

# Sustainable Water in New Zealand

*One of a number of discussion papers produced by the IPENZ Presidential Task Committee on Sustainability during 2003 and 2004.*

Lead Author: **Nadine Wakim**, Maunsell Limited ([nadine.wakim@maunsell.com](mailto:nadine.wakim@maunsell.com))

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*"[Sustainable development] must inevitably involve multi-objective tradeoffs in a multi-disciplinary and multi-participatory decision-making process. I believe no single discipline, and certainly no single profession or interest group, has the wisdom to make these tradeoffs themselves. They can only be determined through a political process involving all interested and impacted stakeholders". (Loucks, 2000).<sup>1</sup>*

## 1. Summary

Sustainable development is a recognised goal for New Zealand. The engineering community have a significant role to play to help our nation achieve it. Careful management of our water resources will be critical in order to ensure the continued existence of our communities and our natural environment.

Water resource engineers have a crucial role to play in the sustainable management of water. Policy initiatives at central and especially local government levels confirm the need for more sustainable water systems and infrastructure. There are a number of challenges and tasks that engineers and the engineering community must face and undertake in order to move New Zealand towards a more sustainable water sector. A checklist is included at the end of this paper to aid towards achieving this goal.

This paper is a working draft and comments for improvements are welcomed.

## 2. Introduction

Many countries are facing serious environmental and socio-political issues concerning their water resources. Examples include inter-country boundary conflicts, overpopulation, severely arid environments, and the need to invest in alternative water sources such as desalination, fog-collection or freshwater / iceberg relocation. Due largely to New Zealand's geographical, population, geological and climatic advantages compared to many other regions in the world, we are lucky enough not to have to directly address such issues, yet. If, in the future however, some of these issues need to be given serious consideration, it will reflect very poorly on New Zealand's water resource management and the sustainability of our water resources.

The need for sustainable water resources management was identified more than a decade ago at the Rio Earth Summit. It was here where the provision of integrated urban infrastructure services (including water supply, drainage and sanitation) was included as a key programme area in Agenda 21 to promote sustainable human settlement development (United Nations, 1992). When we consider that true sustainability involves designing for the long-term (that is, 1000+ years, as

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<sup>1</sup> Loucks, D.P. (2000). Sustainable Water Resources Management. *International Water Resources Association*. 25:(1), 3-10.

mooted by Tonn<sup>2</sup> and Boyle<sup>3</sup>, we start to realise that concerns as listed above may become potential threats to New Zealand, especially in light of climate change issues and national growth. Beyond water supply issues, New Zealand has already been facing threats to our stormwater, wastewater and groundwater resources and infrastructure as these become increasingly outdated, overused and polluting.

The purpose of this discussion paper is not to explain in detail the reasons why sustainable water resources management is required in the New Zealand water industry but to accept, sustainability, as the political-social-environmental ethic by which future water resources management will be based and by doing so, present ideas and guidance as to the future role of engineers in shaping a more sustainable (or “less unsustainable” – James<sup>4</sup>) water industry.

### 3. Sustainability Thinking for Water Resource Engineers

The water resources development paradigm of recent years which has largely been driven by an ethic of growth, is now, in light of the impacts this growth has produced (e.g. degradation of ecosystems, removal of human settlements and cultural sites, disruption of sedimentation processes, contamination of water sources), stalled as social values and political and economic conditions have changed.

Engineers have traditionally described the water industry as being made up of three components and their respective infrastructure (i.e. “water services”): stormwater, wastewater and water supply. The current thinking in regards to sustainable management of water however is to manage water resources as one integrated system rather than separating these components from one another.

Given this new thinking, water engineers need to therefore be able to apply *process thinking* into their work. This means going beyond pure scientific thought, which tends to look at relationships between individual parts of a system and/or the individual parts themselves. Process thinking recognises that the whole is greater than the sum of its parts, and is about identifying how objects and their relationships contribute to a process, and how systems, objects and their relationships change to sustain the process over time. Process thinking is therefore temporally related and well suited as a thought paradigm for sustainability. Process thinking is also especially appropriate when comparing with what water engineers are ultimately trying to manage – the hydrological cycle which is a dynamic process not just a system made up of separate components that operate independent of each other.

