AGEING PIPES AND MURKY WATERS

Urban water system issues for the 21st Century

Office of the

PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT

Te Kaitiaki Taiao a Te Whare Pāremata

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Investigation Team
Phil Hughes (Team leader) BSc, BA, MRRP (Dist), MNZPI

With assistance from

Ronda Cooper	BA (Hons), MA
Julie Haggie	BA, Dip Tchg
Sarah Ireland	BSc, LLB (Hons)

Legal consultant
Rob Goldsbury, Barrister, Wanganui

Researcher
Katie Nimmo, Victoria University of Wellington

Illustrations and cover
Juliet Cooke, designer, cookejc@xtra.co.nz

Internal reviewer
Ewan Gebbie BForSc, MBA (Otago)

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Preface

The supply of adequate drinking water, and the removal of polluted waters, are the two most fundamental needs of towns and cities. Without them cities rapidly become uninhabitable, as history records.

The physical designs of our current water systems have their origins in the 19th century; institutional arrangements have evolved throughout the 20th century. In New Zealand, both appear to have been built on some fundamental assumptions. Physically, water supply and removal models have assumed abundant water resources, and the ability to treat and dispose of any amount of polluted waters. Institutionally, water supply has largely been considered a public good; a basic human right. There is increasing tension with this view/belief as alternative business models are developed to manage water services.

Both the physical and institutional picture that my team has assembled in this discussion paper convinces me that a major redesign is needed. The evidence is compelling and there is a wide spread consensus that this is so among those who are grappling with day-to-day operations. This does not imply a massive failure of the current system but rather a recognition that as knowledge grows, and needs change, so does the way we do things benefit from major reshaping.

Our water systems are like the piston and propeller aircraft and the airlines they spawned from the 1930s. Consider the transition from these aircraft and airlines to todays. We now have a mature generation of jet aircraft and global airline alliances that weave a vast world air transport network. This transition has involved a series of redesigns. While our water systems have been evolving over the years, I believe industry and community evidence indicates that the 'model' has now reach the end of its design life. Further incremental tinkering with the current systems, without going back to first principles of community water and wastewater needs relevant to the 21st century, will simply mean the necessary changes will be harder to achieve and more costly at some time in the future. It is also likely that they will be crisis driven which is never a good substrate for national strategic planning and cost-effective investment. Remember Auckland's water and power crises in the 1990s. They were both partly the products of dated physical systems and narrowly-focused institutions.

So much for the rhetoric. What is some of the evidence that redesign is due? I would recommend reflection on the following. In New Zealand's climate we need a mere two litres of drinking water each day to keep us alive and healthy. Many of us now choose to purchase some or our entire liquid intake as bottled waters, milks, juices, Coke, and other packaged beverages. However we have water networks that deliver, on average, over 400 litres per person per day of potable water for all domestic, commercial and industrial purposes. The system's main arteries are often not designed for just delivery of potable water but other requirements such as fire fighting. Thus pipes are larger and pressures higher. Most potable water is contaminated during use and then requires treatment. As demand for water has increased over the years the emphasis has been on simply supplying more with little focus on reuse options. This approach has, of course, major infrastructure implications. Most of the cost of water supply and disposal are tied up in transport networks. Yet we continue to mostly pursue supply policies that aim to deliver ever more water with insufficient focus on its true cost (value) and a marked resistance by domestic consumers to be charged, on the basis of amounts used or disposed of. This supply side focus, and poor costing of water supply and removal, has also led to a failure to adequately integrate the management of the four water classes (drinking, grey, black and storm). Better integration is essential if the sustainability of our water systems is to improve.

This is all obvious stuff well known to those in the water/wastewater world, but what does the evidence suggest to me, that we need to focus our redesign efforts on? The following would be on my "getting started" shortlist:

- Developing a detailed understanding of community and business expectations, and knowledge, about the current system and future water management needs and options. There are major tensions between some communities and councils over current or proposed ownership and delivery models. Privatisation fears are limiting vision and constraining dialogue. Until these tensions and fears are resolved, and there is some community consensus on needs and options, few water opportunities will be realised.

- Better quantification of water supply and disposal costs; ecological and monetary. In this context we have to acknowledge the bizarre way society values water; around $2.50 per litre in a bottle but an expectation that there is the right, in return for some rates, to have 'unlimited' water from taps for all purposes.

- Critical assessment of the current orthodoxy that one water quality (potable) is the most effective way of meeting the needs of communities, and the environment, while waste and stormwaters are a liability rather than a potential asset.

- A 'gaps' analysis of water and wastewater research and development in New Zealand inclusive of social and economic research.

Addressing these matters, and the others identified in this discussion paper, requires more than a 'band-aid' approach. Implementation of new physical and institutional systems **will** take some time. However, it is no good starting on the journey without a clear understanding of needs and opportunities, clarity of what we want from our future systems and a good 'road map' of how we intend to get there.

I now invite comment on the issues my team, and I have raised and the conclusions I have drawn. Following your responses I will develop a series of recommendations to responsible public authorities if I believe it will help advance urban water management.

Dr J Morgan Williams
Parliamentary Commissioner for the Environment

Summary

What is this investigation all about?
Since 1998 the Parliamentary Commissioner for the Environment has been identifying critical urban water system issues and monitoring progress with the national water services review, currently led by Local Government New Zealand.

Well-maintained water systems are the most critical of the many services that make urban living possible, yet most citizens tend to take them for granted. Improving the sustainability of our cities and towns, and ensuring our 'clean, blue and green image' is a reality, necessitates some major redesign of current infrastructure and organisational models if environmental standards are to be maintained cost-effectively.

In accordance with section 16(1)(b) of the Environment Act 1986, **the purpose of this investigation is to identify the key sustainability issues and significant risks affecting the sustainable management of urban water systems.** This discussion paper raises a series of issues and questions. Further work may be undertaken depending on responses to this discussion paper and progress with the current national water services review.

What are urban water systems?
Urban water systems are the natural, modified and built water systems that exist in towns and cities. These two systems are interconnected and interact in both positive and negative ways. The functions provided by the built system of water supply, wastewater and stormwater infrastructure are commonly referred to as water services.

Water is central to all life and access to water is a basic human right. Natural water systems provide ecosystem services, maintain the 'health' of streams and rivers, provide habitat for flora and fauna, water for urban water supplies, amenity values, and are used for a range of recreational purposes. Built water systems supply potable water, safeguard life and property from flooding, and remove, treat and dispose of waste.

An important but often unrecognised dimension of the urban water cycle is the provision of ecosystem services. Ecosystem services are the functions carried out by nature that maintain, for example, water, carbon, and oxygen cycles, which in combination with a vast array of other ecological functions, support life, including human. Towns and cities directly and indirectly benefit from ecosystem services such as water supply and waste assimilation. Increased recognition and understanding of the role of the many ecosystem services is required and the value of these services needs to be factored into decision-making.

The role of local authorities in water services
Local authorities have a number of roles in terms of the management of urban water systems and water services including: infrastructure owner, customer representative, service provider, and regulator. Concern has been expressed about the multiple and potentially conflicting roles of local authorities with unclear responsibilities, blurred accountabilities, lack of customer choice, and lack of commercial focus. The lack of an appropriate legislative framework that applies to all water services providers has led to proposals for a consolidated Water Services Act.

Around 85% of the population receives water, wastewater and stormwater services from local authorities. Local authority water and wastewater infrastructure is valued at approximately $7.5 billion with around $600 million spent on operational costs each year. It has been estimated that around $5 billion of investment will be required over the next 20 years to upgrade water, wastewater and stormwater infrastructure.

Urban water systems and tikanga Maori
Maori have always valued water, naturally, for its practical usefulness, for drinking, mahinga kai, transportation and irrigation. Water is also a taonga for its spiritual and metaphysical properties, and is central in ritual and healing processes. These levels, the practical and the spiritual, are bound together within the mauri or life-force, which empowers all living things and is integral to the mana and lifeblood of iwi, hapu and whanau.

The current legislative framework provides a strong basis for tangata whenua participation in policy and plan development, and management of the environment, at both central and local government levels.

What are the challenges for urban water systems?
There are a number of key challenges for the management of urban water systems common to all towns and cities. They include environmental, social and economic dimensions but many of the underlying causes are interrelated and overlapping.

One of the biggest challenges will be reaching consensus between the various stakeholders on the environmental, social and economic goals and values of urban water systems. Without much more extensive community input, and greater understanding of water management options, improving the sustainability of current systems will be very difficult and painfully slow.

Other major challenges include:
- inadequate water flows from excessive and inefficient water use;
- contamination of surface waters and groundwater from uncontrolled or poorly managed stormwater drainage and wastewater disposal;
- consumers and ratepayers have increasing expectations about the provision and quality of water services but there is often a negative reaction to large rate increases or increased charges to fund required infrastructure;
- a lack of awareness and understanding of the value of urban water systems and the costs of improving water supplies, and wastewater and stormwater management;
- poor recreational and bathing water quality, and poor information disclosure;
- lack of investment and deferred maintenance, in part through incomplete pricing and inadequate financial contributions from new urban developments;
- institutional and regulatory barriers to improved management; and
- potential risk of infrastructure failure.

Opportunities for progress
There are a number of opportunities for progress with the management of urban water systems. These include:
- demand management and least-cost planning: in practice this will involve a package of measures including regulation, economic instruments, information and education, along with measures which directly address production as well as consumption patterns;
- catchment management planning: integrated management of land uses in catchment areas is critical in ensuring high quality water supply. The natural processes of ecosystems in terms of fresh water provision need to be recognised, valued and managed because the alternative is often more expensive filtration and treatment of water supplies assuming that the technology is available; and
- more integrated management of water services with efficient water use, recycling and reuse. Solutions are needed to support more efficient use and to recognise the important linkages between the different water services components of water supply, treatment, use, and disposal of wastewater and stormwater.

What is being done at present?
In November 1998 the Government announced a comprehensive review of the delivery of water, wastewater (sewerage and trade waste) and stormwater services. In July 1999, Local Government New Zealand was given the opportunity to co-ordinate the review of water services in New Zealand on behalf of local government. While some work on a number of water-related issues has been slowly progressing, work on the national review has now been placed on hold pending ongoing discussions with the Government about future directions.

The Ministry of Health (MOH) and Ministry for the Environment (MFE) have both been undertaking a number of water-related legislation and policy reviews:
- MOH has been reviewing and developing new Water Supplies Protection Regulations to replace the outdated 1961 regulations. MOH has also been undertaking a pilot study in the Hokianga area to assist with the local provision of water supply systems.
- MFE has been developing a long-term national agenda for sustainable water management. Urban water issues were identified as one of three key themes and are accorded a high

priority. MFE is also co-ordinating a four-year microbiological research programme to provide the scientific basis for guidelines on managing water used for bathing and drinking water.

Future evolution of more ecologically sustainable and economically viable water services
There is a compelling need to develop a clearer understanding of the sustainability implications for urban water systems and to develop pathways towards achieving identified and widely-supported goals. Essentially this will mean planning, developing and operating urban water systems in harmony with the natural water cycle and encouraging more efficient resource use. This can be contrasted with the traditional approach to urban water systems with large pipes and treatment plants; a very linear system with few feedback loops and reuse.

It is essential that progress is made with the national water services review. Redesigning the current framework to capitalise on known innovations will inevitably bring a long period of incremental transitions from present to future systems. If the review does not proceed then there will be increased risks of continued variation in management responses and variable environmental, economic and social outcomes. The journey is a long one and immediate action is needed to chart a new course.

Glossary

Aquifer	a geologic formation that will yield water to a well in sufficient quantities; permeable layers of underground rock or sand that hold or transmit groundwater below the water table.
Biosolid	sewage sludge, treated sufficiently so as to be suitable for beneficial reuse.
Blackwater	wastewater from toilet flushing, and from sinks used for food preparation or disposal of waste.
Combined sewer	a sewer system that carries both sewage and stormwater.
Contact recreation	activities involving a significant risk of ingestion of water such as swimming, water skiing and surfing.
Ecosystem	a biological system comprising a community of living organisms (including humans) and its associated non-living environment, interacting as an ecological unit.
Ecosystem services	the functions performed by ecosystems that ensure natural cycles (eg water, carbon, oxygen, and nitrogen), processes and energy flows continue to provide an environment that supports life, including human life. Ecosystem services such as fresh water from catchments and wastewater assimilation by wetlands represent the benefits that people derive, directly or indirectly, from ecosystem functions. These natural services from ecological systems are critical for the continued functioning of urban areas.
Effluent	generally refers to wastewater from sewage treatment or an industrial process.
Externality	(or external cost) something which affects a buyer’s or seller’s utility or profit which is not included in the price of goods and services exchanged in the market eg the environmental and health costs of water pollution.
Faecal coliform	the portion of the coliform bacteria group which is present in the intestinal tracts and faeces of warm-blooded animals. A common pollutant in water.
Greywater	wastewater from clothes-washing machines, showers, baths, and sinks that are not used for disposal of waste.
Groundwater	water within geologic formations that can emerge at thesurface through wells and springs.
Impervious	the quality or state of being impermeable eg to penetration by water. Impervious surfaces like concrete and asphalt affect the quantity and quality of runoff.
Instream use	use of water that does not require withdrawal or diversion from the natural watercourse eg the use of water for habitat for fish and wildlife, navigation and recreation.
Kaitiaki	iwi, hapu or whanau group with the responsibilities of kaitiakitanga.
Kaitiakitanga	the responsibilities and kaupapa, passed down from the ancestors, for tangata whenua to take care of the places, natural resources and other taonga in their rohe, and the mauri of those places, resources and taonga.

Kawanatanga	government, the right of the Crown to govern and make laws.
Mahinga kai	places where food and other resources are traditionally gathered.
Mana	respect, dignity, status, influence, power.
Matauranga Maori	Maori traditional knowledge.
Mauri	essential life force, the spiritual power and distinctiveness that enables each thing to exist as itself.
Non-contact recreation	recreational pursuits not involving a significant risk of water ingestion, including fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity.
Non-point source	a source of pollution in which wastes are not released at one specific identifiable point but from a number of points that are spread out and difficult to identify and control eg stormwater pollution from many points.
Non-potable	water not safe or suitable for drinking.
Outfall	the place where a wastewater treatment plant discharges treated wastewater into the environment, generally into a receiving water.
Papatuanuku	the ancestral elemental Mother, the earth, the land.
PBT	persistent, bioaccumulative, and toxic pollutants (PBTs) are highly toxic, long-lasting substances that can build up in the food chain to levels that are harmful to human and ecosystem health. They are associated with a range of adverse human health effects, including effects on the nervous system, reproductive and developmental problems, cancer, and genetic impacts. PBTs include mercury, dioxins, DDT, and polychlorinated biphenyls (PCBs).
Potable	water safe or suitable for drinking.
Primary treatment	mechanical treatment in which large solids are screened out and suspended solids in the sewage settle out as sludge.
Rangatiratanga	rights of self-regulation, the authority of iwi and hapu to make decisions and control resources.
Receiving waters	a river, ocean, stream, or other watercourse into which wastewater is discharged.
Reclaimed water	domestic wastewater that is under the direct control of a treatment plant owner/operator which has been treated to a quality suitable for a beneficial use.
Rohe	geographical territory customarily occupied by an iwi or hapu.
Rongoa	plants traditionally used for medicinal purposes.
Runanga	committee of senior decision-makers of an iwi or hapu.
Secondary treatment	second step in most waste treatment systems, in which bacteria break down the organic parts of sewage wastes.

Septic tank	underground receptacle for wastewater from a home. The anaerobic bacteria in the sewage decompose the organic wastes, and the sludge settles to the bottom of the tank. The effluent flows out of the tank into the ground through drains.
Sludge	solid matter that settles to the bottom of sedimentation tanks in a sewage treatment plant and must be disposed of by digestion or other methods or recycled to the land.
Stormwater discharge	precipitation that does not evaporate or infiltrate into the ground due to impervious land surfaces but instead flows onto adjacent land or watercourses and into drain or sewer systems.
Tangata whenua	the people of the land, Maori people.
Taonga	valued resources, assets, prized possessions both material and non-material.
Tapu	sacredness, spiritual power, force or prohibition.
Tertiary treatment	removal from wastewater of trace elements or organic chemicals and dissolved solids that remain after primary and secondary treatment.
Tikanga	customary correct ways of doing things, traditions.
Trade waste	any liquid discharged from trade premises in the course of any trade or industrial process but not including condensing water, surface water or domestic sewage.
Turangawaewae	home, ancestral area or marae, literally "a place to stand".
Wai	water.
Waiata	songs, lyrics.
Wahi tapu	special and sacred places.
Wastewater	water containing waste including greywater, blackwater or water contaminated by waste contact, including process-generated and contaminated rainfall runoff.
Water cycle	the natural pathway water follows in changing between liquid, solid, and gaseous states as it moves in various forms through the ecosphere. Also called the hydrologic cycle.
Whaikorero	oratory, speeches.
Whakapapa	genealogy, ancestry, identity.
Whakatauki	proverbs, sayings.
Whanui	broad general collective of the iwi.

Acronyms

CRI	Crown Research Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
ESR	Institute of Environmental Science and Research Ltd (a New Zealand CRI)
FORST	Foundation for Research, Science and Technology
LATE	Local authority trading enterprise
MFE	Ministry for the Environment
MOH	Ministry of Health
MORST	Ministry of Research Science and Technology
NASWAM	National Agenda for Sustainable Water Management
NIWA	National Institute for Water and Atmospheric Research (a New Zealand CRI)
PCE	Parliamentary Commissioner for the Environment
PGSF	Public Good Science Fund
RMA	Resource Management Act 1991
SPO	Strategic Outline Portfolio (developed by FORST to guide the development and investment in research programmes)

Responses to this discussion paper

The purpose of this discussion paper is to identify key sustainability issues and significant risks affecting the sustainable management of urban water systems.

Responses to the discussion paper are welcomed particularly in terms of the series of nine issue boxes identified in the report. These responses should be sent to:

Dr Morgan Williams
Parliamentary Commissioner for the Environment
PO Box 10-241
Wellington

or: pce@pce.govt.nz

By 29 September 2000.

A series of recommendations for future action (based on this discussion paper and the responses to it) may be prepared and provided to responsible public authorities in the future.

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1. Introduction and overview

1.1 What is this investigation all about?

The 1998 Parliamentary Commissioner for the Environment report *The cities and their people. New Zealand's urban environment* discussed a range of issues affecting the management of urban ecosystems and the sustainable development of New Zealand's cities and towns. The report identified "the management of urban water systems including the integrated management of the delivery of water and the management of wastewater and urban stormwater consistent with sustainable development" as a broad priority for future investigation. This was because of the stresses in current systems and the critical importance of water management to ecological sustainability and economic vitality of New Zealand towns and cities (Parliamentary Commissioner for the Environment 1998).

Since 1998 the Parliamentary Commissioner for the Environment has been identifying critical urban water system issues, examining new and innovative approaches towards the management of urban water systems (eg a study tour to Eastern Australia in May 1999), and observing progress with the different stages of the national water services review (see section 4.1.1). This work has provided the basis for this investigation.

Purpose of the investigation
In accordance with section 16(1)(b) of the Environment Act 1986, the purpose of the investigation is to identify the key sustainability issues and significant risks affecting the sustainable management of urban water systems. It is intended that the investigation will inform, stimulate debate, encourage the consideration of alternative approaches, and contribute to the resolution of urban water system issues. Responses to the paper and the issues that are raised are requested in section 5.3.

Terms of reference

i. to identify key sustainability issues and significant risks affecting the management of urban water systems; and
ii. to report on the outcomes of the investigation, in the form of a discussion paper, to relevant public authorities by 30 June 2000.

This investigation does not focus on or examine the issue of ownership of water services. The various issues that are raised <u>are significant in their own right</u> and need to be addressed, regardless of any community decision about the future ownership of water services in different areas.

Urban water systems = Natural water systems + Built water systems
Urban water systems = (streams, rivers, wetlands, estuaries) + (dams, pipes, treatment plants, outfalls)

Investigation process
As part of the investigation, a one-day workshop was held in Wellington in May 2000 to allow for a number of interested individuals to consider a draft discussion paper and provide feedback to the Parliamentary Commissioner for the Environment. The members of the urban water systems working group are listed in appendix 1.

