NEW ZEALAND INFRASTRUCTURE COMMISSION
Te Waihanga

Valuing water

Sustainable water services and the role of volumetric charging

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Cut to the chase

Today's situation

The provision of safe, sustainable and affordable water services is a growing issue for many New Zealand towns and cities. Key causes are ageing assets, more stringent water quality and environmental standards, along with population changes and climate change, which is expected to threaten water security in some regions.

These challenges facing the water sector will necessitate significant investment, posing affordability concerns. As such, we must find ways to save water, reduce costs, defer investment demand and improve equity outcomes for users.

A wave of renewals is upon us

Water assets constructed as our towns and cities grew are approaching (or already exceed) their design life. Water is expensive to abstract, treat and distribute. But leaking pipe networks, whether council owned or on private property, often go undetected. Leaking toilet cisterns and water fixtures are also a source of significant loss. Nearly a quarter of all water that's treated and distributed in New Zealand is lost to network leaks. In some regions, leakage rates are considerably higher.

Constrained environmental and financial resources

As populations grow, a town or city may need new or enhanced water supplies. However, many aquifers and freshwater sources are constrained. Obtaining resource consent for new or increased water withdrawals can be costly and time consuming with uncertain outcomes. Equally, the cost of upgrading existing pipes (which may not have reached their end of life) or building new dams, reservoirs or treatment facilities is daunting. In addition to environmental and financial constraints, major new investments can also impose a range of property and cultural impacts.

Climate trends

Freshwater sources are coming under increasing stress due to sea-level rise and changing rainfall patterns. In some regions, climate change is expected to threaten water security. In the past decade, New Zealand has experienced the highest frequency of drought conditions since recordkeeping began 80 years ago. Indeed, the National Climate Change Risk Assessment identifies the risk to potable water supplies as the most urgent threat facing New Zealand.

Even where water resources can accommodate growth, wastage through leaks and excessive household use could undermine social license for future water takes.

Modifying how we pay for water can be part of the solution

New Zealanders are one of the world's highest per capita users of water – partly driven by the fact that many Kiwi homes are not metered for their water use. Communities who pay for water services through volumetric charges reduce their excess consumption.

As a case in point, per capita water use in Auckland, where volumetric charges have been in place since the 1980s, is among the lowest in New Zealand. Auckland's per capita consumption is on par with many European counterparts like the UK, Ireland and Switzerland. By contrast, Wellington and Hamilton residents (unmetered) use over a third more water than Auckland.

How we pay for water impacts the bottom line

All of New Zealand's local authorities charge their communities for mains water services.

For around 57% of New Zealand households, water meters are used to measure consumption and provide a basis for billing – as happens with power bills. However, many authorities charge a fixed price for water services within council rates.

How services are charged can shape how the service gets used, its delivery efficiency and how the costs are distributed among income groups. Well-designed pricing systems should send signals to both consumers and water service providers to incentivise behaviour change and improve system efficiency.

Volumetric charging can reduce household consumption by providing a financial incentive to conserve. The financial incentives created by volumetric charging are more effective than water-use restrictions or information alone. In addition, the use of water meters and volumetric charging can enhance leak detection, permit housing growth with existing assets, defer the need for capital investment, improve investment choices and increase accountability of water service providers. These benefits are widely enjoyed across OECD countries (OECD, 2010).

As demonstrated in Tauranga, Kāpiti Coast and New Plymouth, efficiencies gained from volumetric charging can also defer investment demand, reduce the cost of services and save ratepayers money.

A separate independent review of outcomes in Tauranga estimated that volumetric charging reduced average household costs by at least 40% from what they would otherwise have been. In the case of Kāpiti District Council, 75% of its ratepayers ended up paying less with water metering than they would have under the previous fixed-charge system.

However, introducing water meters and new billing systems does require investment. As such, water service providers should investigate the net benefits this pricing approach could bring to their individual situation.

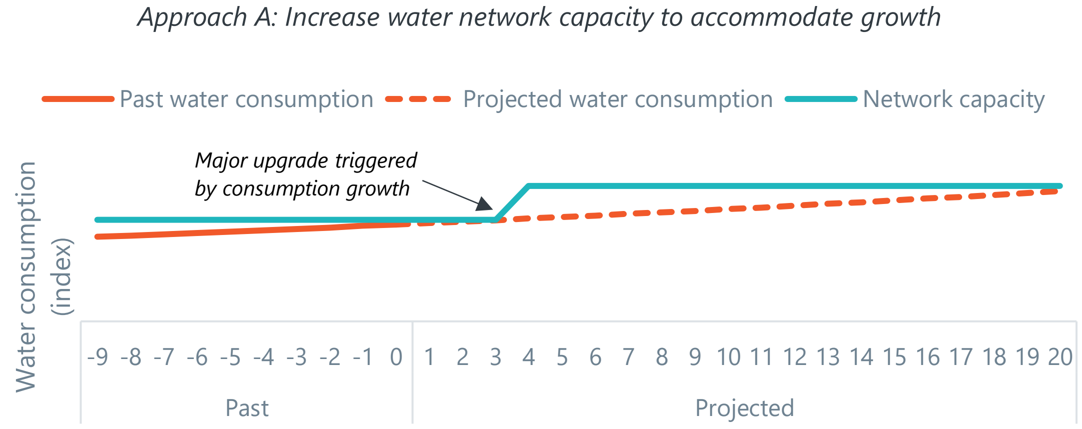
Volumetric charging can defer expensive community investments