New thinking in water resources management have recognised this link and developed the paradigm of Integrated Water Resources Management (IWRM) (International Water Association, 2002). This new thinking has developed out of the realisation that the current water paradigm is characterised by:

- A linear system of water use where water is sourced, used, polluted and disposed of; and
- A fragmented system of management where a single resource is managed as three separate elements (e.g. water supply, wastewater and stormwater)

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<sup>2</sup> Tonn, B.E. (2004). Integrated 1000-year planning. *Futures*. 36, 91-108.

<sup>3</sup> Boyle, C. (2004). Sustainability for Engineers. Paper prepared for IPENZ Task Committee on Sustainability, IPENZ.

<sup>4</sup> James, W. (1999). On smart, benign drinking water, wastewater, and stormwater infrastructure for a less unsustainable future – a personal vision. Paper presented at the Great Cities/Illinois-Indiana Sea Grant Urban Water Resources Conference, September 16-17, Chicago.

Engineers must also consider what sustainability in water infrastructure means within the local, regional and national contexts. One question that arises when considering water resources management and sustainability is, “when and where can sustainability be achieved?”. Is it possible to develop sustainable water services on a specific site, sub-catchment or an entire catchment given that currently the surrounding local or regional contexts are likely to be unsustainable (i.e. upstream catchments contributing to stormwater flows at site; discharges from site connecting to ‘less sustainable’ systems)? It is certainly possible to implement “more sustainable” or “more ecologically-friendly” technologies and approaches at these sites or in catchments but until an entire region’s water infrastructure is modified to reflect sustainability principles and address hydrological process issues, the ultimate aim of sustainable water resources will be impossible to realise.

While our current centralised and separated water services provide essential services for our survival, engineers need to recognise that the continued operation of these existing systems is facing significant threats, not least of which is growth in demand. Sustainability does not necessarily mean replacing the existing systems completely, but will require adaptation, incorporating new approaches and technologies.

But what can water resource engineers do to practice sustainability principles in the meantime given that integrating a currently fragmented water infrastructure will take many years and considerable radical adaptation?

#### 4. Sustainability of New Zealand Water Resources

A working definition of sustainable water use is provided by Gleick <sup>5</sup> as:

*“..the use of water that supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depend on it .”*

"Beyond Ageing Pipes", a report prepared by the New Zealand Parliamentary Commissioner for the Environment (PCE) in 2002 <sup>6</sup>, identifies sustainable urban water systems as having several key characteristics which cover the following measures:

- **Increase the efficiency** of water use, thereby reducing the need for new dams, pipelines and treatment plants;
- **Reduce wastewater** by decreasing total potable water supply, reusing greywater and recycling biosolids from wastewater treatment plants; and
- **Reduce stormwater** through better site design, with reduction in proportion of impervious surfaces, onsite collection use, and retention of natural streams and waterways.

PCE (2002) describes additional features of sustainable urban water systems which are:

- **sufficient water flows** allocated to natural and modified water systems in order to maintain ecosystem health;
- **water management and planning** involves consultation with the whole community of interest including residential uses, industry, tangata whenua, agencies, agriculture and recreational users; and

<sup>5</sup> Gleick, P.H. (2000). The changing water paradigm. A look at twenty-first century water resources development. *International Water Resources Association*. 25 (1) 127 – 138.

<sup>6</sup> Parliamentary Commissioner for the Environment. (2002). *Beyond Ageing Pipes: Urban Water Systems for the 21st Century*. Wellington: Office of the Parliamentary Commissioner for the Environment.

- residents are **guaranteed access** to a minimum supply of potable water to maintain basic health.

The focus of the PCE report is on *urban* water systems with the understanding that smaller rural communities and townships (or 'greenfields') are potentially better placed to make the transition to sustainable urban water systems than larger urban areas that are constrained by a legacy of existing infrastructure. This is largely based on the assumption that these smaller communities will have sufficient finance, in-house knowledge, technology and motivation to achieve the desired sustainable systems which in most situations will not be the case. Many of the principles and issues outlined in the PCE report are therefore also applicable to suburban and rural communities also.

## 5. Influencing legislation and guiding documents

Water supply and use in our communities presents many diverse and competing interests. While water is a common good and community resource, it is also used as a private good or economic commodity; it is not only a recreational resource but also is a basic necessity of life; it is filled with cultural values, *mauri*, and plays an essential part in the social fabric of our communities. Gleick<sup>7</sup> believes that applying sustainable principles to water resource management and design will help to bridge the gaps between such diverse and competing interests.

