	Increased WTP	Not sure
Profitability to farmers	Profitable	Profitable	Profitable
Socio-cultural			
Markets for the crops grown using reclaimed water	Well established	Well established	Local markets only
Psychological aversion towards wastewater usage	For direct potable reuse, not for agricultural use	For direct potable reuse, not for irrigation purposes	No psychological barrier for using wastewater for irrigation
Concern for opinion of reference groups and public criticism	Diminishing	Diminishing	Diminishing

9.3.2.1 Institutional environment

Implementing a successful wastewater reuse scheme mainly depends on the institutional environment existing in that particular state or country. The regulatory and institutional environment encompasses wastewater quality standards and regulations; regulatory and enforcement mechanisms; institutional framework and involvement of the community, public and private sector.

Wastewater quality standards and regulations- The quality standards and regulations for wastewater reuse for agriculture in Australia are clear while in India they are not. Australia in general and South Australia in particular, where the schemes selected for the study are operating, have clear regulations and guidelines for wastewater reuse. In fact, the favourable regulatory and institutional environment or in other words, strict and consistent regulation has been one of the major reasons for the successes of these reuse schemes. In India however, the rules and regulations are not in place and we can find unrestricted use of wastewater along the rivers, which receive effluents from the growing cities and industries. Nevertheless, this study finds that if the WUAs along these rivers (as in the present case) are made responsible for managing the wastewater, the problem of regulating wastewater usage can be largely addressed.

Regulatory and enforcement mechanisms- The regulatory and enforcement mechanisms related to wastewater reuse are strict and strong in Australia. This implies that the rules are enforced as formulated and the regulatory authorities are strict when it comes to enforcement of the rules. For example, throughout the study regions we find signboards

stating ‘reclaimed water being used - not for drinking’ and lilac-coloured pipes to indicate the reclaimed water distribution network. The situation in India is the reverse. The regulatory authorities are either weak or in some cases non-existent, and hence when it comes to wastewater reuse regulations and their enforcement, India is way behind Australian standards.

Institutional framework- The countries under study have different water economies. Australia has a formal water economy with public and/or private service providers serving most of the water users. In the case of India, it is informal, and the water users depend largely on self-supply, informal exchanges and local community institutions. Further, the ‘rules in use’ governing wastewater usage is also well defined and clear for the Australian cases. On the other hand, in India there are ‘self-created rules’ governing water (canal water) in place. However, for cases like the Musi River where the canal water is nothing but the wastewater discharged into the rivers, either the rules are not stated or there are no rules.

Public and private sector involvement- It is understood that community acceptance and participation is of utmost importance to implementing a wastewater reuse scheme. This implies that due to uncertainties related to water quality issues and negative public perceptions, reclaimed water has not yet found acceptance, particularly for direct potable use. In the present case, it was evident from the two case studies in Australia that community, public and private sector involvement backed up by a favourable regulatory regime can lead to implementation of successful reuse schemes. In both these cases, the

involvement of these entities was found to be high. In the case of the Virginia pipeline scheme, it was public-private and community participation; whereas in the case of Willunga pipeline scheme it was total private sector involvement (the community formed itself into a company). In India, it was community organizations represented by the Water Users Associations. Although the WUAs were originally formed to govern canal irrigation systems, in the present case due to the very nature of the Musi irrigation scheme, the WUAs were responsible for managing wastewater use. This was because the river was perennial downstream due to continuous wastewater flows, and hence the WUAs were active, compared to the WUAs upstream where the river ran dry except during the monsoons. So downstream, there was a high level of community participation. However, there was little or no public or private sector involvement. This calls on policy makers to think along the lines of making wastewater use more formal, thereby reducing or minimising the risks associated with the use of untreated wastewater.

9.3.2.2 Technical environment

The technical environment is also equally important for the success of any reuse scheme. It encompasses the conveyance and distribution system, the reliability of wastewater supplies, the quality of the water, and impacts on health, crop yields etc.

Conveyance and distribution- Water distribution is a vital component of any irrigation system and this is no different in the case of wastewater irrigation projects. In case of both the schemes in Australia – the Virginia pipeline scheme and the Willunga pipeline scheme, the private companies (WRSV & WBWC respectively) were responsible for

laying the pipeline, and for operation and maintenance of the system. These schemes have a modern conveyance infrastructure and water distribution is efficient. Although highly technical, the system is user friendly. In India, however, the wastewater conveyance system is the same primitive system used for canal irrigation using river water. In addition, individual farmers have their own structures and channelling methods for distributing water to their fields, which reduces overall distribution system efficiency because of the poor management practices.

Reliability of reclaimed water supplies- In all three cases, there is high reliability of reclaimed water supplies. Considering that the source of water is wastewater from treatment plants (in Australia) and mixture of treated and untreated sewage from the cities and industries (in India), the supply of wastewater is assured. In India, the very fact that the river remains wet downstream as compared to upstream, where there are no wastewater inflows, indicates that the supply is reliable. Further, in both the countries, with the growth of population and urbanisation the supplies of wastewater will be continuous and increasing in the future. In the Australian cases, there is still scope to increase the capacity of the two schemes and efforts in this direction are under way.

9.3.2.3 Financial environment

The financial environment relates to the funding of wastewater reuse schemes and also the willingness of the users to pay for this resource, which is regarded as waste. The profitability of using wastewater, as against fresh water, is also an important aspect of the financial environment as it relates to the tariffs of wastewater. All though this study did

not focus on the profitability analyses some information related to financing the scheme, and tariffs were collected by reviewing of the project documents (in Australian cases).

Financing the scheme- Acquiring funds to develop a water reuse scheme is an onerous task mainly because of the negative public perceptions about wastewater use. However, through proper planning and well-designed partnerships, these issues can be addressed effectively, as in the case of the two schemes in Australia. In the case of the Willunga scheme, the users contributed the initial funding entirely, with no assistance from the public sector, unlike the Virginia scheme where it was a pooled effort by the SA Water Corporation, Federal Government, Water Reticulation Services Virginia (WRSV), and the Virginia Irrigation Association (VIA). In India, there is no cost component involved in construction of any infrastructures and the use of wastewater is uncontrolled.

Tariff structures- The Australian schemes had a clear tariff structure for using wastewater and in India the farmers paid no fees for using wastewater. However, it is to be noted that generally, the WUAs charge the farmers for using canal water, but not in this case since it was the 'wastewater'. The prevailing water fee structure in case of the Virginia pipeline is seasonal and comprise of Connection fees and Water fees which includes the supply fees and water use charges. Water use charges is billed four times a year- Summer, Winter and the spring and autumn Shoulder Season with varying rates. In the case of the Willunga scheme the tariff structure comprised two components: (1) a fixed tariff based on allocated water entitlement and (2) a variable tariff based on usage. Both the tariffs were cheaper than the mains water supplied by SA Water.

9.3.2.4 Socio-cultural environment

The socio-cultural environment largely includes the perceptions the public has towards use of reclaimed wastewater to irrigate crops. It includes the markets for the produce irrigated with reclaimed water, psychological aversion towards the use of reclaimed water, and concern for public opinion and the opinion of reference groups.

Markets for crops grown using reclaimed water- Reclaimed water use for agriculture is a widespread practice, and all three schemes under study delivered water for irrigation. As stated before, in India, the use was to grow crops for self-sustenance or for the local market only. The produce marketed was largely paragrass, a fodder grass. There were some who sold vegetables, but the numbers were much less. In Australia, in both cases the market for irrigated crops (using reclaimed water) is well established. The produce from Virginia market gardens has a very good market within the state and a proportion is exported to other states. In the Willunga scheme, the wine produced from grapes grown using reclaimed water has a good market within South Australia and across all states in Australia and abroad. In all three cases the perception of public towards crops irrigated with reclaimed water seems to be positive; and this can be improved even further with proper awareness and education, particularly in India.

Psychological aversion towards wastewater usage- Many of the previous studies on reclaimed wastewater usage in agriculture have studied the human perceptions about wastewater usage. Most of them conclude that there is generally no psychological aversion by the users towards wastewater usage if it is for non-potable uses such as toilet flushing, watering of gardens and lawns, and agriculture. However, this is only when

there are strict and strong regulatory and enforcement mechanisms in place to control and monitor the entire process. The two case studies in Australia agree with these findings, as farmers had no psychological barriers towards using wastewater for irrigation. The situation was similar in India; however it is to be noted that the farmers there are still using untreated wastewater because it is the only source that supports their livelihoods. Having said this, there is a strict 'NO' to using reclaimed wastewater for potable purposes in both Australia and India.

Concern for opinion of reference groups and public criticism- Concern about the opinion of reference groups and public criticism is one of the disincentives to users of reclaimed water. However, the cases under study clearly indicate that the influence of this factor is diminishing in all regions. But in some places these factors still influence the farmer's attitudes and perceptions towards wastewater usage. Some of the reference groups that were identified in the Indian case study were community leaders, religious leaders, and local politicians. So although this is diminishing it still needs to be taken into account while planning a wastewater reuse project.

9.4 Wastewater reuse schemes and social sustainability

Compared to the concept of environmentally sustainable development the concept of socially sustainable development has received less attention in discussions on sustainable communities. Generally, studies on wastewater reuse focus more on environmentally sustainable development which is of course very important. So is the concept of socially

sustainable development. This study focuses on the later and is more concerned with the development of social capital which is the regulator of sustainability.

It is true that the initial motivation to seek more sustainable alternatives to freshwater supplies (urban wastewater in this case) is driven by economic or environmental or health-related factors. However, it cannot be ignored that achieving 'sustainability' is not a win/lose event, rather it is a process which involves constant awareness and ongoing evaluation of the achievement of the desired goals. Building upon this idea, the findings of this study indicate that a critical factor linking increased social capital with the implementing of a successful and sustainable reuse scheme is that the community citizens and irrigators both begin to see that their (collective) action can make a difference in achieving goals. Social capital therefore makes a difference in terms of a community's ability to solve its own problems – the problem of water scarcity in all these three cases. In addition, it was clear from the case study results that although the governance structures developed to manage urban wastewater reuse in Australia and India varied, one thing common in all the three cases was the increase of community social capital, as measured by level of trust.

Further, based on the concept of entrepreneurial social structure it is apparent that diverse symbolic structures, wider resource mobilisation, and diverse networks result in increased social capital which in turn makes a difference in terms of a community's ability to solve its own problems – water scarcity in this particular case (see Table 9.3).

Table 9.3: Community social infrastructure in the three study sites

Elements of social capital	Virginia pipeline scheme	Willunga pipeline scheme	Musi irrigation scheme
Symbolic diversity	H	L	H
Resource mobilisation	M+	H	L
Networks	H	M+	M

Note: L= Low; M= Medium; H= High

In case of the Virginia pipeline scheme it is noticeable that even with heterogeneous or diverse groups (symbolic diversity) it is possible to achieve increased social capital and thereby social sustainability. This is further supported by the fact that the level of trust among the members of the community and different stakeholders was high. Moreover, after operating successfully for seven years it is still maintained and maintaining social capital means social sustainability. In case of the Willunga scheme, there was wider resource (inputs such as knowledge, time, and money) mobilisation as the scheme is entirely developed and implemented by the users or irrigators.

On the other hand in India, the scheme studied involves unplanned use of wastewater for agriculture. However, diverse institutions and organizations – Urban Farmers Associations, Water Users Associations, and caste groups (as most of the users were from backward communities) were involved with wastewater use, clearly suggesting higher symbolic diversity. Furthermore, the idea of forming the WUAs was undertaken mostly to ensure high levels of community cooperation and involvement in water management activities.

Communities with entrepreneurial social infrastructure can identify problems and alternative ways to solve them. These case studies, particularly the Virginia pipeline scheme, demonstrate that it is possible to develop and maintain ‘entrepreneurial social infrastructure’ even with diverse groups. Only then can the communities participate in any change or shift in a positive, proactive way. Combined with an increase in community social capital, this ultimately can be the path towards achieving social sustainability.

9.5 Policy options — the way forward

Today, in most countries around the world, on the supply side of the wastewater market, wastewater collection is well organised and has reached reasonably high levels. Wastewater treatment still needs to be improved, which can be achieved by adopting a demand-driven approach instead of the existing supply-driven approach, allowing for technological innovations, and integrating it with environment and water resources strategies. On the demand side of the market, the regulatory and institutional frameworks are of great relevance in determining the decisions of the farmers who use the reclaimed wastewater to grow crops, and the community who buy crops irrigated with reclaimed wastewater. In addition, technical, economic, and cultural incentives influence wastewater reuse for agricultural purposes.

Consequently, the following recommendations are made to improve the acceptance level of farmers to using the resource and thereby developing a sustainable and successful

reclaimed water irrigation scheme. These suggestions are based on the findings from the current case studies in Australia and India:

- Prepare location-specific guidelines for wastewater use and management,
- Ensure private sector involvement and enhanced community participation in wastewater treatment and management,
- Design awareness programmes, on the legal, social, economic, environmental, and health issues related to waste water and target all key stakeholders,
- Design appropriate arrangements and agreements among all those who hold a stake in wastewater management,
- Conduct thorough financial and technical feasibility studies to ensure the scheme's long-term viability and to attract private sector funding,
- Prepare a competent technical design and develop appropriate safety measures and practices to avoid any occupational health and safety hazards,
- Conduct regular water quality monitoring, and control best irrigation practice through soil surveys, regular soil and crop management reports in order to ensure environmental sustainability,
- Decide on a tariff structure that is affordable to the users and also ensures the financial sustainability of the project, and
- Above all, build up a favourable policy and regulatory regime for wastewater reuse based on the local socio-economic and political situations.

From the policy perspective, the following policy options are suggested based on the findings of this study;

Policy option 1: When we consider wastewater markets, the supply side collection and treatment of wastewater are usually under the jurisdiction of a sector (such as urban water supply and sanitation) that is different from the reuse sectors (such as agriculture and municipalities), hence intersectoral coordination in planning and management is extremely important. On the demand side, users should be involved in planning and monitoring the quality of the supplied effluent. Effective advisory/extension services are also extremely important.

Policy option 2: Wastewater use should be viewed with a multi-disciplinary approach so that all parties benefited or affected (public and private sectors, consumers and farmers) can be informed about the benefits and risks of wastewater use, the options available to manage such use more effectively and the livelihood activities of different groups that are sustained by wastewater (in the developing world).

Policy option 3: With all the modern technologies available it is not a problem to treat wastewater to a quality matched to particular end uses; however, considering the associated investment and recurring costs that are required to treat wastewater might be a constraint in developing countries like India. In such cases, setting up short-term objective to control wastewater exposure to consumers and producers may be feasible. This can be attained through participatory approaches such as farmer's field schools to educate farmers on crop selection to minimise exposure and safer and sustainable irrigation practices. The benefits of this approach can be enhanced by public health

education, therapeutic medical care for irrigators, and community awareness programmes.

Policy option 4: A major policy shift is needed for water management investments that are important for irrigated agriculture. Although the state is the critical driver, civil societies and the private sector are important actors, and can play important roles in promoting treated wastewater reuse. Therefore, it is essential to table a dialogue between all three societal sectors to find workable solutions.

Policy option 5: Effective and sustainable management of wastewater use in agriculture requires developing and applying practical wastewater use guidelines. But, in absence of strict regulatory enforcement to ensure compliance with the guidelines on the part of water authorities, those discharging wastewater, and those handling and using wastewater it is difficult to adopt a set of guidelines developed based on 'no risk' criteria. This is truer in developing countries like India. Therefore, the approach should be to develop and apply realistic guidelines based on 'managed risk' or 'acceptable risk' criteria.

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The Hague Ministerial Declaration on Water Security in the 21st Century	http://www.gdrc.org/uem/water/hague-declaration.html
naiad™ a web based knowledge repository	http://www.naiad.net.au/naiad.html

Appendices

Appendices

Appendix 1: The Hyderabad Declaration on Wastewater reuse in agriculture, 14 November 2002, Hyderabad, India

1. Rapid urbanization places immense pressure on the world's fragile and dwindling fresh water resources and over-burdened sanitation systems, leading to environmental degradation. We as water, health, environment, agriculture, and aquaculture researchers and practitioners from 27 international and national institutions, representing experiences in wastewater management from 18 countries, recognize that:
    i. Wastewater (raw, diluted or treated) is a resource of increasing global importance, particularly in urban and peri-urban agriculture
    ii. With proper management, wastewater use contributes significantly to sustaining livelihoods, food security and the quality of the environment
    iii. Without proper management, wastewater use poses serious risks to human health and the environment.
2. We declare that in order to enhance the positive outcomes while minimizing the risks of wastewater use, there exist feasible and sound measures that need to be applied. These measures include:
    i. Cost-effective and appropriate treatment suited to the end use of wastewater, supplemented by guidelines and their application
    ii. Where wastewater is insufficiently treated, until treatment becomes feasible:
    (a) Development and application of guidelines for untreated wastewater use that safeguard livelihoods, public health and the environment
    (b) Application of appropriate irrigation, agricultural, post-harvest, and public health practices that limit risks to farming communities, vendors, and consumers
    (c) Education and awareness programs for all stakeholders, including the public at large, to disseminate these measures
    iii. Health, agriculture and environmental quality guidelines that are linked and implemented in a step-wise approach
    iv. Reduction of toxic contaminants in wastewater, at source and by improved management.

3. We also declare that:
    i. Knowledge needs should be addressed through research to support the measures outlined above
    ii. Institutional coordination and integration together with increased financial allocations are required.
4. Therefore, we strongly urge policy-makers and authorities in the fields of water, agriculture, aquaculture, health, environment and urban planning, as well as donors and the private sector to:

   Safeguard and strengthen livelihoods and food security, mitigate health and environmental risks and conserve water resources by confronting the realities of wastewater use in agriculture through the adoption of appropriate policies and the commitment of financial resources for policy implementation.

Appendix 2: Virginia pipeline survey questionnaire (English)

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Survey Questionnaire

Knowing the value of your time and information it is our intention to use them as efficiently as we can. This survey aims to study the institutional arrangements governing water distribution and usage in private reclaimed wastewater schemes of South Australia. The interview should take around 40 minutes and answers provided by you will remain totally confidential. Thanks, in advance for your cooperation and active support for this study.

Respondent No._____ **Scheme:** _____

SECTION 1- Background Information

1. Your country of birth? _____

2. How long have you been engaged in farming? _____ years.

3. What is the present source of water for irrigation? Tick (√) the appropriate

(a) Groundwater ☐ (b) Reclaimed water ☐ (c) a & b ☐ (d) Mains water ☐ (e) b & d ☐

4. Please indicate the proportion of water used for irrigation from the following sources

(a) Mains water_____% (b) Groundwater_____% (c) Reclaimed water_____%

SECTION 2- Information about the reclaimed water scheme

This section aims to get an overall idea about the scheme to which you are connected. It consists of a set of questions pertaining to different aspects of the scheme. Please mention the code for your answer in the boxes provided.

