WATER IN 2067 – WHAT IT MAY LOOK LIKE?

Ian Ho, Simon Warren – Harrison Grierson
Bruce Hinson – Thames Coromandel District Council

ABSTRACT

A successful water sector is fundamental to social well-being and the economic development of our country. Nevertheless, the sector does not receive much deserved recognition nor financial backing. With the challenges of delivering high levels of service with limited resources, our water utilities (the local authorities and council controlled organisations) generally have done a splendid job.

The many challenges ahead, ranging from uneven population growth, aging infrastructure, climate change and many other factors, will likely to test our existing water infrastructure and associated services to reach new performance targets whilst not suffering from reduction in service level or asset failure.

The future depends on what we decide to make it. It may include water systems integrated with artificial intelligence, networks optimised with real time data, and assets that repair themselves, self-healing pipework and many others. The future water sector is likely to be operated by larger organisations that are self-governed and independently regulated. Levels of service will be customer driven, and customers will be able to choose between different services providers.

One thing for sure, the future of our sector will look very different to what it is today. Strong leadership and cultural change will be essential for the sector to thrive and survive in 2067.

KEYWORDS

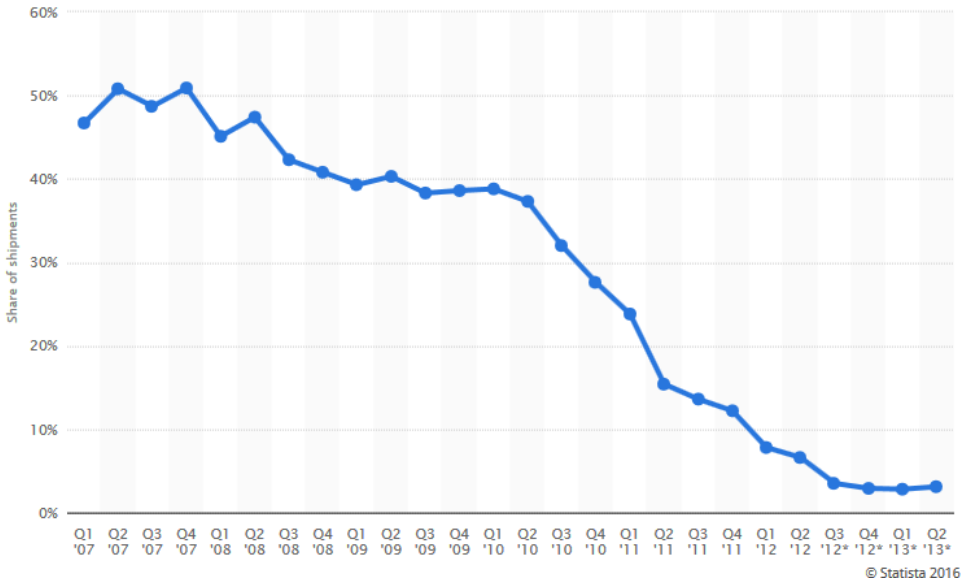
Innovation, Continuous Improvement, Best Practice, Response to Challenge

1 SETTING THE SCENE

We are living in a very interesting time, as change is the only constant. Those not willing or able to change or adapt will be left behind.

Nokia was once the world's leading cellphone manufacturer, its demise is attributed by industry experts to an unwillingness to embrace the changing patterns of consumers' wants and needs.

Figure 1: Nokia Smartphone Global Market Share (Source: Statista, [1])



Back in early 2000s, probably no one would expect Nokia would have such a massive decline in the global phone markets, in only a few years.

1.1 BASIC HUMAN RIGHT TO WATER

Whilst most would agree that comparing water services to the agile and energetic smart-device industries is unusual, the lessons to be learned are hard to ignore: Understand your customer, innovate to meet expectation (customer and regulator) while controlling costs. With those sector challenges in mind, having access to safe water and sanitation services is considered a basic human right, UN Resolution 64/292 on 28th July 2010.

Figure 2: UN definition of human right to water (Source: UN webpage, [2])

- **Sufficient**. The water supply for each person must be sufficient and continuous for personal and domestic uses. These uses ordinarily include drinking, personal sanitation, washing of clothes, food preparation, personal and household hygiene. According to the World Health Organization (WHO), between **50 and 100 litres** of water per person per day are needed to ensure that most basic needs are met and few health concerns arise.
- **Safe**. The water required for each personal or domestic use must be safe, therefore free from micro-organisms, chemical substances and radiological hazards that constitute a threat to a person's health. Measures of drinking-water safety are usually defined by national and/or local standards for drinking-water quality. The **World Health Organization (WHO) Guidelines for drinking-water quality** provide a basis for the development of national standards that, if properly implemented, will ensure the safety of drinking-water.
- **Acceptable**. Water should be of an acceptable colour, odour and taste for each personal or domestic use. [...] All water facilities and services must be **culturally** appropriate and sensitive to **gender, lifecycle** and **privacy** requirements.
- **Physically accessible**. Everyone has the right to a water and sanitation service that is physically accessible within, or in the immediate vicinity of the household, educational institution, workplace or health institution. According to WHO, the water source has to be within **1,000 metres** of the home and collection time should not exceed **30 minutes**.
- **Affordable**. Water, and water facilities and services, must be affordable for all. The United Nations Development Programme (UNDP) suggests that water costs should not exceed **3 per cent** of household income.

As seen from the UN's definition of the right to water services, it is clear that water services are crucial to the wellbeing of society as well as being an essential factor for economic success.

In New Zealand, the Health (Drinking Water) Amendment Act 2007 and Drinking Water Standards New Zealand (2008, revised) stipulate the level of services for public potable water services. Water services providers, primarily local councils, need to comply with the Local Government Act 2002.

Nevertheless, the water sector is often being viewed as conservative, risk averse, slow-moving, highly-regulated, political, and last but not least, as having a low financial return on investment. Those delivering water services are not often recognized for the essential job that they do and get little positive publicity compared with other sectors. (Some may think it's actually a good thing, so they can get on with their job).

With the financial and human resources available, our industry is performing well to deliver the current level of services. With significant challenges ahead for the New Zealand water sector a different approach is needed if the sector is to continue to perform.