The purpose of this section is to summarise the various documents and agencies that influence, restrict and/or encourage water industry engineers to incorporate sustainability principles into their work. The range of influencing documents has been listed under the following headings: Central Government; Local Government; Standards New Zealand; and Professional Associations and Educational Institutions.

### 5.1 Central Government

The water sector in New Zealand has no central government 'home'. PCE<sup>8</sup> recognises that the legislative framework for the management of water services is outdated and conflicting. There is no overarching Act which represents this sector, as there is for example, the building sector or transport section (e.g. Building Act or the Land Transport Act). Water engineers' work is therefore governed by central government policy and legislation that is largely fragmented, as illustrated by the various Acts regulating the water industry listed below.

- **Resource Management Act 1991** – recognises and promotes the goal of sustainable management of natural and physical resources; requires that developments avoid, remedy, mitigate impacts on the environment; establishes a framework for resource consents for air, land, water discharges.
- **Local Government Act 2002** – encourages sustainable development and requires Councils to "promote the social, economic, environmental, and cultural well-being of communities, in the present and for the future" (Part 2, 10 (b)); territorial authorities are required to produce Long Term Council Community Plan (LTCCP) which have a long-term view (i.e. 10yrs).
- **Rating Powers Act 1988 (replaced by Local Government Act 2002)** – had no provision for local authorities to charge for wastewater by volume/contaminant loading except in respect of

<sup>7</sup> Gleick, P.H. (2000). *ibid*.

<sup>8</sup> Parliamentary Commissioner for the Environment. (2002). *ibid*.

trade waste; no provision for local authorities to charge for stormwater by area of impervious area or for capital costs for new developments.

- **Local Government Act 1974** – gives territorial authorities the right to control water supplies; no provision for local authorities to prepare a strategic water services plan (like a waste management plan).
- **The Health Act 1956** – territorial authority to provide sanitary water source but lacks clarity regarding a framework for water delivery.

A number of central government Ministries and /or the Parliamentary Offices have also produced the following documents which are relevant to the water industry:

- **The Water Programme of Action** (Ministry for the Environment, November 2003)
  - “The programme initially consists of a number of projects within three separate strands covering water allocation, water quality and water bodies of national importance.”
- **A Cultural Health Index for Streams and Waterways - Indicators for recognising and expressing Maori values**<sup>9</sup> (Ministry for the Environment, June 2003, MfE Number 475). A trial methodology to calculate the Cultural Health Index (CHI) incorporating the three aspects of traditional association, the mahinga kai (food gathering) measure and a cultural stream health measure.
- **Sustainable Development for New Zealand: Programme of Action** (Department of Prime Minister and Cabinet, January 2003).
  - One of the four key areas of action is ‘Fresh Water’. Specific key programme elements include: *“Identifying better and more strategic ways of conserving and allocating freshwater from the resources available; Maximising the sustainable, efficient and effective use of freshwater”*.
- **Beyond Ageing Pipes: Urban Water Systems for the 21<sup>st</sup> Century** (Parliamentary Commissioner for the Environment, April 2002).
  - One of the recommendations from this report was for *“all territorial authorities and water services providers to prepare an overarching water services strategic plan as a framework for the sustainable and integrated management of urban water systems”*.
- **Sustainable Wastewater Management: A handbook for smaller communities.** (MfE, 2003).
- **Guidelines for the Safe Application of Biosolids to Land.** (DRAFT) (NZWWA, MfE, MoH, MoF, 2003)
- **Making Every Drop Count: The National Agenda for Sustainable Water Management – Action Plan** (Ministry for the Environment (MfE), 2000).

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<sup>9</sup> Ministry for the Environment. (2003). *A Cultural Health Index for Streams and Waterways. Indicators for recognising and expressing Maori values*. Report prepared for the Ministry for the Environment by Tipa, G., and Teirney, L., MfE Number 475, June 2003, Wellington, NZ.

## 5.2 Local Government

A large proportion of the work that New Zealand water engineers undertake relates to the water services that local government own, operate and / or manage. Therefore the majority of water engineers work within local government, for them or have to report to them (e.g. via resource consents).