1	When did you fist come to know about the reuse scheme? (Well before implementation=1; Just prior to implementation=2; After implementation=3)	
2	What was your initial attitude when you first heard about the reuse scheme? (Positive=1; Negative=2;Indifferent=3)	
3	Did you have any knowledge of reclaimed water and its use before implementation of scheme? (Never heard=1; Had heard=2; Knew a lot=3)	
3.1	If yes, then indicate the source of information? (Water authorities=1; Private agencies=2; Community=3; Personal experience=4)	
4	What according to you is the most important reason for implementation of the scheme? (Groundwater depletion =1; High price of mains water=2; Prior experience using reclaimed water=3; Encouragement by water authorities=4; Community interest=5)	
5	What is your present attitude regarding wastewater use? (Positive=1; Negative=2;Indifferent=3)	
6	Who had the main stake in operation of the scheme during the initial stages? (Federal govt. = 1; State govt. = 2; Community = 3; Private company= 4; No idea = 5)	
7	Who has the main stake in operation of the scheme at present? (Federal govt. = 1; State govt. = 2; Community = 3; Private company= 4; No idea = 5)	
8	Who according to you is responsible for enforcing the rules governing water management in the scheme? (Federal govt. = 1; State govt. = 2; Community = 3; Private company= 4; No idea = 5)	
9	Who has the authority to issue water allocations? (Federal govt. = 1; State govt. = 2; Community = 3; Private company= 4; No idea = 5)	

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10	What is the basis for allocating water? (Land area=1; Individual requirement=2; No. of irrigators=3; No idea=4)	
11	Who has the authority to decide upon the water charges? (Federal govt. = 1; State govt. = 2; Community = 3; Private company= 4; No idea = 5)	
12	According to you, the water charges include: (Cost recovery fees =1; water use charges =2; Maintenance fees = 3; Only 1 & 2=4; All 1,2 & 3=5)	
13	What is the basis for charging water use? (Time=1; Volume =2; Land area=3; Crops grown=4; Time & volume=5; No idea=6)	
14	Who is responsible for the operation and maintenance of the pipeline? (Federal govt. = 1; State govt. = 2; Community = 3; Private company= 4; Not aware = 5)	

SECTION 3 – Perception regarding the rules governing reclaimed water management and cooperation

This section consist a number of statements about the rules governing reclaimed water management issues such as water distribution, water pricing, water allocation and collective action & cooperation within the scheme/community. These statements are based on the literature search and are matters of opinion only. There are obviously no right or wrong. We would like to know your views about these statements. Please indicate if you agree or disagree with these propositions on a 10 point likert scale where **0= very strongly disagree and 10= very strongly agree.**

A. Rules governing water management issues

[0= very strongly disagree, 5= neutral & 10 = strongly agree]

1. The rules clearly define the rights to use the water and its boundaries	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2. I feel that the water is shared equally among every user in the scheme	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3. I feel secure with the present water allocation plan	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
4. The basis for allocating water among irrigators is fair	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
5. The basis to charge water fees is appropriate	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
6. All the users are involved in modifying the rules governing water use overtime	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
7. Conflicts between users and the management (water company) are common	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
8. Conflicts between water users are common	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
9. The conflict resolving mechanisms are clear	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10. The sanctions on offenders depend on the seriousness and context of offense	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11. I believe that the rule is enforced in the way formulated	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
12. I think the present maintenance system is effective	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
13. I am satisfied with the present services of the water provider	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

B. Collective action and Cooperation

[0= very strongly disagree, 5= neutral & 10 = strongly agree]

1.A major portion of my income is derived from activities depending on irrigation	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2. I completely trust my neighbouring farmers regarding water usage	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3. Most people in the community are willing to help when in need	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
4. This community has prospered in the last five years	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
5. I feel accepted as a member of this community	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

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6. I have worked with others in the past for the benefit of the community	0	1	2	3	4	5	6	7	8	9	10
7. Most likely the people who do not participate in community activities are criticized	0	1	2	3	4	5	6	7	8	9	10
8. Everyone in the community make a fair contribution to communal activities	0	1	2	3	4	5	6	7	8	9	10
9. People in the community will cooperate when there is water supply problem	0	1	2	3	4	5	6	7	8	9	10
10. Water in this region will be in the hands of a few players	0	1	2	3	4	5	6	7	8	9	10
11. The bigger farmers here have the most influence	0	1	2	3	4	5	6	7	8	9	10

SECTION 4- Perceived problems, knowledge about the scheme and trust in authorities

1	At any given point of time, do you think that the reuse scheme can pose problems? (Yes=1; No=2; Indifferent=3)	
2	If yes, then, (a) What might be the problem like? (Groundwater contamination=1; Health risks=2; Damage to aquifers=3; Accidents=4; Soil quality deterioration=5)	
	(b) What is the likelihood of any problems happening? (Highly unlikely=1; Highly likely=2; Likely=3; Indifferent=4)	
	(c) Who do you think will/is worst effected by these possible problems? (Yourself and your family=1; Environment=2; Water company=3; None=4; No idea=5)	
	(d) How serious do you think the problems to be? (Not serious at all=1; Extremely serious=2; Serious=3; Indifferent=4)	
3	To what extent do you think the following authorities have control to prevent the problems from happening? (No control at all=1; High level of control=2; some control=3; Indifferent=4) (a) Government agencies	
	(b) Water Company	
4	Please indicate the extent of knowledge you possess about the following? (Nothing=1; Very little=2; Little=3; Quite a lot=4; Fully informed=5) (a)Wastewater treatment	
	(b) Wastewater usage/applications	
5	What do you think about the knowledge possessed by experts about wastewater treatment and its use in irrigation? (No knowledge at all=1; Very little=2; Little=3; Quite a lot=4; Fully informed=5)	
6	What is the main source of information regarding water reuse? (Media=1; Internet=2; Newspaper=3; Radio=4; Government authorities=5; Exposure visits=6; Water company=7)	
7	How often you receive information about water ruse? (Daily=1; Weekly=2; Fortnightly=3; Monthly=4; Half yearly=4; Yearly=5)	
8	What is the level of trust you have in the following agencies to perform their responsibilities? (No trust at all=1; Complete trust=2; Some level of trust=3; Indifferent=4)	
	(a) Government agencies	
	(b)Water company/pipeline operator	
	(c)Environment Protection Agency (EPA)	
	(d) Human services department	

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SECTION 5- Attitudes, perception and willingness to pay (WTP) statements

This section consist a number of statements measuring the intentions, attitudes, subjective norms and perceived behavioural control based on the Theory of Planned Behaviour literature. These are matters of opinion only and we would like to know your views about these statements.

A. Intention to participate in the scheme
Please indicate the extent to which you agree or disagree with these propositions on a 10 point likert scale where **0= very strongly disagree and 10= very strongly agree**

1. I expect to continue in the scheme in future	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2. I intend to continue in the scheme in future	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3. I will try to continue in the scheme in future	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
4. I am determined to continue in the scheme in future	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
5. I might not continue in the scheme in future	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

B. Attitude towards participating in the scheme

1. Your participation in the reclaimed water scheme is in the form of
[Water user =1; Shareholder=2; Owner=3; Both 1 & 2= 4; All (1, 2 & 3)= 5] ☐

2. Based on your participation in the scheme, please indicate your opinion by rounding up the number on semantic differential scales. **If you round up number 5 that indicates you are indifferent.**

Participating in the reclaimed water scheme is

1.	Worthless	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	Useful
2.	Harmful (to me)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	Beneficial (to me)
3.	Harmful (to the environment)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	Beneficial (to the environment)

C. Subjective norm
Please indicate the extent to which you agree or disagree with these propositions on a 10 point likert scale where **0= very strongly disagree and 10= very strongly agree**

1. Most people who are important to me think that I should continue in the scheme	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2. Most people who are important to me would be disappointed if I don't continue in the scheme	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3. I feel under social pressure to participate in the scheme	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
4. It is expected of me that I continue to be associated with the scheme	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

D. Perceived behavioural control (agree-disagree scale)
Please indicate the extent to which you agree or disagree with these propositions on a 10 point likert scale where **0= very strongly disagree and 10= very strongly agree**

1. I am confident that I can continue in the scheme if I want to	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2. I can overcome problems that could prevent me from continuing in the scheme	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

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3. Whether I continue in the scheme or not is entirely up to me	0	1	2	3	4	5	6	7	8	9	10
4. The decision to continue in the scheme is beyond my control	0	1	2	3	4	5	6	7	8	9	10
5. For me to decide about continuing in the scheme is very easy	0	1	2	3	4	5	6	7	8	9	10

E. Willingness to pay for reclaimed water

The following questions are designed to elicit your willingness to use recycled water and willingness to pay under different hypothetical scenarios. Please tick (√) which ever you think the most appropriate.

a. Supposing, both fresh water and recycled water were available, which would you use?
1. Reclaimed water if it's 15 cents less then the price of fresh water ☐
2. Reclaimed water if it's 30 cents less then the price of fresh water ☐
3. Reclaimed water if it's cost is 50 cents less than the price of fresh water ☐
4. Reclaimed water if it's cost is 75 cents less than the price of fresh water ☐
5. Reclaimed water if it's cost is 1$ less than the price of fresh water ☐
6. Reclaimed water even if it's cost is same as fresh water ☐
7. Fresh water even if reclaimed water's price were zero ☐

b. If you were aware that reclaimed water use would reduce the fertilizers requirement for crops, in which of the following cases would you use treated wastewater?
1. If the fertilizers used could be reduced by 50 % ☐
2. If the fertilizers used could be reduced by 30 % ☐
3 If the fertilizers used could be reduced by 15 % ☐
4. Always even if no save ☐
5. Never ☐

c. Would you use recreation areas if you knew that they were irrigated with recycled water given that the only potential risk comes from consumption of this water?
1. Definitely not ☐
2. Probably ☐
3. Very likely ☐
4. With great certainty ☐

d. Will you continue using recycled water for the irrigation of your crops in future?
1. Definitely not ☐
2. Probably ☐
3. Very likely ☐
4. With great certainty ☐

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SECTION 6- Respondent profile

A. Age group Tick (√) the appropriate

1	18 - 24	
2	25 - 34	
3	35 - 44	
4	45 -54	
5	55-64	
6	65+	

B. Highest level of education attained Tick (√) the appropriate

1	< Primary	
2	Primary school	
3	Secondary School	
4	Higher school	
5	Additional education (TAFE, Diploma etc)	
6	University Degree	

C. What is the number of household members? _____

D. Gender Tick (√) Male ☐ Female ☐

E. Land holding details

Land holding (Hectares)	Owned			Leased-in			Leased-out		
	Total	Irrigated	Dry land	Total	Irrigated	Dry land	Total	Irrigated	Dry land

F. What percentage of gross household income is derived from farming activity?_____%

G. Area under major crops

Crops	Area(ha)
a.	
b.	
c.	
d.	
e.	
f.	

Thank you for your time, cooperation and active support for this study

Appendix 3: Virginia pipeline scheme letter of information (English)

University of South Australia

School of Commerce
Division of Business

Educating Professionals • Creating and Applying Knowledge • Serving the Community

LETTER OF INFORMATION

Dear Respondent,

The present survey is part of Mr. Ganesh B. Keremane's PhD research titled *Performance of Private Reclaimed Wastewater Markets in South Australia: An Institutional Analysis.*

It aims to examine the institutional arrangements governing treated wastewater management in two private irrigation schemes operating in South Australia. The schemes under study are: (1) the Virginia Pipeline Scheme, and (2) the Willunga Basin Pipeline Scheme.

The interview should take no longer than 40 minutes and includes questions regarding your experiences of the scheme, perceptions about the use of reclaimed water for irrigation and willingness to pay for this valuable resource.

Further, we would like to inform that;

- Participation in this research is voluntary.
- Participant can refuse to answer any question or is free to withdraw from the study at any time during the interview process.
- All discussions and reporting will be confidential so that no individual will be identified.

For queries relating to this research, please contact Ganesh, B. Keremane on 8302 0148 or ganesh.keremane@unisa.edu.au, or Prof. Jennifer McKay on 8302 0887 or Jennifer.McKay@unisa.edu.au at School of Commerce, Centre for Comparative Water Policies and Laws, University of South Australia.

In case of any ethical concerns, please contact Vicki Allen, Executive Officer, University of South Australia Human Research Ethics Committee (HREC) on 8302 3118 or Vicki.allen@unisa.edu.au

Thanking you,

Ganesh B. Keremane_____ Prof. Jennifer McKay _____

Date _____ Date _____

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Appendix 4: Virginia pipeline scheme consent form (English)

University of South Australia

School of Commerce, Division of Business
Center for Comparative Water Policies and Laws

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Consent Form for Participation in Research

I ..... hereby consent to participate as requested in the Information Sheet for the research study titled "Performance of private reclaimed wastewater markets in South Australia: An institutional analysis".

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I understand that:
    - I may not directly benefit from taking part in this research
    - I am free to withdraw from the project at any time and am free to decline to answer particular questions
    - While the information gained in this study will be published as explained, I will not be identified unless I give express permission, and the research team (Ganesh B. Keremane and Prof. Jennifer McKay) will ensure that individual information will remain confidential.
    - I am entitled to receive a copy of the study report if interested

Participant's signature.....

Date:.....

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participate.

Researcher's name.....

Researcher's signature .....

Date .....

Appendix 5: Virginia pipeline scheme survey questionnaire (Vietnamese)

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Các Câu Hỏi Thăm Dò Ý Kiến

Ý định của chúng tôi là dùng các dữ kiện này một cách hiệu quả nhất vì chúng tôi biết rằng thì giờ và những dữ kiện mà quí vị cung cấp cho chúng tôi rất quí báu. Cuộc thăm dò ý kiến này nhằm nghiên cứu những bó trí không có mục đích thương mại liên quan đến kế hoạch phân phối và sử dụng nước thải đã được xử lý do tư nhân quản lý tại Nam Úc. Cuộc phỏng vấn kéo dài không quá 40 phút và những câu trả lời mà quí vị cung cấp cho chúng tôi sẽ được hoàn toàn giữ kín.

Người trả lời số: _____ **Kế hoạch số:** _____

PHẦN 1- Quá trình cơ sở cho các dữ kiện

1. Quốc gia, nơi quí vị được sinh ra? _____
2. Quí vị đã làm về nông nghiệp được bao lâu rồi? _____ năm
3. Nguồn nước tưới quí vị đang sử dụng xuất phát từ đâu? Xin đánh dấu (✓) vào ô thích hợp

(a) Nước ngầm ☐ (b) Nước đã được xử lý ☐ (c) a và b ☐ (d) Nước sạch ☐ (e) b và d ☐

4. Xin vui long cho biết tỉ lệ nước quí vị đã dung cho nông nghiệp trong các nguồn sau

(a) Nước sạch _____% (b) Nước ngầm _____% (c) Nước đã được xử lý _____%

PHẦN 2 – Các dữ kiện liên quan đến kế hoạch nước thải

Phần này nhằm mục đích tìm hiểu tổng quát về kế hoạch sử dụng có liên hệ với quí vị. Nó gồm nhiều câu hỏi liên quan đến nhiều khía cạnh khác nhau của kế hoạch. Xin quí vị ghi mã số của câu trả lời vào ô vuông của mỗi câu hỏi.

1	Lần đầu tiên quí vị biết về kế hoạch này là lúc nào? (Trước khi kế hoạch này thi hành = 1; Ngay trước khi kế hoạch thi hành = 2; Sau khi kế hoạch thi hành = 3)	☐
2	Lần đầu tiên khi nghe về kế hoạch tái sử dụng nước, thái độ của quí vị lúc đó ra sao? (Tích cực = 1; Tiêu cực = 2; Không quan tâm/Không trả lời = 3)	☐
3	Quí vị có biết gì về nước được xử lý cũng như cách sử dụng nước này trước khi kế hoạch được thi hành hay không? (Không biết gì hết = 1; Biết ít = 2; Biết nhiều = 3)	☐
3.1	Nếu quí vị biết về kế hoạch này, xin cho biết nguồn gốc những thông tin đó [Từ những giới chức có thẩm quyền về nước = 1; Cơ quan tư nhân = 2; Cộng đồng = 3; Kinh nghiệm cá nhân = 4]	☐
4	Theo quí vị, lý do quan trọng nhất trong việc thi hành kế hoạch đường ống dẫn nước là gì? [Nguồn nước ngầm bị cạn = 1; Giá nước sạch cao = 2; Kinh nghiệm trước đây về dùng nước đã được xử lý = 3; Được các cơ quan của chính quyền khuyến khích = 4; Vì ích lợi của cộng đồng = 5]	☐
5	Thái độ hiện thời của quí vị về việc dùng nước thải ra sao? (Tích cực = 1: Tiêu cực = 2; Không quan tâm/Không trả lời = 3)	☐
6	Trong giai đoạn đầu, tổ chức nào chịu trách nhiệm chính việc điều hành kế hoạch? (Chính quyền liên bang = 1; Chính quyền tiểu bang = 2: Cộng đồng = 3; Công ty tư nhân = 4; Không biết = 5)	☐
7	Hiện tại, tổ chức nào chịu trách nhiệm chính trong việc điều hành kế hoạch? (Chính quyền liên bang = 1; Chính quyền tiểu bang = 2: Cộng đồng = 3; Công ty tư nhân = 4; Không biết = 5)	☐
8	Theo như quí vị nghĩ, tổ chức nào chịu trách nhiệm thúc đẩy việc thực hiện các qui định về quản lý nước được xử lí? (Chính quyền liên bang = 1; Chính quyền tiểu bang = 2: Cộng đồng = 3; Công ty tư nhân = 4; Không biết = 5)	☐
9	Tổ chức nào có quyền phân phối chỉ tiêu nước? (Chính quyền liên bang = 1; Chính quyền tiểu bang = 2: Cộng đồng = 3; Công ty tư nhân = 4; Không biết = 5)	☐
10	Việc phân phối chỉ tiêu nước đựa trên cở sở nào? [Diện tích đất =1; Nhu cầu cá nhân = 2; Số lương người dùng nước = 3; Không có ý kiến = 4]	☐
11	Tổ chức nào có quyền quyết định việc tính tiền nước? (Chính quyền liên bang = 1; Chính quyền tiểu bang = 2: Cộng đồng = 3; Công ty tư nhân = 4; Không biết = 5)	☐
12	Theo quí vị, tiền nước bao gồm: (Tiền thu hồi các phí tổn = 1; Tiền nước đã tiêu thụ = 2; Tiền bảo trì = 3; 1 và 2 = 4; Tất cả 1,2, và 3 = 5)	☐
13	Nước tiêu thụ được tính theo căn bản nào? (Thời gian = 1; Thể tích = 2; Diện tích đất = 3; Loại hoa màu = 4; Cả hai thời gian lẫn thể tích = 5; Không biết = 6)	☐
14	Tổ chức nào chịu trách nhiệm việc điều hành và bảo trì đường ống? (Chính quyền liên bang = 1; Chính quyền tiểu bang = 2: Cộng đồng = 3; Công ty tư nhân = 4; Không biết = 5)	☐

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PHẦN 3 – Sự hiểu biết về những luật lệ liên quan đến việc quản lý nước thải và phối hợp làm việc giữa các thành phần