1.2 OUR PRESSING CHALLENGES

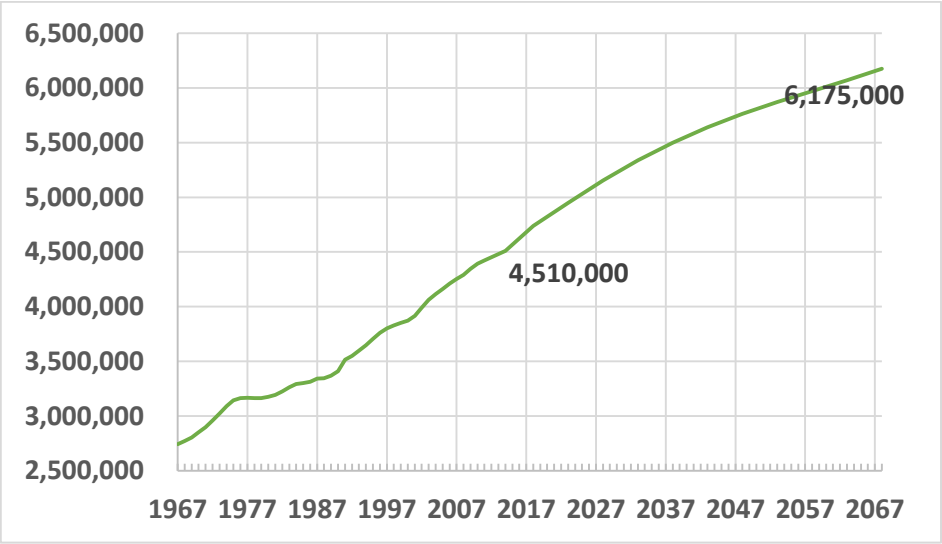
There are many pressing challenges for New Zealand's water services:

- High population growth in urban areas
- Aging population and declining rating base in rural areas
- Significant asset replacement cost – aging assets
- Local and Regional Water Stress
- Climate change
- Rising public expectation
- Cultural aspiration

Urbanisation and Population Growth

Statistics New Zealand predicts that the national population will increase from 4.5 to 6.1 million people (median growth scenario) over the next 50 years [2].

Figure 3: New Zealand Population 1967 to 2067 (Source: Statistics NZ, [3])



The net population increase is equivalent to the current size of Auckland. It would require significant effort to provide adequate infrastructure to achieve the required levels of service. Moreover, this challenge is made more difficult, as most of the growth (~90%) over the next 30 years will happen in the five urban centres, as shown in Table 1.

Table 1: Stats NZ Population Growth Forecast – Selected Urban Centres

	2013 Population	2043 Population Forecast	Population Increase Forecasted	% Increase
Auckland	1,493,200	2,229,300	736,100	49%
Hamilton	150,200	212,900	62,700	42%
Tauranga	119,800	172,100	52,300	44%
Wellington	393,700	444,100	50,400	13%
Christchurch	356,700	436,800	80,100	22%
The selected urban centres to NZ Total Population	56%	62%	87%	-

Moreover, the population of 65 years old or over will increase by 1 million people over the next 30 years [3], which means infrastructure affordability will likely to dominate the public opinions during the future years.

Significant Asset Replacement Cost

According to the 30 Years National Infrastructure Strategy, the estimated asset replacement cost for the existing water infrastructure is approximately $45 billion. Yet, this enormously large figure does not include the new demand from the anticipated population growth.

Similar challenges are also observed in other OECD countries. One of the recent estimates indicated the water sector needs a capital injection in the order of USD$20 trillions to address the aging assets, the increased level of services (due to declining water quality) and expansion (growth provision) [4].

Finding a better means to fund the existing infrastructure is one of the biggest drivers to innovate and implement asset management practices for many municipalities around the world.

Local and Regional Water Stress

Our economy is highly dependent on good and reliable water services to industry, not just only for the primary industries. Our manufacturing base and the service industry such as tourism would not exist if our high standard of water services is not maintained. Similarly, the importance of water is evident in every aspect of a modern society, ranging from power generation, data centres, food stuffs and delivering health services.

Our nation's clean green brand is also built on a robust, trustworthy water services reputation throughout the water cycle from water abstraction, treatment, supply to wastewater collection, treatment and discharge/reuse.

Nevertheless, when drought occurs, the national and regional economy feels the impact directly. For instance, the severe drought in 2013 has an estimated economy cost of $2 billion, which is a substantial chunk when compared with the dairy export value of $11.4 billion at the time [5].

Moreover, whilst New Zealand is not rated as one of the countries which are likely to be susceptible to water stress [6], our natural water resources are not evenly distributed across different regions. Several regions already experience water resource over-allocation [7]. Some actions need to be undertaken to address these chronic and acute water shortages.

Climate Change

The climate change is expected to affect our water resources are as follows [8]. More extreme rainfall events are likely to occur more frequent floods, requiring more proactive flood protection measures. More frequent or longer drought events in eastern and northern regions, as well as exacerbating the water resource imbalance between regions. In addition, the expected rise of seawater level between 0.3 to 1.0m by Year 2100 would result in potential inundation to a number of

coastal communities. Furthermore, the likely acidifying coastal water due to warmer sea temperature would cause possible damage to the marine ecosystem.

The water services providers and local governments would have to adapt to these new challenges especially on managing the available water sources for water supply, as well as possible leap of discharge standards to cater for potentially more sensitive receiving environment.

Rising public expectation

The essential role of water services has been gradually noticed by the public in the past two decades. The wide adaptation of social media has placed a higher expectation on the water services providers. Recently, the temporary bypass of Montreal wastewater treatment plant during the plant construction has become an international headline [9].

The contaminated water supplies of heavy metal lead found in Flint in the United States and in Hong Kong both turned into significant domestic issues for the incumbent governments [10, 11]. In the Flint case, numerous lawsuits have been filed, which creates massive amount of stress for those involved for months and years to come.

Compounding the challenges

When the above challenges combine, they require our water sector to be greener, cleaner, resilient, affordable, adaptable to climate changes, as well as able to withstand increasing public scrutiny.