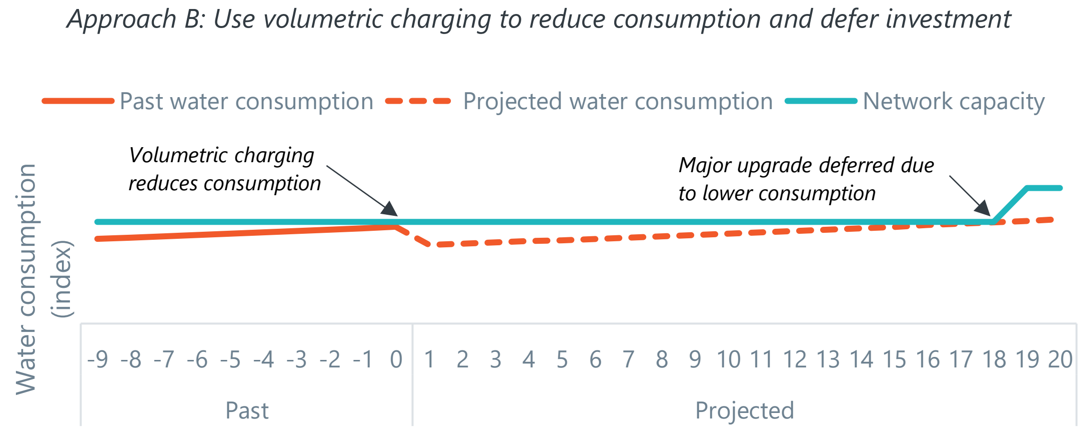
Case studies, both here and from overseas, demonstrate how volumetric pricing can make better use of existing resources and lift water sector performance.

Where water metering was introduced in Tauranga, it allowed the Waiāri Water Supply Scheme to be deferred by more than 10 years, despite high population growth – saving an estimated $53.3m in 2009 dollars. While in Kāpiti, water metering allowed the council to defer construction of a proposed $30m Maungakotukutuku Dam by an estimated 40 years.

In New Plymouth, their current water meter rollout has already allowed the indefinite deferral of an anticipated $4m pump station and pipeline upgrade.

Hypothetical impacts of water metering on investment demand





Volumetric charging can be more equitable than fixed prices for water services

Modelling commissioned by Te Waihanga shows that introducing volumetric charges can reduce costs for many low-income ratepayers. These results are based on the finding that, contrary to common perceptions, low-income households tend to have fewer people than high-income households and therefore use less water. Research also shows that low-income households tend to be more responsive to price than high-income households. Taken together, these two characteristics tend to make volumetric charges more progressive than charges that do not vary with use. Volumetric charges allow lower-income households to reduce their costs by managing water use, whereas fixed charges limit opportunities to save money on their water bills.

Socio-economic traits differ between communities. As a result, many local authorities that have introduced water meters have set up working groups with broad community representation to specifically consider and tailor billing structures to address equity issues. The impact of volumetric charges on renters requires specific consideration as savings from reduced council rates may not necessarily be passed on by landlords.

A recent survey of over 3,000 New Zealanders commissioned by Te Waihanga found that 72% see volumetric charging as the fairest way to pay for mains water services.

1. Introduction

The safe, efficient, and cost-effective delivery of water and wastewater services in New Zealand has grown increasingly challenging. In recent years, the public discourse on water reform has largely focused on enabling council-owned water service providers to borrow more money to finance increased investment. By comparison, less has been said about opportunities for cost reduction and improved efficiency, to reduce investment demand. This report aims to partly remedy that deficit.

While a range of initiatives are required to alleviate pressure on the sector, this report examines the role that usage-based water charges, also called 'volumetric charges', can play in reducing costs and improving efficiency. Volumetric charges are prices paid for every unit of water used. An average price per unit of water is typically applied to a whole community rather than reflect the incremental cost to deliver services to each individual property. Volumetric charges are enabled by water meters which provide a means of measuring how much water each property uses.