Phần này gồm có một số các câu về những luật lệ liên quan đến vấn đề quản lý nước như là cách phân phối nước, giá nước, lượng nước được phân phối, các hành động tập thể và sự phối hợp làm việc. Các câu này dựa theo các tài liệu nghiên cứu và là những ý kiến mà thôi. Trong đó hiển nhiên không có đúng hay sai. Chúng tôi chỉ muốn biết quan điểm của quí vị về những câu này. Xin cho biết quí vị đồng ý hay không đồng ý theo thang điểm như sau: 0 điểm = Cực lực bác bỏ ý kiến đó và điểm tăng dần lên đến 10 = Hoàn toàn tán thành ý kiến đó)

A. Những qui định liên quan các vấn đề quản lý nước

[0 = Cực lực bác bỏ ý kiến đó; 5 = trung lập; 10 = Hoàn toàn tán thành ý kiến đó]

1. Các qui định này định nghĩa rõ ràng những quyền sử dụng nước và những giới hạn của nó	0	1	2	3	4	5	6	7	8	9	10
2. Tôi cảm thấy rằng nước được chia sẻ một cách công bằng giữa những người tiêu thụ trong kế hoạch	0	1	2	3	4	5	6	7	8	9	10
3. Tôi cảm thấy yên tâm với kế hoạch phân phối nước hiện tại	0	1	2	3	4	5	6	7	8	9	10
4. Cơ sở phân phối nước là công bằng	0	1	2	3	4	5	6	7	8	9	10
5. Cách tính tiền nước là hợp lý	0	1	2	3	4	5	6	7	8	9	10
6. Theo thời gian, tất cả những người tiêu thụ nước (kể cả giới tiêu thụ qua trung gian) đều đóng góp trong việc tu chỉnh các luật lệ liên quan đến việc sử dụng nước	0	1	2	3	4	5	6	7	8	9	10
7. Sự xung đột giữa người dùng và các thành viên trong ủy ban quản trị (công ty cấp nước) là bình thường	0	1	2	3	4	5	6	7	8	9	10
8. Sự xung đột giữa những người tiêu thụ nước là bình thường	0	1	2	3	4	5	6	7	8	9	10
9. Các cơ chế giải quyết xung đột rõ ràng	0	1	2	3	4	5	6	7	8	9	10
10. Sự trừng phạt những người vi phạm tùy thuộc mức độ nghiêm trọng và nội dung của sự vi phạm đó.	0	1	2	3	4	5	6	7	8	9	10
11. Tôi tin rằng luật lệ bắt buộc phải thi hành theo những hình thức đã được đặt ra	0	1	2	3	4	5	6	7	8	9	10
12. Tôi nghĩ rằng hệ thống bảo trì hiện tại có hiệu quả	0	1	2	3	4	5	6	7	8	9	10
13. Tôi hài lòng với những dịch vụ hiện tại do các người cung cấp nước đưa ra	0	1	2	3	4	5	6	7	8	9	10

B. Các hành động tập thể và sự phối hợp làm việc

[0 = Cực lực bác bỏ ý kiến đó; 5 = trung lập; 10 = Hoàn toàn tán thành ý kiến đó]

1.Phần lớn lợi tức của tôi thu nhập từ các canh tác lệ thuộc vào nước tưới	0	1	2	3	4	5	6	7	8	9	10
2. Tôi hoàn toàn tin tưởng việc sử dụng nước của các nông gia láng giềng với tôi	0	1	2	3	4	5	6	7	8	9	10
3. Hầu hết những người trong cộng đồng đều sẵn lòng giúp đỡ nhau khi cần thiết	0	1	2	3	4	5	6	7	8	9	10
4. Trong vòng 5 năm vừa qua, cộng đồng này phát triển thịnh vượng	0	1	2	3	4	5	6	7	8	9	10
5. Tôi cảm thấy cộng đồng này chấp nhận tôi là một thành viên của họ	0	1	2	3	4	5	6	7	8	9	10
6. Trong quá khứ, tôi đã từng làm việc với người khác để mang lại lợi ích cho cộng đồng	0	1	2	3	4	5	6	7	8	9	10
7. Hầu hết những người không tham gia sinh hoạt cộng đồng bị chỉ trích	0	1	2	3	4	5	6	7	8	9	10
8. Mọi người trong cộng đồng đều có sự đóng góp công bằng vào các sinh hoạt cộng đồng	0	1	2	3	4	5	6	7	8	9	10
9. Mọi người trong cộng đồng sẽ hợp tác với nhau khi việc cung cấp nước bị trở ngại	0	1	2	3	4	5	6	7	8	9	10
10. Nước trong khu vực này sẽ bị chi phối bởi vài người	0	1	2	3	4	5	6	7	8	9	10
11. Nông gia có đất càng lớn thì càng có nhiều ảnh hưởng	0	1	2	3	4	5	6	7	8	9	10

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PHẦN 4 – Sự am tường những trở ngại, hiểu biết về kế hoạch và mức độ tin tưởng vào giới chức có quyền hành

Phần này gồm có một số các câu hỏi liên quan đến sự am tường các trở ngại, hiểu biết về kế hoạch và mức độ tin tưởng vào giới chức có quyền hành. Xin ghi mã số các câu trả lời của quí vị vào ô vuông đi kèm.

1 Quí vị có nghĩ rằng kế hoạch có thể bị trở ngại gì không? ☐
(Có = 1: Không = 2; Trung lập = 3)

2 Nếu có, thì theo quí vị:

(a) Trở ngại đó là gì? ☐
(Nguồn nước ngầm bị nhiễm bẩn = 1; Nguy hại đến sức khỏe = 2; Làm hư hại tầng địa chất ngậm nước = 3; Các tai nạn = 4; Làm hư hại đất = 5)

(b) Xác suất xảy ra của các trở ngại này như thế nào? ☐
(Xác suất không xảy ra rất cao = 1; Xác suất xảy ra rất cao = 2; Chắc chắn xảy ra = 3; Trung lập = 4)

(c) Theo quí vị nghĩ, ai sẽ là thành phần bị ảnh hưởng nhiều nhất vì các trở ngại đó? ☐
(Quí vị và gia đình của quí vị = 1: Môi sinh = 2; Các công ty xử lý nước = 3; Không ai bị ảnh hưởng hết = 4; Không có ý kiến = 5)

(d) Theo như quí vị nghĩ, mức độ nghiêm trọng của các trở ngại này như thế nào? ☐
(Không nghiêm trọng chút nào hết = 1; Cực kỳ nghiêm trọng = 2; Nghiêm trọng = 3; Trung lập = 4)

3 Theo như quí vị nghĩ, mức độ các cơ quan sau nay kiểm soát việc ngăn ngừa các trở ngại đó xảy ra như thế nào?
(Không kiểm soát gì hết = 1; Mức độ kiểm soát cao = 2; Kiểm soát ở một mức độ nào đó = 3; Trung lập = 4)

(a) Các cơ quan chính quyền ☐

(b) Các công ty điều hành hoặc xử lý nước ☐

4 Xin cho biết mức am tường của quí vị về những việc sau đây:
(Không biết gì hết = 1; Biết rất hạn chế = 2; biết chút ít = 3; Biết nhiều = 4; Biết rất đầy đủ = 5)

(a) Việc xử lý nước thải ☐

(b) Việc sử dụng / Ứng dụng nước đã xử lý ☐

5 Theo như quí vị nghĩ kiến thức của các chuyên gia về xử lý nước thải cũng như cách sử dụng nước này trong việc canh tác như thế nào?
(Không biết gì hết = 1; Biết rất ít = 2; Biết ít = 3; Biết nhiều = 4; Biết rất đầy đủ = 5)

6 Nguồn thông tin chính về việc tái sử dụng nước từ đâu? ☐
(Qua các phương tiện truyền thông = 1; Internet = 2; Báo chí = 3; Radio = 4; Chính quyền = 5; Các cuộc triển lãm = 6; Các công ty nước = 7)

7 Thông thường bao lâu thì quí vị nhận được các thông tin về việc tái sử dụng nước? ☐
(Hàng ngày = 1; Hàng tuần = 2; Hàng nửa tháng = 3; Hàng tháng = 4; Nửa năm = 5; Hàng năm = 6)

8 Mức độ tin tưởng của quí vị đối với những cơ quan sau đây khi họ thi hành trách nhiệm của họ?
(Không tin tưởng chút nào hết = 1; Tin tưởng hoàn toàn = 2; Tin tưởng với một mức độ nào đó = 3; Trung lập = 4)

(a) Các cơ quan của chính quyền ☐

(b) Công ty xử lý nước/ Công ty điều hành đường ống ☐

(c) Cơ Quan Bảo Vệ Môi Sinh [Environment Protection Agency (EPA)] ☐

(d) Phòng An sinh xã hội ☐

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PHẦN 5 – Thái độ, sự am tường và sẵn sàng trả tiền cho việc sử dụng

Phần này gồm có các câu đo lường mức độ về ý định, thái độ, ý kiến cá nhân và sự hiểu biết về kiểm soát hành vi dựa theo các tài liệu về Lý Thuyết về Các Hành Vi Được Trù Định Trước (Theory of Planned Behaviour). Đây chỉ là ý kiến mà thôi, chúng tôi muốn biết quan điểm của quí vị về những câu này.

A. Ý định tham gia kế hoạch

Xin cho biết mức độ quí vị đồng ý hay không đồng ý với những gợi ý theo thang điểm như sau: 0 điểm = Cực lực bác bỏ ý kiến đó và điểm tăng dần lên đến 10 = Hoàn toàn tán thành ý kiến đó.

[0 = Cực lực bác bỏ ý kiến đó; 5 = trung lập; 10 = Hoàn toàn tán thành ý kiến đó]

① Tôi trông đợi để tiếp tục thực hiện kế hoạch trong tương lai	0	1	2	3	4	5	6	7	8	9	10
② Tôi có ý định để tiếp tục thực hiện kế hoạch trong tương lai	0	1	2	3	4	5	6	7	8	9	10
③ Tôi sẽ cố gắng để tiếp tục thực hiện kế hoạch trong tương lai	0	1	2	3	4	5	6	7	8	9	10
④ Tôiquyết định tiếp tục thực hiện kế hoạch trong tương lai	0	1	2	3	4	5	6	7	8	9	10
⑤ Tôi có thể không tiếp tục thực hiện kế hoạch trong tương lai	0	1	2	3	4	5	6	7	8	9	10

B. Thái độ về việc tham gia kế hoạch

1. Sự tham gia của quí vị vào kế hoạch nước đã được xử lý dưới hình thức của (Người tiêu thụ nước = 1; Người có cổ phần = 2; Chủ nhân = 3; Cả hai trường hợp (1 & 2) = 4; Ba trường hợp (1, 2 & 3) = 5) [ ]

2. Căn cứ vào sự tham gia của quí vị vào kế hoạch, xin cho biết ý kiến của quí vị bằng cách khoanh vòng con số trong thang điểm tính theo sự tương phản về ý nghĩa của câu văn. Nếu quí vị khoanh vòng số 5, nó có ý nghĩ là quí vị chọn ý trung lập

Việc tham gia vào kế hoạch nước đã được xử lý

Không có giá trị	1	2	3	4	5	6	7	8	9	Có ích
Có hại (cho tôi)	1	2	3	4	5	6	7	8	9	Mang lại lợi ích (cho tôi)
Có hại (cho môi trường)	1	2	3	4	5	6	7	8	9	Mang lại lợi ích (cho môi trường)

C. Ý kiến bản thân

Xin cho biết mức độ quí vị đồng ý hay không đồng ý với những gợi ý theo thang điểm như sau: 0 điểm = Cực lực bác bỏ ý kiến đó và điểm tăng dần lên đến 10 = Hoàn toàn tán thành ý kiến đó.

[0 = Cực lực bác bỏ ý kiến đó; 5 = trung lập; 10 = Hoàn toàn tán thành ý kiến đó]

1. Hầu hết những người tôi cho là quan trọng đều nghĩ rằng tôi nên tiếp tục thực hiện vào kế hoạch	0	1	2	3	4	5	6	7	8	9	10
2. Hầu hết những người tôi cho là quan trọng sẽ không vui nếu tôi không tiếp tục tham gia vào kế hoạch	0	1	2	3	4	5	6	7	8	9	10
3. Tôi cảm thấy bị áp lực xã hội phải tham gia vào kế hoạch	0	1	2	3	4	5	6	7	8	9	10
4. Mọi người trông đợi tôi tiếp tục liên hệ với kế hoạch	0	1	2	3	4	5	6	7	8	9	10

D. Am tường về kiểm soát hành vi

Xin cho biết mức độ quí vị đồng ý hay không đồng ý với những gợi ý theo thang điểm như sau: 0 điểm = Cực lực bác bỏ ý kiến đó và điểm tăng dần lên đến 10 = Hoàn toàn tán thành ý kiến đó.

[0 = Cực lực bác bỏ ý kiến đó; 5 = trung lập; 10 = Hoàn toàn tán thành ý kiến đó]

① Tôi tự tin rằng tôi có thể tiếp tục tham gia kế hoạch nếu tôi muốn	0	1	2	3	4	5	6	7	8	9	10
② Tôi có thể vượt qua mọi trở ngại hay những khó khăn ngăn cản tôi tiếp tục tham gia vào kế hoạch	0	1	2	3	4	5	6	7	8	9	10
3. Việc tôi có tham gia vào kế hoạch hay không là do ý của tôi	0	1	2	3	4	5	6	7	8	9	10
4. Việc quyết định tiếp tục tham gia vào kế hoạch thì ngoài sự kiểm soát của tôi	0	1	2	3	4	5	6	7	8	9	10
5. Đối với tôi, việc quyết định tiếp tục tham gia vào kế hoạch rất dễ dàng	0	1	2	3	4	5	6	7	8	9	10

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E. Ý định sẵn sàng trả tiền cho việc dùng nước đã được xử lý

Những câu hỏi sau đây được đặt ra để gợi ra ý định sẵn sàng trả tiền cho việc dùng nước đã được xử lý của quí vị dưới hình thức những giả thiết khác nhau. Xin đánh dấu vào ô nào mà quí vị cảm thấy thích đáng nhất.

a. Giả sử cả hai nguồn nước sạch (FW) và nước tái sử dụng (RW) đều có sẵn, quí vị sẽ dùng như thế nào?

1. Nước tái sử dụng (RW) nếu giá nước tái sử dụng rẻ hơn 15 cents so vơi nước sạch ☐
2. Nước tái sử dụng (RW) nếu giá nước tái sử dụng rẻ hơn 30 cents so vơi nước sạch ☐
3. Nước tái sử dụng (RW) nếu giá nước tái sử dụng rẻ hơn 50 cents so vơi nước sạch ☐
4. Nước tái sử dụng (RW) nếu giá nước tái sử dụng rẻ hơn 70 cents so vơi nước sạch ☐
5. Nước tái sử dụng (RW) nếu giá nước tái sử dụng rẻ hơn 1$ so vơi nước sạch ☐
6. Nước tái sử dụng (RW) ngay cả khi bằng giá nươc sạch ☐
7. Nước sạch ngay cả khi nước tái sử dụng miễn phí ☐

b. Biết rằng nước tái sử dụng có chứa các chất dinh dưỡng, trong những trường hợp sau đây, quí vị có muốn dùng nước này hay là dùng nước sạch?

1. Chỉ khi nào tôi tiết kiệm được 50% loại phân bón sử dụng cho diện tích canh tác ☐
2. Chỉ khi nào tôi tiết kiệm được 30% loại phân bón sử dụng cho diện tích canh tác ☐
3. Chỉ khi nào tôi tiết kiệm được 15% loại phân bón sử dụng cho diện tích canh tác ☐
4. Lúc nào tôi cũng dùng, dù rằng sẽ không tiết kiệm được gì hết ☐
5. Không bao giờ dùng ☐

c. Quí vị có muốn dùng nước đã xử lý cho diện tích đất đang sử dụng không?

1. Không ☐
2. Có thể ☐
3. Rất có thể ☐
4. Chắc chắn ☐

d. Trong tương lai, quí vị có tiếp tục dùng nước đã xử lý để tưới cho hoa màu của quí vị không?

1. Không dùng ☐
2. Có thể ☐
3. Rất có thể ☐
4. Chắc chắn ☐

PHẦN 5 – Sơ lược về người trả lời câu hỏi

a. Nhóm tuổi, xin đánh dấu (✓) vào ô thích hợp

1.	18 – 24	
2.	25 – 34	
3.	35 – 44	
4.	45 – 54	
5.	55 – 64	
6.	65+	

b. Trình độ văn hóa, xin đánh dấu (✓) vào ô thích hợp

1.	Dưới bậc tiểu học	
2.	Tiểu học	
3.	Trung học	
4.	Cao hơn trung học	
5.	Giáo dục bổ túc (Trung Tâm Huấn Nghệ, Cán Sự, v.v…)	
6.	Tốt nghiệp đại học	

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c. Số người trong gia đình? _____

d. Giới tính, xin đánh dấu (✓) 1. Nam ☐ 2. Nữ ☐

e. Thống kê chi tiết đất

Đất đai (hecta)	Làm chủ			Đi thuê			Cho thuê		
	Tổng cộng	Đất tưới nước	Đất khô	Tổng cộng	Đất tưới nước	Đất khô	Tổng cộng	Đất tưới nước	Đất khô

f. Phần trăm thu nhập từ hoạt động nông nghiệp của các người trong hộ khẩu là bao nhiêu? _____%

g. Diện tích đất canh tác các loại hoa màu chính

Loại hoa màu	Diện tích (ha)
a.	
b.	
c.	
d.	
e.	
f.	

Xin cám ơn quí vị đã bỏ thì giờ, hợp tác và tích cực hỗ trợ cho cuộc nghiên cứu này.

Appendix 6: Virginia pipeline scheme letter of information (Vietnamese)

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THƯ THÔNG BÁO

Kính gởi quí vị đã hồi đáp cho chúng tôi,

Cuộc thăm dò ý kiến này là một phần trong chương trình nghiên cứu của Ganesh B. Keremane cho học vị Tiến Sĩ của ông, mang tên: "Thành tích của thị trường nước thải đã được xử lý của tư nhân tại Nam Úc: Bản Phân tích không nhằm mục đích thương mại" (*Performance of Private Reclaimed Wastewater Markets in South Australia: An Institutional Analysis).*

Cuộc thăm dò ý kiến nhằm mục đích khảo sát những bố trí không mang tính chất thương mại, chi phối việc quản lý nước thải đã được xử lý của hai kế hoạch dẫn nước dùng cho việc canh tác, do tư nhân điều hành tại Nam Úc. Hai chương trình đó là: (1) Kế hoạch Đường Ống Dẫn Nước Virginia, và (2) Kế Hoạch Đường Ống Dẫn Nước Willunga Basin.

Cuộc phỏng vấn sẽ kéo dài không quá 40 phút, bao gồm luôn các câu hỏi liên quan đến những kinh nghiệm của quí vị về các kế hoạch kể trên, cũng như sự hiểu biết của quí vị về việc sử dụng nước đã được xử lý dùng cho việc canh tác và sự sẵn sàng trả tiền cho việc sử dụng tài nguyên quí giá này.