The development of a discussion paper is **stage one** of the investigation. A decision on whether to proceed with a more detailed **stage two** investigation will be made after responses to the stage one discussion paper are received (see section 5.3), and with due consideration of progress with the national water services review being undertaken by Local Government New Zealand (see section 4.1.1). If progress is achieved, then the Parliamentary Commissioner for the Environment may not need to become involved with a full-scale stage two investigation, but instead may focus on providing targeted input to the national water services review and/or providing recommendations to responsible public authorities.

1.2 What are urban water systems?

1.2.1 Urban water systems and the urban water cycle

Urban water systems are the natural, modified and built water systems that exist in towns and cities in New Zealand. The natural system includes the network of streams, rivers, groundwater, wetlands, estuaries, coastal and marine areas. The built system includes the network of water supply reservoirs, water supply plants, pipes, concrete channels, drains, wastewater treatment plants and outfalls. The functions provided by the built system of water supply, wastewater and stormwater infrastructure are commonly referred to as **water services**.

These natural and built systems are interconnected and interact in both positive and negative ways as part of a much larger urban ecosystem (see section 3.1). For example, the natural water system replenishes water supply reservoirs and aquifers, and streams and wetlands remove and can process stormwater from urban areas. However, excessive water take in times of drought, or discharges from wastewater systems, results in adverse environmental effects on the natural water system and the community. Urban water services, particularly sewers and stormwater services, transport and redirect nutrients, and persistent pollutants such as heavy metals and organic chemicals. These infrastructural functions can impact significantly on the natural material flow processes of urban ecosystems and adjacent rural ecosystems.

Urban water systems are part of a much larger urban ecosystem which has environmental, social and economic dimensions (see section 3.1). People and communities are part of an urban ecosystem and are the primary consumers of energy, water and material flows with resulting waste flows and emissions into the environment. Activities in water catchment areas can significantly affect the quantity and quality of waters which pass through to downstream users.

Particular government agencies, local authorities, tangata whenua, organisations, and stakeholder groups, and the related governance, regulatory and market frameworks are integral components of urban water systems.

The urban water cycle
The urban water cycle includes the natural water cycle, plus urban water flows from the provision of fresh water and the collection and treatment of wastewater and stormwater ie water services (see figure 1.1).

The urban water cycle begins where the water enters urban catchments[1]. Water then flows above and below ground through streams, rivers and groundwater flows to reach lakes, wetlands, estuaries, aquifers and water supply reservoirs. Water supplies are treated and piped to consumers to be used for a variety of residential, commercial and industrial purposes resulting in wastewater flows.

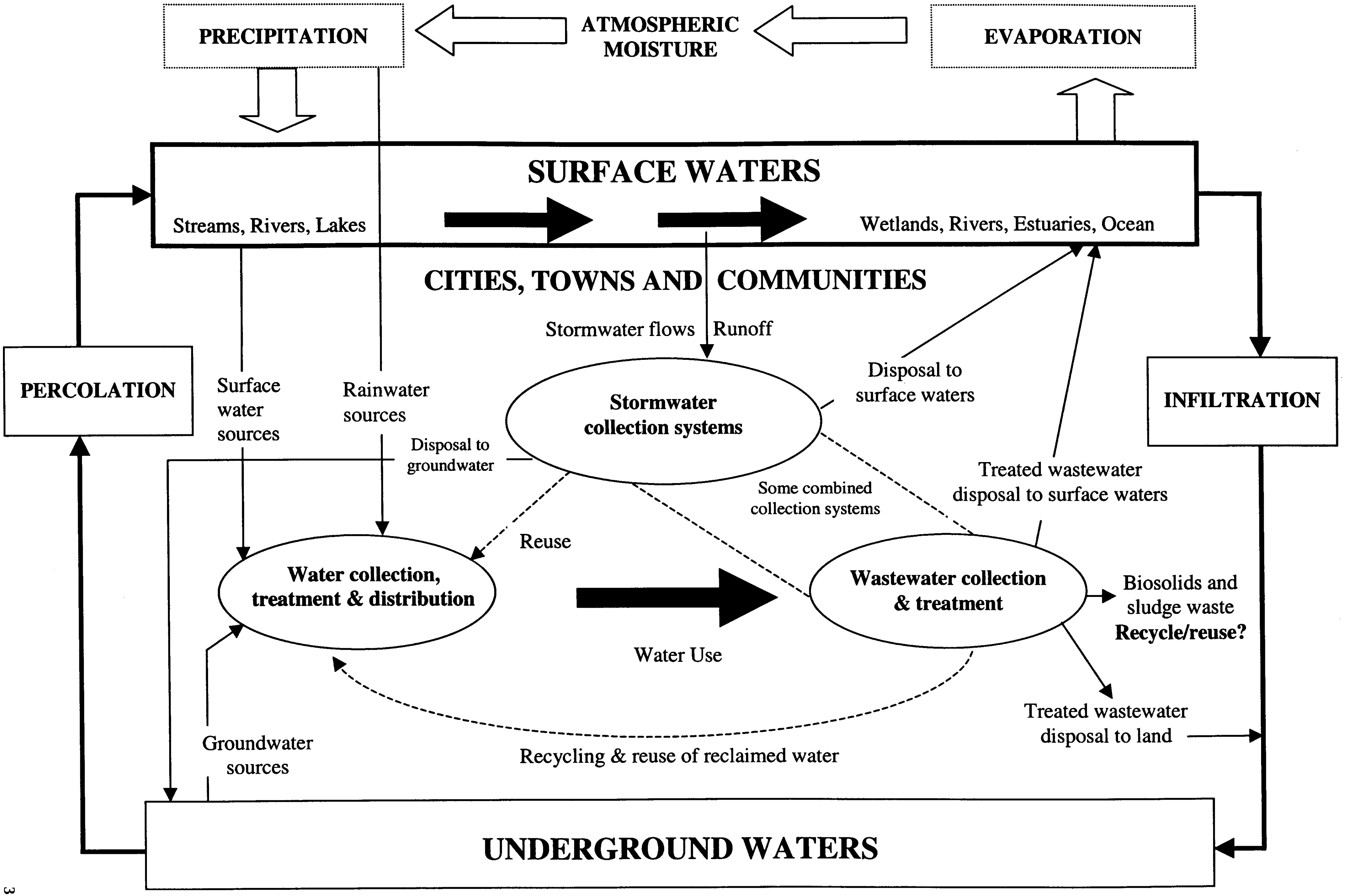
Stormwater flows from impervious surfaces (eg roofs, car parks and roads) are removed from urban areas in streams, pipes and channels to prevent flooding. At times stormwater infiltrates wastewater flows resulting in combined sewer overflows and pollution of the environment as well as extra loads at wastewater treatment plants.

Treated wastewater flows are discharged back to the water environment via outfalls to streams (eg Tokoroa), rivers (eg Hamilton), harbours (eg Auckland), estuaries (eg Christchurch) and the ocean (eg Hutt Valley, Wellington). In some cases natural (eg Paihia) or artificial (eg Whangarei, Taumarunui, Tauranga) wetlands are used as a buffer between the treated wastewater discharge and the environment and for cultural reasons. Land disposal of treated wastewater is used by some middle-sized and smaller communities (eg Rotorua, Taupo, Levin, Whangamata), and in a few instances reclaimed water from treated wastewater is being used for landscape irrigation (eg Tauranga).

Organic sludge solids arising from wastewater treatment processes can be: disposed of as waste to landfills; or treated and recycled to land directly or through composting (eg the Living Earth venture in Wellington); or digested to produce methane. Digestion of solids is common in larger treatment plants where the energy from the resulting gas can then be used for other purposes eg to provide electricity.

The production of these organic sludge solids illustrates the significant cross-media issues that can arise from the treatment of wastewater. Higher levels of treatment to

Figure 1.1 The urban water cycle



reduce impacts on receiving waters generates more solids that remain to be returned to land or disposed of in landfills. Sludge treatment, disposal and reuse will bring cross-media effects on land, water and air.

Every urban water cycle is part of a much larger regional and global water cycle that is affected by global processes such as El Nino and climate change. These global processes provide additional risk factors for the management of urban water systems with increased climatic perturbations and extreme weather events (ie severe droughts and storms).

1.2.2 The 'value' of water

Water is central to all life. Access to clean water is a basic human right. Urban water systems and water services that function well play a vital role in ensuring the health and safety of the community, a productive economy and a healthy environment. The future management of urban water systems and water services is central to whether New Zealand's towns and cities become more ecologically sustainable in the future.

Water is a valuable asset if it is able to be collected or maintained as usable water, but it is a liability as polluted wastewater or stormwater. Hence, there is increasing recognition of the need to minimise the impacts from treated wastewater discharges and stormwater, and to maximise restorative processes that maintain water quality at levels appropriate to its subsequent uses for supply, recreation, and the environment. This is leading to new approaches which seek to keep separate fresh water, greywater and blackwater flows, to maximise the value and potential use of each water, and ultimately to reduce treatment costs and impacts on the environment.

An important but often unrecognised dimension of the urban water cycle is the provision of ecosystem services. Ecosystem services are the functions carried out by ecosystems which ensure natural cycles (eg water, carbon, oxygen, and nitrogen), processes and energy flows continue to provide an environment that supports life, including human life. Towns and cities directly and indirectly benefit from ecosystem services such as water supply and waste assimilation.

As cities have grown and infrastructure has been built, the contribution from natural ecosystem services has been reduced. Water flows are altered by reservoirs, and urban water use reduces the amount of water available for the natural functions of ecosystems; wetlands are drained and built on which then increases the need for flood management and wastewater treatment. Increased recognition and understanding of the role of ecosystem services is required and the value of these services needs to be a factor in decision-making (see section 3.4 for further discussion).

How do communities benefit from urban water systems?

Water is essential to maintain human life. Natural water systems provide ecosystem services, maintain ecological flows, provide habitat for flora and fauna, water for urban water supplies, amenity values, and are used for a range of recreational purposes. Water systems are of cultural and spiritual significance to tangata whenua and provide natural resources such as mahinga kai. Built water systems protect public health, remove waste, safeguard life and property from flooding, and reduce pollution of the environment. Well-managed water systems provide considerable public health benefits and reduce the incidence of water-borne diseases for consumers of water and those who are in contact with polluted receiving waters.

In economic terms, water and wastewater services have a range of public and private good characteristics.[2] Water is a public good because of the community, health and environmental benefits from well-managed water and wastewater systems. Water is a private good because consumption by one person prevents consumption by another. In theory, people can be excluded from consumption of water services although this is not allowed because of health impacts and legislative requirements.

Figure 1.2 The different values of urban water systems

Urban water supplies
The Ministry of Health maintains a register of community drinking water supplies in New Zealand. In 1999 New Zealand had 1,703 registered community drinking water supplies[3] serving around 85% of the population.

The management of microbiological quality of drinking water, including bacteria, viruses and protozoa, is an important factor in maintaining public health. During 1998, 81% of the population was supplied with drinking water that complied with the microbiological guidelines in the Drinking Water Standards for New Zealand 1995. The survey reported that there was an increase in the number of large suppliers who failed to provide adequate monitoring, and an increase in the number of registered water supplies, with an overall nationwide drop in demonstrated compliance with the guidelines (Ministry of Health 1999).

Average daily water supply to urban areas in New Zealand is around 400 litres per person per day for all uses. This includes domestic (indoor and outdoor), commercial, industrial and public uses which vary for different cities depending on the mix of those uses.[4] The supply is significantly affected by the type and size of local industries and their use of the public water supply, together with summer climate conditions and the extent of public open space and private garden watering. Water loss from leaking pipes can be a major issue for some water service providers (eg up to 20% of supply).

Domestic water use in New Zealand, Australia and England is shown in table 1.1.

Table 1.1 Domestic water use in New Zealand, Australia and England

Country	Domestic water use (average range)
New Zealand	180-300 litres per person per day. Christchurch ~ 250l/p/d (150l/p/d for internal use); Waitakere City ~ 200 l/p/d; Auckland City ~ 190 l/p/d
Australia[1]	~ 270 litre per person per day (294 kL/year per household). Sydney ~ 215 l/p/d (237 kL/year/hh); Melbourne ~ 200 l/p/d (218 kL/year/hh); Bribane ~ 310 l/p/d (340 kL/year/hh)
England[2]	~ 380 litres per person per day; Anglian Region ~ 211 l/p/d for one person households; ~ 130 l/p/d for a three person households (total of 390 l/d per household)

1 Australian Bureau of Statistics 2000

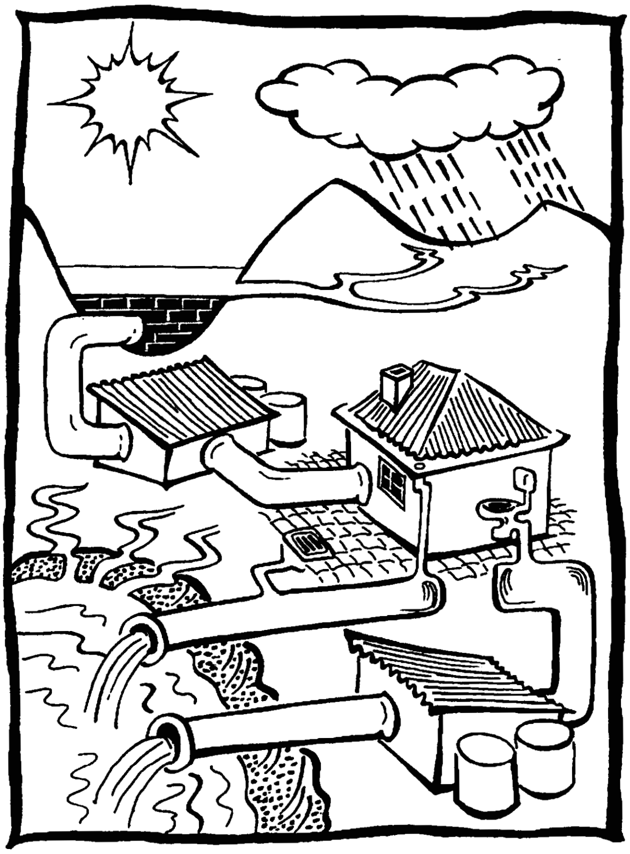
2 Department of the Environment, Transport and the Regions 1997 and Anglian Water annual survey reported in Parliamentary Office of Science and Technology 2000

The Anglian Water survey in England found that per capita consumption decreased with increasing household size. In a single person household, per capita water consumption was 40% greater than in a two-person household, 73% greater than in a four person household and over twice that in households of 5 or more people. This is important as much of the projected growth in households is expected to be from single person households. This is where efforts to manage demand would be most effective. These findings may be similar in New Zealand.

In New Zealand the source, availability, quality, treatment and particular characteristics of potable water varies for each local authority area. Christchurch obtains most of its water from underground aquifers while most other cities including Auckland, Hamilton, Tauranga, Wellington, Nelson and Dunedin rely on surface waters and reservoirs. Some New Zealand cities and towns have summer water restrictions because of reduced flows.

Figure 1.3 Examples of urban water use

Figure 1.4 The traditional approach to water services



1.2.3 The role of water services

As urbanisation has steadily increased in New Zealand, the conventional approach to the provision of water services has been to collect and pipe in a water supply from the purest source available within a reasonable distance from the town or city. The majority of this potable water has then been used to transport wastes out of the city and back into the natural environment. At the same time, the management of stormwater has the primary goal of removing the stormwater from the city as quickly as possible to the nearest stream, river or sea to prevent localised flooding.

In terms of human health, the building of water services infrastructure has achieved the primary goal of drastically reducing water-borne infectious disease in urban populations. However, as urban populations have continued to increase, with increasing water use, other impacts of this approach have become apparent.

A large amount of capital is invested in urban water infrastructure and this cost is becoming a greater burden to local authorities as they face the requirement to renew and/or replace old and deteriorating systems. Many local and easily sourced water supplies have now been fully utilised and new sources will often be more expensive, being of lower quality and from more distant catchments. The environmental impacts of excessive water abstraction in conjunction with the discharge to the environment of large volumes of wastewater and stormwater have become more evident. The monetary costs to mitigate these effects are substantial and increasing as the community wants higher standards for new or augmented water supplies and for wastewater treatment.

The current linear approach to urban water flows illustrates why the use of concepts like life cycle analysis are so important when considering urban water system issues. The amount of water used at the start of the system has considerable effects downstream, and determines the size of wastewater treatment plants. Likewise, the contaminant loading in stormwater or wastewater has major impacts on downstream and coastal ecosystems. There are opportunities to turn linear water services flows into a water cycle through better reuse, recycling and onsite management.

1.2.4 The role of local authorities in water services

In New Zealand, around 85% of the population receives water[5], wastewater and stormwater services from local authorities. These services are usually provided by local authority departments or stand-alone business units. Many local authorities have contracted out operational and maintenance services and a number have established dedicated local authority trading enterprises (LATEs). Smaller local authorities like Thames-Coromandel District Council, Southland District Council, Clutha District Council, and Queenstown Lakes District Council have contracted out their water and wastewater operations. Wellington City Council has a 25 year design/build/operate contract with a private operator for the Wellington wastewater treatment plant and Papakura District Council has a 25 year franchise with a private operator to manage the council-owned water infrastructure.

Local authority water and wastewater infrastructure is valued at approximately $7.4 billion with around $600 million spent on operational costs each year (MOC 1999a). Further capital is invested in private systems for business, industry and agriculture. There are considerable demands on local authorities to extend and upgrade existing infrastructure. For example, it is estimated that the Auckland region requires around $1 billion over the next four years to upgrade its water, wastewater and stormwater infrastructure[6].

Key legislation and the roles and responsibilities of public authorities for water services are outlined in section 1.2.5. The roles include:

- owner of the infrastructure assets and provider of capital for improvements;
- customer representative;
- price regulator in what is largely a monopoly industry;
- service provider, although increasing use of outsourcing and contracting is occurring with councils focusing on asset management, policy develop ment, customer services, billing, and project management;
- regulator under the Local Government Act 1974, Health Act 1956, Building Act 1991, and the Resource Management Act 1991.

Concern has been expressed about the multiple and potentially conflicting roles of local authorities with unclear responsibilities, blurred accountabilities, lack of customer choice, and lack of commercial focus (see section 2).

1.2.5 Overview of key legislation

The management of water services ie water supply, water use, and wastewater and stormwater treatment and disposal is affected by a number of pieces of legislation. Generally the legislation has been enacted to remedy or control specific problems and their effect on the urban water system is not co-ordinated .

The main pieces of legislation that have some impact are the:

- Health Act 1956 and Water Supplies Protection Regulations 1961;
- Local Government Act 1974;
- Conservation Act 1987;
- Rating Powers Act 1988;
- Resource Management Act 1991;
- Building Act 1991 and Building Regulations 1992 (The Building Code); and
- Health and Safety in Employment Act 1992 and Health and Safety in Employment Regulations 1995.

It has been suggested that there are up to 130 separate pieces of legislation that affect urban water systems and water services.[7] Brief research has revealed at least 60 Acts of Parliament affecting the water supply or drainage of individual localities.

This legal review will divide urban water services into five parts:

- water collection and catchment management;
- conveying water to the consumer;
- consumer use;
- conveying wastewater and stormwater from the consumer's premises; and
- treatment and disposal.

Water collection and catchment management

At least five separate pieces of legislation and three agencies attempt to "control" contamination of potential water supplies:

- the Resource Management Act ("RMA") (s 15) gives Regional Councils ("RCs") control over *contaminants* that may get into water;
- the Local Government Act ("LGA") (s 378) gives Territorial Authorities

("TAs") control over sources of water supply;
- the LGA (s 392) makes *pollution* of water supply or *watershed* an offence for which a TA may prosecute. It should be noted that a *watershed* is only that part of a catchment owned by the TA;
- the Conservation Act 1987 (s 39(4)) makes *contaminating* a freshwater fishery (potentially also a water supply catchment) an offence. The Department of Conservation could prosecute;
- the Health Act (s 29) provides that *contamination* of water sources is a nuisance under that Act;
- the Health Act (s 60) also provides that *pollution* of a water supply is an offence. The Health Inspectorate of a TA could prosecute; and
- the Water Supplies Protection Regulations 1961 make it an offence to allow any water other than *whole some drinking water* into a public water supply system. The term *wholesome drinking water* does not appear to be defined. The Health Inspectorate of a TA could prosecute. The TA could be the defendant.