This really require our water industry to re-invent itself to meet these future challenges.

As Albert Einstein once said, **"We can't solve problems by using the same kind of thinking we used when we created them.**" This means the survival of our wellbeing relies on finding new and innovative ways to deliver the water services.

2 OUR ACCOMPLISHMENT IN THE LAST 10 YEARS

This section describes the innovation that took place in our country in the past 10 years or so.

2.1 INTRODUCING GAME CHANGING TECHNOLOGIES

A number of game-changing technologies were introduced to NZ in the past 10 years, some examples are presented in Table 3.

Table 3: Examples of Game-Changing Water Technologies introduced in New Zealand since 2005

Year	Technologies	Significance
2005-Now	OSET Trials (Rotorua)	*This RDC and EBOP initiative provides a platform for the onsite wastewater treatment system vendors to test and optimize their performance. The results were made publically available.*
2006	Membrane Bioreactor (MBR)	*This technology enables the high rate nutrient removal treatment plants to be built with much smaller footprints.*
2007	MIEX	*This provided an alternative technology to remove organics in raw water and prevent THMs formation.*
2008	Low Pressure Sewer System	*Significantly lower/negligible inflow and infiltration sewerage systems (Point Wells and Rotorua). Also enable alternative funding model for scheme implementation.*
2008-10	Actiflo	*First application in municipal wastewater treatment for significant improvement in pond effluent quality (Gore) or storm flow treatment (Warkworth)*
2011	Vacuum Sewerage System	*A viable sewerage system alternative, suitable for very flat topography and coastal communities, such as Kawakawa Bay*
2016	TERAX	*A new sludge minimisation and resources recovery technology, utilizing well known advanced treatment processes such as wet air*

		oxidation and ammonia stripping (Rotorua), in progress
2016	Advanced Oxidation Process (AOP)	*Now an established technology to address seasonal taste and odour issue in drinking water supplies (Invercargill), under construction*

The introduction of these technologies has greatly changed the local scene, not only by offering more choices to the water asset owners, but also challenging the engineers and operators on how to plan, design, operate and maintain the existing infrastructure.

2.2 STRONGER FOCUS ON GOVERNANCE STRUCTURE

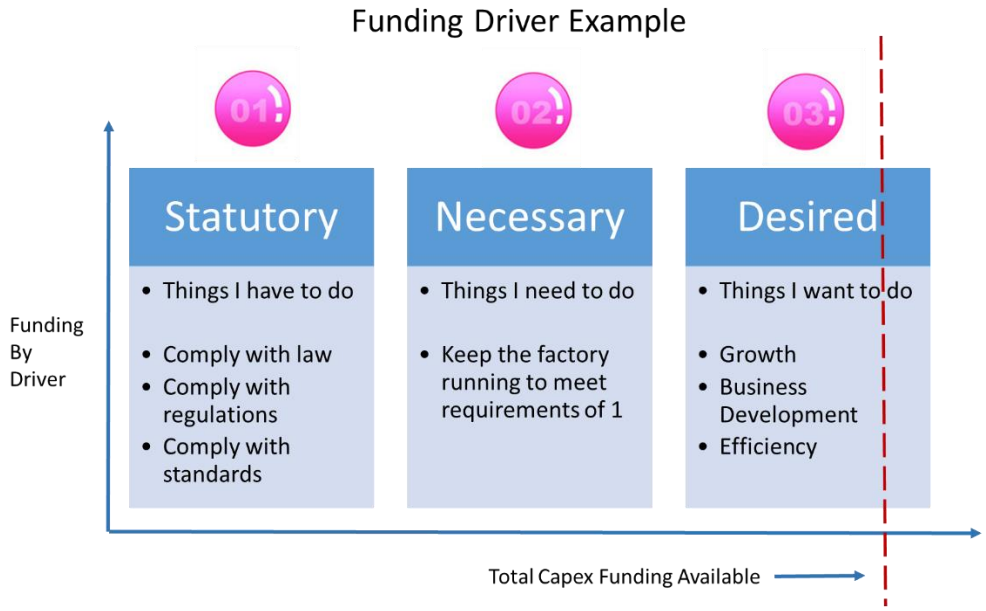
It is probably fair to say that for some industries a common and consistently applied form of governance and regulation is or should be a mandatory requirement. This is particularly true where the byproduct of that industry could have an adverse impact on wellbeing, be it to the environment, public health or the economy.

Governance of freshwater, the provision of safe, healthy drinking water and the disposal of wastewater in New Zealand is complex. Government provides National Policy through various Ministries, and management against standards in those policies is provided by regional and local council authorities which includes Council Controlled Organsiations (CCO's).

In the case of local authorities with or without CCO's the regulator is the also the service provider. This governance structure creates challenges in the asset management investment decision making process as water and wastewater issues must be considered against all other local authority asset investment decisions (excludes Watercare in Auckland). This can lead to situations where dealing with risks in other areas can mean vital water or wastewater asset investment is deferred indefinitely.

Funding then is a dominant factor affecting current levels of service and asset condition across the country. The model for deciding where to invest is also challenging.

Figure 4: Typical Priorities of Funding Drivers



If we consider Figure 4 above, the traditional drivers for investment across local government are being tested. In the first instance it is necessary to comply with laws including the Local Government Act (2002), health and safety regulations, drinking water quality standards and discharge consents, all included as **"Driver 1"**.

Then usually we consider how best to invest in our assets and resources to deliver the requirements of Driver 1, as included as **"Driver 2"**. Finally if the available funding allows, we can decide how to invest in the business to develop the business, make the business more efficient and to provide for growth, as **"Driver 3"**.

Growth is now a major influence in decision-making, where in the past, growth would sit behind meeting statutory requirements and delivering levels of service. Meeting the challenges of growth in our major urban centers within a constrained funding envelope will mean reduced funding elsewhere in this simple model. If Driver 1 has to be met, then the

logical assumption is that Driver 2 will be targeted for a reduced level of investment, which translated into reducing or deferring rehabilitation and replacement of assets.

Alternative funding models should be explored to achieve a better balance among various Asset Funding Drivers.