Thêm vào đó, chúng tôi cũng xin được thông báo rằng:

- Việc tham gia vào cuộc nghiên cứu này là tự nguyện.
- Tham dự viên có thể từ chối trả lời bất kỳ câu hỏi nào được đặt ra và trong suốt cuộc phỏng vấn, đương sự được tự do rút lui bất cứ lúc nào mình muốn.
- Tất cả những thảo luận và báo cáo đều được bảo mật để không một cá nhân nào có thể bị nhận diện.

Nếu có những thắc mắc liên quan đến cuộc nghiên cứu này, xin quí vị liên lạc với Ganesh B. Keremane, số điện thoại 8302 0148 hoặc ganesh.keremane@unisa.edu.au, hay với Giáo Sư Jennifer McKay, số điện thoại 8302 0887 hoặc Jennifer.McKay@unisa.edu.au ở *School of Commerce, Centre for Comparative Water Policies and Laws, University of South Australia.*

Trong trường hợp nếu có những vấn đề liên quan đến nguyên tắc về đạo lý nghề nghiệp, xin quí vị liên lạc với bà Vicki Allen, Nhân viên điều hành, *University of South Australia Human Research Ethics Committee (HREC),* số điện thoại 8302 3118 hoặc Vicki.allen@unisa.edu.au

Xin cám ơn quí vị,

Ganesh B. Keremane_____ Giáo sư Jennifer McKay _____

Ngày _____ Ngày _____

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Adelaide SA 5000
Australia

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Adelaide SA 5001
Australia

Telephone: 8302 0148
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Appendix 7: Virginia pipeline scheme consent form (Vietnamese)

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Giấy Đồng Ý Tham Gia Cuộc Nghiên Cứu

Tôi, ... đồng ý tham gia theo như sự yêu cầu trong Bản Thông Tin về cuộc nghiên cứu mang tựa đề "Thành tích của thị trường nước thải đã được xử lý của tư nhân tại Nam Úc: Bản Phân tích không nhằm mục đích thương mại" (*Performance of Private Reclaimed Wastewater Markets in South Australia: An Institutional Analysis).*

1. Tôi đã đọc các thông tin mà tôi được cung cấp.
2. Tôi đã được giải thích thỏa đáng các chi tiết về cách làm việc và những bất trắc của cuộc nghiên cứu.
3. Tôi hiểu rằng:
    - Tôi có thể không được thụ hưởng trực tiếp các lợi lộc gì khi tham gia trong cuộc nghiên cứu này
    - Tôi được tự do rút lui khỏi cuộc nghiên cứu ở bất cứ giai đoạn nào và tôi có quyền tự do từ chối không trả lời một vài câu hỏi đặc biệt nào đó trong cuộc nghiên cứu.
    - Khi các dữ kiện thu thập trong cuộc nghiên cứu được phổ biến, như đã giải thích, tôi sẽ không bị nhận diện, trừ trường hợp tôi cho phép, và toán nghiên cứu (Ganesh B. Keremane và Giáo Sư Jennifer McKay) bảo đảm rằng các chi tiết liên quan đến cá nhân đều được bảo mật.
    - Tôi có quyền nhận được một phó bản của bản báo cáo về cuộc nghiên cứu này, nếu tôi muốn.

Chữ ký của người tham gia vào cuộc nghiên cứu: .....

Ngày: .....

Tôi xác nhận rằng tôi đã giải thích cho người tình nguyện tham gia vào cuộc nghiên cứu và nhận xét rằng người này hiểu được cuộc nghiên cứu liên quan đến đề tài gì và đương sự tự nguyện đồng ý tham gia.

Tên của nghiên cứu sinh: .....

Chữ ký của nghiên cứu sinh: .....

Ngày: .....

Appendix 8: Virginia pipeline scheme survey questionnaire (Khmer)

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លោកអ្នកបានជ្រើសរើសដោយចៃដន្យ ដើម្បីចូលរួមក្នុងការស្ទង់មតិនេះ ដែលមានគោលបំណងដើម្បីប្រមូលព័ត៌មានអំពីទស្សនៈរបស់លោកអ្នកចំពោះគម្រោងមួយ ដែលអាចផ្តល់ជូនប្រជាជនក្នុងតំបន់នេះ នូវប្រភពទឹកបន្ថែមសម្រាប់ប្រើប្រាស់ក្នុងផ្ទះ។ ការចូលរួមរបស់លោកអ្នកគឺមានសារៈសំខាន់ណាស់ ដើម្បីឱ្យយើងអាចធ្វើការសម្រេចចិត្តបានត្រឹមត្រូវ។ ការសម្ភាសន៍នេះនឹងចំណាយពេលប្រហែលជា ២០នាទី ហើយចម្លើយរបស់លោកអ្នកនឹងត្រូវបានរក្សាទុកជាការសម្ងាត់។ សូមអរគុណចំពោះការចូលរួមរបស់លោកអ្នកក្នុងការស្ទង់មតិនេះ។

ស្ថិតិនេះមានបំណងដើម្បីសិក្សាអំពីការគ្រប់គ្រងនិងចែកចាយទឹក ហើយនិងការប្រើប្រាស់ ជាឯកជននៃស្គីម (scheme) ទឹកសំណល់ (reclaimed wastewater)នៅអូស្ត្រាលីរួមខាងលិច។ ការសំភាស៍មានរយៈពេលចំនួនសែសិបនាទី ហើយចំណើរបស់លោកអ្នកនឹងត្រូវបានរក្សាទុកជាសំងាត់។

សូមអរគុណចំពោះការចូលរួមនិងការសិក្សាស្រាវជ្រាវនេះ។

លេខរបស់អ្នកឆ្លើយតប: _____ **ស្គីម (scheme):**_____

ផ្នែកទី 1 ពត៌មានទូទៅ

1. ប្រទេសកំណើតរបស់អ្នក? _____

2. តើអ្នករស់នៅទីតាំងនេះបានប៉ុន្មានឆ្នាំហើយ? _____ ឆ្នាំ

3. ប្រភពទឹកសម្រាប់ប្រើប្រាស់ក្នុងផ្ទះរបស់អ្នកមានអ្វីខ្លះ? សូមធីក√ ចំគ្រប់ចម្លើយដែលអ្នកជ្រើសរើស

(a) ទឹកក្រោមដី ☐ (b) ទឹកសំណល់ ☐ (c) ទាំងពីរកន្លែង ☐ (d) c + a ☐ (e) c + b ☐

4. ចុះអ្នកប្រាប់ពីសមាមាត្រ ប្រភពទឹកសម្រាប់ប្រើប្រាស់ក្នុងផ្ទះរបស់អ្នក

(a) ទឹកស្អាត _____% (b) ទឹកក្រោមដី _____% (c) ទឹកសំណល់ _____%

ផ្នែក 2 ពត៌មានអំពីស្គីមទឹកសំណល់

ផ្នែកនេះមានគោលបំណងដើម្បីសិក្សាអំពីចំណាប់អារម្មណ៍របស់អ្នកចំពោះស្គីមទឹកសំណល់ ដែលអាចផ្តល់ជូនប្រជាជនក្នុងតំបន់នេះ។ ស្គីមនេះមានន័យថាទឹកសំណល់ដែលត្រូវបានប្រើប្រាស់ក្នុងផ្ទះ ត្រូវបានប្រមូលផ្តុំ ហើយត្រូវបានបញ្ជូនទៅកាន់រោងចក្រកែច្នៃ ដើម្បីធ្វើឱ្យវាមានសុវត្ថិភាពសម្រាប់ការប្រើប្រាស់ក្នុងផ្ទះ។ ទឹកដែលបានកែច្នៃនឹងត្រូវបានបញ្ជូនទៅកាន់ផ្ទះរបស់អ្នក តាមរយៈបំពង់ដាច់ដោយឡែក។ ទឹកនឹងត្រូវបានប្រើប្រាស់សម្រាប់ការបង្ហូរទឹកបង្គន់ ការបោកខោអាវ និងការស្រោចស្រពសួនច្បារ។ ទឹកនឹងមិនត្រូវបានប្រើប្រាស់សម្រាប់ការងូតទឹក ការចម្អិនអាហារ ឬការផឹកឡើយ។ សូមចុះលេខកូដនៅក្នុងប្រអប់ដែលបានផ្តល់ជូន។

1. តើអ្នកបានឮពីស្គីមនេះពីពេលណាមក ?
(មុនពេលការបង្កើតស្គីមនេះ=1 ក្នុងអំឡុងពេលបង្កើតស្គីមនេះ=2 ក្រោយពេលការបង្កើតស្គីមនេះ=3) ☐

2. តើចំណុចអ្នកមានចំណាប់អារម្មណ៍យ៉ាងណាពេលពីឮលើគំនិតស្គីមនេះ?
(ឃល់ស្រប =1 ប្រឆាំង=2 មិនចាប់អារម្មណ៍=3) ☐

3 តើអ្នកធ្លាប់មានការយល់ដឹងអំពីទឹកសំណល់មុនមានការបង្កើតស្គីមនេះឡើងទេ?
(មិនដែលឮ =1 ធ្លាប់ឮ=2 មានការយល់ដឹងច្រើន=3) ☐

3.1 បើសិនជាអ្នកធ្លាប់បានដឹង ចូរបញ្ជាក់ពីប្រភពព័ត៌មាន?
(រាជរដ្ឋាភិបាល=1 អង្គការឯកជន=2 សហគមន៍=3 បទពិសោធន៍ផ្ទាល់ខ្លួន=4) ☐

4. តាមយោបល់របស់អ្នក តើមូលហេតុចំបងនៃការដែលនាំឱ្យមានការសាងសង់ស្គីមនេះឡើង?
(មានការបញ្ចេញទឹកក្រោមដី=1 គំលៃទឹកស្អាតមានតំឡៃខ្ពស់=2 មានបទពិសោធន៍ប្រើប្រាស់ទឹកសំណល់ពីមុនមក=3 ការលើកទឹកចិត្តពីរាជរដ្ឋាភិបាលទឹក=4 ការិយាល័យចម្រុះចិត្តប្រើ=5) ☐

5. តើឥឡូវអ្នកមានចំណាប់អារម្មណ៍ដែរឬទេអំពីស្គីមនេះ?
(ឃល់ស្រប=1 ប្រឆាំង=2 មិនចាប់អារម្មណ៍=3) ☐

6. តើអ្នកណាជាអ្នកគ្រប់គ្រងចំបងលើស្គីមពេលចាប់ផ្តើមដំបូង?
(រដ្ឋាភិបាលថេរ =1 រដ្ឋាភិបាលស្តេត =2 សហគមន៍ =3 ក្រុមហ៊ុនឯកជន =4 គ្មានយោបល់ =5) ☐

7. តើឥឡូវអ្នកណាជាអ្នកគ្រប់គ្រងចំបងលើស្គីមនេះ?
(រដ្ឋាភិបាលថេរ=1 រដ្ឋាភិបាលស្តេត =2 សហគមន៍ =3 ក្រុមហ៊ុនឯកជន =4 គ្មានយោបល់ =5) ☐

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8. តោមយោបល់របស់អ្នក តើអ្នកណាគួរជាអ្នកមានសិទ្ធិចេញច្បាប់គ្រប់គ្រងលើស្តីមនេះ?
(រដ្ឋាភិបាលថ្នេរកាល់ =1 រដ្ឋាភិបាលស្រុក =2 សហគមន៍ =3 ក្រុមហ៊ុនឯកជន =4 គ្មានយោបល់ =5)

9 តើអ្នកណាជាអ្នកមានសិទ្ធិចេញច្បាប់ក្នុងការចែកចាយទឹក?
(រដ្ឋាភិបាលថ្នេរកាល់ =1 រដ្ឋាភិបាលស្រុក =2 សហគមន៍ =3 ក្រុមហ៊ុនឯកជន =4 គ្មានយោបល់ =5)

10 តើអ្វីដែលជាគោលការណ៍ក្នុងការចែកចាយទឹក?
(ទំហំដី =1 សេចក្តីត្រូវការផ្គាល់ខ្លួន =2 ចំនួនអ្នកប្រើប្រាស់ទឹក =3 គ្មានយោបល់ =4)

11 តើអ្នកណាជាអ្នកមានសិទ្ធិក្នុងការកាប់រឹតតំលៃទឹក?
(រដ្ឋាភិបាលថ្នេរកាល់ =1 រដ្ឋាភិបាលស្រុក =2 សហគមន៍ =3 ក្រុមហ៊ុនឯកជន =4 គ្មានយោបល់ =5)

12. តោមយោបល់របស់អ្នក តំលៃទឹកគួរមានអ្វីខ្លះ?
(តំលៃថ្លៃសុទ្ធ =1 តំលៃទឹក =2 តំលៃថែទាំ =3 ១និង២=4 ទាំងអស់១,២និង៣ =5)

13. តើអ្វីដែលជាគោលការណ៍បង់ថ្លៃទឹក?
(ពេលវេលា =1 ចំណុះប្រើ =2 ថ្លៃដី=3 ថ្លៃដីតាំងណាំ=4 គ្មានយោបល់=5 គ្មានយោបល់ =6)

14. តើអ្នកណាជាអ្នកទទួលខុសត្រូវលើការប្រើប្រាស់និងថែទាំបំពង់ទឹក?
(រដ្ឋាភិបាលថ្នេរកាល់ =1 រដ្ឋាភិបាលស្រុក =2 សហគមន៍ =3 ក្រុមហ៊ុនឯកជន =4 គ្មានយោបល់ =5)

ផ្នែកទី 3 ការនិងលើអំពីក្រិត្យក្រមនៃការចាត់ចែងទឹកសំណល់ហើយនិងការមួមចំនែក

ផ្នែកនេះមានសំណើមួយចំនួនអំពីក្រិត្យក្រមរួនៃការគ្រប់គ្រងពីបញ្ហាចាត់ចែងទឹកទ្វេចជាការចែកចាយទឹក តំលៃទឹក ការផ្គត់ផ្គង់ទឹក
និងសកម្មភាពមួមនិងការមួមចំណែកក្នុងការប្រើប្រាស់ស្តីមៗ.សំណើទាំងឡាយយោលទៅតាមការនិពន្ធ័ស្រាវជ្រាវ
ហើយនេះគ្រាន់តែជាយោបល់មួយបណ្តោះ។វាមិនមានចំលើយខុសឬត្រូវទេ។យើងចង់ដឹងពីទស្សនៈរបស់អ្នកអំពីសំណើទាំងនេ។
សូមវាយតំលៃនៃការយល់ស្រលើប្រធាំងនៅតាមកុំរិតដែលមានកុំរិតចាប់ពីបអល់១០ ០មានន័យថាខ្ញុំមិនយល់ទាំស្រុង ១០មានន័យថាយល់ស្រលទាំងស្រុង

a ក្រិត្យក្រមលើបញ្ហាគ្រប់គ្រងទឹក

0=ខ្ញុំមិនយល់ទាំងស្រុង 5=ធម្មតា 10=យល់ស្រលទាំងស្រុង

1. ក្រឹត្យក្រមពីការបញ្ចាំក្បាលំលាស់នៃសិទ្ធិប្រើប្រាស់ទឹកនិងលក័ខណ	0	1	2	3	4	5	6	7	8	9	10
2. ខ្ញុំយល់ថាទឹកគួរតែចែកចាយអោយបានស្មើភាពជារវាងអ្នកប្រើ	0	1	2	3	4	5	6	7	8	9	10
3. ខ្ញុំពេញចិត្តនិងការបែងចែកទឹកសព្វថ្ងៃ	0	1	2	3	4	5	6	7	8	9	10
4. ការចែកចាយទឹកក្នុងចំនោមអ្នកប្រើសព្វថ្ងៃមានលក្ខណៈស្មើភាពគ្នា	0	1	2	3	4	5	6	7	8	9	10
5. គោលការបង់ថ្លៃទឹកមានលក្ខណៈសមរម្យនិងពីមគ្រូវ	0	1	2	3	4	5	6	7	8	9	10
6. អ្នកប្រើប្រាស់ទាំងអស់(រួមជាមួយអ្នកក្រៅទៀត) ចន្លួមចំណែកពីមួយថ្ងៃទៅមួយថ្ងៃក្នុងការកែសំលួលក្រិត្យក្រមនៃការប្រើប្រាស់ទឹក	0	1	2	3	4	5	6	7	8	9	10
7. ទំនាស់រវាងសមាជិកអ្នកប្រើនិងអ្នកគ្រប់គ្រង(កុមហ៊ុនទឹក)តែងមានជាធម្មតា	0	1	2	3	4	5	6	7	8	9	10
8. ទំនាស់រវាងអ្នកប្រើតែងមានជាធម្មតា	0	1	2	3	4	5	6	7	8	9	10
9. ការដោះស្រាយទំនាស់មានភាពល្បាស់លាស់	0	1	2	3	4	5	6	7	8	9	10
10. ចិន័យលើជនល្មើសប្រែប្រួលទៅតាមកិរិតនៃកំហុសដែលបានប្រព្រឹត្ត	0	1	2	3	4	5	6	7	8	9	10
11. ខ្ញុំជឿថាក្រិត្យក្រមបានត្រូវប្រើប្រាស់ទូទៅដែលបានចែងឡើង	0	1	2	3	4	5	6	7	8	9	10
12. ខ្ញុំយល់ថាបណ្តាញថែរក្សានិងជួសជុលសព្វថ្ងៃមានភាពល្អប្រសើរ	0	1	2	3	4	5	6	7	8	9	10
13. ខ្ញុំពេញចិត្តលើសេវាផ្គត់ផ្គង់ទឹកសព្វថ្ងៃ	0	1	2	3	4	5	6	7	8	9	10

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b. សកម្មភាពចូលរួមនិងការរួមចំណែក

0=ចំខាស់ទាំស្រុង 5=ធម្មតា 10=ឃល់ស្របទាំងស្រុង

1. មួយផ្នែកធំនៃប្រាក់ចំណូលប្រែប្រួលតាមសកម្មភាពប្រើទឹកស្រោចចំណាំ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2. ខ្ញុំទុកចិត្តទាំងស្រុងលើអ្នកចំការជិតខាងចំពោះការប្រើប្រាស់ទឹក	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3. មនុស្សភាគច្រើនក្នុងសហគមន៍មានសមាជិកចិត្តចង់ជួយបើសិនត្រូវការ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
4. សហគមន៍នេះកកើតឡើងយ៉ាងតិច៥ឆ្នាំមកហើយ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
5. ខ្ញុំគិតថាគ្រូវបានគេទទួលស្គាល់ថាជាសមាជិកមួយរូបនៃសហគមន៍នេះ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
6. ខ្ញុំធ្លាប់បានធ្វើការជាមួយអ្នកដទៃទៀតពីមុនមកសំរាប់ផលប្រយោជន៏រួមរបស់ សហគមន៍	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
7. ភាគច្រើនអ្នកដែលមិនចូលរួមចំណែកក្នុងសកម្មភាពសហគមន៍គឺជាអ្នកក្រីក្រខំ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
8. ម្ចាស់ៗក្នុងសហគមន៍ចូលរួមចំណែកស្មើភាពគ្នាលើសកម្មភាពរួម	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
9. អ្នកនៅក្នុងសហគមន៍នឹងសហការណ៏គ្នានៅពេលការផ្គត់ផ្គង់ទឹកមានបញ្ហា	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10. ទឹកនៅតំបន់នេះនឹងមិនក្នុងការគ្រប់គ្រងរបស់ក្រុមមួយចំនួនតូច	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11. អ្នកមានចំការតិចនៅទីនេះមានឥទ្ធិពលដាងគេ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