Given the many examples of sustainable development rhetoric in local government policies, strategies, objectives and plans it would suggest there are vast opportunities for engineers to action the intents and visions of these documents. The fundamental question is, how, especially when there are many different agencies controlling the different water services? In many cases, it is the work of individual engineers, planners and asset managers at the local government level who are already enacting changes to the way water projects are prioritised and implemented. One avenue is certainly also for councils to remind and encourage engineers at every opportunity (and vice versa) to incorporate sustainable principles into their infrastructure designs, contracts and maintenance requirements, while producing budgetary and consultative allowances for these considerations (i.e. through requests for proposals, contractual arrangements, involvement at the policy/project decision-making stage). Examples of local government documents which promote and/or influence sustainability principles in water resources management include:

- Regional Policy Statements and Plans:
  - e.g. Auckland Regional Policy Statement (1999), *"...to promote the sustainable use of natural and physical resources; to manage the use of water to enable people and communities to provide for their present and future social, economic and cultural wellbeing...."*;
  - e.g. Proposed Auckland Air, Water, Land Plan (2001): *"to provide for the integrated and sustainable management of natural and physical resources"*;
- District Council Plans and Strategies:
  - e.g. Waitakere City Comprehensive Urban Stormwater Management Strategy and Plan: *"To achieve a multi-disciplinary approach to address all aspects of stormwater management"*;
  - e.g. North Shore City Strategic Plan: *"To implement sustainable, integrated water supply, stormwater and wastewater services that are in harmony with the natural water cycle."*;
- Infrastructure Design Standards / Codes of Practice:
  - e.g. North Shore City Council Infrastructure Design Standards (2003) - provides the engineering design requirements for all land development and new infrastructure projects within North Shore City; including stormwater, wastewater, water supply, as well as roads, geotechnical, parks, playgrounds. Latest version has included 'more sustainable' design options for stormwater management and wastewater designs (e.g. design requirements for raintanks, swales, raingardens etc and specific design features such as, reducing the number of manholes in wastewater systems to reduce stormwater infiltration volumes);
  - e.g. Waitakere City Stormwater Management Code of Practice (2002) – *"focused on implementing stormwater management solutions that mitigate against adverse effects on development"*;
- Technical Publications:

- e.g. Auckland Regional Council TP10 Stormwater Treatment Devices: Design Guideline Manual;
- e.g. Auckland Regional Council TP124: Low Impact Design Manual (Stormwater Management); and
- e.g. Waitakere City Council's Guidelines for Best Practice: Water Management.

### 5.3 Standards NZ

There are numerous codes, standards and guidelines that Standards New Zealand has produced relating to the field of water management. Some standards can present barriers to implementing more sustainable water infrastructure solutions by restricting the use of certain materials and/or setting strict design criteria, while others include reference to or allowances for more sustainable designs:

- NZS 9201 Model General Bylaws – these influence Local Authority By-Laws which in turn influence engineers' design work. Examples are:
  - NZS 9201.23 1999 – Trade Waste ;
  - AS/NZS 4271.1 2000 – Utilities;
  - NZS 9201.7 1994 – Water Supply;
  - NZS 9201.22 1999 – Wastewater Drainage; for example *"in order to meet the principles of sustainable management as promoted by the Resource Management act 1991 (RMA)...recommends a customer fits the devices contained in Table 1.1 on all new installations"* (e.g. dual flush toilet cistern, low flow shower head, urinal flushing control);
- NZHB 44:2001 – Subdivisions for People and the Environment;
- ISO 14000 – Environmental Management Systems; and
- ISO 9000 – Quality Management Systems.