2.3 STRONGER ASSET MANAGEMENT FOCUS

Lessons can be learned from changes in regulation experienced close to home, in Australia and from the privatisation of water and wastewater companies in the UK.

AUSTRALIAN CONTEXT

In Australia, the Water Reform Act, which came into effect in 1994, included a need for companies to act more commercially. In 2004, the National Water Initiative changed the way in which Australian companies plan for, manage, measure and price water. They each have a Board of Directors, pay dividends and are measured against industry standards.

UK CONTEXT

Privatisation of the water and wastewater companies (WWCS) in the UK in 1989 gave rise to independent regulation through the Office of the Water Regulator (Ofwat) and the formulation of a five year Asset Management Plan (AMP) cycle for the new private WWCS's. Over the last 25 years, five cycles have been completed and AMP6 is now underway.

To begin with, the WWCS's were able to meet Ofwat's economic expectations with some ease as companies were able to select from a wide range of asset investment choices including those that were relatively cheap combined with more expensive solutions on a cost per meter basis. The unit cost targets being met in the first two AMP periods successfully by all companies [12]. Asset investment choices became more difficult during AMP3 where choices regarding underperforming assets began to include complex and difficult assets where solutions were more expensive on a unit cost basis. Something had to change.

It is difficult to view privatisation of water and wastewater companies negatively given the UK experience. Private investment was introduced and many of the older under-performing assets have now been replaced. The focus moving into AMP6 is moving towards how assets are run and maintained to meet customer expectations.

ANGLIAN WATER EXAMPLE

Using Anglian Water, one of the UK WWCS company as an example, this company developed an asset management model called "**Total Asset Management**" following privatisation, an approach that considered assets under three categories. Within a System, Within a Process and as Individual Assets themselves. Assets were categorized initially using a set of metadata standards developed through a cross-company forum. Benefit realization became a fundamental part of project selection based on asset performance outcomes and a separate team was created to understand current asset performance, benchmark against performance targets, and monitor delivery of benefit post project completion.

This approach worked well driving innovation, enabled different choices about asset investment and delivered better performance. This is a different approach yet still following the very traditional thinking about asset management.

TOTEX CONSIDERATION, NOT JUST CAPEX

The term Totex (Total Expenditure) is becoming more familiar as a different approach to how we can think about investing in asset maintenance and rehabilitation rather than replacement. As a concept this remains challenging for many regulators. Traditionally there has been a reluctance to increase ongoing year on year costs, (Operational expenditure or "Opex") to provide solutions for managing asset issues. Capital Expenditure or (Capex) is more widely favored as a one off cost for providing solutions for failing or underperforming assets.

"Totex" is mostly described as a simple combination of an Opex and Capex solution combined. What's intended is a much more strategic view of how assets are performing viewed over a longer timeframe to consider more innovative solutions which will have a whole life of cost benefit to consumers.

NEW ZEALAND INFRASTRUCTURE ASSET MANAGEMENT IMPROVEMENT

The local governments are required to prepare 30 years Infrastructure Strategy as part of their asset planning programme. In order to arrive this strategic document, the asset managers would need to go through the conventional methodologies applicable to Asset Management, such as Service levels definition, Future demand forecasting, Asset condition assessments, Asset capital, operational and maintenance decision-making.

One of the recent examples here in New Zealand is Thames Coromandel District Council (TCDC). TCDC operates a number of small to medium size water and wastewater schemes, which experience a 5 to 20 fold increase in holiday population during the Christmas and New Year period. In order to cater for the anticipated population growth and the significant tightening of discharge consents, TCDC invested an enormous amount of capital expenditure in the three Eastern Seaboard wastewater schemes, a total of $85 millions.

Yet growth continues to occur within various townships in TCDC, further upgrades to the wastewater treatment plants would be needed. TCDC has commissioned a project to assess conditions, capacity and pinch points of their treatment plants. As a result of the assessment, the water services manager and engineers are able to have a "bird-eye" view of the treatment plant asset condition and capacities, and develop the infrastructure strategy for their wastewater treatment facilities.

FURTHER CHANGES AHEAD?

Meanwhile, regulation in the UK is evolving further. Rather than an income cap set by the regulator against associated performance targets, the WWCS's now have the opportunity to select a revised set of targets and measures (agreed by Ofwat) that come with rewards and penalties. On one hand, outperforming new agreed targets would improve revenue, on the other hand, failing an agreed new target would incur a financial penalty. This is a very different approach as it further encourages the WWCS's to lead innovations to result in increased benefit for customers. Anglian Water supplies the same volume of water into supply now and 20 years ago, despite population has increased by 20%.

In order to link the new approach to customer benefits, Ofwat uses a service incentive mechanism (SIM) to survey customers, the results also feed into the economic assessment of each WWCS. AMP 6 is very much about delivery efficiency and performance for customers without customer bills increasing.

Given the experiences from the independent UK regulatory model and the commercial structure of Australian companies and now Watercare, the single Water Utility in Auckland, independent regulations and new standard performance drivers are long overdue here.

2.4 COLLABORATION ACROSS STAKEHOLDERS

In the past few years, stakeholders have become more proactive to promote collaborative efforts in water services in this country. One example is the formation of the Land and Water Forum, which intends to bring together the water services providers, water and environmental professionals, industrial bodies, agricultural and industrial water users and various NGOs and community groups.

The forum has published a number of papers since its formation, providing collective insight into issues faced across the whole spectrum of users, regulators and service providers. It is a new beginning for an era where collaboration rather than confrontation will dominate.

3 30 YEARS NATIONAL INFRASTRUCTURE STRATEGY

The 30 Years National Infrastructure Strategy forms the backbone of forecasting how to meet the future infrastructure demand on a national scale.