There is some inconsistency between the legislation with either *polluting* or *contaminating* used in different circumstances. *Contaminating* is the more modern word.

There is also some inconsistency between the various descriptions of water as *wholesome*, *potable or pure* although the Courts have held that there is no difference between the words in practice.

Under the Health Act (s 23) a TA has a duty to promote public health. The Minister of Health can require a TA to provide *sanitary works*, which include both water supply and sewage treatment (Health Act s 25). The LGA (s 379) empowers a TA to construct and run waterworks for the supply of *pure* water. A TA can contract out this function (LGA s 381).

The Courts have interpreted the TA's obligations under these Acts to mean that the TA must supply water free from impurities but not necessarily "chemically pure" (for instance chlorine and fluoride can be added).[8]

Agencies potentially involved in the supply of water include:
- the Minister of Health;
- the District Medical Officer of Health;
- the TA; and
- a commercial supplier.

The actual "collection" of the water from the source is governed by the RMA and will generally require a land use consent (s 9) for the infrastructure and a water consent (s 15) for the actual "taking". Both TAs and RCs will be involved as consent authorities and the TA may also be the applicant.

Conveying water to the consumer

At present the organisation conveying the water from source to consumer will often be a TA. It will try to convey the water in pipes under roads under its control (specifically permitted by the LGA s 445). In that case there will be no other agency involved in the process. Otherwise there may need to be a land use consent under the RMA. The same TA will often be both applicant and consent authority. If the organisation is a LATE or other commercial organisation it may need land use consents for its entire infrastructure.

Consumer use

This aspect can itself be divided into two parts:
- legislation affecting the water itself; and
- legislation providing for passing the cost of supply to the consumer.

Legislation affecting the water itself

The LGA (s 382) requires consumers to prevent waste of water. The LGA provides that the TA's remedy is to stop the supply *in such manner as it thinks fit*. This could, arguably, empower the TA to restrict the supply rather than cut it off altogether.

The LGA (s 647, s 648) also obliges TAs to keep their water systems *charged* with water for fire fighting and to install fire hydrants.

The Health and Safety in Employment Regulations 1995 (regulation 8) oblige employers to supply *sufficient* and *wholesome* drinking water to work places. The Health Act (s 39) makes it unlawful to build a dwelling house unless there is an adequate supply of *wholesome* water.

The Building Act (s 44, s 45) requires some buildings to have sprinkler systems for fire suppression although existing buildings cannot be required to upgrade. The Building Act also contains provisions relating to control of *insanitary* buildings (s 64). The Building Code requires buildings to have *adequate* piped water (G12.2).

Legislation providing for passing the cost of supply to the consumer.
The LGA imposes a "user pays " philosophy (s 122F). The primary mechanism for cost recovery is the Rating Powers Act 1988. This gives TA's the power to "rate" property to provide the TA with its main income stream. Rates are generally charged on property in proportion to property value (s 12). However a number of "public" institutions and the Crown are exempt from this system (s 4 to s 6).

TAs are empowered to "rate" for water supply by additional specific charges which apply to all consumers. The possible mechanisms include a fixed yearly charge (s 19) or a flow-based charge based on actual water consumption (s 26). Which charge to apply, if any, is left to the TA.

All such charges are recoverable by the TA by Court proceedings and ultimately the land in question can be sold by the TA to enforce payment (s 137 to s 146). The TA can also stop the supply of water (s 135) but health issues would arise if the water was stopped altogether. Again (as with the LGA) the power to stop is *in such manner as [the TA] thinks fit* and restricting the supply in some manner rather than total stopping is possible.

The RMA (s 108) provides a mechanism for a TA to recover infrastructure costs. A TA is empowered to impose financial conditions in regard to land use resource consents and the imposition of the additional cost of water supply and drainage infrastructure caused by a subdivision has been held to allow such a condition provided the actual charge is "fair and reasonable". An issue is the time required to bring these provisions into effect – as they do not become operative until the district plan is operative.

LATEs or private suppliers have no ability to "rate" and must rely on a contractual relationship with consumers.

Conveying wastewater and stormwater from the consumer's premises
The RMA deals with the environmental "effects" of discharges of water and water containing "contaminants" where those things may enter natural water. Discharge consents are required (s 15). The RCs are the regulatory agency. However, from an urban consumers point of view, all discharges are into an urban drainage system and the TA is the body that needs to apply for a discharge consent.

The Building Code divides "waste" water into two categories: stormwater (called *surface water*) and *foul water*. The Building Code does not distinguish between "grey" water and "black" water. All is treated the same. Stormwater is treated as if it will not contain contaminants. There are also differing descriptions of the same thing (eg surface water rather than stormwater).

Under the Building Code *surface water* can be disposed of into a natural watercourse, kerb and channel (presumably on a road) or soakage system (presumably onsite) (E1.3.3).

Under the Building Code *Foul Water* **must** be drained to a public sewer if one is available or to a septic tank system onsite if a sewer is not available (G13.3.1).

In addition the LGA empowers a TA to insist that properties are connected to its drainage system provided the drainage system is close enough to the buildings on the property (LGA s 459). These requirements can inhibit innovative approaches particularly in respect of grey water.

Trade waste is dealt with by way of the RMA and Bylaws passed by TAs. In essence, the consumer can simply dispose of trade waste into the public sewerage system provided it is treated onsite to a standard set in the local bylaw. Any RMA consent issues then become the TA's (LGA s 498). The TA can require onsite treatment to a standard, or provide the treatment itself and charge the trade waste consumer to the extent that the treatment required is "greater" than that for domestic sewage (LGA s 494).

While the user-pays philosophy still applies in theory to the cost of disposal and treatment of wastewater, the TAs do not have the same mechanisms (that are available with water supply) and cannot charge by quantity (flow-based charges) or by contaminant loading except in the area of trade waste.

Treatment and disposal
Generally the treatment and disposal of all wastewater is the responsibility of the TA.

The LGA (s 442) empowers, but does not oblige the TA to construct and run the drainage and treatment system. The Health Act (s 23) impliedly requires the TA to operate such a system. Under the RMA the TA may need both land and discharge consents for its infrastructure, particularly treatment plants and disposal systems. Although, as with water pipes, the drainage pipes themselves do not need any consents if they travel along TA owned roads.

The LGA requires TAs to promote *effective and efficient* waste management but this only applies to solid waste not to wastewater.

Other matters

The RMA (s 166) provides that water and wastewater operators are *network utility operators* and accordingly may be approved by the Minster for the Environment as *Requiring Authorities* (TAs are, of course requiring authorities in their own right). This status would place the "private" operator in the same position as TAs and the Crown in being able to designate land in District Plans for particular projects and subsequently to not need resource consent to carry out that project.

Recent amendments to the LGA (Part 44C) have set up Infrastructure Auckland and altered the powers of Watercare Services Ltd. In some ways this has solved the problem of LATEs not having the same powers as TAs and may be seen as a model for separating the service and regulatory functions of TAs. The following points are worth noting however:

- Infrastructure Auckland (in this context) is only concerned with the stormwater infrastructure (LGA s 707ZZK). Watercare Services Ltd is limited to water supply and wastewater (LGA s 707ZZZS(1)(e)). Any overall strategy will depend on co-operation between the two bodies; and
- Watercare Services Ltd has a statutory obligation to maintain its prices to a minimum level subject to obligations to be an effective business and to maintain its assets in the long term (LGA s 707ZZZS(1)(a)). This focus on low price may mean that the true cost of the services may not be passed on to consumers. Unless the cost of environmental externalities can be regarded as either "effective business" or "long term asset maintenance" it may not be possible for Watercare Services Ltd to add these in as charges to consumers.

A number of overseas jurisdictions are applying a nation wide policy to water by passing legislation similar to the Electricity Act 1992 or Gas Act 1992. Such legislation does not affect the obligations and processes under the RMA but enables a more co-ordinated approach to the issue.

1.2.6 Urban water systems and tikanga Maori

He huahua te kai? E, he wai te kai.

Are preserved birds the best food? No, water is the most important.

Maori have always valued water, naturally, for its practical usefulness, for drinking, mahinga kai, transportation and irrigation. Water is also a taonga for its spiritual and metaphysical properties, and is central in ritual and healing processes. These levels, the practical and the spiritual, are bound together within the mauri or life-force, which empowers all living things and is integral to the mana and lifeblood of iwi, hapu and whanau. Water bodies have their own mauri as ancestors of the tribe. Their metaphysical significance, and their physical presence and special character, are key elements in establishing and maintaining the identity, mana, whakapapa and turangawaewae of iwi, hapu and whanau. The close identification of tangata whenua with their rivers, lakes, streams and wetlands is reflected in the words of waiata, whaikorero and whakatauki.

Maori distinguish seven categories of water (see box 1.1). In many claims to the Waitangi Tribunal and other environmental management cases, the mixing together of different types of water has been a major concern for tangata whenua. Such practices as diverting and combining waters from different sources or catchments, or discharging water that contains or has contained human, animal, toxic or industrial wastes into another body of water, both degrade and damage the mauri of the water, and are offensive to tangata whenua.

Maori believe that waters containing wastes and pollutants must be discharged onto the land for proper purification by Papatuanuku, and alternative treatments based on some form of land disposal are favoured, usually as a compromise to full land disposal. The discharge of stormwater into rivers and the sea also causes concern, as stormwater contains liquids of various levels of purity and contamination - again, land based disposal is preferred. Hence the importance of managing stormwater onsite (see section 3.2).

Box 1.1 Categories of water[9]

Waiora	Purest form of water, with potential to give and sustain life and to counteract evil.
Waimaori	Water that has come into unprotected contact with humans, and so is ordinary and no longer sacred. Waimaori has mauri.
Waikino	Water that has been debased or corrupted. Its mauri has been altered so that the supernatural forces are non-selective and can cause harm.
Waipiro	Slow moving, typical of repo (swamps). For Maori these waters provide a range of resources such as rongoa for medicinal purposes, dyes for weaving, tuna (eels) and manu (birds).
Waimate	Water which has lost its mauri. It is dead, damaged or polluted, with no regenerative power. It can cause ill-fortune and can contaminate the mauri of other living or spiritual things.
Waitai	The sea, surf or tide. Also used to distinguish seawater from fresh water.
Waitapu	When an incident has occurred in association with water, for example a drowning, an area of that waterway is deemed tapu and no resources can be gathered or activities take place there until the tapu is lifted.

Water resources and ownership

Before the signing of the Treaty of Waitangi in 1840, tangata whenua had for centuries utilised water and other natural resources on the basis of rangatiratanga, mana, tikanga and matauranga Maori. The Treaty provides the basis from which New Zealand Government and laws are established, through a fundamental bargain between the Crown and Maori. This is seen in the relationship between the provisions of Articles I and II of the Treaty – the right to govern and make laws, and the confirmation and guarantee of the rangatiratanga of tangata whenua and their existing rights to land and natural resources. In a number of claims to the Waitangi Tribunal, and other legal cases, iwi have maintained that they did not alienate their resources or taonga by signing the Treaty of Waitangi; they contend that the Crown has not formally acquired the ownership of resources such as water, fisheries and mahinga kai, and that these assets are still taonga of tangata whenua. Each Maori claim is unique; where one iwi or hapu might work with concepts of ownership in the English sense, others might make their priority co-management arrangements, or rights to consultation.

In the Whanganui River report (1999), the Mohaka River report (1992) and the Te Ika Whenua report (1998), the Waitangi Tribunal concluded that the rivers and tributaries under claim were and are taonga of iwi, and that the Crown had breached Treaty principles, including that of ‘active protection’. The Tribunal recommended that the Crown must consult fully with Maori in the exercising of kawanatanga, must redress Treaty breaches, and must act towards its Treaty partner “in good faith, fairly and reasonably”.[10]

With regard to resources managed by local authorities, it is generally acknowledged that issues of resource ownership are not able to be directly addressed by local authorities, with Treaty claims being managed through other government systems. However, there is considerable potential for the policies and management practices of local authorities to impact on claims and to contribute towards their resolution. As a minimum, Maori consider that local authorities need to ensure that their actions and activities do not exacerbate existing claims or lead to the establishment of new ones (Nuttall & Ritchie 1995).

Statutory provisions under the Resource Management Act 1991

The duties and obligations of local authorities under the Treaty and its principles derive from the incorporation of the Treaty principles into statutes, as in the Resource Management Act 1991 (RMA). Maori participation in resource management is expressly provided for in the RMA requirements that local authorities:

- recognise and provide for the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, wahi tapu, and other taonga (section 6(e) RMA);
- have particular regard to kaitiakitanga (section 7(a) RMA);
- take the Treaty principles into account (section 8 RMA);
- consult with tangata whenua in the preparation of policy statements and plans (Clause 3(1)(d), First Schedule, RMA); and
- have regard to a number of matters, including iwi management plans, in the preparation of policy statements and plans (sections 61(2)(a), 66(2)(c), and 74(2)(b) RMA).

The 1994 New Zealand Coastal Policy Statement recognises that tangata whenua are the kaitiaki of the coastal environment; it includes policies for the protection and appropriate management of those characteristics of the coastal environment of special value to tangata whenua. Other statutes also make specific provision for the Treaty principles and tangata whenua interests in natural resources, such as section 4 of the Conservation Act 1987.

Management and kaitiakitanga

The Treaty guarantee to protect rangatiratanga, combined with the hereditary responsibilities of kaitiakitanga, give tangata whenua distinct interests in the management of natural resources such as water systems. In practical terms this could involve co-operative management with local authorities, perhaps over the total catchment as well as in regard to specific resource consents. Tainui has proposed co-operative management for the Waikato River, in the form of a 'Guardians of the Waikato River Trust', jointly managed by the Crown, Iwi and other stakeholders, with the sole beneficiary being the river. Tainui seeks a co-management role with greater status than is currently available under the RMA (Solomon 1999).

Increasingly iwi are developing resource planning and management documents of their own. For example, Kai Tahu's Natural Resource Management Plan for Otago (1995), incorporates policies, values and protocols of the runanga and wider iwi of Kai Tahu whanui. Iwi environmental management and planning documents, if fully recognised and provided for by local authorities, can be a practical and proactive means for local authorities to identify and integrate Maori values in their resource management work, for example, better management of urban water systems.

Recognition of values, access, participation and consultation

Resource managers need to be aware of the cultural impacts of water use, particularly discharges to water, and the reuse of stormwater or wastewater. In order to manage urban water systems in a sustainable manner and to fulfil their statutory obligations, resource managers need good information about the values and significance of water to iwi, hapu and whanau. This information could be gained from close consultation with tangata whenua, from their involvement in environmental management processes, and from iwi environmental management plans.

Food from the sea and fresh water is greatly prized by Maori, with each hapu having its own local speciality; waterways are an important source of other resources such as weaving materials. But a range of factors have put at risk the relationships of Maori and their culture with the taonga on which they depend. These developments include loss of ownership, constraints upon the practical ability of tangata whenua to fulfil their kaitiaki responsibilities, physical and spiritual pollution of water, and restriction of access to waterways, despite such measures as marginal strips and conservation covenants.

In a more general sense, recognition that the Treaty gives tangata whenua a status over and above that of other stakeholders and interest groups is essential, for effective partnerships between government (central or local) and tangata whenua, for the mana of tangata whenua to be respected in relation to natural taonga such as water, and for recognition and provision for Maori values and concerns in contemporary management systems for water and waterways. Nuttall and Ritchie (1995) state that "for many Maori this is likely to be the biggest sticking point in any area of consultation. If their position is to be treated as no more than another interested party it is unlikely that a realistic basis for ongoing dialogue, consultation and participation is to be forthcoming".

The current legislation provides a strong basis for tangata whenua participation in policy development and management for the natural environment, at both central and local government levels. However, interviews conducted for the PCE *Kaitiakitanga and local government* investigation (June 1998) and the Nuttall and Ritchie study (1995) showed wide dissatisfaction with current arrangements for consultation and participation between iwi and local authorities, and with the environmental results. Better and more effective environmental outcomes are more likely to be achieved, more efficiently, when there are better processes in place between tangata whenua, local authorities and resource users.

Issue 1. Urban water systems and tikanga Maori

a) How can the values of tangata whenua be given greater recognition, and provided for, with the sustainable management of urban water systems?

b) How can tangata whenua, as kaitiaki, be more involved in the management of urban water systems through partnerships, co-management and other approaches?

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1 Some urban water supplies are sourced from catchment areas outside a region eg the proposed Waikato pipeline that will provide water for the Auckland region is sourced from the Waikato catchment.

2 A public good is a commodity or service which if supplied to any one person automatically makes it available to others (non-excludable), and one person's consumption does not reduce supply of the good to others (non-rival). It can be contrasted with a private good where one person's consumption reduces the quantity available to others and a producer can restrict use of the good to those consumers who are willing to pay (MIT 1992).

3 A registered water supply is one which serves 25 people or more at least 60 days of each year and is listed on the Ministry of Health register.

4 For example, in 1996 Wellington's total water use averaged 512 litres per person per day. In 1999 Christchurch's average total water use was around 440 l/p/d with 800 l/p/d in summer and 350 l/p/d in winter.

5 Around 4% of the population rely on private community water supplies and 11% have individual water supplies eg rainwater collection or bores. Industry obtains more than 60% of its water requirements from non-public supplies although this amount includes large water uses like the Kawerau pulp and paper mill.

6 New Zealand Herald 15/5/2000.

7 Ministry of Commerce 1999a, Wilson 1998.

8 *A-G v Lower Hutt Corp* [1965] NZLR 116.

9 Definitions derived from McCan & McCan 1990 and Douglas 1984.

10 Statement by Sir Ivor Richardson, in Court of Appeal decision, *New Zealand MaoriCouncil v Attorney-General* [1987] 1 NZLR 641, p 683.

2. What are the challenges for urban water systems?

This section outlines a series of key challenges for the management of urban water systems. The challenges are considered in terms of environmental, social and economic dimensions but many of the underlying causes are interrelated and overlapping. These challenges apply to all urban areas, towns and cities, in New Zealand. The challenges are summarised in table 2.1. **One of the biggest challenges will be reaching agreement with the various stakeholders on the environmental, social and economic goals and values of urban water systems.**

Effective and efficient urban water systems are essential to ensure that New Zealanders' quality of life can be sustained, now and for the future. As a trading nation, New Zealand is dependent on its 'clean, blue and green image' for tourism and the export of produce and this image underpins economic opportunities and growth. Sustaining this image will require improving water, wastewater and stormwater management to maintain and enhance the quality of the environment.

2.1 The environment and urban water systems

Increasing water consumption, inefficient water use, excessive water extraction particularly from groundwater resources, and uncontrolled or poorly managed stormwater drainage and wastewater disposal, impact on ecosystems and the community. This includes adverse effects on ecosystem services[1], instream values including aquatic biodiversity, public health, cultural values, amenity values (eg odour and visual pollution) and recreational values (eg poor bathing water quality and contaminated shellfish). The natural character and habitat quality of many fresh and estuarine waters has been lost or degraded by urban development, drainage, construction of flood control channels and stopbanks, removal of riparian vegetation, waste disposal, and urban stormwater (Ministry for the Environment 1997).