### 5.4 Professional Associations and Educational Institutions

The various professional and non-governmental organisations that engineers belong to (including the organisation they work in) represent another area-of-influence for the promotion of sustainability principles. Examples of such groups include:

- New Zealand Water and Wastes Association (NZWWA) – a non-profit technical and educational organisation which aims to *"be the pre-eminent organisation in New Zealand for promoting and enabling the sustainable management and development of the water environment."* [www.nzwwa.org.nz](http://www.nzwwa.org.nz)
- At a business, organisation or council level e.g. development of company-policy relating to sustainability principles; consider joining a 'sustainability-linked' organisation, for example the Sustainable Business Network, [www.sustainable.org.nz](http://www.sustainable.org.nz)
- Institute of Professional Engineers in New Zealand (IPENZ) – Code of Ethics; discussion papers on sustainability issues. [www.ipenz.org](http://www.ipenz.org)
- New Zealand Society for Sustainability Engineering and Science (NZSSES) - a Technical Interest Group of IPENZ [www.nzsses.org.nz](http://www.nzsses.org.nz)
- Centre for Advanced Engineering - a not-for-profit organisation which aims to enhance engineering knowledge within New Zealand by technology transfer and the application of NZ and overseas research to engineering-related issues of national importance. [www.caenz.com](http://www.caenz.com)

In addition, the following list provides some website links to articles, projects, organisations etc that discuss sustainability in water resources management:

- International Water Association (IWA) - [http://www.iwahq.org.uk/documents/sus/V\\_2\\_1.pdf](http://www.iwahq.org.uk/documents/sus/V_2_1.pdf) <sup>10</sup>
- The Engineer's Response to Sustainable Development (WFEO) - [www.ecouncil.ac.cr/rio/focus/report/english/wfeo.htm](http://www.ecouncil.ac.cr/rio/focus/report/english/wfeo.htm)
- Western Australia State Water Strategy - [www.ourwaterfuture.com.au/community/statewaterstrategy.asp](http://www.ourwaterfuture.com.au/community/statewaterstrategy.asp)
- Murdoch University: Institute for Sustainability and Technology Policy – [www.istp.murdoch.edu.au](http://www.istp.murdoch.edu.au)
- Sustainable Water: Uncertainty, Risk and Vulnerability in Europe - [www.ncl.ac.uk/swurve/case4.html](http://www.ncl.ac.uk/swurve/case4.html)
- Association of Engineers and Geoscientist British Columbia (APEGBC) – [www.sustainability.ca](http://www.sustainability.ca)
- The Dublin Statement on Water and Sustainable Development - [www.wmo.ch/web/homs/documents/english/icwedecce.html](http://www.wmo.ch/web/homs/documents/english/icwedecce.html)
- Integrated Water Cycle Management and Water Sensitive Urban Development (University of Newcastle) - <http://rambler.newcastle.edu.au/~cegak/Coombes/CoombesKuczera.pdf>
- USEPA Municipal Technologies - [www.epa.gov/owm/mtb/mtbfact.htm](http://www.epa.gov/owm/mtb/mtbfact.htm)

## 6. Water Resource Engineering in a Sustainable Society

### 6.1 Issues to consider regarding alternative technologies and approaches

This section discusses the issues associated with promoting and implementing alternative, “more sustainable” technologies, given that such alternatives are likely to be underrepresented at site and regional levels until there are significant changes to economic, political and regulatory incentives. Weaver et al <sup>11</sup> highlight the phenomenon of new technology being locked out of the marketplace by old technology and old technology being locked in. Not having sustainable technologies being here ‘on the shelf’ is a barrier to the general restructuring of incentives, while not having the incentives and framework conditions to make sustainable technologies viable means there is little business imperatives to develop such technologies. This “Catch 22” is one that many other industries are grappling with as they strive to implement more sustainable, or “less unsustainable” technologies.

Engineers who work at a site level are often constrained by economics, the desire of the client and particular physical constraints of the site which mean more sustainable options are frequently ruled out. On the other hand however there are water resource engineers who operate at a planning, infrastructure and asset management level, who are capable of having a much wider influence on the promotion of regional and district water infrastructure priorities.

It is also noted that sustainable technologies, unlike many other new technologies, rely on fundamental cultural, social and economic reform. All markets are socially constructed and markets are subject to potential reconstruction by societies and their representatives to achieve societal objectives. Nonetheless, the heavy dependence of sustainable technologies on market reconstruction to enable technologies to become cost-competitive makes for a special case (Weaver et al). Uptake of sustainable technologies is therefore also likely to take longer compared to other types of technology (such as the uptake of internet and email) because of this reliance on market reconstruction.

<sup>10</sup> International Water Association (IWA). (2002). Industry as a partner for sustainable development: Water Management. United Kingdom: Beacon Press for the International Water Association and the United Nations Environmental Programme (UNEP).