ផ្នែកទី 4 ការឃល់ចឹងលើបញ្ហា ចំណេះដឹងរំពីស្តីម និងការដើទុកចិត្តលើរាជ្ជាឆរទាំងឡាយ

1. តើអ្នកគិតថានៅថ្ងៃណាមួយការប្រើប្រាស់ស្តីមនេះអាចនឹងបង្កើតបញ្ហាទេ ?
(អាច =1 មិនអាចទេ =2 គ្មានយោបល់ =3) ☐

2. បើសិនជាអាច

(a) តើអាចមានបញ្ហាអ្វី? ☐
(ទឹកក្រោមដីក្រៃកំ =1 បញ្ហាសុខភាព =2 បំផ្លាញស្រទាប់ថ្ម =3 ក្រោះថ្នាក់ =4 ចាត់បង់ពុលភាពជី =5)

(b) តើវានឹងអាចកើតមានបញ្ហានេះដែរឬទេ? ☐
(មិនអាច =1 ប្រហែលជានឹងកើតឡើង =2 ប្រហែលជានឹងកើតឡើង =3 គ្មានយោបល់ =4)

(c) តើអ្នកឃល់ថាអ្នកណាជាអ្នកទទួលរងគ្រោះថ្នាក់ជាងគេ ? ☐
(អ្នកចិងច្រូសាអ្នក =1 បរិដ្ឋាន =2 ក្រុមហ៊ុនទឹក =3 គ្មានអ្នកណា =4 គ្មានយោបល់ =5)

(d) តើអ្នកឃល់ថាបញ្ហាអាចមានក្រោះថ្នាក់ឆល់ករីតណា ? ☐
(គ្មានបញ្ហាទេ =1 ទ្ធន់ទ្ធរណាស់ =2 មធ្យម =3 គ្មានយោបល់ =4)

3. តើអ្នកឃល់យ៉ាងណាចំពោះការគ្រប់គ្រងរបស់អង្គារខាងក្រោមនេះដើម្បីកុំអោយមានបញ្ហាខាងលើកើតឡើង ?
(គ្មានការគ្រួតគ្រា =1 ករីតគ្រួតគ្រាខ្ពស់ =2 ករីតគ្រួតគ្រាមធ្យម =3 គ្មានយោបល់ =4)

(a) រាជ្ជាឆរជ្ញាតិពាល ☐

(b) ក្រុមហ៊ុនផ្គត់ផ្គង់ទឹក ☐

4. ចូរបញ្ជាក់ពីការឃល់ចឹងរបស់អ្នករំពីបញ្ហារខាងក្រោម?
(មិនចឹងរីសោះ =1 កិចច្ចចណាស់ =2 បង្គិចបង្ខូច =3 ចឹងច្រើន =4 ចឹងច្រើនណាស់ =5)

(a) ការកែប្រែទឹកសំណាស់ ☐

(b) របៀបប្រើប្រាស់ទឹកសំណាស់/ការធុរវត្តន៏ ☐

5. តើអ្នកឃល់យ៉ាងណាចំពោះចំណេះដឹង(ពិតមាន)របស់អ្នកឯកទេសជំនាញរំពីការ កែប្រែនិងការប្រើប្រាស់ទឹកសំណាល់សំរាប់ស្រោចចំណាំ?
(មិនចឹងរីសោះ =1 កិចច្ចចណាស់ =2 បង្គិចបង្ខូច =3 ចឹងច្រើន =4 ចឹងច្រើនណាស =5) ☐

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6. តើអ្វីដែលជាប្រភពព័ត៌មានចំបងអំពីការប្រើប្រាស់ទឹកសំណល់នេះ?
(ទូរទស្សន៍ =1 វិទ្យុធំណាត =2 សារព័ត៌មាន =3 វិទ្យុ =4 អាជ្ញាធរបរិយាកាស =5 ឃើញអ្នកជិតខែង =6 ក្រុមហ៊ុនទឹក =7)

7. តើក្នុងរយៈរាល់ពេលប៉ុន្មានដើមទទួលបានព័ត៌មានអំពីការប្រើប្រាស់ទឹកសំណល់នេះ ?
(រាល់ថ្ងៃ =1 រាល់អាទិត្យ =2 ពីរអាទិត្យម្តង =3 រាល់ខែ =4 កន្លះឆ្នាំម្តង =5 រាល់ឆ្នាំ =6)

8. ចូរបញ្ជាក់ពីកម្រិតនៃការជឿជាក់របស់អ្នកលើការទទួលខុសត្រូវរបស់អង្គភាពខាងក្រោម?
(មិនទុកចិត្ត =1 ទុកចិត្តទាំងស្រុង =2 ទុកចិត្តខ្លះ =3 គ្មានយោបល់ =4)

(a) អាជ្ញាធរបរិយាកាស

(b) ក្រុមហ៊ុនផ្គត់ផ្គង់ទឹក/អ្នកគ្រប់គ្រងប័ណ្ឌទឹក

(c អង្គការការពារបរិយាកាស (EPA)

(d) ក្រសួងកិច្ចការបរិយាកាសនិងសុខភាព

ផ្នែកទី 5 ចំណាប់អារម្មណ៍ ការយល់ដឹង និង ការពេញចិត្តក្នុងប៉ាន់ថ្លៃ

ក្នុងផ្នែកនេះមានសំណើមួយចំនួនដែលសូមអ្នកឆ្លើយបំណងចំណាប់អារម្មណ៍មតិផ្ទាល់ខ្លួនដែលកើតមានឡើងលើទ្រឹស្តី ដែលសិល្បៈកំណាងសិក្សាបង្ហាញ។
វាគ្រាន់តែជាការសួរមតិប៉ុណ្ណោះយើងចង់ដឹងពីទស្សនៈរបស់អ្នកចំពោះសំណើទាំងនេះ។

A. ប័ណ្ឌក្នុងការមួយចំណែកក្នុងស្តីម

ចូរបញ្ជាក់ពីកម្រិតយល់ស្របរបស់អ្នកពីសូនយល់ឃើញចំពោះសំណើខាងក្រោមនេះ **0=មិនយល់ស្របទាំងស្រុង 10 យល់ស្របទាំងស្រុង។**

1. ខ្ញុំសង្ឃឹមថានឹងបន្តរប្រើស្តីមនេះទៅអនាគត	0	1	2	3	4	5	6	7	8	9	10
2. ខ្ញុំមានបំណងនឹងបន្តរប្រើស្តីមទៅអនាគត	0	1	2	3	4	5	6	7	8	9	10
3. ខ្ញុំនឹងសាកល្បងប្រើស្តីមនេះទៅអនាគត	0	1	2	3	4	5	6	7	8	9	10
4. ខ្ញុំប្តេជ្ញាបន្តរប្រើស្តីមនេះទៅអនាគត	0	1	2	3	4	5	6	7	8	9	10
5. ខ្ញុំប្រហែលជានឹងមិនបន្តរប្រើស្តីមនេះក្នុងអនាគត	0	1	2	3	4	5	6	7	8	9	10

B. ចំណាប់អារម្មណ៍ចំពោះការរួមចំណែកប្រើសប្រាស់ស្តីម

1. ការចូលរួមចំណែកក្នុងការប្រើប្រាស់ទឹកសំណល់របស់អ្នកស្ថិតក្នុងលក្ខណៈជា
(អ្នកប្រើទឹក =1 អ្នកមានភាពហ្មត =2 ម្ចាស់ =3 ទាំងពីរ (១និង២) =4 ទាំងអស់(១,២,៣) =5

2. ដោយយោងទៅលើការរួមចំណែករបស់អ្នកក្នុងការប្រើប្រាស់ស្តីម សូមផ្តល់យោបល់របស់អ្នកដោយមានកម្រិតពីមួយឃល់ព្រំប្លង។ ប្រសិនបើមិនចាប់អារម្មណ៍។

ការរួមចំណែកក្នុងស្តីមទឹកសំណល់គឺ

1.	គ្មានប្រយោជន៍	1	2	3	4	5	6	7	8	9	មានប្រយោជន៍
2.	ក្រោះថ្នាក់ (ចំពោះអ្នក)	1	2	3	4	5	6	7	8	9	មានប្រយោជន៍
3.	បំផ្លាញ(បរិយាកាស)	1	2	3	4	5	6	7	8	9	មានប្រយោជន៍

C. មតិផ្ទាល់ខ្លួន

ចូរបញ្ជាក់ពីកម្រិតយល់ស្របរបស់អ្នកពីសូនយល់ឃើញចំពោះសំណើទាំងឡាយខាងក្រោមនេះ។ **0មានន័យមិនយល់ស្របទាំងស្រុង ហើយ 10 មានន័យយល់ស្របទាំងស្រុង។**

1. អ្នកដែលសំខាន់សំរាប់ខ្ញុំទាំងអស់យល់ថាគួរប្រើស្តីមនេះតទៅទៀត	0	1	2	3	4	5	6	7	8	9	10
2. អ្នកដែលសំខាន់សំរាប់ខ្ញុំទាំងអស់នឹងយកចិត្តបើសិនជាខ្ញុំមិនប្រើស្តីមនេះ តទៅទៀត	0	1	2	3	4	5	6	7	8	9	10
3. ខ្ញុំមានអារម្មណ៍ចិតក្រោមសំរៀតសង្គមក្នុងការរួមចំណែកក្នុងស្តីមនេះ	0	1	2	3	4	5	6	7	8	9	10
4. ឲ្យគេសង្ឃឹមថាខ្ញុំនឹងបន្តការខំធ្វើក់ខំងក្នុងស្តីមនេះ	0	1	2	3	4	5	6	7	8	9	10

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D. ការស្កប់ចិត្ត (ភាពរីករាយនិងមិនរីករាយ)

ចូរបញ្ជាក់ពីភាពរីករាយនិងមិនរីករាយរបស់អ្នកពីស្ថានភាពបច្ចុប្បន្នរបស់អ្នកដែលបានរៀបរាប់ខាងក្រោមនេះ **0**=មានទុក្ខយ៉ាងមិនរីករាយបំផុត **10**=រីករាយបំផុត។

1. ខ្ញុំជឿជាក់ថាខ្ញុំអាចបន្តប្រើស្តីមនេះបើសិនជាខ្ញុំចង់	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**
2. ខ្ញុំអាចដោះស្រាយនូវបរាល់បញ្ហាទាំងឡាយណាដែលមករារាំងខ្ញុំមិនឱ្យ បន្តប្រើស្តីមនេះ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**
3. ការបន្តប្រើមិនបន្តប្រើស្តីមនេះគឺខ្ញុំជាអ្នកសំរាច់	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**
4. ការសំរេចចិត្តបន្តប្រើស្តីមនេះគឺស្ថិតក្រោមអំណាចរបស់ខ្ញុំ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**
5. សំរាប់ខ្ញុំការសំរេចចិត្តបន្តប្រើស្តីមនេះគឺជាការងាយស្រួលបំផុត	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**

E. ការពេញចិត្តក្នុងការបង់ថ្លៃទឹកប្រើម្តងហើយ

សំនួរទាំងឡាយខាងក្រោមនេះគឺធ្វើឡើងដើម្បីចង់ដឹងពីចំណងរបស់អ្នកក្នុងការប្រើទឹកដែលប្រើម្តងហើយ និងការសុខចិត្ត បង់ថ្លៃទឹកប្រភេទនេះក្នុងស្ថានភាពផ្សេង។។ ចូរដាក់ (√) ក្នុងប្រអប់ណាដែលអ្នកយល់ថាសមរម្យជាងគេ។

a. បើសិនជាមានទឹកធម្មតានិងទឹកដែលប្រើម្តងហើយ តើអ្នកជ្រើសយកប្រភេទមួយណា?

1. ទឹកដែលប្រើម្តងហើយបើសិនជាវាថោកជាងទឹកធម្មតា១៥សេន ☐
2. ទឹកដែលប្រើម្តងហើយបើសិនជាវាថោកជាងទឹកធម្មតា៣០សេន ☐
3. ទឹកដែលប្រើម្តងហើយបើសិនជាវាថោកជាងទឹកធម្មតា៥០សេន ☐
4. ទឹកដែលប្រើម្តងហើយបើជាវាថោកជាងទឹកធម្មតា៧៥សេន ☐
5. ទឹកដែលប្រើម្តងហើយបើសិនជាវាថោកជាងទឹកធម្មតា១ដុល្លា ☐
6. ទឹកធម្មតាទោះបីជាទឹកប្រើម្តងហើយមានតំលៃស្មើសូន្យ ☐
7. ទឹកដែលប្រើម្តងហើយបើសិនជាវាថោកជាងទឹកធម្មតា១ដុល្លា ☐

b. បើសិនជាអ្នកពឹងថាការប្រើប្រាស់ទឹកដែលប្រើម្តងហើយអាចបន្ថយការប្រើដី តើក្នុងករណីណាអ្នកនឹងប្រើទឹក ប្រើម្តងហើយ?

1. បើសិនជាវាអាចបន្ថយការប្រើដីបាន៥០% ☐
2. បើសិនជាវាអាចបន្ថយការប្រើដីបាន៣០% ☐
3. បើសិនជាវាអាចបន្ថយការប្រើដីបាន១៥% ☐
4. ប្រើទឹកដែលប្រើម្តងរហូតទោះបីជាវាមិនបានកាត់បន្ថយការប្រើប្រាស់ដីក៏ដោយ ☐
5. មិនប្រើទាល់តែសោះ ☐

c. តើអ្នកនឹងប្រើទឹកដែលប្រើម្តងដើម្បីស្រោចស្រពំណាំនៅតំបន់បង្កើតថ្មីទេ បើសិនជាពីងថាវាអាចនឹងនាំមកនៅពុះវិបត្តិណាមួយ?

1. ប្រាកដជាមិនប្រើ ☐
2. ប្រហែលជាប្រើ ☐
3. មុខជានឹងប្រើ ☐
4. ប្រាកដជាប្រើ ☐

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d. តើទៅថ្លៃអនាគតអ្នកនឹងប្រើទឹកដែលប្រើម្តងហើយងើយ្បីស្រោចដំណាំទេ? ____

1. ប្រាកដជាមិនប្រើ ☐

2. ប្រហែលជាប្រើ ☐

3. មុខជានឹងប្រើ ☐

4. ប្រាកដជាប្រើ ☐

ផ្នែកទី 6 ពត៌មានលំអិតផ្ទាល់ខ្លួនរបស់អ្នកឆ្លើយតប

A. ក្រុមអាយុ ចូរដូស (√) ក្នុងប្រអប់អាយចាន់សមរម្យ

1	១៨ - ២៤	
2	២៥ - ៣៤	
3	៣៥ - ៤៤	
4	៤៥ -៥៤	
5	៥៥-៦៤	
6	៦៥ ឡើងទៅ	

B. កំរិតសិក្សាខ្ពស់បំផុត ចូរដូស (√)ក្នុងប្រអប់អាយចាន់សមរម្យ

1	ក្រោមបឋមសិក្សា	
2	បឋមសិក្សា	
3	មធ្យមសិក្សា	
4	វិទ្យាល័យ	
5	ឯកទេសជំនាញ (TAFE, Diploma។ល។)	
6	កំរិតមហាវិទ្យាល័យ	

C. តើគ្រួសារអ្នកមានសមាជិកប៉ុន្មានអ្នក? _____

D. ភេទ ចូរដូស (√) ប្រុស ☐ ស្រី ☐

E. ថ្លៃពីកាន់កាប់

ឯថ្លៃពីកាន់កាប់ (ហិចតា)	របស់ខ្លួនឯង			ជួលពីគេ			ជួលអោយគេ		
	សរុប	ទាំងំណាំ	ទុកចោល	សរុប	ទាំងំណាំ	ទុកចោល	សរុប	ទាំងំណាំ	ទុកចោល

F. តើប្រាក់ចំណូលដែលបានមកពីការធ្វើចំការនេះចានប៉ុន្មានភាគរយ?_____%

G. ទំហំថ្លៃពីសំរាប់ដំណាំជាចំបង

ដំណាំ	ទំហំថ្លៃពី (ហិចតា)
ក	
ខ	
គ	
ឃ	
ង	

សូមអរគុណដល់អ្នកដែលបានចំណាយពេលវេលាដ៏មានតំលៃមួយចំណែកដ៏ធំធេងសកម្មហើយគាំទ្រដល់ការសិក្សានេះ។

Appendix 9: Virginia pipeline scheme letter of information (Khmer)

សាកលវិទ្យាល័យសាវអូស្ត្រាលីយ៉ា

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សាលាពាណិជ្ជកម្ម
ផ្នែកដំឡូង

អប់រំអ្នកមានវប្បធម៌ជាវិជ្ជាជីវៈ • បង្កើតនិងអនុវត្តចំណេះដឹង • បំពីសហគមន៍

លិខិតព័ត៌មាន

ចំពោះអ្នកឆ្លើយតប,

ស្ថិតនេះជាផ្នែកមួយនៃការសិក្សាស្រាវជ្រាវរបស់លោក Ganesh B. Keremane's PhD ដែលមានចំណងជើងថា "ភាវិតសំដែងនៃទីផ្សារឯកជនក្នុងការប្រើប្រាស់សំណល់ទឹកនៅសាវអូស្ត្រាលីយ៉ា: ការសិក្សាវែកញែកជាលក្ខណៈរដ្ឋមួយ"។

គោលបំណងនៃការសិក្សានេះគឺដើម្បីធ្វើការពិនិត្យអំពីការចែកចាយដែលទាក់ទងទៅនឹងចំនាត់ចែងសំណល់ទឹកស្អាតរបស់ក្រុមប្រើសំណល់ទឹកស្អាតឯកជនពីរនៅសាវអូស្ត្រាលីយ៉ា។ ក្រុមទាំងពីរនោះគឺ: (1) ក្រុម Virginia Pipeline , និង (2) ក្រុម Willunga Basin Pipeline។

ការសំភាសនឹងប្រើពេលមិនលើសពី 40 នាទីទេ ហើយមានសំនួរទាក់ទងទៅនឹងបទពិសោធន៍របស់អ្នកក្នុងការប្រើប្រាស់ក្រុមនោះ, យោបល់អំពីការប្រើប្រាស់ឡើងវិញនូវសំណល់ទឹកស្អាតសំរាប់ស្រោចជំនាំ និងបំណងក្នុងការបង់ប្រាក់សំរាប់ជនពាន់ឥមានតំលៃនេះ។

ម៉្យាងទៀត យើងសូមជំរាបថា:

- ការរួមចំណែកនៃការស្រាវជ្រាវនេះជាការស្ម័គ្រចិត្ត។
- អ្នកចូលរួមចំណែកអាចមិនឆ្លើយនូវសំនួរណាមួយ រឺមានសេរីភាពក្នុងការដកខ្លួនចេញពីការសិក្សាគ្រប់ពេលវេលាទោះបីនៅពេលកំពុងធ្វើការសំភាសក៏ដោយ។
- ការពិភាក្សានិងរចាយការណ៍ទាំងឡាយនឹងត្រូវបានរក្សាទុកយ៉ាងសំងាត់ ដើម្បីមិនអោយនរណាដឹងអំពីឈ្មោះអ្នកដែលចូលរួមឡើយ។