Figure 2.1 Urban water systems and the water cycle

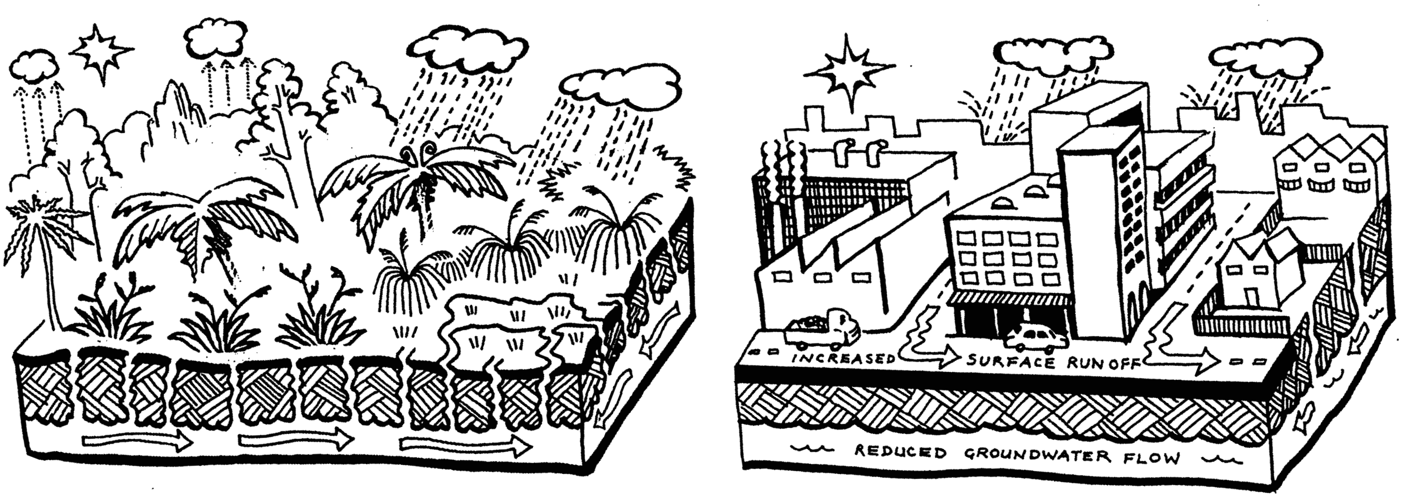


Table 2.1 Urban water system problems, underlying causes and impacts

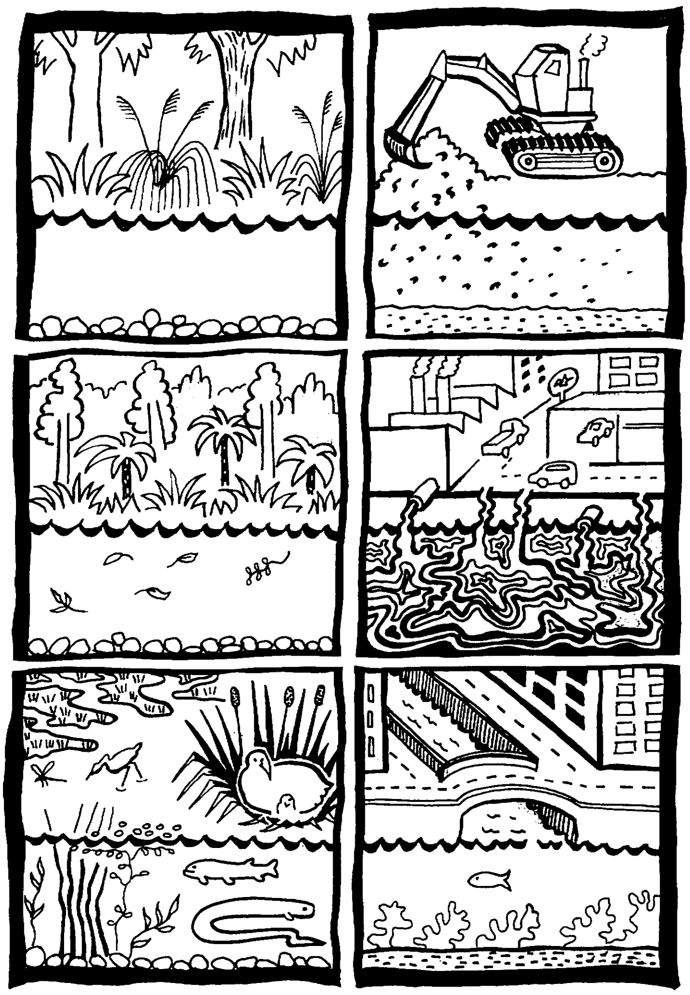
Issue	Problems	Underlying causes	Impacts
Environment	Inadequate water Flows	Excessive extraction and use with supply-side focus ie large dams/pipes Incomplete pricing and cross-subsidies Fire Service supply requirements mean larger networks (legislation) Poor asset management eg broken/leaking pipes Lack of awareness and information Lack of demand management and use of old/inefficient technology Little integration of water supply, wastewater and stormwater networks Lack of research into reuse and efficiency measures	Low environmental flows – adverse effects on instream values and biodiversity Adverse effects on taonga of tangata whenua, and on the mauri of the water resource Large volumes of wastewater requiring treatment and disposal Restricted economic development
	Contamination of surface waters and groundwater	Contamination at source or recharge area (which may include rural areas) due to inappropriate landuse and management Low or incomplete treatment of wastewater flows and reliance on assimilative capacity of surface waters Inadequate investment and poor asset management eg sewer overflows Some communities unable to fund required infrastructure Peak period overload for coastal/holiday centres Incomplete pricing and cross-subsidies (legislation) Inadequate management of trade waste (legislation) Limited stormwater management/lack of onsite control and recycling Inadequate monitoring and public disclosure of bathing water quality	Adverse effects on instream values and biodiversity Adverse effects on the coastal and marine environment and biodiversity Adverse effects on public health Adverse effects on taonga of tangata whenua, and on the mauri of the water resource Adverse effects on recreational values Community inability to pay for infrastructure
	Excessive flows eg flooding, stormwater flows	Increased flood peaks due to inappropriate landuse and catchment management: high proportion of impervious surfaces and runoff Some communities unable to fund flood control infrastructure Inadequate investment and maintenance eg failed channels and drains Inadequate investment in stormwater management Reliance on piped systems - neglect of natural waterways and wetlands Lack of 'whole catchment' approaches to urban water management	Localised flooding, damage to property, potential loss of life and economic impacts Adverse effects on instream values and biodiversity Adverse effects on taonga of tangata whenua, and on the mauri of the water resource Adverse effects on recreational values
Social/Cultural /Health	Perception that water is 'free'	Historical abundance - 'fundamental right' Societal/cultural attitudes influence water use Incomplete pricing and 'hidden' costs through funding by property rates Consumers not paying the 'true' costs of water services and have little understanding of the value of services - reduced incentives for change Lack of awareness and information - urban residents separated from environment	Excessive extraction and inefficient use Increased wastewater flows requiring large treatment systems Resulting environmental, economic, and social impacts Adverse effects on taonga of tangata whenua, and on the mauri of the water resource

Issue	Problems	Underlying causes	Impacts
Social/Cultural /Health	Lack of access to potable water/low water quality/water-borne diseases eg giardia, cryptosporidium, campylobactor	Inadequate investment and asset maintenance Some communities unable to fund infrastructure Inadequate catchment management (legislation) No national drinking water standards -only guidelines Inadequate monitoring of water quality - no mandatory disclosure of water quality and service levels Lack of small systems/local solutions - limited research	Potential health risks - individual and community Restricted economic development Water not always 'fit for purpose'
	Poor recreational/ bathing water quality/water-borne diseases	Inadequate investment and poor asset management eg sewer overflows Inadequate investment in stormwater management and lack of onsite control and reuse of stormwater Inadequate monitoring/reporting of bathing water quality (legislation)	Potential health risks - individual/community Adverse effects on taonga of tangata whenua, and on the mauri of the water resource Adverse effects on recreational values Adverse effects on economic development
	Poor information disclosure	No mandatory requirements for formal contracts and customer charters (legislation)	Customers unable to hold service provider to account for quality of service
Economic	Lack of investment and incomplete pricing	History of poor asset management - now improving Incomplete pricing and charging for services (legislation) Limited valuation and pricing of ecosytem services Difficulties with establishing and obtaining financial contributions via RMA processes (legislation)	Intergenerational payment issues Estimates of $5-10 billion in new investment and deferred maintenance over next 20 years Community inability to pay for infrastructure
	Inefficient delivery of services	Inadequate investment and history of poor asset management - now improving Limited financial controls and 'drivers' for efficiency and no requirements to disclose information on operational performance (legislation) Fragmented and unclear legislation - responsiblities of consumers and suppliers are not clearly defined in legislation (legislation) Limited research and development of alternative service provision	Excessive extraction/inefficient use Increased wastewater flows requiring large treatment systems Reduced economic efficiency and potential loss of international competitiveness Difficult for customers to evaluate the quality of service provision
	Potential risk of infrastructure failure	Inadquate investment and poor asset management Lack of community awareness and information Limited research and development of alternative devliery approaches and cost-benefit analysis of different solutions	Potential health risks - individual/community Disruption to the community Impact on commerce and economic development, exports and tourism Effects on environment and 'clean blue and green image'

There are a number of specific environmental issues that need to be addressed in relation to New Zealand's urban water systems:[2]

- lack of understanding of local
- ecosystems and natural water cycles;
- lack of integrated management of catchments, wastewater and stormwater eg total water cycle planning and integrated water supply, wastewater and stormwater
- management ie an integrated business from source to the receiving environment;
- non-point source pollution that affects water quality, coastal areas, beaches and public health eg from urban stormwater and agriculture runoff;the management of groundwater and recharge areas with landuse change eg Christchurch;
- the management of water supply catchments and drinking water quality;
- increasing demands on water supplies in some areas with plans for more reservoirs and pipelines and potentially lower river levels;
- limited focus on water demand management and the efficiency of water use;
- full-pricing of water including the valuation of ecosystem services (ie the natural services provided by the environment eg the role of wetlands for flood protection, habitat and filtering water);
- recognition and management of adverse effects on cultural and spiritual values from wastewater and stormwater flows;
- recognition and management of adverse effects on instream values from wastewater and stormwater flows; and
- lack of understanding of cross-media effects and methods for assessing and managing cumulative effects.

Figure 2.2 Environmental effects of urban water systems



One of the big challenges of the 21st century will be to reduce the large flows per capita of both solid and liquid wastes to limit environmental impacts and increase the efficiency of resource use inclusive of energy. Water supply reservoirs, pipes and treatment plants dominate our existing urban water supply and wastewater systems. The cost associated with simply maintaining or replacing this existing infrastructure is potentially a major impediment to the development of more ecologically efficient and cost-effective systems.

Under-valued and under-priced urban water resources encourage inefficient use and create barriers to changes in user behaviour and adoption of new technology. The current legislative framework may also discourage more efficient use and the management of water in an ecological context (see box 2.1).

Currently trade waste is often sent through urban wastewater systems (see box 2.2). The addition of trade waste to wastewater flows can result in heavy metals, persistent, bioaccumulative and toxic (PBT) chemicals and pathogens being added to wastewater flows. This can then limit the reuse of wastewater and the recycling of biosolids because of high levels of heavy metals, PBTs or pathogens and their potential impact on ecosystem health and public health. Opportunities exist for reducing and even eliminating trade waste streams through more efficient processes, reuse and onsite treatment.

Urban stormwater

Urban stormwater quality is often similar to that of secondary-treated sewage. Urban stormwater causes serious problems in some areas (eg Auckland) polluting estuaries and harbours with sediment and toxic substances (eg heavy metals and hydrocarbons derived from motor vehicles) and, in some cases, infiltrating and flooding sewerage systems. (Ministry for the Environment 1997).

Box 2.1 The Waikato Pipeline and the Environment Court

This case was an appeal against resource consents which were granted to Watercare Services Ltd to allow up to 150,000m^3 of water each day to be taken from the Waikato River in order to supplement Auckland's water supply. The water would be treated and delivered via a 38 km pipeline to an existing reservoir at Redoubt Road in Manukau City.

The appellant argued that Watercare had not complied with section 88(4)(d) of the Resource Management Act 1991 (RMA) as it had not specified that it would need a resource consent to discharge the water into Manukau Harbour after it had been used. In addition, it was argued that the consent authority, Environment Waikato, had not considered adverse effects on people and communities from the treated drinking water, when determining the application for resource consent.

The Environment Court, led by Judge Sheppard, found that in relation to the application of s 88(4)(d) of the RMA, the discharge of water into Manukau Harbour was too remote from the activity of taking the water to be "in respect of the activity to which the application relates." The Court considered that the causal link between the taking and the discharge was "tenuous" and in any event Watercare already had an existing resource consent to discharge the water.

The Court also considered that the quality of the treated water delivered to the ultimate consumers was independent from the activity of 'taking' the water from the river, and thus any potential effects of the use of the water were not adverse effects of 'allowing' the activity. Therefore, Environment Waikato did not have to consider those effects under s 104(1)(a) of the RMA when granting the resource consent. Having Environment Waikato stipulating standards of treatment for the water would not be "enabling the Auckland people and community to provide for their well-being, health and safety" within the terms of s 5(2) of the RMA.

Figure 2.3 Sources of stormwater pollution

Channel erosion and a decline in ecological health are apparent in some urban waterways, caused by a combination of physical impacts associated with increased runoff and degraded water quality from catchments with altered landuses. Urban stormwater management needs urgent attention if there is to be significant improvement in the quality of urban streams and coastal marine areas.

2.2 Society and urban water systems

There are many social, health and cultural issues associated with the management of urban water systems.

Consumers and ratepayers have increasing expectations about the provision of water services, with respect to water quality, public health, environmental protection and cultural and spiritual values. However, there is often a negative reaction to large rate increases or increased charges to fund new infrastructure and the backlog of deferred maintenance. This is based on the erroneous perception that ‘water is free’. There is a lack of awareness and understanding of the value of urban water systems and the costs of improving water supplies, and wastewater and stormwater management.

The RMA is requiring many local authorities to obtain/renew resource consents for the discharges to the environment (eg odour and wastewater). This necessitates communities reevaluating their local environmental standards and their willingness to pay for improved standards and appropriate treatment.

Population growth and urban water systems
Some New Zealand cities and towns are experiencing rapid population growth (eg Auckland, Tauranga, and the Kapiti Coast) which brings demands for additional capacity and treatment. Other cities and towns have low or negative population growth (eg Dunedin and Invercargill) and this brings the challenge of how to manage existing infrastructure with a declining rating base. Coastal towns and holiday resorts face the issue of how to finance and manage seasonal demands on water services.

In urban areas, particularly where there is rapid growth, there is a need for integrated management that often extends beyond the boundaries of any individual territorial

Box 2.2 Management of trade waste

Trade waste is primarily controlled by local authority bylaws made under Part XXVIII of the Local Government Act 1974 (LGA), although this Part is subject to both the Resource Management Act 1991 (RMA) and the Health Act 1956. Section 489 of the LGA defines "trade waste" as "any liquid … discharged from trade premises in the course of any trade or industrial process or operation or in the course of any activity or operation of a like nature; but does not include condensing water, surface water or domestic sewage."

Section 491 of the LGA empowers local authorities to make bylaws with respect to discharge of any trade wastes from trade premises into any sewerage drain controlled by the local authority. Such bylaws can include: notice of the volume, composition and rate of discharge of any trade waste; the time of discharge; maximum quantities of trade waste to be discharged; the temperature; sample-taking; metering; and control of solids or grease or other constituents by the occupier.

Charging for trade waste is covered by s 494 of the LGA. A local authority may make such charges as may be necessary for the treatment by the local authority of the trade wastes to reduce them to a quality or strength equivalent to the average quality or strength of domestic sewage. What this means is that there is a base level (the quality and strength of domestic sewage) over and above which the local authority can charge based on strength and quality. The local authority cannot charge for waste below that base level. Assessment of charges may be appealed to the District Court.

Where the trade waste is legally disposed into the sewer, the territorial authority is responsible for obtaining the appropriate discharge consent for any wastewater treatment plant and, in applying for the consent, for providing an assessment of environmental effects setting out the actual or potential effects of the discharge upon the environment.

If a trade premises discharges trade waste in accordance with trade waste bylaws it cannot breach the LGA or the RMA. If a trade premises does breach the trade waste bylaws then it will be liable for a fine of up to $10,000 with $1,000 per day if the breach continues. The trade premises would also be liable for the costs of remedying any damage to the sewerage drains or trade wastes treatment, reception, or disposal works of the local authority caused in the course of committing the offence.

There are a number of issues and unsatisfactory matters with existing trade waste bylaws and these have been noted by the Courts. There is a lack of congruency between the RMA and LGA provisions regarding trade waste. A council faces the potential liability of not being able to control discharges of trade wastes into council sewers in such circumstances that council may in turn be placed in breach of its resource consent conditions for discharge of wastewater from its sewage treatment plant. Likewise the fines under the LGA for any breach of trade waste provisions are well below the much higher RMA fines.

The new New Zealand Standard 9201: Part 23 Model General Bylaws on Trade Waste (recently issued) includes provisions for cleaner production, and discharge management plans, both of which are mechanisms that can be used to promote waste reduction and a move towards achieving sustainable water management.

authority. Robust long-term strategic planning mechanisms are needed to ensure the development of a sound water services network. Otherwise, the provision of water services will proceed in an ad hoc manner and result in inefficiencies, added operational costs and avoidable environmental impacts.

An example of this ad hoc approach is the Kapiti Coast area. Prior to 1989 and local authority reform, the area had a number of local authorities addressing problems in isolation from an overall framework and largely on a subdivision by subdivision basis. This has resulted in an over-engineered network with many pumping stations and several treatment facilities. This could have been managed in a more integrated way with an improved infrastructure network (Wilson 1998).

The recent 'future of local government' discussion paper for the Auckland region has identified that "the management of urban growth, land transport and water/wastewater are key regional problems that are not well supported by the current local authority governance or service delivery arrangements. Some of the smaller local authorities in the region are facing funding pressures that could be better approached regionally" (Auckland Region Mayoral Forum 2000).

Small towns and water services
Many small towns are facing increasing pressures to improve the quality of their water supplies and the management and disposal of wastewater. Other towns, particularly those in popular coastal areas and tourist locations, often have low resident populations but the population can expand 10-fold in peak periods with many holiday-makers and visiting tourists (eg Thames-Coromandel and the Bay of Plenty).

A small resident population and large itinerant holiday population can cause major problems for the funding and management of water services infrastructure. The large holiday population places an increased pollution load on wastewater systems in the peak period. This pollution loading can place severe pressure on the very recreational and water resources that have attracted these visitors to the area in the first place. Small schemes can also suffer from the lack of economies of scale both in capital and operating and accordingly lesser safeguards and less stringent and proactive monitoring can result.

Proposals to upgrade these small systems to address health and environmental related concerns through technical solutions are often opposed by the resident community who may face substantial upgrade costs. A related concern is that the new infrastructure will bring further development to the area. This is often not wanted by the local community who enjoy the 'peace and tranquillity' and local amenity values outside the main holiday periods. However, there remains a need to address the public health risks during peak holiday periods.

The issues of adequate infrastructure, 'appropriate' solutions, and the management of urban growth, need to be recognised and addressed in an integrated way. Ultimately, a 'vision' and strategic plan for the evolution of each area is required.

Drinking water and public health
The Ministry of Health has reported that there are a number of concerns with the quality of drinking water (Ministry of Health 1999):

- some small community drinking-water supplies remain inadequately
- monitored and often fail to meet the microbiological compliance criteria of the drinking-water standards;
- some private water suppliers do not report on the quality of their supply;
- some water suppliers do not monitor all parameters that may be of public health significance in their water supply; and
- some district plans do not adequately provide for the protection of drinking-water supplies.

The need for better water supply catchment management policy and planning has been identified during the development of proposals for upgrading the drinking water legislation under the Health Act 1956. However, these drinking water proposals are not intended to deal with water supply catchments that are governed by the Resource Management Act 1991 and this issue remains to be addressed.

The legislative and management framework
Local authorities have a number of roles in managing urban water systems and water services including being the owner of the infrastructure, customer representative, price regulator, service provider, and regulator (see section 1.2.5).

Concern has been expressed about the multiple and potentially conflicting roles of local authorities with unclear responsibilities, blurred accountabilities, lack of customer choice, and lack of commercial focus.[4] The lack of an appropriate legislative framework that applies to all water services providers has led to proposals for a consolidated Water Services Act.[5]

The priority given to urban water systems and the management response by local

Issue 2. The legislative framework

a) Does New Zealand need a consolidated Water Services Act for the provision, management, and delivery of water services? This Act would address utility, service provision, supply and demand management, accountability and transparency issues. It would not replicate the Resource Management Act 1991. Alternatively, can incremental changes be made to the existing legislative frame work to bring required improvements?

authorities varies. Some local authorities like Waitakere City and Christchurch City are working with their community to enhance the sustainability of their water systems. Other local authorities perceive that high environmental and health standards create economic barriers to attracting industry and people to an area. For example, the Ministry of Commerce has reported that "one authority openly acknowledged its support for lower water related environmental and health standards for industry as a strategy for securing comparative advantage over other regions (Ministry of Commerce 1999b). This local authority view is an extreme example of very narrow and short-term thinking that is not in accordance with sustainability or improved quality of life.