3.1 ASPIRATION OF 30 YEARS NATIONAL STRATEGY

The Strategy recognized the important role of the 4 waters (potable water, wastewater, stormwater and produced water) as one of the key social and economic enablers. It has identified the following improvement areas and opportunities for the sector:

- Effective data and Maturing asset management
- Ongoing improvement of compliance with regulation
- Understanding the renewal challenge
- Alternative governance models
- Better delivery of produced water projects

The Strategy also predicts their expected future outcome for the water sector:

- Micro-treatment plants, especially for small communities
- Water recycling and alternative water source
- Wider use of automation and robotics
- More consumer participation in conservation and environmental protection
- Formation of large-scale water operating service providers
- Effective (or alternative) water allocation models
- More efficient use of produced water and wide-spread storage
- Changes in regulations and policies on produced water and effluent reuse

3.2 WHAT ABOUT SUSTAINABLE BUSINESS GROWTH?

The immediate concern, faced by water utilities as fresh water becomes scarce, is providing sufficient safe healthy drinking water to satisfy demand and to treat wastewater to the required discharge standards. But water is also a major contributor to having a successful economy overall; high quality water is the backbone of healthcare and the core component in the production of many food stuffs. So how can we get the most from our water?

In a similar context, many European water utilities respond to this challenge by driving towards "smart water" (water or wastewater), meaning their systems and networks are live or fully monitored. Technology is changing at a rapid rate enabling new and un-thought of applications across various industries. The investment needed to create these totally monitored "live" systems using Business Information Management approach (BIM) is enormous, and this is likely to drive changes in business models. Urban populations are increasing, water consumption as a whole is trending upwards as a result although per capita consumption is falling as awareness of water scarcity rises.

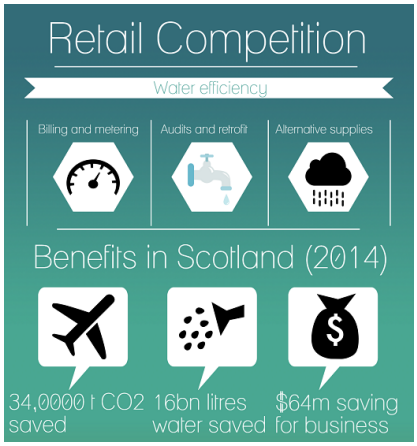
3.3 METADATA COLLECTION

As one of the recognized information gaps by the 30 Years National Infrastructure Strategy, LINZ has recently published the draft metadata standards for water supply, wastewater, stormwater and residential and light commercial buildings. The purpose of these draft standards is to establish a consistent approach that collects key asset data across the vast amount of organisations, which will then enable improved decision-making, and achieve greater resilience.

Singapore PUB is one of the world's leading example in terms effectively and efficiently using the data collected in their system. One of their key success is to significantly reduce water consumption collection, between 2003 and 2014, the potable water consumption was reduced from 165 to 151L/day per capita, equivalent to 10% reduction. They have got ambitious goal to achieve 140L/day by 2030. They have comprehensive data collection and analysis programmes in place which would enable them to achieve their ultimate goal of becoming self-sufficient in water by 2061.

Scotland is another successful example of how the development of retail competition for non-household water and sewerage providers, as well as more efficient use of data since has helped customers saved 16 billion litres of water, more than 28,000 tonnes of CO2 emissions and an estimated US$64m in business savings (Scottish Water's Commercial Entity) [13].

Figure 5: Benefits of retail competition in Scotland 2008 – 2013



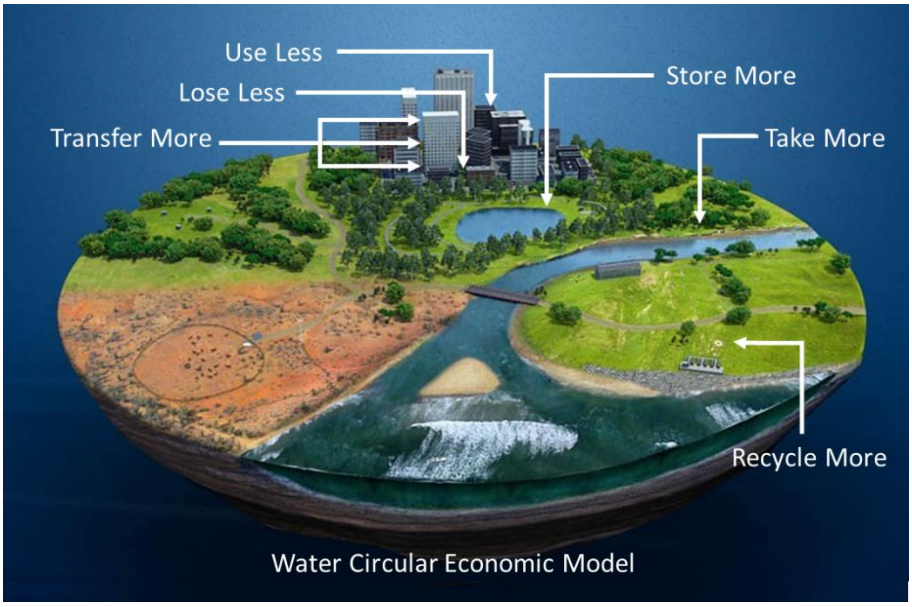
4 IMAGINING NEW ZEALAND'S WATER SECTOR IN 2067

Forecasting what shape and form of our water sector in 50 years is undoubtedly crystal ball gazing. However, based on the current trends, we will glimpse of what the future may hold for us.

4.1 CIRCULAR ECONOMY OF WATER SERVICES

The term "Circular Economy" is one of the latest buzz words. It is more than just a buzzword, and there are some simple concepts may be worth applying across the water and wastewater cycle.

Figure 6: Potential Circular Economic Model of Water



- **Take more** (when we can) - If we had the capability to take more water from freshwater sources in the plentiful months during the winter we could store it for when it is most needed.

- **Store More** – what if we could store the water somehow without creating expensive capital assets, recharge natural aquifers?

- **Lose Less** – the supply demand balance of water systems recognizes the measurement of non-revenue water (water lost through leakage or from operational use). The need for managing leakage from local authority operational sites and networks is understood and underway to a larger or lesser degree in most areas but what about customer side leakage, are we doing enough?

- **Use less** – The water sector is unusual in that most regulators challenge companies to reduce the consumption of the product from which their income is derived. As freshwater sources are placed under pressure through

abstraction educating customers and changing customer behavior will become an important part of asset management.

- **Transfer More** – Little is understood about the benefits of transferring water between Agriculture, Industry and the public water sector. Are there advantages or benefits to be realised from these potential exchanges?