ចំពោះពត៌មានបន្ថែមទាក់ទងទៅនឹងការស្រាវជ្រាវនេះ សូមទាក់ទងលោក Ganesh, B. Keremane លេខ 8302 0148 រឺអ៊ីមែល ganesh.keremane@unisa.edu.au, រឺ Prof. Jennifer McKay លេខ 8302 0887 រឺ Jennifer.McKay@unisa.edu.au នៅសាលាពាណិជ្ជកម្ម មជ្ឈមណ្ឌលប្រៀបធៀបក្រឹតក្រមទឹកនិងច្បាប់នៃសាកលវិទ្យាល័យសាវអូស្ត្រាលីយ៉ា។

បើមានការឈឺឆ្អាលអំពីបញ្ហាអេទិក(Ethics) សូមទាក់ទងភ្នាក់ងារជាន់ខ្ពស់ Vicki Allen នៅសាកលវិទ្យាល័យសាវអូស្ត្រាលីយ៉ា ផ្នែកខាងHuman Research Ethics Committee (HREC) តាមទូរស័ព្ទលេខ 8302 3118 រឺអ៊ីមែល Vicki.allen@unisa.edu.au។

សូមអរគុណ

Ganesh B. Keremane_____ Prof. Jennifer McKay _____

ថ្ងៃទី _____ ថ្ងៃទី _____

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Appendix 10: Virginia pipeline scheme consent form (Khmer)

សាកលវិទ្យាល័យសាខអូស្ត្រាលីយ៉ា | University of South Australia

សាលាពាណិជ្ជកម្ម វិទ្យាស័ក្តិយ
មជ្ឈមណ្ឌលប្រៀបធៀបក្រឹត្យក្រមទឹកនិងច្បាប់

អប់រំអ្នកមានវប្បធម៌វិជ្ជាជីវៈ • បង្កើតនិងអនុវត្តន៍ចំនេះដឹង
• បំរើសហគមន៍

លិខិតអនុញ្ញាតសំរាប់ចូលរួមធ្វើការស្រាវជ្រាវ

ខ្ញុំ ..... ស្ម័គ្រចិត្តចូលរួមចំណែកជួចដែលចានចែងក្នុងក្រដាសពត៌មានសំរាប់ធ្វើការសិក្សាស្រាវជ្រាវដែលមានចំនងជើងថា "ការិតសំដែងនៃទីស្ថានឯកជនក្នុងការប្រើប្រាស់សំនល់ទឹកនៅសាវអូស្ត្រាលីយ៉ា: ការសិក្សាវែកញែកជាលក្ខណៈរដ្ឋមួយ"។

1. ខ្ញុំចានអានពត៌មានដែលចានផ្តល់អោយ។
2. របៀបធ្វើជាលំអិត និងភាពប្រថុយទាំងឡាយត្រូវចានពន្យល់យ៉ាងត្រឹមត្រូវដល់ខ្ញុំ។
3. ខ្ញុំយល់ថា:
    - ខ្ញុំប្រហែលជាមិនចានចំនេញអ្វីអំពីការចូលរួមចំណែកក្នុងការស្រាវជ្រាវនេះទេ។
    - ខ្ញុំមានសេរីភាពឯកន្លងឈប់រួមចំណែកក្នុងប្រូចិចនេះពេលណាក៏ចាន ហើយមានសេរីភាពមិនឆ្លើយនឹងសំនួរណាក៏ចាន។
    - ទោះបីជាពត៌មានពីការសិក្សាស្រាវជ្រាវនេះនឹងត្រូវចោះពុម្ពផ្សាយក្តីចានពន្យល់ក៏ដោយ ខ្ញុំនឹងមិនត្រូវចានគេស្គាល់ឈ្មោះលុះត្រាណាតែមានការអនុញ្ញាតពីខ្ញុំ ហើយក្រុមអ្នកស្រាវជ្រាវ (Ganesh B. Keremane និង Prof. Jennifer McKay) នឹងធ្វើការជានាថាពត៌មានផ្នាល់ខ្លួនត្រូវចានកត់ត្រាទុកជាសំងាត់។
    - ខ្ញុំមានសិទ្ធិនឹងទទួលរចាយការណ៏សិក្សាមួយច្បាប់បើសិនជាខ្ញុំចង់ចាន។

ហត្ថលេខាអ្នកចូលរួម .....

ថ្ងៃទី: .....

ខ្ញុំអះអាងបញ្ជាក់ថាខ្ញុំចានពន្យល់អំពីការសិក្សាដល់អ្នកស្មាក់ចិត្ត ហើយជឿថាគេយល់អំពីអ្វីដែលត្រូវធ្វើ និងការចូលរួមចំណែកដោយមិនយកកំរៃ។

ឈ្មោះអ្នកស្រាវជ្រាវ .....

ហត្ថលេខាអ្នកស្រាវជ្រាវ .....

ថ្ងៃទី: .....

Appendix 11: Willunga pipeline scheme questionnaire (Telephone survey)

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Willunga Basin Pipeline Scheme - Survey Questionnaire

Knowing the value of your time and information it is our intention to use them as efficiently as we can. This survey aims to study the institutional arrangements governing water distribution and usage in two reclaimed water schemes of South Australia. The interview should take around 20-25 minutes and the information provided will be used for research only and remain totally confidential. Thanks, in advance for your cooperation and active support for this study.

SECTION 1- Background Information

1. How long have you been engaged in grape growing? _____ years.

2. What is the present source of water for irrigation? Tick (√) the appropriate

(a) Groundwater only ☐ (b) Mains water only ☐ (c) Reclaimed water only ☐ (d) c + a ☐ (e) c + b ☐

3. Please indicate the acreage under irrigation using reclaimed water?_____

4. Please indicate the proportion of water used from each source?

(a) Mains water_____% (b) Groundwater_____% (c) Reclaimed water_____%

SECTION 2- Information about the reclaimed water scheme

This section aims to get an overall idea about the scheme to which you are connected. It consists of a set of questions pertaining to different aspects of the scheme. Please mention the code for your answer in the boxes provided.

1	When did you fist come to know about the reuse scheme? (Well before implementation=1; Just prior to implementation=2; After implementation=3)	
2	What was your initial attitude when you first heard about the reuse scheme? (Positive=1; Negative=2;Indifferent=3)	
3	Did you have any knowledge of reclaimed water and its use before implementation of scheme? (Never heard=1; Had heard=2; Knew a lot=3)	
3.1	If yes, then indicate the source of information? (Water authorities=1; Private agencies=2; Community=3; Personal experience=4; General knowledge=5)	
4	What according to you is the most important reason for implementation of the scheme? (Groundwater depletion =1; High price of mains water=2; Prior experience using reclaimed water=3; Encouragement by water authorities=4; Community interest=5)	
5	What is your present attitude regarding reclaimed water use? (Positive=1; Negative=2;Indifferent=3)	
6	Who owns the reclaimed water scheme at present? (Federal govt. = 1; State govt. = 2; Community = 3; Water company= 4; No idea = 5)	
7	Who is responsible for the operation and maintenance of the pipeline? (Federal govt. = 1; State govt. = 2; Community = 3; Water company= 4; Not aware = 4)	
8	Who has the authority to decide upon the accessibility to reclaimed water from the scheme? (Federal govt. = 1; State govt. = 2; Community = 3; Water company= 4; No idea = 5)	
9	What is the basis for determining the accessible volume of reclaimed water? (Land area=1; Individual requirement=2; No. of irrigators=3; No idea=4)	
10	Who has the authority to decide upon the water charges? (Federal govt. = 1; State govt. = 2; Community = 3; Water company= 4; No idea = 4)	
11	According to you, the water charges include: (Cost recovery fees =1; water use charges =2; Maintenance fees = 3; Only 1 & 2=4; All 1,2 & 3=4)	

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12	What is the basis for charging water use? (Time=1; Volume =2; Land area=3; Crops grown=4; Time & volume=5; No idea=6)	
13	Do you think the area under grapes in the region has increased after implementation of the reclaimed water scheme? (Yes=1; No=2)	
13.1	If YES then, what do you think about the increase? (Significant =1; Normal=2; Negligible=3; No idea=4)	

SECTION 3 – Attitudes, perception and willingness to pay (WTP) statements

This section consists of statements that are matters of opinion only. There are obviously no right or wrong answers. We would like to know your views about these statements.

A. Rules governing reclaimed water management issues

Please indicate if you agree or disagree with these propositions on a 10 point likert scale where **0= very strongly disagree and 10= very strongly agree.**

1. The rules to use the water is clearly defined in the water supply agreement	0	1	2	3	4	5	6	7	8	9	10
2. I feel that the water the water distribution system is efficient	0	1	2	3	4	5	6	7	8	9	10
3. I feel secure with the present water distribution system	0	1	2	3	4	5	6	7	8	9	10
4. The basis for distributing water among irrigators is fair	0	1	2	3	4	5	6	7	8	9	10
5. The basis to charge water fees is appropriate	0	1	2	3	4	5	6	7	8	9	10
6. Conflicts between users and the management (water company) are common	0	1	2	3	4	5	6	7	8	9	10
7. In event of any conflicts, the conflict resolving mechanisms are in place and clear	0	1	2	3	4	5	6	7	8	9	10
8. I believe that the scheme operates in compliance with the water reuse regulations/EPA regulations	0	1	2	3	4	5	6	7	8	9	10
9. I think the present maintenance system is effective	0	1	2	3	4	5	6	7	8	9	10
10. I am satisfied with the present services of the water provider	0	1	2	3	4	5	6	7	8	9	10

B. Collective action and Cooperation

1.A major portion of my income is derived from activities depending on irrigation	0	1	2	3	4	5	6	7	8	9	10
2. Most people in the community are community oriented	0	1	2	3	4	5	6	7	8	9	10
3. This community has prospered in the last five years	0	1	2	3	4	5	6	7	8	9	10
4. I have worked with others in the past for the benefit of the community	0	1	2	3	4	5	6	7	8	9	10
5. Most likely the people who do not participate in community activities are criticized	0	1	2	3	4	5	6	7	8	9	10
6. Everyone in the community make a fair contribution to communal activities	0	1	2	3	4	5	6	7	8	9	10
7. People in the community will cooperate when there is water supply problem	0	1	2	3	4	5	6	7	8	9	10
8. Water in this region will be in the hands of a few players	0	1	2	3	4	5	6	7	8	9	10
9. The bigger growers here have the most influence	0	1	2	3	4	5	6	7	8	9	10

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C Perceived problems, knowledge about the scheme and trust in authorities

1 What might be the danger that the reuse scheme can pose at any given point of time?
(Groundwater contamination=1; Health risks=2; Damage to aquifers=3; Spillage=4; Soil quality deterioration=5) ☐

2 What is the likelihood of any problems happening?
(Highly unlikely=1; Highly likely=2; Likely=3; Indifferent=4) ☐

3 Who do you think will/is worst effected by these possible problems?
(Yourself and your family=1; Environment=2; Water company=3; None=4; No idea=5) ☐

4 How serious do you think the problems to be?
(Not serious at all=1; Extremely serious=2; Serious=3; Indifferent=4) ☐

5 To what extent do you think the following authorities have control to prevent the problems from happening?
(No control at all=1; High level of control=2; some control=3; Indifferent=4)
(a) Government agencies ☐

(b) Water Company ☐

6 Please indicate the extent of knowledge you possess about the following?
(Nothing=1; Very little=2; Little=3; Quite a lot=4; Fully informed=5)
(a)Wastewater treatment ☐

(b) Reclaimed water usage/applications ☐

7 What do you think about the knowledge possessed by experts about reclaimed water and its use in irrigation?
(No knowledge at all=1; Very little=2; Little=3; Quite a lot=4; Fully informed=5) ☐

8 What is the main source of information regarding water reuse?
(Media=1; Internet=2; Newspaper=3; Radio=4; Government authorities=5; Exposure visits=6; Water company=7) ☐

9 How often you receive information about water ruse?
(Daily=1; Weekly=2; Fortnightly=3; Monthly=4; Half yearly=4; Yearly=5) ☐

10 What is the level of trust you have in the following agencies to perform their responsibilities?
(No trust at all=1; Complete trust=2; Some level of trust=3; Indifferent=4)
(a) Government agencies ☐

(b)Water company/pipeline operator ☐

(c)Environment Protection Agency (EPA) ☐

(d) Department of health ☐

D. Attitude towards participating in the scheme

1. Based on your participation in the scheme, please indicate your opinion by rounding up the number on semantic differential scales. **If you round up number 5 that indicates you are indifferent.**

Participating in the reclaimed water scheme is

1.	Worthless	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	Useful
2.	Harmful (to me)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	Beneficial (to me)
3.	Harmful (to the environment)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	Beneficial (to the environment)

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E. Willingness to pay for reclaimed water

The following questions are designed to elicit your willingness to use recycled water and willingness to pay under different hypothetical scenarios. Please tick (√) which ever you think the most appropriate.

1. Supposing, both fresh water and recycled water were available, which would you use?
   1. Reclaimed water if it's 15 cents less then the price of fresh water ☐
   2. Reclaimed water if it's 30 cents less then the price of fresh water ☐
   3. Reclaimed water if it's cost is 50 cents less than the price of fresh water ☐
   4. Reclaimed water if it's cost is 75 cents less than the price of fresh water ☐
   5. Reclaimed water if it's cost is 1$ less than the price of fresh water ☐
   6. Reclaimed water even if it's cost is same as fresh water ☐
   7. Fresh water even if reclaimed water's price were zero ☐

2. What do you think about the affect of using reclaimed water on quality grape production? (Detrimental=1; Beneficial=2; No affect=3; No idea=4) ☐

3. If you were aware that reclaimed water use is beneficial in quality grape production, in which of the following cases would you use reclaimed water?
   1. If the grape production could be increased by 50 % ☐
   2. If the grape production could be increased by 30 % ☐
   3 If the grape production could be increased by 15 % ☐
   4. Always even if no increase in production ☐
   5. Never ☐

c. Would you use recreation areas if you knew that they were irrigated with recycled water given that the only potential risk comes from consumption of this water?
   1. Definitely not ☐
   2. Probably ☐
   3. Very likely ☐
   4. With great certainty ☐

d. Will you continue using recycled water for the irrigation of your crops in future?
   1. Definitely not ☐
   2. Probably ☐
   3. Very likely ☐
   4. With great certainty ☐

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SECTION 4- Respondent profile

A. Your age group? Tick (√) the appropriate

1	18 - 24	
2	25 - 34	
3	35 - 44	
4	45 -54	
5	55-64	
6	65+	

B. Highest level of education attained by you? Tick (√) the appropriate

1	< Primary	
2	Primary school	
3	Secondary School	
4	Higher school	
5	Additional education (TAFE, Diploma etc)	
6	University Degree	

Thank you for your time, cooperation and active support for this study

Appendix 12: Willunga pipeline scheme letter of information

Centre for Comparative Water Policies and Laws

School of Commerce
Division of Business

University of South Australia

Educating Professionals • Creating and Applying Knowledge • Serving the Community

LETTER OF INFORMATION

Dear Respondent,

I am Ganesh; a PhD student with the School of Commerce, University of South Australia. As a part of my research study, I am examining the institutional arrangements governing reclaimed water use and management in two innovative wastewater schemes operating in South Australia namely, (1) the Virginia Pipeline Scheme, and (2) the Willunga Basin Pipeline Scheme.

In order to collect the information for my study, a group of professionals will be helping me to conduct telephone interviews with the irrigators associated with these schemes. Each interview should take no longer than 25 minutes and you will be asked questions related to:

- Your experiences with the scheme
- Your perceptions about the rules governing reclaimed water distribution and usage
- Your perceptions about using reclaimed water for irrigation
- Your willingness to pay for this valuable alternative resource

I would also like to inform that;

- Your participation in the study is voluntary and you can refuse to answer any question or free to withdraw from the study at any time during the interview process.
- All discussions and reporting will be confidential so that no individual will be identified.

The research has been approved by the Human Research Ethics Committee (HREC), UniSA. In case of any ethical concerns, you can contact Vicki Allen, on 8302 3118 or Vicki.allen@unisa.edu.au

Through this mail-out, I am inviting you to participate in my study. If you volunteer to participate in the research, please provide us the following details:

- your contact number;
- Suitable day and the time to call you.

You can inform us about your decision through phone or e-mail. Alternatively, you can also fill in the attached form and fax it to one of the contact persons mentioned below:

Name of the person	Telephone	Fax	E-mail
Lucy Hyde	(08) 83238999 (only Monday & Tuesdays)	83239332	lucy@mclarenvale.info
Ganesh	(08) 8302 0148	8302 0992	ganesh.keremane@unisa.edu.au
Prof. Jennifer McKay	(08) 8302 0887	8302 0992	Jennifer.McKay@unisa.edu.au

Thank you in advance.

(Ganesh B. Keremane) Date:

School of Commerce
Adelaide SA 5000
Australia

GPO Box 2471
Adelaide SA 5001
Australia

Telephone: 8302 0148
Facsimile: 8302 0992
www.unisa.edu.au

Appendix 13: Willunga pipeline scheme consent form

Center for Comparative Water Policies and Laws

University of South Australia

School of Commerce
Division of Business

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Consent Form

I have read the information provided and hereby consent to participate as requested in the Information Sheet for the research study titled "Performance of private reclaimed wastewater markets in South Australia: An institutional analysis".

The details are as follows:

Name: ……..

Telephone:……

Day and time to call: ……..

Participant's signature…… Date:……

Appendix 14: Key informant survey questions

Key Informant Interview Questions

Date ……

Name of Irrigation Scheme ……..

Responsibility/ Position …… ……..

1) What are the factors responsible for implementing this scheme?

2) Who initiated the construction of the irrigation scheme?

3) What was the response from the community initially at the time of implementation?

4) Did the community participate in the construction?

5) What is the role of government or SA Water in the entire exercise?

6) Who financed the scheme (initial investment)?

7) Whom does the irrigation structure belong to?

8) What do people now feel about the scheme?

9) What have people gained because of the scheme?

10) How do you help the irrigation users?

11) What is the organizational set up of the water company?

12) Do you make decisions pertaining to irrigation on your discretion or have to wait for guidelines to come down from SA Water?

13) Does the Community participate in decision making?

14) How is water allocated and distributed to users? (What is the basis?)

15) How is maintenance and rehabilitation handled?

16) Can you please explain the process of wastewater collection, storage and distribution? What is the quality of water?

17) Does SA water charge you for the reclaimed water?

18) Do you collect water use fees?

19) What is the basis for fixing water fees and what does it cover?

20) Have there been any conflicts pertaining to irrigation/scheme?

21) Are there mechanisms in place to encounter such conflicts?

22) Is there a water users association for the scheme representing the irrigators?

23) What is the perception of people about the produce grown using reclaimed water?

24) Does use of reclaimed water in any way affect the marketing of the produce?

25) What are the future plans of the company?

Appendix 15: Musi River survey questionnaire (English/Telgu)

Study on Legal aspects of rules and internal conflict resolution processes in Water User's Associations of Andhra Pradesh State, India.