2.3 The economy and urban water systems

There are existing pricing deficiencies throughout New Zealand caused by historic distortions from subsidies, insufficient provision for renewals, no investment discipline, a practice of funding debt but not equity, no use of economic instruments to modify demand, no customer choice, and social and political policies affecting pricing without transparency. Water is both underpriced and undervalued (Wilson 1998).

The New Zealand economy, our international competitiveness and societal wellbeing depend on well-managed natural water systems and well-functioning built water systems. Inefficient and poorly managed urban water systems have the potential to affect our international competitiveness, economically and environmentally. Poor water quality and lower quality wastewater and stormwater management will impact on the export sector, the tourism industry and international perceptions of New Zealand's 'clean, blue and green image'.

There are considerable demands on local authorities to extend and upgrade existing water services to improve the quality of service, management of the environment and reduce potential risks to public health. It has estimated that around $5 billion of investment will be required over the next 20 years to upgrade water, wastewater and stormwater infrastructure throughout New Zealand.

Local authorities as providers of water services have had to explore new ways of funding and managing these services. Funding of services has been compounded by the political difficulties associated with the introduction of pricing and the absolute public rejection of any changes that could signal a move to privatisation (Hutchings 2000). However, fair and efficient charging and better environmental and economic management of water services is not dependent on ownership. The water 'stewardship' function can be provided from a wide range of ownership models.

Discussion of 'what is an appropriate business model for water services?' has tended to overshadow the system challenges, to develop more sustainable urban water systems. Short-term decision-making, insufficient investment, inadequate pricing and conflicting priorities have not enabled sound management of urban water services and infrastructure. There are also difficulties in establishing appropriate provisions for financial contributions for funding of infrastructure through the RMA.

Marshall (1999) has suggested the backlog of deferred maintenance has been due to the:

- difficulties in establishing water issues as political priorities;
- absence of tools for long term
- financial planning by local authorities prior to the 1990s; and
- difficulty in getting the community interested in infrastructure issues unless there has been some disruption to services that directly affects them.

A related issue is local authorities using negative or small percentage rate increases as a key local authority 'performance' measure, particularly in election years. Such a 'performance' measure has not allowed funding and investment in infrastructure at the required level.

The apparent lack of community interest is partly because many pipes are underground and 'hidden' from the community. Physical deterioration is often not immediately obvious until a water main or sewerage pipe fails with localised flooding and contamination. The community cannot also observe the gradual 'wear and tear' like potholes in roads. Some of the lack of community interest is also because of a lack of understanding of water quality issues and the associated public health risks.

Water services pricing and charging
The charging powers available to local authorities to recover the costs of providing water services are set out in the Rating Powers Act 1988. The main charging options for water and wastewater services are general rating, flow-based charges, uniform annual charges (UAC), and pan charges. However, local authorities are not currently empowered to use flow-based charges for wastewater unless they establish a local authority trading enterprise (see box 2.4). This is a major barrier to the introduction of better pricing and charging.

Box 2.4 Local authority trading enterprises (LATEs)

LATEs can be created under Part XXXIVA of the Local Government Act 1974. Section 594Q states that the principal objective of a LATE is "to be a successful business". There is no requirement that a LATE act in an ecologically sustainable way. However, LATEs are bound by the provisions of the RMA. Most of the "powers" of territorial authorities are not available to LATEs and they generally act through contractual agreements. An issue is how a local authority requires or encourages a LATE to consider broader issues such as sustainability eg through the statement of corporate intent under the legal requirement of being a "successful business".

Although councils in the Auckland region, Tauranga and Nelson use flow-based charges for water supply, most other local authorities use a flat rate that is collected either through the general rate or by a UAC. Where these charges are added to the general rate, most customers have no concept of either the value of water services they receive, or the cost of the service. This contributes to water services being perceived by some members of the community as 'free', and contributes to opposition to charging regimes for water services.

A move towards improved charges for the use of water services need not be seen as a precursor towards privatisation, although it frequently is. Better pricing and charging for water is essential for the improved management of urban water systems and can be totally independent of ownership.

In March 1999 the Ministry of Commerce (1999b) reported on common themes from interviews with local authorities including that:

- the use of water meters was not viable on a cost-benefit basis because of on-going transaction costs in reading, account processing and maintenance of meters, and the need to include depreciation of the asset in operating costs.
- the main benefit of meters was thought to be demand management. However, because of a presumed high fixed/variable cost ratio, the influence that the variable charge could have on the amount of water consumed was believed to be small.
- there was generally strong resistance at the political level to the
- implementation of metering. How ever, most councils interviewed used metering for large users eg industry.

Contrary to the views expressed by local authorities, the Ministry of Commerce has calculated that there is a positive net benefit from introducing water meters and they are viable on a cost-benefit basis. This analysis excluded the additional benefits to the environment and for improved network operation and investment decisions (Ministry of Commerce 1999c).

Most OECD countries use flow-based water charges and water metering and it is not seen as a contentious issue. New Zealand, England and Wales are major exceptions to this approach where metering is a more controversial policy issue (OECD 1999a). As well as assisting better pricing through flow-based charges, metering helps leak identification and provides water service managers with information on consumption patterns which is very useful in assessing peak use and the demand for new infrastructure. This assists water service managers to determine appropriate levels of investment in the future.

The use of metering and flow-based charges ultimately results in greater efficiencies and lower water use. There is substantial evidence that metering leads to a marked and sustained reduction in both peak demand and annual usage. Typically, in New Zealand, reductions in annual use following the introduction of metering are at least 15% as demonstrated by Auckland City Council and Tasman District Council. Over nine years, Rotorua District Council experienced falls in average annual use (35%) and peak demand (50%). Christchurch City has installed meters and notifies residents of their water use but the council does not use flow-based charges. The meters are used to identify any leaks in the system and have the potential to be used as an education tool.

It is acknowledged that the application of flow-based charges to water services is a sensitive issue. However, better pricing and charging will ensure that the consumer understands the cost and degree of service and will ultimately provide the consumer with the choice of varying the level of service (eg varying time of use to reduce peak loads). A balance between fixed and variable charges is needed to inform consumers of the actual costs of water use and to provide incentives for using water efficiently.

Waitakere City has assessed how different charging systems would affect different households in Waitakere City (Waitakere City 2000). Some low-income users would actually be better off if flow based charges were introduced to replace property rates (see table 2.2).

Table 2.2 An example of different charging options (Waitakere City 2000)

Household	Property rates	Uniform annual charge (UAC)	Flow-based charges
A family of five in Ranui, using more water than average (600 l/day).	99/00 rates plus water charges **$1409**. This family pays slightly below average rates as their land value of $60,000 is below average. Their water charge is above average.	99/00 rates plus UAC or pan charge **$1462**. Moving to a UAC would mean this family pays the same as every other household for wastewater, in this case $53 more than currently.	99/00 rates plus flow-based charges **$1469** Under flow-based charges, if the family continued to use 600 litres of water per day, they would pay a little more. However, they could reduce this cost by reducing the amount of water they use.
A single pensioner in New Lynn, using much less water than average (82 l/day).	99/00 rates plus water charges **$1098**. This person pays below average rates as the flat has a low land value. Water charges are also well below average.	99/00 rates plus UAC or pan charge **$1151**. Moving to a UAC would mean paying more for wastewater, in spite of the low land value.	99/00 rates plus flow-based charges **$873** Under flow-based charges, the single pensioner, who is a careful water user, will pay significantly less.
A couple in Titirangi, using more water than average (550 l/day)	99/00 rates plus water charges **$2472**. This couple pays well above average rates, and as wastewater charges vary with land value, they contribute more than average to the City's wastewater costs.	99/00 rates plus UAC or pan charge **$2240**. A UAC will benefit this couple. They will contribute the same as other households to wastewater costs.	99/00 rates plus flow-based charges **$2159**. This couple would be better off under flow-based charges than a rates based system, since their water use, while high, is not excessive.

Social implications of water charges
Concerns about the social implications of water charges and impacts on social equity are often raised by groups and individuals opposed to water charges. It is argued that user charges adversely affect low-income/ high use households who cannot afford to pay. As can be seen from the above table, while this is partly true, a system that uses general rates also affects low income single person households. These equity issues are not unique to water. The real challenge is to minimise the undesirable social effects of water charges. This can be done through explicit means, and is best addressed as part of a comprehensive package of social policy responses including tax rebates, rates relief, and benefits.

Some fear that if water is charged for directly and a consumer cannot pay the bill, then the water supply may be cut off as with non-payment of telephone and electricity bills. This is unlikely to occur for water because of the risks to personal and public health and legislative requirements. In Western Australia, a restricter is sometimes used where water bills have not been paid. This ensures that all residents have adequate water for washing, cooking and public health purposes (eg 15 litres per person per day) but it limits the availability of water for external and recreational uses (eg gardening and swimming pools).

The United Kingdom Environment Agency has been co-ordinating research into an environmentally effective and socially acceptable strategy for water metering to address important social equity issues. There is a real need to distinguish between the reactions of the general public and the effects on socially disadvantaged households. More research of this nature work needs to be undertaken in New Zealand.

Economic efficiency and utility reform
Economic efficiency is often the sole criterion for decision-making on infrastructure options and when undertaking utility reform. The focus of utility reform is often targeted at reducing the price per unit of resource ie 'cheaper' water for consumers is considered to make the country more competitive. There has been less attention focused on how to reduce the total volume of water and materials that are consumed ie addressing both economic and environmental efficiency through greater efficiency of use and thus improving the sustainability of the whole system.

Historically, pricing of water services has only covered operational costs and has not included other factors such as rate of return, depreciation or environmental costs (in economic terms referred to as externalities). Often environmental costs are seen as only 'the costs of complying with environmental regulation' ie compliance costs. While this is partly true, it totally fails to recognise the services and functions provided by the environment ie ecosystem services. These services need to be recognised and 'paid' for regardless of environmental regulation. If not, then the longer-term result is a degraded environment and lower quality of life.

Issue 3. Pricing and charging for water services

a) **How can better pricing and charging systems for the provision of water services be developed and implemented ie what community processes need to be developed?**
b) **What changes are required to the current system for establishing and charging financial contributions from new subdivisions in order to fund new infrastructure?**
c) **What research is needed to assist the implementation of better pricing and charging systems?**

2.4 Risk management and urban water systems

There are many risks that may adversely affect the management of urban water systems. These risks can be caused by climatic variation (causing droughts or floods), mechanical failures, poor management, and health risks from pollution and water-borne diseases. The consequences of these risks can be considered in terms of financial, environmental, health, cultural and ethical impacts (to name a few), short-term, long-term and cumulative risks.

Managing risk involves understanding the factors that contribute to that risk's causality.

Often these involve complex interrelationships. However, by understanding these relationships, we can actively work toward reducing the factors that contribute to that risk's likelihood and consequence. These factors include communications, resourcing, or ecosystem variability.

By better understanding these risks and the factors that influence their magnitude, better decision-making processes can be implemented to create improved solutions for urban water systems throughout New Zealand

An example of this process might be the comparison between major reticulated water schemes and disaggregated household or community schemes.

	Major reticulated water schemes	**Disaggregated or community water schemes**
Advantages	Professional operation eg monitoring of water quality	Not susceptible to major system failure
	Internal system redundancy	Reduced environmental effects
		Reduced direct financial cost
Disadvantages	Increased impact on the environment (and with associated wastewater flows)	Onsite management and monitoring may be extremely variable
	Failure will affect many consumers	Maintenance may not be good enough

Using a risk management approach, the disadvantages (potential risks) from each can be further refined, assessed and evaluated (as per the risk management standard, AS/NZS 4360:1999). Once these risks are better understood, the effect of the implementation of suitable control strategies to address the particular risks can be assessed.

Excellent risk management planning does reduce risk, but rarely eliminates it. Thus appropriate contingency plans will need to be produced to effectively manage risk issues should they materialise. For example, is there adequate capability to monitor public health and respond to outbreaks of cryptosporidium, giardia and the like?

Issue 4. Risk management

a) Do we have adequate understanding of what are the risks to urban water systems and the nature and inter-relationship of these risks?

b) Is there adequate risk management for urban water systems and water services?

c) Are there appropriate contingency plans to respond to the range of environmental and public health risks to urban water systems?

[1] Ecosystem services are the functions carried out by ecosystems that ensure natural cycles of water, carbon, oxygen, and nitrogen continue to support life. Ecosystem services such as clean water from catchments and wastewater assimilation by wetlands represent the benefits that people derive, directly or indirectly, from ecosystem functions. These natural services from ecological systems are critical for the continued functioning of urban areas.

[2] List adapted from Hughes 2000.

[3] *Cayford v Watercare Services Ltd* 4 NZED 13

[4] For example, see NZWWA 1999; Sampson 1999; Ministry of Commerce 1999a, Fitzmaurice and Wilson 2000.

[5] For example, see NZWWA 1999, and Cayford 2000.

3. Opportunities for progress

This section reviews a number of opportunities for progress. It includes improved management of the urban ecosystem, catchment management, integrated management of water services, the use of alternative systems and recognition and valuation of ecosystem services.

3.1 Improved management of urban ecosystems

What is an ecosystem?
Ecosystems[1] are biological systems comprising all life forms such as plants, animals, micro-organisms and humans, and its associated non-living environment. There are many interdependencies within biological systems which mean that impacts on any one component can have widespread and often subtle effects on other components.

For tangata whenua, the biophysical resources and systems are part of a larger web or network of inter-connecting forces, including whakapapa and history, mana, tikanga, and the spiritual dimensions of mauri and tapu. These linking strands bring together the physical and metaphysical worlds, determining not only the value and significance of taonga such as water, rivers, lakes and other water sites, but also appropriate relationships between the component parts of the system, including people.

Urban ecosystem management
A city or town can be considered as an ecosystem and ecological concepts can be used to understand urban sustainability issues and to develop more sustainable solutions. A city is a physical ecosystem and, like a forest or wetland, energy and material flows can be analysed as well as the effects of material flows on other ecosystems. Ecosystem concepts can also be applied to the planning, design and management (physical, social and economic dimensions) of cities by viewing them as complex, interconnected and dynamic ecosystems.

Viewing a city in ecological terms as a dynamic organism resident in a wider regional or catchment system is a profound departure from viewing a city solely as a system where impacts are managed via infrastructural and organisational arrangements that can be remote from the day to day lives of citizens. An ecosystem approach to water management involves changing the management focus from end-of-pipe pollution control to closing-the-loop and life-cycle analysis, with an increased focus on efficient use of resources and the reclamation and recycling of materials sourced from waste.

Effective urban ecosystem management involves taking a long-term and strategic approach to the management of the entire urban ecosystem. Urban development, growth and evolution has many flow-on effects for people and communities, road transport systems, water services infrastructure, stormwater management, water use, wastewater disposal, and coastal management.

Integrated management of land and water is a key urban issue with many resource management approaches appropriately addressed at the urban catchment level eg water supply management and stormwater management.

Water catchment management
International priorities in water management planning are shifting from supply management towards demand management and catchment management planning. Increasingly, integrated management of land uses in catchment areas is critical to ensuring high quality water systems (Cayford 2000).

To enable sound catchment management for water supply purposes, there will need to be more rigorous standards and a range of initiatives to address the full costs of intensive landuse (eg new controls will be needed to prevent intensive agriculture or subdivision in water supply catchments).

The natural processes provided by ecosystem services in terms of fresh water need to be recognised and valued. These services need to be managed and enhanced because the alternative is often more expensive filtration and treatment of water supplies assuming that the technology is available (see box 3.1 and 'the New York example' in section 3.4).

Box 3.1 The Sydney Catchment Authority

The Sydney Catchment Authority was established in July 1999 to manage water supply and protect catchments, supply bulk water, and regulate activities within the catchment areas to improve water quality, protect public health and protect the environment. The Authority was created after the inquiry into water quality incidents experienced by Sydney Water between July and September 1998. The main finding of the inquiry was that the catchments were seriously compromised by many possible sources of contamination and that Sydney Water did not have sufficient regulatory control of the catchments to guarantee safe drinking water – hence the need for a separate catchment authority.

The Sydney Catchment Authority and the NSW National Parks and Wildlife Service have jointly developed a special areas strategic plan of management - a blueprint for managing Sydney's drinking water catchments. The aim is to ensure clean water into the twenty-first century and to protect the ecological values of the inner catchment lands. The special areas are the inner catchments – approximately 370,000 hectares of land – surrounding the water reservoirs for the Sydney, Blue Mountains and Illawarra water supply.

These areas form the first and most critical barrier in a multi-barrier approach to protecting water quality. They act as a natural filter for water entering the reservoirs by removing some nutrients and other substances that could affect water quality. The greater the ecological integrity of the special areas, the more effectively they operate. The other barriers are the reservoirs themselves, the water treatment processes and the system of delivery to the tap.

The Plan will protect drinking water supplies through five key strategies:

1. *A whole of catchment management approach:* Management of the entire catchment is necessary to ensure that stored water quality is protected. A regional environmental plan to protect Sydney's drinking water supplies is to be developed.
2. *An ecosystem management approach:* A healthy ecosystem which can assimilate wastes and deliver clean water is the most effective means of protecting water quality. An on-going applied research programme will be implemented to enable more informed decision-making regarding catchment lands.
3. *A public education and awareness campaign:* This programme will seek to provide the community with critical information regarding the role of catchments and their ecosystems in providing high quality drinking water,and the potential risks if this is not maintained.
4. *Effective joint management processes:* a joint management agreement between the Sydney Catchment Authority and the NSW National Parks and Wildlife Service is an integral component of the plan.
5. *Public scrutiny:* The plan provides for increased public information about the management of the special areas.

Sustainability reporting

The use of indicators to report on sustainable development would assist all water service providers to better monitor and report on progress with sustainability and urban ecosystem management. They are also good performance indicators of the business.

For example, Sydney Water has a policy to implement the principles of ecologically sustainable development (ESD) by integrating environmental, social and economic considerations in all of its business. To assist reporting on how it is implementing ESD, Sydney Water is developing a list of sustainability indicators that address: water use, pollution control, greenhouse gases, energy use and efficiency, material life cycles, biodiversity, social/health, economic and management.[2]

Issue 5. Urban ecosystem management

a) **How can integrated management of urban water systems be improved, particularly issues relating to growth management and the adequate provision of water services?**

b) **What changes are required in legislative functions and/or policies/practices to improve the management of urban water catchments for water supply purposes?**

c) **How can water service providers be encouraged to develop and report on sustainability indicators?**

3.2 Integrated management of water services

Integrated water resources management considers both production and demand-side pressures, and has the multiple objectives of minimising water waste; maximising the efficiency of water use; maximising water availability by limiting degradation of water supplies, and through reuse; optimising water allocation to competing users; and limiting withdrawals to sustainable levels (OECD 1998).

Internationally, there is increasing emphasis on integrated management of the supply of water and disposal of waste and stormwater. The reasons for this shift are because new water supplies are capital intensive, are often of lower quality than existing supplies, and increased water-take affects the environment by reducing ecological flows ie flows in streams and rivers. The change in approach also recognises that existing resources need to be better managed with more efficient resource use and less waste (Cayford 2000).

Successful long-term management of the urban water system will require integrated management of water services (see box 3.2). This will tend to emphasise the demand-side ahead of the supply-side focus of current services to the community. This integrated management approach has significant implications for the design of future regulatory and management frameworks for water services. Solutions are needed to support more efficient resource use and to recognise the important linkages between the different water service components of water supply, treatment, use, and disposal of wastewater and stormwater. The water service supply and disposal components **cannot** be considered as separate entities and split like the electricity and gas generation, distribution and retail networks if the services are to be ecologically and economically robust and socially just.

Box 3.2 Waitakere City and EcoWater

In 1997 Waitakere City established a business unit EcoWater Solutions to provide urban water services. EcoWater was set up to deliver high quality water services efficiently and reliably. The business unit must also not unduly affect the environment, it must safeguard resources for future generations and take into account the principles of the Treaty of Waitangi. The council has moved the focus of the business from the maintenance of pipes, to the sustainable delivery of services (Dacombe 1997).

Waitakere City has taken a water cycle strategy approach to the management of urban water systems with community support and ownership. This approach was favoured because it provided for integrated management of the three waters, was a catchment-based approach, involved better use of resources, was the lowest cost solution, and produced better environmental outcomes, community acceptance and support.