<sup>11</sup> Weaver, P., Jansen, L., Grootvelf, G.V., Spiegel, E.V., and Vergragt, P. (2000). *Sustainable Technology Development*. Greenleaf Publishing, Sheffield, UK.

Replacements for technologies that are to be phased out or scaled down on the grounds of being 'unsustainable' must be capable of addressing multiple needs by fulfilling multiple functions. Such technologies will not come about however through incremental improvements of existing technologies, nor will they come about without a conscious, concerted and focused effort on the part of government, business and societal groups to tackle the issue strategically and systematically (Weaver et al <sup>12</sup>).

It is also important for water resource engineers to challenge the assumption that an alternative approach or technology is more sustainable just because it appears to be more environmentally-friendly or aesthetically-pleasing. Sustainable solutions and designs need to be more than just minimising adverse effects on the hydrological cycle or surrounding ecology and environment – sustainability is about a new way of thinking that includes all aspects of cultural, social, economic and environmental issues. Engineers are in a position to play a leading role in creating examples of what sustainable water infrastructure can look like and therefore providing practical steps towards more sustainable water resource practices.

While many water resource engineers are familiar with assessments including economics and environmental aspects, the inclusion of cultural and social criteria is a new concept. The cultural aspect is especially important for water infrastructure in New Zealand as the Maori perspective is different in its treatment of the interactions between people and nature. The Ministry for the Environment have developed a trial set of guidelines for calculating the Cultural Health Index (CHI) for streams and waterways <sup>13</sup>. The index includes three components:

- Traditional Association – Is there a traditional association between runanga (local Maori) and the site? Would Maori come to the site in the future?
- Mahinga kai features – How many mahinga kai (food and other resources) species are present? Are the species that were gathered in the past still here? Are the species accessible for gathering? Would Maori come to the site in the future?
- Cultural Stream Health - includes five indicators of catchment land use, use of riparian margin, use of river, river flow and water quality.

In addition, one of the major factors in the acceptability of different wastewater options is in the method of disposal of the treated water and solids. Discharge of wastewater effluent to streams, rivers, estuaries, harbours and the ocean has traditionally been used by most New Zealand cities that have been developed in close proximity to such waters. However, cultural issues associated with Maori spiritual values, together with the recognition that water re-entry systems often do not provide sound environmental performance, have shifted the emphasis away from water re-entry to land re-entry.

The social aspect of sustainable water includes more than merely including social criteria into the sustainability decision-making matrix. It includes a social process of decision-making. That is, more than just public consultation, but true participation by an active and informed public. The state of our water bodies are often very visible (e.g. oil and scum floating on the surface, discolouration from excess sediment) and hence very much in the public eye. For the engineer, this means educating the public in clear and simple language that the public can understand. This is especially difficult when grappling with the all-inclusive nature of sustainability.

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<sup>12</sup> Weaver, P., Jansen, L., Grootvelf, G.V., Spiegel, E.V., and Vergragt, P. (2000). *ibid*.

<sup>13</sup> Ministry for the Environment. (2003). *A Cultural Health Index for Streams and Waterways. Indicators for recognising and expressing Maori values. ibid*

***The choice of different water technologies often leads to confrontation, polarization and indecision of stakeholders.*** This issue is often one of scale and personal preference. For instance, advances in new technologies are often at opposite ends of the scale of treatment. The challenge here is the choice of assessment criteria when comparing one technology versus another. In the area of the three-waters (stormwater, wastewater and water supply), examples of new technological advances at opposite ends of the scale are:

- i) Wastewater – new, higher quality, individual treatment systems (replacement of the traditional septic tank) versus the “economies of scale” and new sophisticated centralised treatment plants;
- ii) Stormwater – the benefits of at-source treatment methods versus a mature wetland at the bottom of the catchment;
- iii) Water supply – the development of more strict drinking water standards versus the use of rainwater as non-potable (or potable) water use within the household.