భారతదేశంలోని ఆంధ్రప్రదేశ్ రాష్ట్రంలో నీటి వినియోగదారుల సంఘాలలో నిబంధనలు మరియు అంతర్గత సంఘర్షణల పరిష్కార ప్రక్రియలకు సంబంధించిన న్యాయపరమైన అంశాలపై అధ్యయనం.

This survey aims to study the institutional arrangements governing water distribution and usage the WUAs in the state of Andhra Pradesh. Each interview should take around 20-25 minutes and knowing the value of your time and information it is our intention to use them as efficiently as we can. The information provided will be used for research only and remain very confidential. Thanks, in advance for your cooperation and active support for this study.

*ఆంధ్రప్రదేశ్ రాష్ట్రంలోని నీటి వినియోగదారుల సంఘాలకు వర్తించే సంస్థాగత ఏర్పాట్లపై అధ్యయనం ఈ సర్వే లక్ష్యం. ప్రతి ఇంటర్వ్యూకు **20-25** నిమిషాలు పట్టవచ్చు. మీ కాలం మరియు సమాచారం అమూల్యం కనుక సాధ్యమైనంత సమర్థవంతంగా వాటిని వినియోగించుకోవాలన్నది మా సంకల్పం. మీరు సమకూర్చే సమాచారాన్ని పరిశోధనకు మాత్రమే వినియోగిస్తారు మరియు అది అత్యంత గోప్యంగా ఉంచబడుతుంది. ఈ అధ్యయనానికి సహకరిస్తున్నందుకు మరియు చురుకుగా పాల్గొంటున్నందుకు ముందస్తుగా కృతజ్ఞతలు.*

SECTION 1 - Background Information

విభాగం 1 – నేపధ్య సమాచారం

1. How long have been engaged in farming ? _____years.
   వ్యవసాయ కార్యకలాపాల్లో మీరెంత కాలంగా నిమగ్నమయ్యారు _____ ఏళ్ల

2. What is the present source of water for irrigation? (✓)Tick the appropriate.
   ప్రస్తుతం నీటి పారుదలకు నీటి వనరు ఏది? సరైన గడిలో గుర్తు (✓) పెట్టండి.

   (a) Groundwater only ☐ (b) Canal water only ☐ (c) Wastewater only ☐ (d) Other source (rainwater) ☐
   భూగర్భ జలాలు మాత్రమే ☐ కాలువ నీరు మాత్రమే ☐ వ్యర్థ జలాలు మాత్రమే ☐ ఇతర వనరులు (వాన నీరు) ☐

3. Please indicate the proportion (percentage) of water used from each source?
   ప్రతీ వనరు నుంచి వినియోగించే నీటి నిష్పత్తి (శాతం) ఎంతో తెలపండి?

   (a) Groundwater ☐ (b) Canal water ☐ (c) Wastewater ☐ (d) Other source (rainwater) ☐
   భూగర్భజలాలు ☐ కాలువ నీరు ☐ వ్యర్థ జలాలు ☐ ఇతర వనరులు (వాన నీరు) ☐

4. Please indicate the total area under irrigation?
   మొత్తం నీటి పారుదల అందుతున్న భూముల విస్తీర్ణం ఎంతో తెలపండి?

   (a) Total area _____ acres (b) Irrigated area _____ acres.
   (అ) మొత్తం విస్తీర్ణం _____ ఎకరాలు (ఆ) నీటి పారుదల విస్తీర్ణం _____ ఎకరాలు.

5. Whether all the land gets sufficient irrigation water (✓)Tick the appropriate Yes ☐ No ☐
   భూములన్నింటికీ తగినంత స్థాయిలో నీటిపారుదల జరుగుతోందా? సరైన గడిలో (✓) గుర్తు పెట్టండి అవును ☐ కాదు ☐

6. If No, give reasons ;
   [No-existence of FIC=0; Disturbed FIC=1; Faulty designing of the FIC=2; Land is at the tail end of the canal =3]
   Note: FIC = Field Irrigation channel
   లేదు అయినట్లయితే, కారణాలు తెలపండి
   (క్షేత్ర నీటిపారుదల కాలు (ఎఫ్ఐసి) లేదు =0; ఎఫ్ఐసికి అవరోధం =1; ఎఫ్ఐసి రూపకల్పనలో లోపం = 2, భూమి కాలువ చిట్టచివర ఉంది = 3) ☐
   గమనిక : ఎస్ఐసి =ఫీల్డ్ ఇరిగేషన్ చానల్

7. What is your main source of information regarding water use & management? ☐
   [Newspaper=0; Radio=1; Television=2; Government authorities=3; WUA=4; NGO's=5]
   నీటి వినియోగం మరియు యాజమాన్యంపై మీరు ప్రధానంగా దేని నుంచి సమాచారం తెలుసుకుంటారు.
   (వార్తాపత్రికలు = 0; రేడియో = 1; ప్రభుత్వాధికారులు = 3; నీటి వినియోగదారుల సంఘం = 4; స్వచ్ఛంద సంస్థలు = 5)

8. How often you receive the information ? ☐
   (Daily=1; Weekly=2; Fortnightly=3; Monthly=4; Half yearly=4; Yearly=5)
   ఎంత తరచుగా మీకు ఈ సమాచారం అందుతుంది ?
   (ప్రతీరోజు = 1; వారానికి ఒకసారి = 2; పక్షం రోజులకు = 3; నెలకు ఒకసారి = 4; ఆరు నెలలకు ఓసారి = 5; ఏడాదికి = 6)

SECTION 2 - Information about the Water User Association Membership and Administration ☐

విభాగం-2 నీటి వినియోగదారుల సంఘం (డబ్ల్యుయుఎ) సభ్యత్వం మరియు పాలనను గురించిన సమాచారం

2.1 Name of the WUA : _____ 2.2 Year of formation : _____
సంఘం పేరు: _____ స్థాపించిన సంవత్సరం: _____

2.3 Village : _____ 2.4 District : _____ ☐
గ్రామం : _____ జిల్లా : _____

2.5 Location on the Main Canal? :
(Head=0; Middle=1; Tail =3)
ప్రధాన కాలువ వెంట మీ భూములు ఉన్న ప్రదేశం?
(కాలువ అగ్ర భాగాన = 0, మధ్యలో =1, చిట్టచివర = 3)

2.6 Location on the Distributary ?
(Head=0; Middle=1; Tail=3)
నీరు పంపిణీ జరుగుతున్న కాలువ వెంట భూమి ఉన్న స్థలం
(కాలువ అగ్ర భాగాన = 0, మధ్యలో =1, చిట్టచివర = 3)

2.7 According to you what is the most important reason to be a member of the WUA?
[Water scarcity=0; Inefficiency of Irrigation department =1; Key person encouragement=2; Compelled by ruling/legislation=3]
నీటి వినియోగదారుల సంఘంలో సభ్యత్వం పొందడానికి అత్యంత ముఖ్యమైన కారణం ఏదని మీరు భావిస్తున్నారు?
(నీటికొరత =0, నీటి పారుదల శాఖ అసమర్థత =1, కీలక వ్యక్తి ప్రోత్సాహం =2, రూలింగ్ / చట్టం నిర్బంధం వల్ల = 3)

2.8 I am associated with the WUA in the capacity of?
నీటి వినియోగదారుల సంఘంతో ఈ హోదాలో నాకు సంబంధం ఉన్నది.
(అధ్యక్షుడు = 0, ప్రాంతీయ కమిటి (టీసీ), సభ్యుడు =1)

2.9 Who is responsible for maintenance of the canal on which the WUA is formed?
[Irrigation department =0; WUA=1; Local government/Panchayat =2; Government=3; Not aware=5]
నీటి వినియోగదారుల సంఘం ఏర్పడిన కాలువ నిర్వహణ బాధ్యత ఎవరిది?
(నీటి పారుదల శాఖ =0; నీటి వినియోగదారుల సంఘం =1, స్థానికి పాలనా సంస్థ /పంచాయతీ =2, ప్రభుత్వం = 3, తెలియదు =5)

2.10 Who has the authority to decide upon the accessibility to water from the canal?
[Irrigation department ;0; WUA=1; Local government/Panchayat=2; Government=3; Not aware=5]
కాలువ నుంచి నీరు పొందడాన్ని నిర్ణయించే అధికారం ఎవరికి ఉంది?
(నీటి పారుదల శాఖ =0; నీటి వినియోగదారుల సంఘం =1; స్థానిక పాలనా సంస్థ / పంచాయతీ =2; ప్రభుత్వం =3; తెలియదు =5)

2.11 Who has the authority to decide upon the water charges?
[Irrigation department =0; WUA=1; Local government/Panchayat=2; Government=3; Not aware =5]
నీటి చార్జీలపై నిర్ణయం తీసుకొనే అధికారం ఎవరికి ఉంది?
(నీటి పారుదల శాఖ =0; నీటి వినియోగదారుల సంఘం =1; స్థానిక పాలనా సంస్థ / పంచాయతీ =2; ప్రభుత్వం =3; తెలియదు =5)

2.12 According to you, the water charges include:
[Cost recovery fees=0; Water use charges=1; Maintenance fees=2; Only 0&1=3; All (0,1 &2)=4; No idea=5]
మీరు తెలిసిన మేరకు, నీటి చార్జీలలో ఇవి ఉన్నాయి :
(ఖర్చుల వసూలు ఫీజు =0; నీటి వినియోగ చార్జీలు =1; నిర్వహణా ఫీజు =2; 0 &1 మాత్రమే =3; అన్నీ (0,1 & 12) =4; తెలియదు =5)

2.13 What is the basis for charging water use?
[Time=0; Volume=1; Land area=2; Crops grown =3; Time & Volume=4; No idea=5]
నీటి వినియోగానికి చార్జీల విధింపును ప్రాతిపదిక ఏమిటి?
(కాలం =0; పరిమాణం =1; భూమి విస్తీర్ణం = 2; సాగుచేసే పంటలు =3; సమయం & పరిమాణం =4; తెలియదు =5)

2.14 Would you like to take over the responsibility of collecting the water charges?
[Yes=0, No=1]
నీటి చార్జీలు వసూలు చేసే బాధ్యతను చేపట్టే ఆసక్తి మీకు ఉందా?
(ఔను =0; కాదు =1)

2.15 Do you think the area under irrigation in the region has increased after the formation of WUA?
[Yes=0, No=1]
నీటి పారుదల సంఘం స్థాపన అనంతరం నీటిపారుదల సదుపాయం పొందుతున్న భూముల విస్తీర్ణం పెరిగిందని భావిస్తున్నారా?
(ఔను =0; కాదు =1)

2.16 If YES then, what do you think about the increase?
[Significant=0; Normal=1; Negligible=2; No idea=3]
ఔను అయిన పక్షంలో, పెరుగుదలను గురించి మీ అభిప్రాయం ఏమిటి?
(గణనీయం = 0; సాధారణం = 1; అత్యల్పం = 2; తెలియదు = 3)

2.17 Do you think the overall management of water distribution and management have improved after the formation of WUA?
[Yes=0; No=1]
నీటి పారుదల సంఘం ఏర్పాటు అనంతరం జలాల పంపిణీ మరియు నిర్వహణ సమ్మిళితంగా మెరుగు పడిందని భావిస్తున్నారా?
(ఔను =0; కాదు =1)

2.18 Do the government Lashkars interact with the WUA?
[Yes=0; No=1]
ప్రభుత్వ కళాసులు(లష్కర్లు) నీటి వినియోగ సంఘాలతో కలిసి పని చేస్తారా?
(ఔను =0; కాదు =1)

2.19 Do your WUA have private lashkars?
[Yes=0; No=1]
మీ నీటి వినియోగదారుల సంఘానికి ప్రైవేటు కళాసీలు ఉన్నారా?
(ఔను =0; కాదు =1)

2.19.1 If yes, please specify the number of private lashkars in your WUA?_____
మీ సమాధానం ఔను అయితే, మీ నీటి వినియోగదారుల సంఘంలో ఎంతమంది ప్రైవేటు కళాసీలు ఉన్నది నిర్దిష్టంగా తెలపండి _____

2.19.2 What is the mode of payment?
[Cash=0; Kind=1]
చెల్లింపు పద్ధతి ఏమిటి?
(నగదు =0; వస్తురూపేణా =1)

2.19.3 What is the area under the supervision of each lashkars? _____acres
ప్రతి కళాసీ పర్యవేక్షణలోని ప్రదేశం విస్తీర్ణం ఎంత? _____ఎకరాలు.

2.20 Do you see the need to form a Distributary Committee?
[Yes=0; No=1]
ఓ పంపిణీ సంఘాన్ని (కమిటీ) ఏర్పాటు చేసుకోవాల్సిన అవసరం ఉన్నదని మీరు భావిస్తున్నారా?
(ఔను =0; కాదు =1)

2.21 Do you see the need to form a Project Committee? ☐
[Cash=0; Kind=1]
ఓ ప్రాజెక్టు సంఘాన్ని (కమిటీ) ఏర్పాటు చేసుకోవాల్సిన అవసరం ఉన్నదని భావిస్తున్నారా?
(లేదు =0; అవును =1)

2.22 According to you what should be the role of the Distributary committe and Project committee? Tick (✓) all the appropriate ☐
పంపిణీ కమిటీ మరియు ప్రాజెక్టు కమిటీ ఎలాంటి పాత్ర నిర్వహించాలని మీరు అభిప్రాయపడుతున్నారు? సరైన గడిలో (✓) గుర్తు పెట్టండి.

	పంపిణీ కమిటీ	ప్రాజెక్టు కమిటీ
ఎ. నీటిసేకాయింపు		
బి. నీటిపంపిణీ		
సి. వనరుల సమీకరణ		
డి. వివాదాల పరిష్కారం		
ఇ. ఇతరత్రా (నిర్దేశించండి)		

SECTION 3 - Farmer perceptions on statements regarding self-created rules and WUA administration processes

This section consists of statements formulated based on our readings and discussions held with many people about the water user's group and water sharing. The statements are matters of opinion only. There are obviously no right or wrong answers. We would like to know your views about these statements. Please indicate if you agree or disagree with these propositions on a 10 point likert scale where **0=very strongly disagree and 10=very strongly agree.**

విభాగం- **3** సొంతంగా సృష్టించుకున్న నిబంధనలు మరియు నీటి వినియోగదారుల సంఘం పాలనా ప్రక్రియలను గురించిన ప్రకటనలపై రైతుల అభిప్రాయాలు నీటివినియోగదారుల గ్రూపును మరియు జలాలను పంచుకోవడాన్ని గురించి మెజ్కుమందితో మేము జరిపిన చర్చలు, గ్రహించిన అంశాల ఆధారంగా రూపొందించిన ప్రకటనలు ఈ విభాగంలో ఉన్నాయి. ఈ ప్రకటనలుకేవలం అభిప్రాయాలు మాత్రమే. వీటికి సరైన లేదా తప్పు సమాధానాలు అంటూ ఏమీ ఉండవన్నది విస్పష్టమే. ఈ ప్రకటనలపై మీ అభిప్రాయలను మేము తెలుసుకోగోరుతున్నాము. 10 పాయింట్లతో కూడిన స్కేలు సహాయంతో, ఈ ప్రకటనలతో మీరు ఏకీభవిస్తున్నది లేదా విభేదిస్తున్నది సూచించండి. ఇందులో 0 = గట్టిగా విభేదిస్తున్నాను మరియు 10 =గట్టిగా ఏకీ భవిస్తున్నాను.

3.1	The water sharing process is fair in the WUA	0	1	2	3	4	5	6	7	8	9	10
	నీటి వినియోగదారుల సంఘంలో జలాల పంపిణీ ప్రక్రియ న్యాయంగా జరుగుతుంది.	0	1	2	3	4	5	6	7	8	9	10
3.2	I feel that the water distribution system is efficient	0	1	2	3	4	5	6	7	8	9	10
	జలాల పంపిణీ వ్యవస్థ సమర్థంగా పని చేస్తోందని భావిస్తున్నాను.	0	1	2	3	4	5	6	7	8	9	10
3.3	I feel secure with the present water distribution system	0	1	2	3	4	5	6	7	8	9	10
	ప్రస్తుత జలాల పంపిణీ వ్యవస్థ నాకు భద్రతనిస్తోందని భావిస్తున్నాను.	0	1	2	3	4	5	6	7	8	9	10
3.4	The basis for distributing water among irrigators is fair	0	1	2	3	4	5	6	7	8	9	10
	రైతుల మధ్య జలాల పంపిణీకి ప్రాయిదిక న్యాయపూరితమైనది.	0	1	2	3	4	5	6	7	8	9	10
3.5	The basis to charge water fees is appropriate	0	1	2	3	4	5	6	7	8	9	10
	నీటి చార్జీల విధింపునకు ప్రాతిపదిక సబబుగా ఉంది	0	1	2	3	4	5	6	7	8	9	10
3.6	I think the present maintenace system is effective	0	1	2	3	4	5	6	7	8	9	10
	ప్రస్తుత నిర్వహణావ్యవస్థ సమర్థంగా పని చేస్తోందని భావిస్తున్నాను	0	1	2	3	4	5	6	7	8	9	10
3.7	The way the executive committee was formed is fair	0	1	2	3	4	5	6	7	8	9	10
	కమిటీ ఏర్పాటు తీరు న్యాయబద్ధంగా ఉంది.	0	1	2	3	4	5	6	7	8	9	10
3.8	The committee is fair in its processes	0	1	2	3	4	5	6	7	8	9	10
	కమిటీ తన ప్రక్రియలలో నిజాయతీగా వ్యవహరిస్తోంది	0	1	2	3	4	5	6	7	8	9	10
3.9	All caste members get an equal hearing during the meetings	0	1	2	3	4	5	6	7	8	9	10
	సమావేశాల్లో అన్ని కులాలకు చెందిన వారికి మాట్లాడానికి సమానావకాశాలు లభిస్తున్నాయి.	0	1	2	3	4	5	6	7	8	9	10
3.10	The bigger farmers have the most influence during meetings	0	1	2	3	4	5	6	7	8	9	10
	సమావేశాల సందర్భంగా మోతుబరి రైతుల పలుకుబడి అధికంగా ఉంటోంది.	0	1	2	3	4	5	6	7	8	9	10
3.11	Crop restriction by WUA is good for better management of the available water	0	1	2	3	4	5	6	7	8	9	10
	నీటి వినియోగదారుల సంఘం పంటలపై విధించిన ఆంక్షలు అందుబాటులోని నీటిని మరింత	0	1	2	3	4	5	6	7	8	9	10
	మెరుగుగా ఉపయోగించుకోవడానికి ఉపకరిస్తుంది.	0	1	2	3	4	5	6	7	8	9	10
3.12	Crop restriction by the government is good for better management of water	0	1	2	3	4	5	6	7	8	9	10
	ప్రభుత్వం పంటలపై విధించిన ఆంక్షలు అందుబాటులోని నీటిని మరింత మెరుగుగా	0	1	2	3	4	5	6	7	8	9	10
	ఉపయోగించుకోవడానికి ఉపకరిస్తుంది.	0	1	2	3	4	5	6	7	8	9	10
3.13	All the users are involved in modifying the rules governing water use overtime	0	1	2	3	4	5	6	7	8	9	10
	పరిమితికి మించి ఎక్కువ సమయంపాటు నీటిని వినియోగించుకోవడానికి సంబంధించిన	0	1	2	3	4	5	6	7	8	9	10
	నిబంధనలను సవరించడంలో వినియోగదారులందరి ప్రమేయం ఉన్నది.	0	1	2	3	4	5	6	7	8	9	10
3.14	The government should do more to help water users group	0	1	2	3	4	5	6	7	8	9	10
	నీటి వినియోగదారుల గ్రూపునకు తోడ్పాటు విషయంలో ప్రభుత్వం మరిన్ని చర్యలు తీసుకోవాలి.	0	1	2	3	4	5	6	7	8	9	10
3.15	I believe the rules are enforced as formulated	0	1	2	3	4	5	6	7	8	9	10
	నిబంధనలను నిర్దేశించిన మేరకు అమలు చేస్తున్నారని భావిస్తున్నాను	0	1	2	3	4	5	6	7	8	9	10

SECTION - 4 Farmer perceptions on collective action, cooperation, and conflicts and its management

This section consists of statements that are matters of opinion only. There are aobviously no right or wrong answers. We would like to know your views about these statements. Please indicate if your agree or disagree with these propositions on a 10 point likert scale where 0=very strongly disagree and 10=very strongly agree.