Eco-efficiency and urban water systems

The OECD has recognised that the focus of environmental concern is shifting away from pollution-related problems towards resource-based ones (OECD 1999b). Technical, social and economic changes can contribute to major improvements in the efficient use of resources, ie eco-efficiency, and thus contribute to sustainable development. Eco-efficiency is an approach which combines the efficient use of both economic and ecological resources.

In practice, many initiatives to improve water resource use involve a package of measures: a mixture of regulation, economic instruments, information and education, along with measures which directly address production as well as consumption patterns. Increasingly, water demand management, water reuse and life cycle analysis will help ‘close the loop’ on water use and better replicate natural water systems.

It is acknowledged that reuse of water sourced from stormwater and treated wastewater raises significant cultural and spiritual concerns for some Maori and these issues will need to be discussed and addressed. The broader community also has concerns about water reuse, the perceived quality of the water, and effects on human health and the environment.

There is a major need for research in New Zealand to model and assess the benefits and costs of different 'long pipe' and 'onsite' systems such as is being undertaken by CSIRO, Australia (see section 3.3 and appendix 2). There are a range of ways of reusing and recycling water resources and developing more efficient systems, often through the use of locally developed solutions (see section 3.3 for New Zealand examples). This research would also need to address societal concerns about these approaches and how these concerns could be resolved.

Small-scale local solutions and the use of decentralised water systems compared to large centralised systems brings a number of management issues. Some landowners do not make good 'managers' of onsite water supply and wastewater treatment solutions as shown by the inadequate state of many onsite rainwater drinking supplies and septic tanks.

These management issues do not rule out these approaches but do require a different management response. For example, rather than the individual being responsible, a local authority, community or body corporate could be given the responsibility to ensure that these onsite systems receive regular monitoring and maintenance. A water services provider could have a network of small-scale decentralised systems compared to one or two large centralised systems. Decentralised systems may also be more appropriate for new subdivisions and 'new towns' or where new systems need to be installed in areas with population growth eg for small rural and coastal settlements.

The new AS/NZS 1547:2000 "Onsite domestic wastewater management" standard focuses on regular monitoring and maintenance by either public agencies or via an owner commissioned 'warrant of fitness' check. Environment Bay of Plenty has already instituted a requirement for checks of existing and new systems to improve management.

Demand management

Demand management options include full-cost pricing through user charges, education, information, retrofitting and installation of water-efficient devices. These approaches act to influence and reduce flows through water systems providing significant operational savings and environmental benefits. Often full-cost pricing has been the favoured approach by water service providers but more demand management programmes of a structural nature are needed eg redesign of buildings with dual pipe systems and the use of water efficient equipment.

Demand management has received considerable attention in other OECD countries. For example, the United Kingdom Environment Agency established the National Water Demand Management Centre in 1993 to help achieve sustainable use of water in England & Wales. As a centre of expertise it provides a "one stop shop" for anyone wanting general information and technical advice on any aspect of water demand management and water conservation. Likewise the Water Services Association of Australia has promoted demand management solutions eg through the preparation of a demand management manual for water utilities (White 1998).

Cayford (2000) has noted that demand management is not a formal requirement of water service providers in New Zealand. This is in contrast to solid waste management where objectives for waste minimisation, recycling, reducing and reuse must be met. Local authorities are required to prepare a waste management plan under section 539 of the Local Government Act 1974.

Water service providers could also be required to prepare a similar demand management plan for water services to maximise the use of existing infrastructure and water resources. Demand management can also take into account the cost of environmental externalities ensuring a more integrated approach to water management.

Where there is a wholesaler/retailer split in water services as in Auckland, the absence of a requirement to undertake demand management at both regional and territorial level means that demand management can be given a lower priority except in times of drought. This represents a lost opportunity to increase the overall efficiency of the water system.

Wastewater management

If not adequately treated, wastewater discharges can result in pollution and extensive environmental damage to receiving ecosystems with public health risks, nuisance and adverse effects on cultural values and resources of significance to tangata whenua. There are also cross-media issues from the advanced treatment of wastewater with resulting biosolids requiring further treatment and management.

In recent years, opportunities have increased for local-scale domestic and industrial wastewater treatment/re-use schemes to meet non-potable water demands eg gardening, irrigation and cooling. Appropriate reuse in the urban environment can include domestic toilet flushing, irrigation of public, commercial and private open space, and industrial needs.

Box 3.3 ACT, Australia

In ACT, Australia, the electricity and water services company ACTEW has been addressing the reuse of wastewater at the local scale. The objective was to prevent sewage overflows in key catchments and create incentives for water reuse. At present only 4% of total wastewater is reused. Large satellite underground storage tanks are being built to handle overflow problems and absorb peak volumes. The effectiveness of this approach is financially marginal but it is able to be considered if the whole catchment system is taken into account as the benefits of reuse increase by counting in deferred investment in dams, plants and pipes.

Stormwater management

Some regional councils have taken a very active role in addressing the management of urban stormwater eg Auckland Regional Council (ARC) has prepared a regional stormwater strategy (ARC 1998) and is working with local councils to address stormwater issues. Other regional councils have yet to address stormwater in an integrated way. There is an opportunity for the Ministry for the Environment to work in partnership with regional councils, and provide national level information on stormwater management and best practice like the United States Environmental Protection Agency and the New South Wales Environmental Protection Authority (NSW EPA).

Since May 1997 the NSW EPA has been developing and implementing a major stormwater management programme. The two key initiatives have been a requirement on local councils to prepare stormwater management plans, and the development of partnerships between local councils and the private sector to implement innovative cost effective stormwater management technologies.

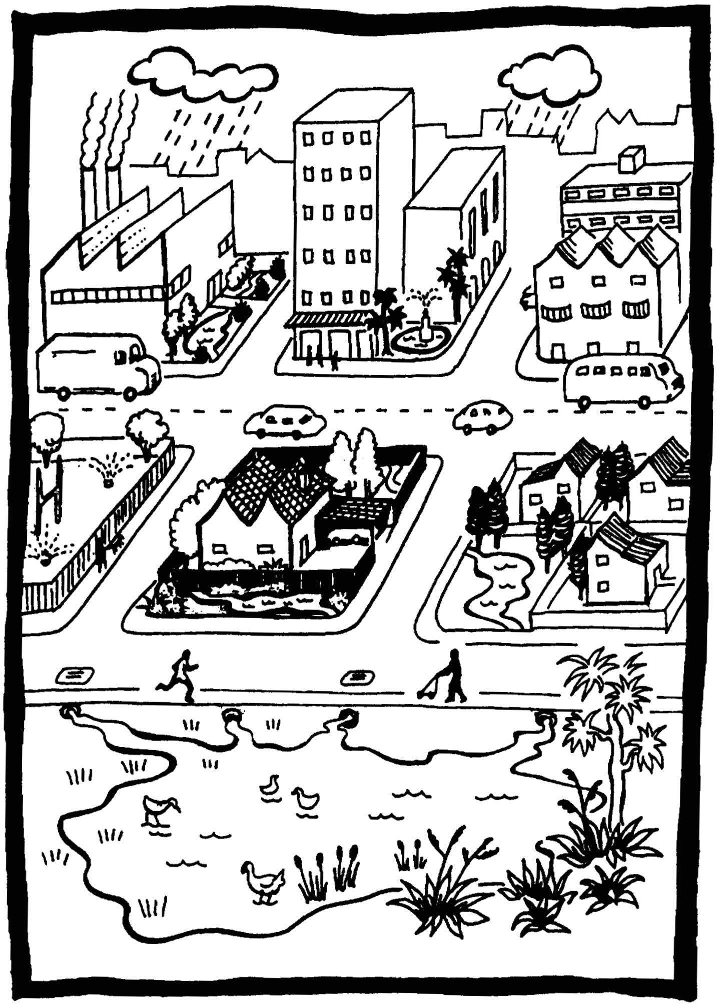
In the past, urban stormwater management has tended to concentrate on removing stormwater as quickly as possible to prevent flooding. This has resulted in built networks of channels and pipes within altered catchments and re-aligning and lining of natural streams and rivers.

Improved onsite management can reduce the need for expensive networks of stormwater pipes and channels, and when combined with the enhancement of existing natural drainage systems, can provide opportunities for pollution mitigation and local environmental reuse. For example, stormwater can be ‘harvested’ by the use of rainwater tanks and this water can be later used for watering the garden and other external uses as well as for flushing toilets. This removes stormwater from the system at peak rainfall periods and reduces potable water use. The use of retention and detention systems including ponds, wetlands and restored natural waterways can allow for infiltration, evaporation and other natural processes to remove and treat the stormwater flows.

This approach benefits the environment by reflecting much better the pre-development catchment hydrological conditions. Increasingly stormwater management can meet multiple objectives of flood control, water reuse, provision of ‘green space’ in towns and cities, and landscape and amenity values.

ARC has produced a stormwater design manual for use by land developers. Economic analysis has shown that it can provide increased economic returns through better site layout and improved stormwater management outcomes. (ARC 2000). Funded through the PGSF, NIWA is undertaking a range of stormwater research to examine: the effects of transport on aquatic ecosystems; mitigating contaminent effects in urban aquatic habitats; and stormwater contamination of urban estuaries.[3]

Figure 3.1 Sustainable stormwater management



Box 3.4 The Christchurch waterway enhancement programme

For most of the 20th century the primary objective of the Christchurch Drainage Board was to remove stormwater from the district through efficient drainage. In 1991 the Christchurch Drainage Unit investigated future management options and concluded that management should emphasise the natural attributes of waterways wherever practicable. Catalysts for change were local government reform, the Resource Management Act 1991, increased environmental awareness and the increasing costs of managing and extending the existing drainage system (Bicknell and Gan 1997).

This change in philosophy led to the establishment of the waterway enhancement programme for the long term improvement of the tributary waterway system. Enhancement would emphasise the natural contours of the waterways with planting of native species to promote aquatic and birdlife. This was a major contrast to the former use of piping and straightened watercourses. On a discounted basis, enhancement was found to be a lower cost option at approximately $165 per metre compared to $540 per metre for piping. This was in addition to the added value from ecosystem services such as water filtration, biodiversity, recreation, and landscape values from the enhanced natural waterways. It is recognised that there can also be negative impacts from poorly managed waterways with potential for nuisance insects, concerns about safety, and unsightly debris and litter.

Community participation and involvement with the enhancement programme has been a key to getting progress at the local level. The programme offers an opportunity for environmental education and getting local groups involved in their neighbourhood.

Stormwater charges
Currently, stormwater management is funded through the general rate. This appears to be because stormwater management is seen as a public good. However, it is possible that a charge on the area of impervious surface on a property could be levied to fund stormwater management in the future. Properties with more impervious surface and more stormwater runoff would therefore pay higher management charges. This would also create an incentive for maintaining permeable surfaces and discounts could be provided for the reuse of stormwater, for example, through the installation of tanks to hold roofwater that can then be used on gardens or slowly released into the drainage system.

There are many examples of dedicated stormwater utilities in the United States. These utilities are responsible for managing stormwater flows and levying stormwater management charges eg an impervious surface tax. In New Zealand the North Shore City Council is investigating options for the introduction of stormwater charges.

Issue 6. Integrated management of water services

a) How can more water services providers be encouraged to take an urban water cycle strategy approach to the management of urban water systems with integrated management of all waters?
b) How can greater priority be given to demand management responses including preparation of a demand management strategy?
c) What are the opportunities for increased 'water harvesting' and reuse of reclaimed water in New Zealand given the need to manage a range of public health, cultural and environmental issues?
d) How can the management of stormwater be improved through the use of the full range of onsite and offsite solutions?

3.3 New solutions and urban water systems research

New Zealand provides the majority of its urban water services through large scale infrastructure solutions and is still adding to the network of dams, pipes and treatment plants (eg the Waikato water supply pipeline, the proposed Kapiti Coast water supply pipeline). There is an opportunity to rethink and revise our approach to urban water services through the use of new solutions and innovative approaches that will enhance the sustainability, viability and social justice of our water systems.

The near future will bring increasing use of 'new solutions' such as:

- individual or clustered small-scale wastewater treatment plants that produce little odour or noise pollution and service 5000 to 20,000 house holds;
- improved onsite wastewater systems;
- reuse of stormwater and reclaimed water linked to small-scale wastewater treatment plants or through 'water mining' from existing wastewater systems;
- improved urban design and onsite management of stormwater by natural processes;
- 'smart time of use meters' for water supplies that are electronically read, that allow different service providers and a range of tariffs linked to demand and consumption patterns;
- risk based solution identification and management;
- advanced use of automation and control for system optimisation;
- matching urban water systems outputs (eg wastewater discharges) to the variation of the natural receiving environment (ie 'mix and match' wastewater systems involving land application and discharge to water); and
- improved asset management procedures including life cycle approaches.

Box 3.5 Research into sustainable alternatives[4]

The Australian Federal research agency, CSIRO, has an Urban Water Programme which is a study into the economic, technical, environmental and social feasibility of alternative approaches to the supply of urban water services. The study is an attempt to apply full life cycle costing to all aspects of urban water services. The study has been undertaken in collaboration with the Water Services Association of Australia and a reference panel of industry experts.

It is acknowledged that the study is only the first stage of analysis and so only limited conclusions can be reached. Environmental externalities have yet to be costed and the social acceptability of alternative technologies (eg composting toilets, wetlands, localised treatment plants) requires further research.

What the study does demonstrate is that it is possible to analyse urban water systems and obtain comparative data for different scenarios for the provision of water and wastewater services to a hypothetical, densely populated urban area. Four alternative scenarios were evaluated based on reducing supply pressures, minimising peak flows and the recovery and recycling of greywater (see appendix 2).

A key finding from the study was that while there was no significant difference in system capital and operating costs between the four designs, systems which allow for separation of blackwater and recovery and recycling of greywater offer the potential for significant reduction in headworks costs and environmental impact, including reduction in nutrient discharges and increases in environmental flows.

Large cost savings (>35%) in potable water supply infrastructure are possible through levelling peaks in demand. However, these savings are offset through the increased cost at the household level of installing 1000 litre storage tanks and pumps in order to maintain supply pressure.

Reducing the pressure rating of potable supply has the potential to reduce the cost of potable supply infrastructure by about 10%. The cost savings were again offset by the increased cost at the household level, where individual low-pressure sprinkler systems were installed. It has been assumed that in each house there will be a series of low-pressure sprinklers installed, connected to the in-house potable water storage tank.

Box 3.6 Swedish urban water systems research[5]

The Swedish Foundation for Strategic Environmental Research (MISTRA) has granted SEK 30 M (~ NZ$ 7.5 M) for the period 1999-2001 for the research programme ‘sustainable urban water management’. Research departments from eight Swedish universities are participating in the programme. It encompasses about 15 research projects that deal with drinking water, wastewater and stormwater, taking into consideration health, social, economic and environmental aspects. The central task for the entire programme is to answer the question: how should the urban water and wastewater system be designed and operated in the future ‘Sustainable Sweden’?

New solutions in New Zealand

It will be essential that the application and adaptation of new and alternative urban water services technologies and solutions is undertaken in New Zealand. This will also need to include research of consumer attitudes and awareness.

The Institute of Environmental Science and Research Limited (ESR) is currently developing a four to six year research project on multi-stakeholder consultation, holistic thinking, and improved decision-making in the area of urban water management. This project will shortly be submitted to the Foundation for Research, Science and Technology for approval and funding (ESR 2000).

An example of a new solution being applied in New Zealand is the Solan Estate at Waimauku in the Auckland region. The estate contains around 35 lots with full sewerage to a self contained wastewater system within the subdivision that provides treatment via a communal septic tank and recirculating sand filter. About $^{1}/_{3}$ of the high quality treated wastewater (also disinfected) is recycled back to each lot as reclaimed water for toilet flushing. The remaining treated wastewater is drip irrigated to a land application area. An application is to be made to the ARC to allow use of the recycled reclaimed water for on-lot garden watering (Gunn 2000).

The Ansky Subdivision at Kuaotunu is also around 35 lots. Here each dwelling will be serviced with an individual septic tank with the outflow discharged via a 50 mm diameter sewer line to a communal recirculating sand filter. Reclaimed water is delivered back to each house via a 25 mm diameter line laid in the same shallow trench as the septic wastewater sewer. The reduced volume of treated wastewater is drip irrigated to a land application area to be planted with eucalypts (Gunn 2000).

These two projects are design/build/operate contracts. The company concerned uses monitoring sensors to maintain a watch over treatment operations via data transfer to their Auckland office computer, with locally trained service personnel on call for dealing with normal maintenance and emergency call-out actions. The property owners belong to, and financially support, a body corporate which engages the service company (Gunn 2000).

Improving the efficiency of water use
There are considerable opportunities for improving the efficiency of water use and reducing wastewater flows. The design flow allowances in Table 3.1 below are adapted from a 1997 report, updated to reflect current technologies (Gunn 2000). The estimated additional cost of providing for scenario 5 over and above scenario 1 (that is going from no water reduction fixtures to full water reduction and reclaimed water recycle for toilet flushing) is around $4000 to $4500 in fixtures, equipment, and greywater treatment per household.

Table: 3.1 Household water use reduction and design wastewater flows (3 bedroom dwelling, 5 person household) (Gunn 2000)

Household water use scenarios	Per capita daily flow allowance (litres/person/day)	Household daily wastewater flow allowance
1. Dwellings with standard water use facilities [11 litre toilet; automatic washing machine; standard shower heads; standard taps (faucets)]	200	1000
2. Dwellings with standard water reduction fixtures [dual flush 11/5.5 litre toilet; showerhead flow restrictors; aerator faucets; water conserving washing machines]	180	900
3. Dwellings with enhanced water reduction fixtures [dual flush 11/5.5 litre toilet; showerhead flow restrictors; aerator faucets; water conserving washing machines plus FOFC (fixed orifice flow control) valves on all outlets]	140	700
4. Dwellings with full water reduction fixtures [dual flush 6/3 litre toilet; showerhead flow restrictors; aerator faucets; front load washing machines plus FOFC valves on all outlets]	90	450
5. Dwellings with full water reduction fixtures [dual flush 6/3 litre toilet; showerhead flow restrictors; aerator faucets; front load washing machines plus FOFC valves on all outlets, plus greywater or reclaimed water recycle for toilet flushing]	70	350

New solutions and water services reform in New Zealand
It will be essential that New Zealand takes into account these new and alternative urban water services technologies and solutions when considering water services reform.

This is also the case with the provision of water supplies for fire-fighting purposes (see box 3.7).

Box 3.7 Fire-fighting and urban water supplies (Wilson 1998)

The Fire Service Act 1975 requires the Fire Service Commission to promulgate a code of practice for fire-fighting water supplies. Sizing urban water reticulation systems to provide a fire protection system means that the fire flows totally dominate the hydraulic requirements of all but trunk water mains. This means that water mains are usually oversized for normal consumption, more expensive to construct and maintain, and it is more difficult to sustain water quality. In isolation from a holistic management approach, building fire protection systems (eg sprinkler systems) constructed to the code of practice, result in water service providers not being able to reduce leakage problems by lowering pressure, without making existing fire protection systems non-compliant.

Some estimates suggest that up to 30% of the total cost of providing, operating and maintaining an urban water supply network can be attributed to the fire protection capability. Having established the code of practice with considerable costs for local authorities, the Fire Service is now making less use of fire hydrants for fire-fighting (particularly internal residential fires) and is introducing technology which for most fires will only require one-tenth of current water needs (eg compressed air form). The code of practice is being reviewed by the Fire Service. There needs to be a rigorous assessment of alternatives and a benefit-cost analysis of the use of urban water supplies to provide fire fighting systems and who should pay for the costs. There are also alternative approaches such as building sprinkler systems that could be assessed.

It will be essential that the outcomes of the reforms do not prevent the development and use of these alternative approaches. For example, a situation such as in the electricity industry where there are barriers to the use of embedded generation because of the design of the market framework and pricing structures. A lack of information on the application of these alternative approaches can also result in a limited support.

Issue 7. New solutions

a) As a contribution to water services reform, how can New Zealand research and examine the costs and benefits and potential applications of new and alternative urban water services technologies and solutions?

b) How can we identify and price the environmental externalities of different systems as part of theprovision of water services?