***Another issue relates to the short-term and long-term actions that can be taken in regards to integrated three-waters approach (including stormwater, wastewater and water supply).*** For instance, Weaver et al <sup>14</sup> found that when analysing five different water technologies, the greatest impact was found with a combination of innovations, a tailor-made solution based on sets of integrated measures. Weaver et al also found that most of these improved measures could be implemented today, as they depended less on technological innovation and more on organisational innovation. For instance, in many cases, the installation of rainwater tanks in the urban environment is only economically viable when including both stormwater and water supply benefits. However, for long-term sustainability, Weaver et al concluded that fine-tuning today’s systems is not sufficient. Achieving major improvements in sustainability depends on defining a new strategic approach and on restructuring the water system using new criteria and insights.

## 6.2 Future priorities

Water resource engineers should first give attention to ‘beginning of the pipe’ solutions relating to the following areas:

- Water demand management and forecasting;
- Water resources management in relation to ecosystem needs;
- Efficient water use;
- At-source water collection, use, and treatment; and
- Decision-making that uses sustainability assessment and life-cycle analysis tools.

Accepting that the current piped systems (and the pipe paradigm) are here to stay for a few decades to come, there are opportunities to improve the performance and life of these systems using smart technology and new techniques. James <sup>15</sup> expects that future urban drainage systems will be retrofitted with real time control designed to support a pollution prevention strategy. Real time control could be used to reduce the number and duration of overflow events, reduce basement flooding, reduce downstream environmental impacts and monitor and enforce water quality. James predicts that by linking networks with Geographical-Information-Systems (GIS) data and accurate rainfall sensors, real-time information could be put “online” to enable water resources information and issues available to the general public and to counter the “out of sight out of mind” attitudes.

<sup>14</sup> Weaver, P., Jansen, L., Grootvelf, G.V., Spiegel, E.V., and Vergragt, P. (2000). *ibid*.

<sup>15</sup> James, W. (1999). *ibid*

Greater material choice, smaller pipe sizes, improved construction techniques (e.g. shallow-buried, improved erosion and sediment controls), effective establishment and use of distributed storage, more efficient use of raw water, greywater, stormwater and potable water, greater use of renewable energy for pressurising flows where necessary, and new and improved maintenance techniques (e.g. using robots to access small diameter pipes) are all potential technological advances of the future which will improve the sustainability of our water resources.

Already in the New Zealand industry, software water management models are becoming the dominant decision-making tools for water infrastructure development, management and optimization. Developing models for integrated situations (i.e. stormwater, wastewater and water supply networks and systems), in accordance with Integrated Water Management good practice, will require models with superior technical correctness and capabilities to represent the complexities of these real situations. Further models that have the capacities to accurately build and model alternative systems (i.e. infrastructure beyond concrete pipes) will assist with future decision-making regarding 'more sustainable' options.

There are many ways in which water resource engineers and the engineering community can help move New Zealand towards sustainability. Parts of the following checklist draw heavily from the Hanover Principles by William McDonough Architects, <sup>16</sup> for which acknowledgement is given.

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<sup>16</sup> William McDonough Architects and Michael Braungart. (1992). *The Hanover Principles: Design for Sustainability*. New York: William McDonough Architects.

## 7. Sustainable Water Checklist

### General Responsibilities for Water Resource Engineers:

1. Water resource engineers need to understand the concept of sustainability, holistic-thinking it requires and what it means in the field of water resource management.
2. Water resource engineers need to actively seek out more efficient and sustainable technologies, and, more importantly, find ways to make them competitive with conventional approaches.
3. Water resource engineers need to realise that sustainability must be addressed at multiple levels and by many disciplines, and we need to change how we work accordingly.

### Specific Tasks for Water Resource Engineers:

1. Water use must be carefully accounted for throughout the entire design process.
2. Water sources (including groundwater) must be protected from contamination and careful consideration given to efficiency techniques at every step.
3. Potable water consumption should only be used for life-sustaining functions.
4. Water from aquifers, rainwater, surface run-off water, greywater, and any water use for sewage transport or processing systems should all be considered within a cyclical concept.
5. Wastewater must be returned to the earth in a beneficial manner. Organic treatment systems should be considered.
8. Designs should minimise impermeable ground cover.
7. Designs shall consider rainwater and surface run-off water as a possible water resource for use in infrastructure systems and processes.
9. Greywater can be treated and applied to practical or natural purposes suitable to its characteristics.
10. Water use in any process-related activity shall be put back into circulation, and contamination should be minimized.
11. Water, if used for sewage treatment or transportation, shall be restored to appropriate water quality standards prior to distribution or reuse.