- **Recycle more** – Another behavioral challenge facing water and waste service providers is the public perception regarding water produced as a byproduct of the wastewater treatment process. Should we call this recycling rather than wastewater treatment? Others are doing just that and seeing this by product as more and more as an opportunity.

- **Resource focus** - Wastewater contains plentiful of energy and nutrients. The historical approach is to remove the nutrients as part of the treatment process. What if we can harness the nutrients in the wastewater and convert them into useful resources (e.g. fertilizers). The technology already exists, and it will take time to become a common practice across all sizes of treatment works.

Some of these ideas seem unachievable now but if we learn from the examples of disruption like Tesla [13] and Technology 4.0 (the term applied to the current technology revolution), the possibilities for innovation in our sector are exciting indeed.

4.2 ENERGY AND CARBON NEUTRAL WATER UTILITIES

The water services account for 3 to 5% of national electricity usage in the developed countries. Whilst this may not seem to be significant enough to change the landscape, however being energy neutral or even energy positive would reap massive benefits to the water services providers.

A number of wastewater treatment plants around the world have already attained energy neutral, or even being energy-positive. Anaerobic ammonia oxidation (Anammox) is no longer a wishful game-changing wastewater treatment technology, it is already applied in various full-scale installations. The major advantage is that it does not require complete re-design of the existing treatment works. Further advance and wide-spread adoption of such new and innovative treatment technologies will see water services providers eventually becoming energy and carbon neutral. They will be able to trade excess power generated from the treatment plants, to gain further financial independence.

A number of water services providers such as Sydney Water and Watercare have already set targets to become carbon and/or energy neutral in their facilities in the foreseeable future.

4.3 CUSTOMER FOCUSED

The customer revolution is beginning to take hold in the UK water industry, you can now find a “switch” option on water companies websites, something reserved for gas and electricity companies not so long ago. So acknowledging, understanding and incorporating what customers really want from their service providers is essential.

The use of behavioral science (or behavioral economy) has gained more popularity overseas. The UK government started up a Behavioral Insight Team in 2010, primarily to improve and optimize public services and the respective outcomes. The EAST concept (Easy, Attractive, Social and Timely) has recently been introduced to the health sector and the Financial Management Authority (FMA).

It is just a matter of time when the local authorities and water services providers will employ concepts and principles of Behavioral Science to increase the engagement level of the communities.

We must also remember that, we are now living in the age where the public has a high expectation of “government services”, thus any unexpected reliability issues will attract negative publicity. One of the most recent examples is as the recent IT hiccup of Australian census [14]. People would prefer open and honest information regarding services disruptions.

Because of the bigger roles played by the customers, water services providers will therefore need to more and resources on consumer engagement which will influence and encourage good stewardship of water resources.

4.4 REAL SMART WATER

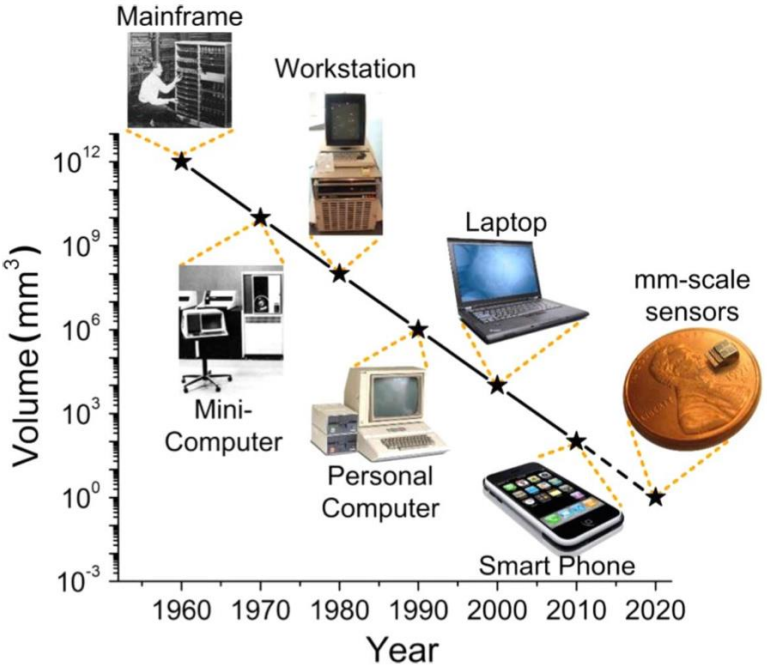
Smart water is a term being used to describe how we can monitor our assets to tell us what is happening in our water and wastewater systems so that we can make better and more informed decisions.

Already water and wastewater companies around the world are recognizing that moving away from reactive asset maintenance to proactive asset maintenance, can add value to their business. Already we are seeing companies invest

heavily in data and information, real time monitoring of live networks is already here, so that this shift from reactive to proactive decision-making can take place. With the new metadata standards in place, our water industries should be a lot more astute with asset data collection, monitoring and analysis to support the decision making.

But what if the water was smart? Smart dust is already with us. Tiny chips created to measure, monitor, test and record have been developed and can be introduced to the environment, and these chips are microscopic.

Figure 7: The Evolution of Computer Classes, as observed by Bell's Law, University of Michigan



What if we enable water to become Smart in the same way? It may look like a step too far for now. But it will bring immense benefits to public health, businesses as well as environmental outcomes.

Disruption is beginning to take hold across the world. By disruption we mean the process whereby people power is changing the way we do things. A good example in New Zealand is UBER. Existing Taxi drivers must attain a standard to become a taxi driver, the taxi itself must meet certain standards. Uber operate outside these standards, the drivers are often untrained, their taxis may not be safe and certainly some are not clean! People power has decided that Uber is a good thing and the company is "disrupting" the taxi industry worldwide.

But smart water inside us on its way through the water cycle? Unthinkable?

What if smart water is adding more value than just monitoring water systems on its journey? What if there were health benefits? Once consumed, what if that same smart water could identify illness inside us early enough that we could prevent ourselves becoming seriously ill?

Technology is the enabler for the disruption revolution to take place. The truth is that the pace of disruption revolution is advancing ever more quickly. What we understand today is being surpassed tomorrow. Technology 4.0 is changing to make the impossible possible and the water sector needs to keep pace.