3.4 The role of ecosystem services

Ecosystems services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain all life, including human life. These natural services from ecological systems are critical for the continued functioning of urban areas.

Ecosystem services maintain biodiversity and the production of ecosystem goods, such as forage, timber, biomass fuels, natural fibre, seafood, and many pharmaceuticals, industrial products and their precursors. The harvest and the trade of these goods represent an important part of the human economy. In addition to the production of goods, ecosystem services are the actual life support functions, such as cleansing, recycling, and renewal, and they confer many intangible aesthetic and cultural benefits as well (Daily 1997).

Ecosystem goods and services provided by urban water systems include[6]:

- stabilising processes (eg management of hydrological flows, responses to environmental fluctuations and perturbations such as storm protection, flood control, and drought recovery);
- the production of goods (eg water supply, storage and retention of water in catchments and aquifers);
- waste treatment and regeneration processes (eg filtration of water and processing of wastes by wetlands);
- habitat (eg fish nurseries and habitat for migratory species); and
- cultural and spiritual values.

A good example of ecosystem services is the supply of clean water. A recent study showed that the provision of adequate clean water to New York City by forests in the Catskill Mountains was equivalent to a capital investment of US$6-8 billion and an annual US$1-2 billion operating cost for a plant to carry out the same service. The City took the option of maintaining water quality via ecosystem services by purchasing some small parcels of land, applying some covenants on use of fertilisers in the catchment, and making a one-off investment of approximately US$1 billion for upgrading local sewerage plants. The purchase of land was funded through private restoration bonds with excellent rates of return (Chichilnisky and Heal 1998).

As ecosystem services are not fully valued in commercial markets or adequately quantified in terms comparable with economic services, they are often given too little weight in policy decisions. However, these services are very expensive to replicate and the loss of these services has socio-economic effects with long term implications for urban sustainability (Costanza et al 1997).

Craig (1998) has noted the often perverse incentives for addressing ecosystem services in the urban environment. For example, property rating systems are used to encourage ‘development’ that ignores natural systems with the result that water cycles are highly modified in many cities. No difference in rating is made between residential and commercial areas that have maintained natural systems through pervious surfaces and tree cover, and areas with impervious surfaces and little vegetation.

Water service charges similarly appear to act as perverse subsidies in that they favour environmental damage over more sustainable approaches. Current water charges do little to encourage more efficient use: they vary from a standard charge for all users regardless of use, charges by pipe size (an asset maintenance charge independent of client requirements), or charges that are cheaper for higher volumes. Moving to charges that increase as availability decreases and that increase as demand increases (eg rising block tariffs) would both reduce infrastructure costs and would assist in the management of water ecosystems.

Greater consideration of the value of ecosystem services and sustainability matters may provide alternative and innovative approaches for management of urban water systems. Increasingly, emphasis will need to be placed on enhancing natural systems, rather than replacing them with built systems. For example, onsite treatment of stormwater can be accomplished with natural landscaping, which helps replenish groundwater, eliminate runoff, enhance biodiversity, store carbon, and save money, among other benefits. Conventional engineering solutions for stormwater runoff usually involve flushing the water downstream, resulting in more flooding, costly engineering structures, and other costs.

Ecosystem services, charging and asset management planning

Ecosystem services provide a particular challenge for asset management planning in terms of how to recognise and value both natural and built urban water systems, and to then incorporate these values into traditional financial management processes. A co-ordinated approach will be needed to value all ecosystem services ie just charging for water-related ecosystem services could result in distortions in the value of other services and landuses.

The achievement of sustainability is closely linked to the internalisation of externalities, as negative externalities are indicative of ongoing environmental and social impacts for which no action is being taken. Current designs for the provision of urban water services do not separately recognise any costs associated with incorporating externalities or maintaining ecosystem services. The inclusion of such costs could significantly alter the approach to system design, by making some alternative approaches more cost competitive (Booker et al 2000) (see section 3.3).

The recognition and valuation of ecosystem services such as water filtration, nutrient management, and flow mitigation must be incorporated into the valuation of water in the future. This will influence how water is charged for and used, and will have implications for asset management with more sustainable and ecologically based solutions superceding built infrastructure as per the example of the Christchurch waterway enhancement programme.

Addressing ecosystem services and urban sustainability will require well constructed financial charges and incentives. This will ultimately depend on the findings of research such as being led by CSIRO (see box 3.8). This research programme could also be established in New Zealand with a primary focus on the ecosystem services from urban water systems.

Box 3.8 Ecosystem services - a research opportunity

In Australia in 1999, CSIRO and the Myer Foundation launched a new four year project called *The Nature and Value of Australia's Ecosystem Services*[7]. The project aims to produce detailed assessments of:

- ecosystem services from a range of Australian ecosystems;
- likely changes to these services under a set of plausible future land management scenarios developed in collaboration with the full range of stakeholders; and
- costs and benefits, in forms useful to decision-makers fromlocal to national levels.

The project aims to raise awareness of the benefits of better natural resource management among Australians. The first assessment will lead to greater investment and collaboration in valuing Australia's ecosystems, further refinement of the methods of valuation, changes in the policy and practice of land management, and the development of new technologies.

The project was started because apart from a few isolated examples, there was virtually no appreciation of the nature or the value of the services that Australia's ecosystems provide. There was a need to conduct a scientifically rigorous assessment of the kinds, magnitudes and values of the functional processes in ecosystems, in order to better manage resources and derive value from them over the long term. Ultimately, the success of the project will be assessed on the extent to which these presently unaccounted and unpriced services are incorporated into natural resource management and policy.

Examples of potential policy and legislative changes from this project include:

- improved capacity to price and create markets for critical ecosytem services;
- development of new techniques for environmental impact assessment;
- improved capacity to develop regionally based natural resourcemanagement strategies and codes of practice (the capacity for such strategies to be accredited under quality assurance processes, such as ISO 14000, may lead to significant marketing advantages in the future); and
- improved capacity to establish priorities for natural resource management within different regions and ecosystem types.

Issue 8. Recognition and valuation of ecosystem services

a) How can the concept of ecosystem services be better applied to the management of urban water systems with enhanced recognition and valuation of these services?

b) How can asset management planning be enhanced to recognise, value and incorporate the roles provided by ecosystem services resulting in more appropriate financial charges and incentives?

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1 The Environment Act 1986 defines "ecosystem" to mean "any system of interacting terrestrial or aquatic organisms within their natural and physical environment".

2 See http://www.sydneywater.com.au/environment/

3 See the SWAT update, the official newsletter for NIWA's PGSF research on stormwater and transport effects on urban aquatic ecosystems.

4 This section is sourced from Booker et al 2000 and information on the urban water programme website at: http://www.dbce.csiro.au./urbanwater

5 Malmqvist 1999.

6 Adapted from Costanza et al 1997 and CSIRO 1999.

7 See http://www.dwe.csiro.au./ecoservices

4. What is already being addressed?

There are a considerable number of water-related reviews at the national and regional levels that are relevant to this investigation. There are also a number of recent legislative and policy developments that influence the water services sector.

4.1 National reviews

4.1.1 The water services review

In November 1998 the Government announced a comprehensive review of the delivery of water, wastewater (sewerage and trade waste) and stormwater services. The water services review was initiated in response to a number of concerns about the sector including the:

- fragmented nature of the regulatory framework for water and wastewater and whether it was adequate to promote good management practices and deliver quality services efficiently;
- poor state and lack of capacity of existing infrastructure in some areas and difficulties associated with investment and maintenance of infrastructure;
- variable quality of drinking water in some areas with the potential for public health to be compromised; and
- impact the sector could have on the environment.

This Ministry of Commerce-led water services review was expected to take 18-24 months to complete. The Hon Max Bradford stated "if we don't take the initiative, the emerging issues faced by the sector will become more difficult to manage, and more expensive to fix in the future. The Mercury Energy failure, and recent overseas events demonstrate the need for sound infrastructural investment and maintenance" (November 1998).

In July 1999, local government, as the main provider of water services, offered to take on the review. This was accepted by the then Prime Minister, Rt Hon Jenny Shipley, and Local Government New Zealand is now co-ordinating the review of water services in New Zealand on behalf of local government.

Local Government New Zealand then developed a framework for the review. A draft approach "Towards a Terms of Reference for a Water Review", was widely circulated to all local authorities in late 1999. This terms of reference began by identifying four principles that the sector might seek to further as part of the review (see section 5).

Nearly 80% of local authorities provided supportive comments about the draft terms of reference. A small number did not believe that a water review was necessary and/or did not want Local Government New Zealand to lead the review.

After the 1999 general election, the National Council of Local Government New Zealand become concerned about the priority to be given to the water services review given that there was an already 'crowded agenda' of reform initiatives eg Local Government Act 1974, Rating Powers Act 1988 and transport reform proposals. The National Council resolved to discuss the priority to be given to the review and the financing of it with the new Government (Hutchings 2000).

While work on a number of water-related issues has been progressing, work on the Local Government New Zealand review has now been placed on hold pending ongoing discussions with the Government. The Minister of Commerce, the Hon Paul Swain met with Local Government New Zealand in March 2000. The Minister sought further information on how best the two parties can work in partnership to address water related issues, what priority these issues should be accorded and a timetable for the review process. In a related development, the Minister of Local Government is seeking to convene a meeting of the interested Ministers to facilitate a strategic response to water-related issues across the interested portfolios.

In a related development, the New Zealand Water and Wastes Association has held several conferences to discuss water services reform (Crossroads 1998 and 1999) and developed proposals for a new water services framework including a proposed new Water Act.[1]

4.1.2 Ministry of Health

Review of Water Supplies Protection Regulations 1961

In 1995 consultation by the Ministry of Health with the water industry and the public showed that legislation protecting the public from diseases derived from drinking-water was incomplete, outdated, fragmented and occasionally inconsistent. A significant proportion of the legislation only applied to public drinking-water supplies. The legislation needed to take into account the many private drinking-water supplies throughout New Zealand.

Subsequently, the Ministry of Health has been reviewing and developing new Water Supplies Protection Regulations. These new regulations will, if adopted, make the 1995 drinking water standards binding on private and public water suppliers, including local authorities. These new regulations would mean little change to suppliers providing A or B grade water, but would require some form of upgrade or improved treatment for those supplies below C grade.[2]

The Ministry of Health is also involved in a number of studies examining specific risk management aspects of water services:

- risk management plans for backflow prevention;
- risk management plans for service reservoirs;
- risk management plans for breaching of water mains; and
- risk management plans for incorrect placing and dosing of treatment chemicals.

There is also a review underway of clause G12 (Water Supplies) of the Building Regulations for water supplies within buildings. These regulations are being reviewed by the Building Industry Authority. The Ministry of Health is working with the Building Industry Authority to ensure the two reviews are co-ordinated to produce coherent, comprehensive and seamless legislation.

Small water supply/wastewater systems

The Ministry of Health is undertaking a pilot study in the Hokianga area to assist with the re-establishment of water supply systems after damage caused by the January 1999 floods. Post-flood investigation in the Hokianga area confirmed that supplies of water remained faecally contaminated, some heavily, and that some supplies were heavily contaminated prior to the floods. The Hokianga pilot illustrates the fundamental difficulty of providing quality water supply systems to rural communities with dispersed, low income populations. This pilot study may be the gateway for consideration of the reintroduction of a subsidy programme for small and medium sized communities facing significant health risks.

4.1.3 Ministry for the Environment

National Agenda for Sustainable Water Management (NASWAM)

The Ministry for the Environment is developing a long-term agenda for sustainable water management (Ministry for the Environment 1999). This will set priorities for managing water and assist the development of better tools to manage water under the Resource Management Act 1991. NASWAM has identified that progress needs to be made on:

- allocation, efficiency and equity issues and impacts of abstraction on instream values;
- the condition of lowland stream ecosystems;
- groundwater, quality and quantity, and the impacts on streams of abstraction of water;
- estuaries and harbours, in particular, the impacts of stormwater;
- microbiological contamination, especially of fresh water; and
- eutrophication and loss of habitat in lowland lakes.

Urban water issues were identified as one of three key themes and are accorded a high priority in NASWAM. This is shown by the identification of many urban water system issues in the above list of priorities. An urban issues working group has been proposed to address urban water management issues including demand management, stormwater management and the amenity values of water resources.

Fresh water microbiological research programme

The Ministry for the Environment is co-ordinating a four-year microbiological research programme to investigate disease-causing organisms in fresh water. This joint venture with the Ministries of Agriculture and Health, local government and research institutions will provide the scientific basis for guidelines on managing water used for bathing, stock drinking water and human drinking water. The Ministry for the Environment has revised the 1998 Bacteriological Water Quality Guidelines for Marine and Fresh Water. They have been renamed and are now the Recreational Water Quality Guidelines. These guidelines are to assist water managers to implement the Resource Management Act 1991 and the Health Act 1956 in relation to shellfish gathering and contact recreation. The guidelines cover three categories of water use:

- marine bathing and other contact recreation activities;
- fresh water bathing and other contact recreation activities; and
- recreational shellfish-gathering in marine waters (but not commercial shellfish harvesting).

Other Ministry for the Environment water related work includes:

- revision of the ANZECC Water Quality Guidelines for Fresh and Marine Waters. The guidelines provide an authoritative reference for water quality management in New Zealand, particularly for toxic contaminants;
- Flow Guidelines for Instream Values (May 1998). These guidelines provide a consistent approach to setting minimum flows and other flow requirements in rivers including instream values;
- the Water Quality Guidelines No 1, which cover the management of biological growths in rivers used for swimming and Water Quality guidelines No 2, which cover the management of water clarity for bathing in fresh waters; and
- the development of water indicators as part of the national environmental indicators programme.

4.2 Regional and local reviews

Some local authorities have embarked on review programmes of their own. The various local authorities in the Auckland, Taranaki and Wellington regions are investigating key issues and exploring alternative models of delivery of water services in their respective region. For example, the three territorial authorities in Taranaki are investigating options for future management of water and wastewater in the region. There is potential for the three territorial authorities to operate their water services as a jointly owned LATE with an internal facilities management contract (Sampson 1999).

Many local authorities participate in a performance measurement and benchmarking initiative for water services conducted by Price Waterhouse Coopers. There is an opportunity to extend this template for wider application (Hutchings 2000). However, the relevance of this benchmarking for all local authorities has been questioned, with a suggestion that the methodology used by the United Kingdom Water Regulator (OFWAT) is more appropriate.

4.3 Recent policy developments

The Local Government Amendment Act (No. 3) 1996 requires local authorities to prepare asset management plans as a precursor to the preparation of long term financial strategies and funding policies. The application of the 1996 Amendment has revealed to many local authorities, for the first time, the sheer size of the investment in water services that is required (Hutchings 2000).

Information provided by these plans will improve the level of knowledge about the state of urban water infrastructure and will ultimately contribute to better decision-making eg providing for depreciation and replacement of assets. An issue that needs to be examined in the future is how asset management planning has actually been used and what influence has it had in terms of any adjustments to funding arrangements and local authority investment decisions (Hutchings 2000). A related, but potentially very important issue is whether asset management planning will only look at how to maintain or improve existing infrastructure or whether it will include opportunities for innovation as well.

The Office of the Controller and Auditor-General has a key role in auditing long-term financial strategies and associated funding policies. The Auditor-General has been reviewing the performance of nine local authorities which have been implementing the new financial planning requirements in advance of Local Government Act 1974 specifications.

4.4 Linkages between the reviews

The above sections have identified a considerable number of reviews on aspects of urban water systems and water-related issues. The coverage of the various water-related reviews and policy proposals are shown in figure 4.1.

This summary indicates that none of the current reviews, or proposed reviews, addresses the whole water spectrum. While that is not essential to advance water system management, a very broad systems and ecologically-oriented review is essential if opportunities for improved water management are to be realised and risks minimised.

Any effort to advance the management of urban water systems must acknowledge that natural ecosystems are the very basis for the provision of water services and they cannot be considered to be 'external' or 'secondary' to the water and wastewater industry. It is not sufficient to develop a new water framework with no regard to sustainability issues and to simply assume that other legislation, for example, the Resource Management Act 1991, can address any subsequent environmental effects.

This reality contrasts with the approach of the initial Ministry of Commerce led review where it was stated that (Ministry of Commerce 1999a p 6):

> *Environmental and health issues are managed by regulatory frameworks that are generally considered to be 'external' to the water and wastewater industry. This also applies to the ownership, management and allocation of natural water resources…*
>
> *That said, it is anticipated that some benefits to the environment and public health will result from the review. For example, improved management of infrastructure may lead to improved use of water resources, with less waste, better quality water services and wastewater treatment, and imrpvoements in collection and treatment to meet environmental and health standards*

In a similar vein, some local authority submissions on the Local Government New Zealand draft terms of reference suggested that Local Government New Zealand should;

> *Make community water and wastewater services the main focus of the review – with environmental issues, private supplies and stormwater issues to be considered where there are strong interlinkages with community water and wastewater services.*[3]

Any future development of the national water services review by Local Government New Zealand must address the full range of sustainability and environmental issues. Failure to do so will simply doom New Zealand cities and towns to ever increasing water provision costs and declining environmental quality.

Issue 9. Linkages between the reviews

a) Despite the substantial number of reviews and policy developments, what consideration is being given to addressing broader sustainability issues, for example, resource efficiency and ecosystem services?

b) What is the degree of integration between the various water-related reviews?

c) How will the Local Government New Zealand national water services review promote more sustainable water systems by improving ecological efficiency and economic efficiency?

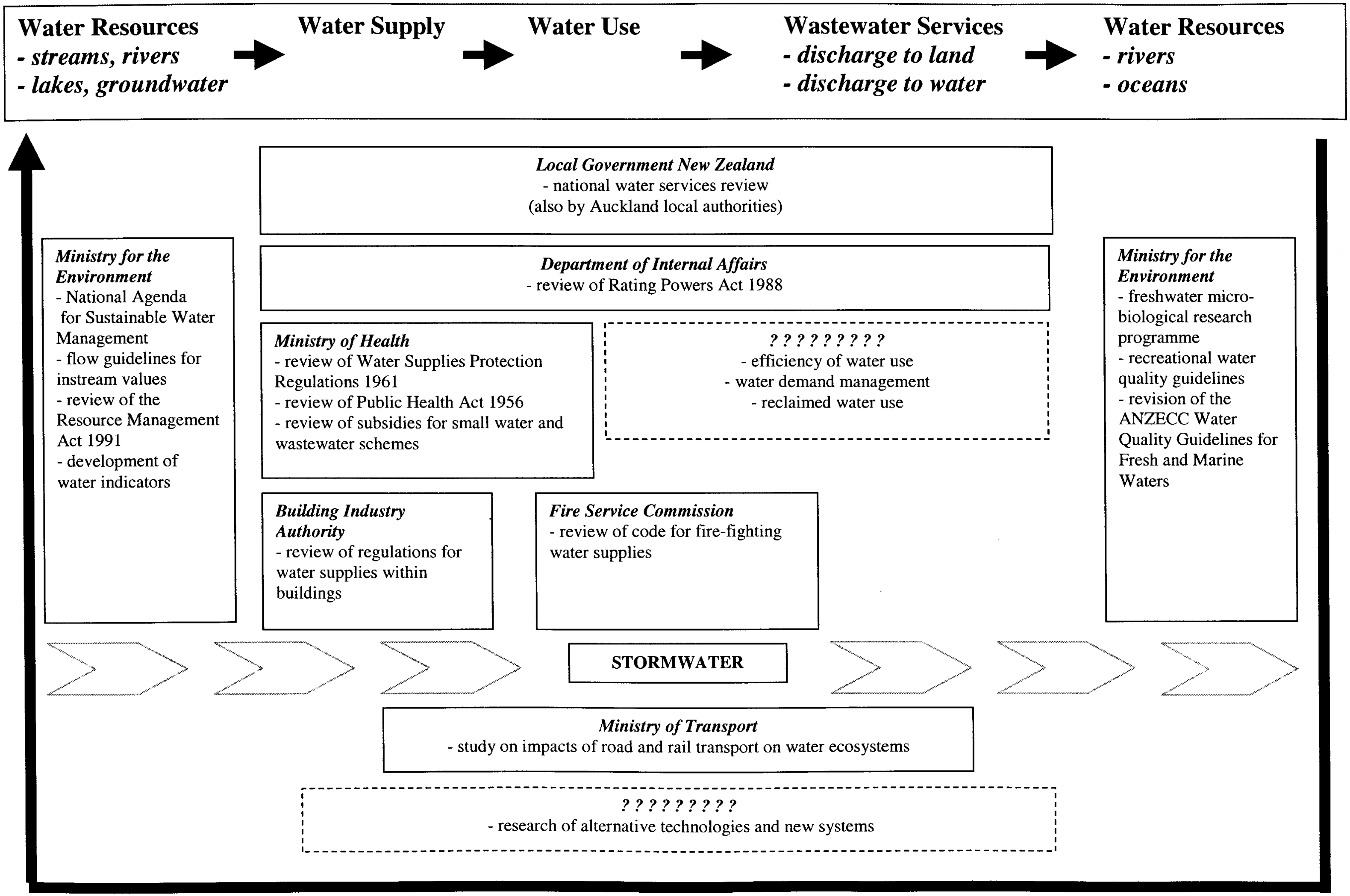
d) While addressing local water quality and health issues, how can any future national sewage subsidy address broader sustainability issues and also address ecological efficiency? New systems and management processes may allow small communities to meet a range of economic, environmental, social and cultural goals.