విభాగం- **4** సంఘటిత కార్యాచరణ, సహకారం మరియు సంఘర్షణలు మరియు వాటి పరిష్కారంపై రైతుల అభిప్రాయాలు

ఈ విభాగంలో అభిప్రాయాలను మాత్రమే సంబంధించిన ప్రకటనలు ఉన్నాయి. వీటికి సరైన లేదా తప్పు సమాధానాలంటూ ఏమీ లేవన్నది సుస్పష్టమే. ఈ ప్రకటనపై మీ అభిప్రాయాలను తెలుసుకోగోరుతున్నాము. 10 పాయింట్లతో కూడిన స్కేలు సహాయంతో, ఈ ప్రకటనలతో మీరు ఏకీభవిస్తున్నది లేదా విభేదిస్తున్నారా సూచించండి. ఇందులో 0 = గట్టిగా విభేదిస్తున్నాను మరియు 10 =గట్టిగా ఏకీ భవిస్తున్నాను.

4.1	When there is water supply problem, all people in the community will cooperate	0	1	2	3	4	5	6	7	8	9	10
	నీటి సరఫరా సమస్య తలెత్తినప్పుడు సమాజంలోని వారంతా సహకరిస్తారు.	0	1	2	3	4	5	6	7	8	9	10
4.2	We all talk to each other regularly about water use and management	0	1	2	3	4	5	6	7	8	9	10
	నీటి వినియోగం మరియు నిర్వహణపై మేమంతా క్రమం తప్పకుండా పరస్పరం చర్చించుకొంటాం.	0	1	2	3	4	5	6	7	8	9	10
4.3	I believe that my neighbouring farmer does not overuse the water	0	1	2	3	4	5	6	7	8	9	10
	నా పొరుగున గల రైతు నీటిని పరిమితికి మించి వాడుకోవడం లేదని విశ్వసిస్తున్నాను.	0	1	2	3	4	5	6	7	8	9	10
4.4	Conflicts between users and the management are common	0	1	2	3	4	5	6	7	8	9	10
	వినియోగదారులు మరియు యాజమాన్యం మధ్య సంఘర్షణలు సర్వ సాధారణం	0	1	2	3	4	5	6	7	8	9	10
4.5	In event of any conflicts, the conflict resolving mechanism are clear	0	1	2	3	4	5	6	7	8	9	10
	ఏవైనా సంఘర్షణలు తలెత్తిన సందర్భంలో సంఘర్షణల పరిష్కారయంత్రాంగాలను స్పష్టంగా ఉన్నాయి.	0	1	2	3	4	5	6	7	8	9	10
4.6	Conflicts between the members are common	0	1	2	3	4	5	6	7	8	9	10
	సభ్యుల మధ్య సంఘర్షణలు సర్వసాధారణం	0	1	2	3	4	5	6	7	8	9	10
4.7	The members of WUA in head-reach take more water	0	1	2	3	4	5	6	7	8	9	10
	నీటి వినియోగదారుల సంఘంలో ఎగువ ప్రాంతాలలోని సభ్యులు ఎక్కువ నీటిని పొందుతున్నారు.	0	1	2	3	4	5	6	7	8	9	10
4.8	Subjecting to social pressure is the common conflict resolution process	0	1	2	3	4	5	6	7	8	9	10
	సామాజిక ఒత్తిడికి గురిచేయడం అన్నది సమస్యా పరిష్కార ప్రక్రియలో సర్వసాధారణం	0	1	2	3	4	5	6	7	8	9	10

SECTION 5 - Respondent profile

విభాగం **5** - సమాధానాలు ఇచ్చిన వ్యక్తి వివరాలు

5.1. Your age group? Tick (✓)the appropriate

మీ వయోగ్రూపు (✓) సరైన గడిలో గుర్తు పెట్టండి.

1.	**18-24**	
2.	**25-34**	
3.	**35-44**	
4.	**45-54**	
5.	**55-64**	
6.	**65+**	

5.2. Highest level of education attained by you? Tick (✓) the appropriate

మీ అత్యధిక విద్యార్హత సరైన గడిలో (✓) గుర్తు పెట్టండి.

1.	Primary (up to 5th Std.)	ప్రాథమిక విద్య (**5**వ తరగతి వరకు)		
2.	Secondary (6-7th Std.)	సెకండరీ విద్యా (**6-7** తరగతులు)		
3.	High School (8-10th Std.)	ఉన్నత పాఠశాల (**8-10** తరగతులు)		
4.	Pre-university (year 11&12)	ప్రీ-యూనివర్సిటీ (ఇంటర్మీడియట్-**11 & 12**)		
5.	University Degree	విశ్వవిద్యాలయ డిగ్రీ		
6.	Postgraduate	పోస్ట్ గ్రాడ్యుయేట్		

5.3 Gender Tick (✓) the appropriate

స్త్రీ లేక పురుషుడు సరైన గడిలో (✓) గుర్తు పెట్టండి. (**1**) Maler/పురుషుడు (**2**) Female/స్త్రీ

5.4 Caste: Tick (v) the appropriate (1) Reddy (2) Brahmin (3) Other (Specify) _____

ఏ కులానికి చెందినవారో సరైన గడిలో (✓) గుర్తు పెట్టండి. (1) Reddy / రెడ్డి (2) Brahmin / బ్రాహ్మణుడు (3) Other (specify) /ఇతర (వివరించండి) _____

Appendix 16: Rotated factor loadings for socio-economic, demographic and perception-based variables

Variables	F_1	F_2	F_3	F_4	F_5	F_6	F_7	R^2
INATTUD	.011	-.420	.063	**.609**	-.071	-.307	-.109	0.663
KNOWLDGE	*.347*	*.092*	*-.208*	*-.135*	*-.138*	*.474*	*.454*	*0.640*
PRATTUD	-.049	.177	.018	**.747**	-.167	-.151	-.330	0.752
RLSCLEAR	*.477*	*-.123*	*.103*	*-.068*	*.416*	*.225*	*.013*	*0.482*
WTRFAIR	**.602**	.186	.046	.065	.128	.351	-.102	0.553
CONFMEMCOM	.245	**.834**	-.030	.171	.102	-.012	.060	0.800
CONFMEMB	-.153	.115	-.111	.011	**.821**	.024	.072	0.729
CONFRSLCLR	**.615**	.321	.012	-.191	.097	-.095	-.128	0.553
RLENFRCD	**.675**	-.042	-.170	-.141	.012	.217	.155	0.577
NGBRTRST	**.837**	-.164	.009	-.057	.044	.007	.128	0.749
ACCPTCOMMUN	**.812**	-.170	-.058	.043	-.144	.010	.009	0.714
COMMFAIRCONTR	**.759**	.242	.050	.037	-.126	-.028	.037	0.657
COMCOOPWTR	**.823**	-.032	-.038	.010	.231	.117	.054	0.750
AGEGRP	-.264	.112	-.121	.100	**-.696**	.223	.087	0.649
EDNLEVEL	.096	-.265	-.039	.078	-.140	**.631**	-.067	0.509
FMLYSZE	.058	.052	.119	-.012	.027	-.115	**.874**	0.798
FMNGINCOME	.076	-.063	-.138	**-.725**	-.074	-.132	-.228	0.629
FMGEXP	.073	.146	.037	-.137	.049	**.695**	-.030	0.533
ETHNGP	.454	**-.673**	.011	.122	.278	.022	-.018	0.752
GOVTRST	-.135	.076	**.879**	.077	-.065	.089	.065	0.819
WTRCOMTRST	.072	-.110	**.877**	.086	.071	-.117	.021	0.813
% of variance	**21.75**	**8.46**	**8.11**	**7.80**	**7.75**	**7.48**	**5.91**	**67.26**

Notes: Extraction method=Principal Component Analysis with Varimax rotation; F1-F7=Factor 1 to Factor 7; R^2=communalities; N= 128; Variables in italics had lower factor loadings and hence excluded from next analysis

Model's Fit:

KMO Measure of Sampling adequacy=0.734

Bartlett's test of sphericity: Chi-square (approx.) = 906.071; df = 210; Sig.= 0.000

Appendix 17: Rotated factor loadings for socio-economic, demographic and perception-based variables (*KNOWLDGE and RLSCLEAR* removed)

Variables	F_1	F_2	F_3	F_4	F_5	F_6	R^2
INATTUD	-.013	-.434	.068	**.607**	-.063	-.353	0.690
PRATTUD	-.062	.147	-.031	**.833**	-.141	-.140	0.760
WTRFAIR	**.608**	.160	.017	.106	.116	.335	0.532
CONFMEMCOM	.271	**.822**	.006	.173	.126	-.028	0.796
CONFMEMB	-.132	.117	-.063	-.053	**.813**	.042	0.701
CONFRSLCLR	**.605**	.303	-.051	-.107	.089	-.101	0.490
RLENFRCD	**.687**	-.033	-.130	-.208	-.058	.138	0.556
NGBRTRST	**.840**	-.179	.051	-.105	.040	-.005	0.753
ACCPTCOMMUN	**.816**	-.202	-.037	.040	-.098	.027	0.720
COMMFAIRCONTR	**.764**	.223	.063	.039	-.126	-.029	0.656
COMCOOPWTR	**.834**	-.059	-.004	-.017	.246	.121	0.774
AGEGRP	-.248	.142	-.096	.054	**-.754**	.173	0.692
EDNLEVEL	.112	-.269	-.054	.063	-.185	**.581**	0.464
FMLYSZE	*.112*	*.123*	*.386*	*-.372*	*-.095*	*-.245*	*0.384*
FMNGINCOME	.041	-.072	-.272	**-.554**	-.021	-.116	0.402
FMGEXP	.099	.141	.026	-.139	.023	**.750**	0.613
ETHNGP	.443	**-.692**	.028	.083	.276	.030	0.760
GOVTRST	-.148	.056	**.859**	.107	-.026	.122	0.790
WTRCOMTRST	.046	-.127	**.840**	.115	.075	-.098	0.752
% of variance	**22.49**	**9.34**	**9.04**	**8.83**	**7.93**	**7.02**	**64.65**

Notes: Extraction method=Principal Component Analysis with Varimax rotation; F1-F6=Factor 1 to Factor 6; R^2=communalities; N= 128; Variable in italics had lower factor loadings and hence excluded from next analysis

Model's fit:

KMO Measure of Sampling adequacy=0.715

Bartlett's test of sphericity: Chi-square (approx.) = 784.514; df = 171; Sig.= 0.000

Appendix 18: Application form and customer contract format (Virginia pipeline water)

APPLICATION AND CUSTOMER APPROVAL FOR NEW CONNECTION TO WRSV PIPELINE

FAX TO	Please authorize and send to the next recipient		
Approvals	1. Euratech Mr. P Neville 03 97912444	2. WRCS Mr. K. Smit 02 98957686	3. WRSV Mr. J. Collins 08 83809954
Signature			
1. Customer Name		2. Customer contact number	
3. Customer number		4. Contact person	
5. Address of supply			

Application Details				
6. Volume	a. Proposed Annual Quantity	_____megalitres	a. Proposed Minimum Daily Quantity	_____kilolitres

7. Show preferred location of outlet

↑
N

8. Connection located in (street)	Nearest intersecting street	Distance from nearest intersection	Located on which side of street
		_____metres	

9. WRSC assessed cost of change	Pipe and laying		Outlet and installation		Road crossings		Other works
Total Cost **$**_____	Pipe length		Outlet size		Number		
	$_____		**$**_____		**$**_____		**$**_____

10. **Customer approval**: I approve of the above connection cost. Attached is the connection deposit of _____ and I agree to pay the balance of _____on completion of the connection, which is the above cost of connection, less the deposit attached to this approval. On payment of this deposit and signing this approval my contract for water becomes unconditional.

Signature	Name	Date

APPLICATION FORM

1. Customer details	Under what name do you trade?	ACN number if a company	ABN

2. Property Owner Provide your name if you own the property, or if the property is owned by a partnership, names of each partner, or for a company, all company director names Surname	First and second names

3. Postal address Street/RMB/ Box			
Town		Postcode	

4. Address for all notices Same as above €	

5. Telephone	Home Telephone	Fax	Business or Mobile phone

6. How many individual property connection applications attached		If more than one connection are the properties contiguous?	

Individual Connection Application (one per connection)

You are required to identify each property and provide title details for each property, which will be supplied water by the connection.

Please complete a separate form for each property for which there is a separate connection.

Don't forget to phone us on 8380 9994 for assistance if you have difficulty in completing this form.

1. Property details for which a connection is required			
Street number or lot number and street	Town	Property title details	
		Volume	Folio

2. Other properties to be supplied with water from this connection outlet?
€2.1 No other properties will be supplied water from this outlet or:

2.2 Other properties to be supplied water from this connection outlet			
Street number or lot number and street	Town	Property title details	
		Volume	Folio

3. Preferred Location: At which point on your property boundary do you want the outlet for your connection located?				
Nearest road intersection	Distance from intersection	Direction from intersection (circle)		
		South	North	East
	_____meters	South East	North East	West
and		South West	North West	

<table>
<tr><td>4. Sketch map of where you want outlet?

(Show the street or road where your property is located, the nearest intersection and the position of your outlet. Be sure to indicate which side of the road you want the connection)</td><td colspan="4">↑North</td></tr>
<tr><td colspan="2">5. What is the approximate area to be irrigated?</td><td colspan="3">Acres _____or Hectares_____</td></tr>
<tr><td rowspan="2">6. If the property is leased or rented what are the contact details for the owner of the property?</td><td>Name and address</td><td colspan="2">Phone and fax</td><td>When can the lease or land rental expire?</td></tr>
<tr><td rowspan="2"></td><td>Phone:

Fax:</td><td></td><td>Earliest

Latest</td><td></td></tr>
<tr><td>7. Is the owners/lessors consent attached?</td><td>Yes \ No</td><td colspan="2">8. How much on farm storage will you have?</td><td>Megalitres_____
Kilolitres_____</td></tr>
<tr><td rowspan="2">9. How much water do you want?

(see brochure for explanation)</td><td>9.1 Annual Contract Quantity in kilolitres</td><td colspan="3">_____kilolitres</td></tr>
<tr><td>9.2 minimum Daily Quantity in kilolitres [0.54% of Annual Contract Quantity (9.1)]</td><td colspan="3">_____kilolitres</td></tr>
</table>

Undertaking by customer

I/ We agree to be bound by this contract including the attached Schedules.

To: Water Reticulation Systems (Virginia) Pty Ltd, (WRS(V)).

I/We (please print)_____

_____

_____

apply for an allocation of water for the purposes of irrigating the property or properties set out in the attached forms.

1. I/we acknowledge that by signing this application form that offer becomes unconditional on the basis that a separate contract will be entered into in relation to each connection.

2. Upon this offer being accepted in writing by WRS(V) in accordance with above, the Customer acknowledges that he/she/they will be bound by the contract and any variations thereof agreed between the Customer and WRSV.

This contract comprises:

this application

the water contract approval form;

the Virginia Pipeline Amended Customer Rules July 1997.

3. As an applicant I, or if the applicant is a partnership, each partner:

3.1 Consents to WRS(V) obtaining from credit reporting agencies, credit reports containing personal information for the purpose of assessing the credit worthiness of the Applicant;

3.2 Consents to WRS(V) obtaining from any other credit providers from time to time for the purpose of reviewing and assessing the Applicants commercial credit-worthiness;

3.3 Acknowledges that these authorisations will continue to remain in force and effect until such time as the Applicant ceases to be a customer of the WRS(V) and all amounts owing by the Applicant to WRS(V) have been paid in full.

4. I acknowledge that WRS(V) may not accept an offer.

5. Delete that which is **not** applicable

€ I/We am the owner, (registered proprietor), of all the land for which the water Application is made or,

€ I/We have obtained the Lessors consent to this Application on the terms and conditions set out below

6. **Applicants declaration and signature.**

As the applicant, I. or if the applicant is a partnership, each partner, warrants that the information in this application is complete, true and correct.

If the entity contracting is a company please complete sections 6.a and 6.b below. If not a company complete only section 6.b

6.a Signed on behalf of _____Pty Ltd (name of company)
ACN _____by _____ (print name and position in company)

6.b Signature COMPANY SEAL
(if applicable)

Signed _____ Signed _____
Name _____ Name _____
Date _____ Date _____

7. **Lessors consent**

I/we am the owner of the property identified in the attached Schedule which land is leased to the Lessee(s) named above.

By signing this Application I/We acknowledge that I/we have read and understood the contract that accompanies this Application. By signing this application we agree to be bound as a customer under this contract for the balance of the Contract period should the lease or other rental arrangement terminate for any reason or should the lessee be unable to meet the obligations of the Contract.

If the lessor is a company please complete the section 7.a and 7.b below. If not a company complete only section 7.b.

7.a Signed on behalf of _____Pty Ltd (name of company)
ACN _____by _____ (print name and position in company)

7.b Signature COMPANY SEAL
(if applicable)

Signed _____ Signed _____
Name _____ Name _____
Date _____ Date _____

Where the owner or the lessee of the land is a company the above signatories are to be responsible officers of the company or, in the case of partnerships, all partners to the partnership.
(Please attach an extra page if there is not enough space for all signatures)

APPLICATION FORM AND CUSTOMER CONTRACT
VIRGINIA PIPELINE WATER

Please forward the completed application form to:
WRSV, Box 926,
Virginia, South Australia 5120

BEFORE SENDING YOUR APPLICATION MAKE SURE THAT:

All details required in the application form are correct

The Volume and Folio number for your property is correct

All properties for which you require water have been properly listed

For leased or rented land you have obtained the approval and signature of the property owner

You have completed both the contact information section and the section about each property

You have shown how much storage you intend to install

You have shown both the Annual Contract Volume you are requesting and the corresponding Minimum Daily Quantity

If you have any questions or you need another application form please contact WRSV on (08) 8380 9994