4.5 RECOGNITION OF TRUE VALUES OF WATER

Without appropriate financial models, disruption revolution cannot take place. As we all know, our water sector does not receive adequate funding. In order to embrace disruption revolution in the water sector, the funding model needs to be revisited. According to the World Bank, the principles to determine the cost of water is as follows.

Table 4: General Principles to Determine the Cost of Water [15]

Cost Category	Description
Full Supply Cost	*Covers the cost of supplying the water by the utility, including operational, maintenance and capital costs.*
Full Economic Cost	*Covers the full supply cost, the opportunity cost associated with alternative use of the water resource and the economic impact imposed by other means, as well as economic externalities. Economic externalities include, for example, the impact of upstream pollution on users further downstream.*
Full Cost	*Covers the full economic cost, and environmental externalities. Environmental externalities include impact on public health or ecosystem.*

At a glance, it seems that the above cost definitions are clear and easy to understand the "Value of Water". But how is the value of water perceived by consumers?

The key difference in the above cost definitions is the inclusion of "invisible" costs such as economic and environmental costs. How can we communicate the invisible costs to our customers? This is a challenge when they are not being quantified at the present time.

Moreover, we may think the customers are unwilling to pay more on their water charges. Is this true?

For example, Watercare currently charges \$1.444 per m^3 for potable drinking water. That's 1000 litres for \$1.444 for the cost of abstraction, treatment and supply to the consumer, a very good value indeed.

Perversely we seem quite happy as consumers to then visit the dairy and pay \$3 for a single litre of water, that's equivalent to \$3000/m^3. This has yet to take into account the environmental cost of those water bottles. This example clearly demonstrates that we really don't give serious consideration to the value that water services represents.

Calculating the true economic value of freshwater creates quite a challenge and then consideration needs to be given to the question, should we let the market set the price when freshwater becomes scarce by charging for abstraction and allowing tradeable water rights? If we don't, how do we incentivize real efficiency throughout the water cycle as demand pressure on water supply increases. Given the experience of other countries around the world and with Watercare in Auckland, separation of water and wastewater services from local authority pressures does drive better efficiency and values for the customers. Then adding independent regulation into the mix and opportunities for increasing efficiencies, driving consumer value upwards and potentially allowing better funding models are created.

Yes of course, the cost of water and wastewater services would rise but given consumer acceptance (at a general level) of purchasing this precious natural resource at a substantial premium because it is convenient, it is a small price to pay for the advancement needed.

4.6 DIFFERENT GOVERNANCE STRUCTURE

If disruption and Technology 4.0 begin to take hold of the water and wastewater industry as they already are across other sectors [13], then even more pressure will be applied for a change in governance and regulation if it is to remain relevant and add value.

New Zealand must make some difficult choices in the near future about this central core resource that enables the general population to exist and thrive and to underpin a successful economy. Recent changes in the governance of Auckland have seen the water and wastewater Local Network Operators (LNO's) of the former local councils join the bulk water supplier Watercare when the councils were integrated in November 2010. Some benefits of forming the new, not for profit CCO are obvious. Water and wastewater charges were set through the legislation process at the lowest combined network and bulk water charges pre-integration resulting in lower prices across the majority of Auckland. Wastewater charges were separated from council rates.

What is not so obvious is the \$150m of savings realised in the first three years of operation that enabled Watercare to invest in poorly performing assets inherited from former councils to significantly improve levels of service. This investment was in addition to the company's 20 year asset management plan totaling a further \$4.1b over the first 10 years. Because Watercare is self-funded through its charges, asset investment decisions are not directly affected by other factors.

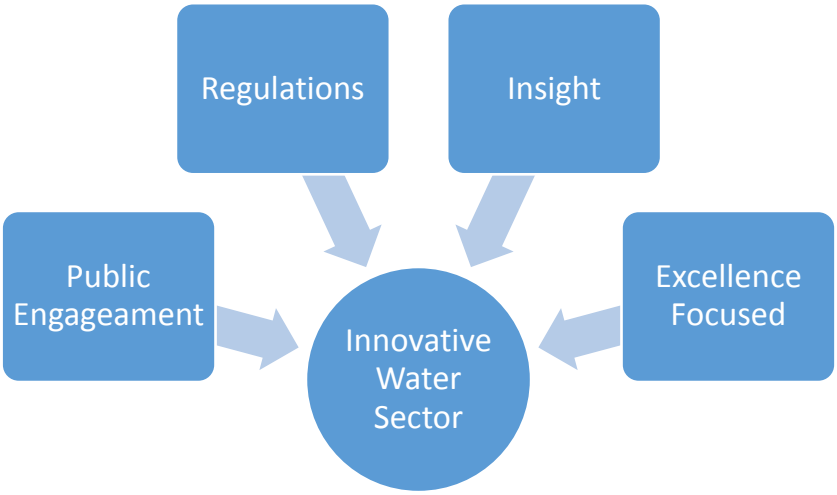
Is it time to introduce different governance models in New Zealand?

Given the strong and very appropriate social and cultural significance attached to natural resources in New Zealand, privatisation of the water and wastewater sector is too challenging a concept to entertain. However there are other models that could deliver better efficiencies through combined management and pooling of resources. The question has been raised in the Wellington and Waikato regions, which are examples of good thought leadership.

5 FINAL REMARKS – ELEMENTS TO INNOVATION

The water sector requires innovation enablers and strong leadership to transform, which ensures we can meet the required levels of services in 50 years, whatever they may be. The choice that we make now will shape our future.

Figure 8: Four Elements to Attain Innvoation



5.1 PUBLIC ENGAGEMENT – GET THE PUBLIC BEHIND US

Public feel informed if the benefits and challenges are clearly laid out to them.

For example, the general public perception about the byproduct of the wastewater treatment process has been found to be unfavourable. K. G. Robinson et al [16] found that when they assessed the attitudes, knowledge and information sources concerning wastewater reuse and evaluate the results with respect to population demographics, both men and women unfavorably view the use of wastewater for possible consumption (released into potable surface or groundwater supplies) or applications involving close and personal contact (laundry).