[1] "The straw person". A possible new structure for our industry: water and waste(water) 1999 (NZWWA 1999).

[2] There are two components to grading. A source/treatment grading (A – E) and a reticulation grading (a – e).

[3] Local Government New Zealand memo dated 15 December 1999.

Figure 4.1 Coverage of the various water-related reviews and policy



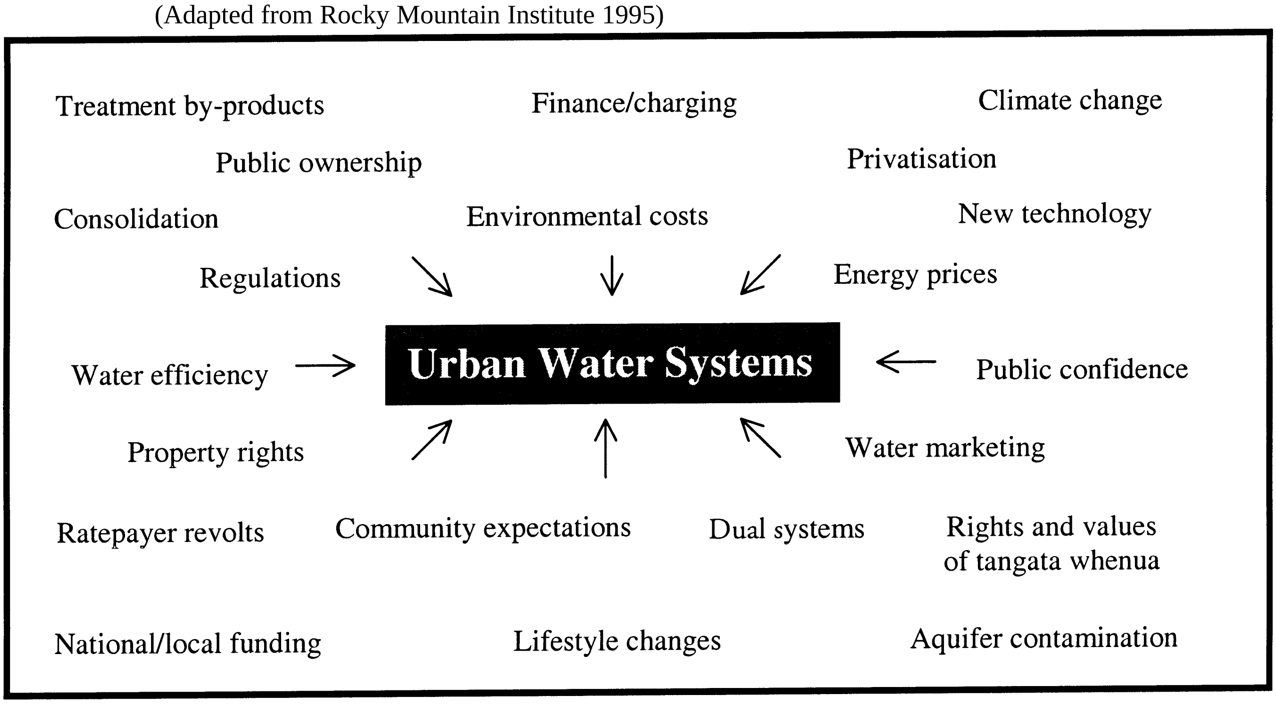
5. Future evolution of sustainable water services

5.1 What will the future bring?

This century will bring new urban models and management approaches that will influence the evolution of New Zealand's towns and cities. Increasingly, these new models will be premised on ecological principles and this will especially apply to the management of urban water systems.

Water services reform will inevitably bring a major overhaul of water management policies and practices but it will also require the adoption of systems that are more sustainable with higher levels of resource reuse and greater recognition of the need for water efficiency measures. **New water business models that are only dependent on increased sale of their goods or services (ie increased throughput) will not deliver on the environmental resource efficiency gains that are available and needed.**

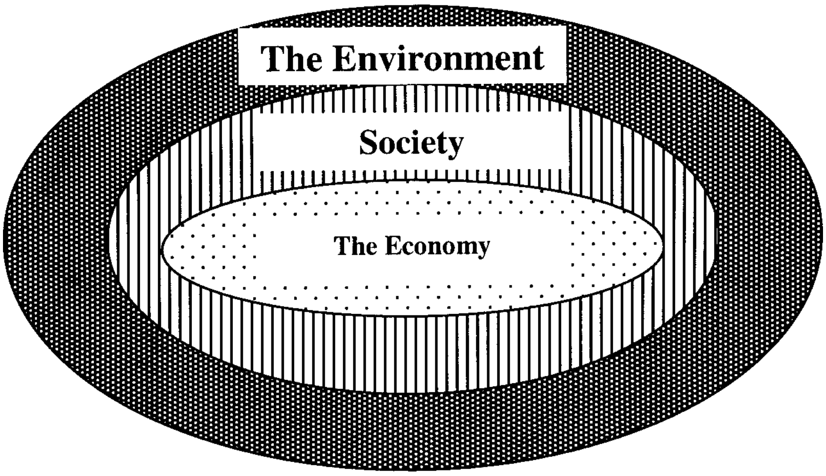
Box 5.1 How will these and other factors combine to shape future urban water systems?
(Adapted from Rocky Mountain Institute 1995)



5.2 The characteristics of sustainable urban water systems

Sustainable development has been described as "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). Sustainable development involves integrating the requirements of environmental management, social equity and economic opportunity into all decision-making (see figure 5.1). Sustainable development is not a fixed state, but rather a process of change in which the use of resources, technological development, and institutional change are managed so as to meet future as well as present needs – while all the time not reducing the health and life-supporting apacity of natural ecosystems.

Figure 5.1 **Sustainable development:** where the economy is part of society, and society lives within the bounds of a finite biophysical environment.



Sustainable urban water systems and sustainable urban water management, necessitates closer integration of built and natural water systems plus a concerted effort to minimise waste and consumption.

There is a compelling need to develop a clearer understanding of the sustainability implications for urban water systems and to develop pathways towards achieving identified goals. Essentially this will mean planning, developing and operating urban water systems in harmony with the natural water cycle, utilising a life cycle approach based on ecological principles to 'close the loop' on resource use, and implementing an urban water systems strategy with community support and ownership, as demonstrated by the approach of Waitakere City (see section 3.2).

Focusing on sustainability, in the water services sector, would optimise opportunities for environmental enhancement, product development and clean technology, while providing a reliable and affordable service to consumers. Technology will increasingly provide new and smaller scale solutions that are appropriate at urban catchment level and to the immediate community. An effective market framework will also be required to assist the development of an innovative, efficient and effective customer focused industry. The market framework must

Box 5.2 Comparison of sustainable and traditional urban water systems

Sustainable urban water systems use the principles of reduce, reuse and recycle, and new technologies and distributed systems to:

- increase the efficiency of water use thereby reducing the need for new dams and pipelines. This also reduces wastewater flows and results in less wastewater having to be managed at treatment plants;
- reduce wastewater by using less water, reusing greywater and recycling biosolids from wastewater treatment plants; and
- reduce stormwater through better site design leading to reduced stormwater flows, reduced flood hazards, reduced pollution, and less pollution load entering streams and harbours.

Traditional urban water systems:

- increase water supply where necessary by building more dams and pipelines with few incentives to reduce water use;
- utilise large wastewater pipe networks and treatment systems which facilitate throughput and result in greater volumes of wastewater needing to be treated. There are potential impacts on the receiving environment from the final disposal of treated wastewater and remaining biosolids;
- utilise large pipe systems and treatment ponds for managing stormwater; and
- provide a linear system, with little reuse and few feedback loops like a cyclic system.

recognise the ecological realities and constraints of water cycles and ecosystem services and not create or impose artificial barriers on more sustainable solutions. Traditional economic and engineering approaches can continue to impose barriers.

Sustainable urban water systems will use the principles of 'reduce, reuse and recycle', and new technologies and distributed systems to deliver a range of water services, onsite and at a community level (see box 5.2). These will work in harmony with natural water cycles as well as maintaining flexibility for future changes. This can be contrasted with the traditional approach to urban water systems with linear systems ie long pipe networks and no feedback loops.

5.3 Outcomes and principles for the evolution of water services

A series of outcomes and principles for water services and water services reform have been identified by the New Zealand Water and Wastes Association, the Ministry of Commerce (now Ministry of Economic Development) and Local Government New Zealand over the last two years.

In 1998 the New Zealand Water and Wastes Association developed a scenario for the water sector business in 2010. The overall vision was that the water sector business is essential and valued and that:

- the water sector is a key component of the economic and social fabric of New Zealand;
- water supply is adequate in quantity, quality, reliability and responsiveness to meet the needs of New Zealand;
- wastewater and stormwater quality meet environmental and public demands;
- consumers are paying the true value of the services; and
- there is an economically, socially and environmentally integrated and efficient infrastructure.

In 1999 the Ministry of Commerce identified that the following outcomes should be achieved by any reform of the water, wastewater and stormwater industry:

- customers have access to safe and secure water, wastewater and stormwater services at a reasonable price;
- services are delivered in a efficient and environmentally sustainable way;
- appropriate investment occurs in both assets and water quality;
- clear accountability is established for the management of the services;
- strong incentives exist for innovation and service improvement; and
- fairness to both public and private providers of water, wastewater and stormwater services is achieved.

The Ministry of Commerce identified three key principles to guide the development of a policy framework to achieve the above outcomes:

- *comprehensiveness:* where relevant, the policy framework will be applicable to all water and wastewater providers, whether public or private, and all of the goods and services they provide;
- *non-discrimination:* the policies developed will apply in a manner that does not discriminate between or among providers in like circumstances; and
- *flexibility:* the policies developed will be able to be applied in a variety of circumstances as well as enable providers to adapt to changes in the operating environment.

After taking over the national water services review, in late 1999 Local Government New Zealand identified four principles that the sector might seek to further as part of the review:

- water, wastewater and stormwater services should enhance the public health and wellbeing of our communities in an affordable, equitable, efficient, effective and environmentally sustainable way;
- local authorities and communities that own or manage water services should continue to be able to determine future ownership and service delivery arrangements;
- all water services, particularly those relating to drinking water quality should be fit for purpose; and
- quality and performance standards above agreed national minimum standards should be determined by water service providers and their consumers.

Outcomes for sustainable management of urban water systems
In addition to the above outcomes and principles, a set of criteria focusing on sustainable management of urban water systems that will address the problems and issues identified throughout this paper need to be developed (see box 5.3). These criteria will need to be considered as part of the national water services review being conducted by Local Government New Zealand.

Box 5.3 Sustainable urban water systems will require management that:

- adheres to the principles of sustainable development ie ecologically sound, socially acceptable and economically viable;
- enables meeting the needs of the present without compromising the needs of future generations to meet their own needs;
- is based on boundaries defined by natural water systems and natural hydrology with full recognition of the role and value of ecosystem services;
- takes into account water quantity, water quality, and the use and delivery of water in the most efficient manner while maintaining flexibility for future changes;
- fosters use of innovative technologies that increases the efficiency of water use and creates opportunities to reduce, reuse and recycle;
- recognises the value of water to Maori and fosters involvement of kaitiaki through partnership, co-management and other approaches;
- co-ordinates the needs, goals and objectives of individuals, the community, water services industry, agencies and industry while sustaining ecosystem requirements;
- takes into account land uses as they relate to water resources; and
- has well designed, yet flexible monitoring systems, that can detect cumulative effects and long term changes.

It is essential that progress is made with the national water services review as a basis for implementing sustainable urban water systems and improving environmental, social and economic wellbeing.

If the review does not proceed then there will be increased risks of:

- continued variation in management responses and in environmental, economic and social outcomes throughout New Zealand;
- further water business developments tending towards wholesale/retail splits that ignore the urban water system life cycle;
- potential ‘closing-off’ of future options with new investment
- continuing to be in ‘traditional’ large dam, pipe and treatment plant systems; and
- limited research to underpin change and inform the community and providers about environmental, economic and social dimensions of urban water systems.

Responses to this discussion paper

The purpose of this discussion paper is to identify key sustainability issues and significant risks affecting the sustainable management of urban water systems.

Responses to the discussion paper are welcomed, particularly in terms of the series of nine issue boxes identified in the report. These responses should be sent to:

Dr Morgan Williams
Parliamentary Commissioner for the Environment
PO Box 10-241
Wellington
or: pce@pce.govt.nz

By 29 September 2000.

A series of recommendations for future action (based on this discussion paper and the responses to it) may be prepared and provided to responsible public authorities in the future.

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Appendix 1 Members of the urban water systems working group

Members of the urban water systems working group

Mayor Gordon Blake, South Waikato District Council

Jim Bradley, Montgomery Watson New Zealand Ltd, Dunedin

Dr Joel Cayford, North Shore City Council, North Shore City

Andrew Dakers, Lincoln University, Christchurch

Dr Jan Gregor, ESR (Institute of Environmental Science & Research Ltd), Christchurch

Ian Gunn, University of Auckland, Auckland

John Hutchings, Local Government New Zealand, Wellington

William Karaitiana, Optimax Research Associates, Christchurch

Dr Alexander Kouzminov, Ministry of Health, Wellington

Bill Larsens, Waitakere City Council, Waitakere City

Earl Shaver. Auckland Regional Council, Auckland

Chrissie Williams, Burwood-Pegasus Community Board, Christchurch

Anthony Wilson, New Plymouth District Council, New Plymouth

Bob Zuur, Ministry for the Environment, Wellington

Appendix 2 Background information on the CSIRO urban water programme[1]

The CSIRO Urban Water Programme is a study into the economic, technical, environmental and social feasibility of alternative approaches to the supply of urban water services. Its aim is to characterise existing water, wastewater and stormwater systems in an innovative way allowing opportunities for the fundamental improvement in their operation to be identified. This knowledge will provide a basis for reducing the environmental impact of these systems, and an increase their efficiency.

The goals of the study are:

- To reduce significantly the ecological impact of Australia's water use and wastewater disposal;
- To reduce the importance of water availability and wastewater disposal as a limit to the growth of Australia's cities; and
- To reduce the costs of water, wastewater and stormwater service delivery by 25% per unit of water supplied.

The study has analysed four different scenarios for the provision of water and wastewater services to a hypothetical, densely populated urban area. This estate contained 100,000 people in 40,000 dwellings spread over an area of 3,000 hectares. The estate of 40,000 houses was split into 10 equivalent clusters of 4,000 houses to simplify calculations and enable assessment of localised treatment and recycle at the cluster scale. Four alternative scenarios were evaluated based on reducing supply pressures, minimising peak flows and the recovery and recycle of greywater:

- scenario 1 is the base case, representing a current typical Australian urbanised area with potable water being used to supply all water demands. Wastewater was gravity collected and transported 20 km to a treatment plant. Wastewater treatment consisted of screening, primary sedimentation, biological nutrient removal, chemical precipitation of phosphorus, sand filtration and UV disinfection before discharge to a coastal outfall. Sludge was anaerobically digested, filter pressed and trucked off site.
- scenario 2 is the same as scenario 1, except that the pressure rating of the potable water supply system within the clusters was reduced to 800 kPa.
- scenario 3 is the same as scenario 2, except peaks in potable demand were flattened by the use of in-house storage tanks and pressure booster pumps. Firefighting needs were met by the installation of low pressure sprinklers in each house.
- scenario 4 used low pressure potable supply to provide potable water for kitchen and bathroom use only, with peak demand levelled through the use of in-house storage tanks and booster pumps. Greywater and blackwater from each house was collected separately and transported through separate pipes to a local treatment plant for separate treatment. Stormwater and treated greywater were collected and stored in a storage wetland system and pumped back to each house as reclaimed water for use in laundries, toilet flushing and outside house uses. Reclaimed water, not used within the cluster was discharged to a local waterway, thus eliminating the need for long distance transportation of wastewater.

The study assumed that wastewater will continue to be removed from a customer's property for treatment by a water supplier, rather than treatment occurring on-site due to risks associated with householder maintenance of such facilities. However, as noted in section 3.2, by providing communally managed on-site system supervision, the risks relating to householder maintenance are eliminated, and options for achieving economies of scale via a mix of on-site and off-site systems are increased.

The cost of water services was estimated per household and per kilolitre of water and these are shown in Table 3.1.

Key findings and conclusions from the CSIRO study

It is acknowledged that the study is only the first stage of analysis and so only limited conclusions can be made. Furthermore, the social acceptability of alternative technologies (eg composting toilets, wetlands, localised treatment plants, etc) requires further research.

Table A2.1. Calculated total costs for each scenario (A$)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Potable water volume (GL/year)	17.3	17.3	17.3	2.8
Wastewater treated (GL/year)	4.6	4.6	4.6	4.6
Reclaimed water volume (GL/year)	0	0	0	14.5
Total system capital costs ($M)	316	304	312	323
Total system operating costs ($M/year)	4.4	4.3	3.5	3.4
Amortised capital (20 years @ 5%) ($M/year)	22.5	21.6	22.2	23.0
Average annual cost ($M/year)	27.4	26.5	26.2	26.7
Annual cost per household ($/hh)	$685	$662	$656	$667
Cost of water services ($/m³)	1.26	1.22	1.20	1.22
NPV (20 years @ 5%) ($M)	341	330	326	332

A key finding from the study was that while there was no significant difference in system capital and operating costs between the four designs, systems which allow for separation of blackwater and recovery and recycling of greywater offer the potential for significant reduction in headworks costs and environmental impact, including reduction in nutrient discharges and increases in environmental flows.

The analysis does not include the cost of externalities nor does it include the costs of potable water reservoirs and head works. In scenario 4 there is the potential to substantially reduce the flow of nutrients to the environment and gain further benefits from reduced nutrient discharges.

Decentralised treatment of blackwater and greywater reduced the overall cost of treatment of wastewater and showed the potential for more effective nutrient separation and control in wastewater treatment. Analysis of nutrient flows in these urban water scenarios showed a potential 45% reduction in phosphorus and about 10% reduction in total nitrogen discharges to the environment, when localised treatment and reuse was practised.

The calculated cost of water is dominated by the capital cost of the installed components of the urban water infrastructure. Estimated operating costs for the urban water systems amount to about 15% of the total annual cost (based on amortising capital at 5% over 20 years). Large cost savings (>35%) in potable water supply infrastructure are possible through levelling peaks in demand. However, these savings are offset through the increased cost at the household level of installing storage tanks and pumps in order to maintain supply pressure. The size of the tank needed for each house is not large (1000 litres) and would not require a major rebuild to install into existing houses.

Reducing the pressure rating of potable supply has the potential to reduce the cost of potable supply infrastructure by about 10%. The cost savings resulting from reducing the pressure to the point where fire-fighting capacity is compromised were again offset by the increased cost at the household level, where individual low-pressure sprinkler systems were installed. It has been assumed that in each house there will be a series of low-pressure sprinklers installed, connected to the in-house potable water storage tank. Universal adoption of these types of fire protection schemes has the potential to reduce the overall costs for the equipment through mass production, with probable insurance benefits.

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[1] This section is sourced from Booker et al 2000 and information on the urban water programme website at: http://www.dbce.csiro.au./urbanwater