Women in the study were especially concerned about pumping wastewater into the groundwater for subsequent potable use. Both genders felt that wastewater reuse for applications not involving close personal contact (such as firefighting, car washing, lawn irrigation and agricultural uses) was acceptable. General knowledge concerning wastewater reuse was mixed.

Appreciate the diversity of the public is important; newspaper and television are the primary source of information, particularly for the older generation or those with lower household income. On the other hand, the internet is the primary information source for the middle age and younger generation. This study was carried out in Phoenix of Arizona. Tailoring the outreach strategy to the entire spectrum is a necessary consideration.

Attitudes were found to be completely different in South Africa [17] where 88% of those surveyed were not concerned about the possible reuse of non-potable water. A marked difference and there would seem to be an obvious perception that due to water resource shortage in South Africa, there naturally be wider acceptance of the principle. Yet the annual rainfall in the African study was noted to be 500mm (worldwide average 860mm), the average rainfall in Phoenix Arizona is only 250mm.

As mentioned, some water utilities are already using the term recycling rather than wastewater treatment. Another term applied lately is “Used Water” (by Singapore PUB) and “Opportunity Water” [18].

We therefore need to reach out to the public more actively, and make sure our challenges and opportunities are clearly communicated.

5.2 REGULATIONS – WE NEED THEM TO ENCOURAGE INNOVATIONS

Whilst specific regulations are often developed and formed after disruptions already took place, regulations can also play a huge role in terms of encouraging innovation. One example is the use of BAT standard (best available technology economically achievable) in the US, which prompted the water services providers to explore further into more advanced technological yet cost-effective options [19].

To encourage innovations, regulations should encourage the development of new technologies, discourage the use of dated or inappropriate technologies, introduce financial incentives and grants for innovation developments, permitting changes to the governance structures (e.g. introducing independent regulators) and many others. It will be interesting to see how the UK water companies perform over AMP6 and subsequent periods, to see how they respond to the newly introduced financial reward/penalty system, which directly links to their performance.

This is the focus area likely requiring most of the changes in the near future.

5.3 INSIGHT– ENCOURAGE INNOVATION AND EMBRACE TECHNOLOGIES

Innovation is more than just technology-savvy; it is more about being adaptive to the challenges now and the near future. We require insights to identify potential wins and changes, as well as embracing technologies. Deeper integration of our activities with automation, smart sensors and data analytics will continue to drive disruption revolution at an unprecedented pace.

Insights also come from closer collaboration across different industries and segments, which enable our sector to learn from each other.

We need to embrace new technologies, and having a strong link between different stakeholder groups, such as asset owners, engineers, design professionals, academics, lobby groups, would be essential.

5.4 EXCELLENCE-DRIVEN CULTURE

Our traditional culture is unique largely due to the colonial past and physical distance from the rest of the world, mainly Europe and the US. However, with the rising tides of the Asian economies and the ever-growing influence of the internet, we are now only a foot-step away from our key trading partners. This will call for our country to have an excellence-drive culture, whilst not losing our traditional friendly and welcoming attitudes.

To continue to stay with the pack from the rest of the world, all of our industries including the water services providers will need to continue to reinvent themselves to develop various centers of excellence. This will enable us to share and market our specialized products and expertise to the rest of the world. At the same time, we can take pride that we have maintained our clean green national image for service industries.

So, the most daunting question is, do you want to be part of this?

6 ACKNOWLEDGEMENTS

We would like to thank Thames Coromandel District Council for their permission to refer to their recent projects.

7 REFERENCES

1. Statista, Global market share held by Nokia smartphones, access on 30th July 2016
2. United Nations, http://www.un.org/waterforlifedecade/human_right_to_water.shtml, access on 30th July 2016
3. Statistics NZ, Population data and projection of New Zealand and major centers, access on 30th July 2016
4. Deloitte UK (2016), Water Tight 2.0.
5. Bloomberg, New Zealand's Worst Drought in 30 Years may cost NZ$2 billion.
6. Water Economic Forum (2011), Water Security – The Water-Food-Energy-Climate Nexus, Island Press.
7. NZIER (2014), Water management in New Zealand, Working Paper 2014/01.

8. New Zealand Climate Change Centre (2014) IPCC Fifth Assessment Report – New Zealand Findings

9. CBC News (2015), http://www.cbc.ca/news/canada/montreal/montreal-s-sewage-dump-saga-explained-in-5-key-points-1.3263739, accessed on 6th August 2016

10. CNBC (2016), http://www.cnbc.com/2016/03/24/americas-water-crisis-goes-beyond-flint-michigan.html, accessed on 12th August 2016

11. Hong Kong FP (2015), https://www.hongkongfp.com/2015/07/13/explainer-how-a-public-estates-lead-contamination-became-a-citywide-concern/, accessed on 12th August 2016

12. World Bank, Water Privatisation and Regulation in England and Wales, http://siteresources.worldbank.org/EXTFINANCIALSECTOR/Resources/282884-1303327122200/115vdbrg.pdf, accessed on 15th August 2016

13. http://www.financingsustainablewater.org/blog/lessons-uk-water-efficiency-through-retail-competition-water-services

14. Stefan Heck, Matt Rogers, Paul Carroll (2014) Resource Revolution, Melcher Media

15. The Australian (2016), http://www.theaustralian.com.au/national-affairs/census-2016-turnbull-counts-debacle-cost-as-ibm-legal-row-looms/news-story/611c7db33ce65ec1c9c4309631868413, accessed on 13th August 2016

16. K.G. Robinson, C.H. Robinson, S.A. Hawkins (2005), Assessment of Public Perception Regarding Wastewater Reuse. Water Science and Technology, March 2005, 5 (1) 59-65

17. J.R. Adewumi1* , A.A. Ilemobade1 and J.E. van Zyl (2009), Model to Assess Public Perception Towards the Reuse of Treated Wastewater Effluent in South Africa, Proceedings of the Conference on Confluence of water industry 2009, Paper 190.

18. Rabbits, I (2014), Toilet to Tap the reality of our drinking water. HG Perspective.

19. Stanford Woods Institute for the Environment (2014) The Path to Water Innovation