The increased use of volumetric charging is one of the recommendations in New Zealand's Infrastructure Strategy. In this report we build on the Strategy to examine how volumetric charging might assist more water service providers in meeting their challenges. To do so, we briefly review both literature and local evidence to understand how volumetric charging:

- might affect how much water people use
- might influence investment needed for growth and asset management
- compares with other water charging mechanisms with respect to the distributional impacts on households.

We conclude that volumetric charging can make a positive contribution toward addressing New Zealand's water service challenges. Volumetric charging may not be appropriate in all circumstances, but the evidence suggests good reason for examining the costs and benefits on a case-by-case basis. When designed well, volumetric charging can incentivise positive behaviours among both consumers and water service providers that improve efficiencies, lower costs and enhance equity outcomes.

2. Current state

2.1 Water services are under pressure

The challenges facing water service providers in New Zealand are well documented (Hansen, 2019; New Zealand Productivity Commission, 2019; Water New Zealand, 2022). These challenges include meeting more stringent water quality standards, environmental compliance, water shortages and the looming cost of renewals, repairs, and growth. In addition, climate change is set to make water security one of the most significant risks facing New Zealand (Ministry for the Environment & Stats NZ, 2020).

The cost to address these challenges is significant at a time when households are already facing cost-of-living pressures. Many councils face challenges with the financial sustainability of their water services. For instance, a 2021 survey by the Department of Internal Affairs, identified 43 councils (out of 67) with insufficient three waters (storm water, drinking water and wastewater) revenue to cover their operating costs, interest costs and asset depreciation. Moreover, an independent review (Water Industry Commission for Scotland, 2021) found that:

- almost all councils (63 out of 67) expected their water infrastructure assets to last longer than international benchmarking suggests is plausible, posing a risk that some assets will need replacement earlier than planned
- seven councils saved no funds for depreciation, meaning they set no money aside for future renewals.

While some councils are finding ways to reduce costs, most are facing rising costs as they grapple with investment challenges. Between 2017 and 2020, most councils (54 out of 67) faced three-waters operating costs that were increasing faster than overall inflation. For some, operating costs have climbed more than 50% in real terms (Water Industry Commission for Scotland, 2021).

Sustained progress on current and emerging challenges will require delivery models that are not only financially sustainable, but affordable. For many communities, affordability will rely on ways of raising sufficient revenue and reducing costs. Volumetric charging can provide a means of doing both.

2.2 Everyone pays for water services

All New Zealanders pay for water and wastewater services, even if they don't realise it. While water is treated as a public good with no royalties owing for its use (Ministry for the Environment, 2021), costs are incurred to abstract, treat, pump and dispose of water and wastewater.[1] The way in which New Zealanders pay varies depending on where they live.

Households in some parts of the country – like Auckland, Tauranga, Kāpiti or Whangarei – pay for services based in part, on the volume of water used (volumetric charging). Over 57% of residential properties and 72% of non-residential properties in New Zealand are now metered (Water New Zealand, 2022).[2]

[1] Water charges or water rates do not explicitly reflect environmental externalities arising from water extraction and discharge. However, consent conditions for wastewater networks are aimed at preventing excessive pollution, and the costs of complying with these conditions are met from water charges/rates. Where consent conditions are effective at mitigating environmental externalities, water charges should pass on the cost of these externalities to users. However, as of December 2019, nearly a quarter of wastewater treatment plants (comprising 73 plants) were operating on expired discharge consents, and in 2017/18 only 27% of wastewater treatment plants fully complied with their consent conditions, with 15% recording significant non-compliance (New Zealand Infrastructure Commission, 2021).

[2] The reliability of National Performance Review findings is limited by the data that individual participants have made available.

While the use of volumetric charging is on the rise, residential properties in most communities across New Zealand remain unmetered (Benison & Talbot-Jones, 2023).[3] In these unmetered communities, water services are paid for through council rates. A uniform, annual general charge included in council rates is a fixed charge per property, unaffected by the volume of water used (Garnett & Sirikhanchai, 2018). Depending on the transparency of the rates bill, homeowners may or may not have visibility of how much they pay for water. While landlords pass some or all of these costs on to tenants through rent,[4] tenants often lack visibility of their water-related costs.

Some households, particularly in rural areas, provide their own water and wastewater services, through the use of private bores, rainwater collection tanks, septic tanks or other on-site disposal systems (*How New Zealanders Pay for Infrastructure*, 2023).[5]

Although everyone pays for water services in one way or another, the way we pay influences the amount that we use. The way we pay can also affect investment decisions, service efficiency and the benefits that consumers receive.

2.3 Water sector pricing lags behind other sectors

Pricing, or the way costs are recovered, can influence the behaviour of both infrastructure providers and users. When designed well, pricing sends signals to users, about the value of a service. Pricing also guides decisions by infrastructure providers that improve services and distribute benefits more widely.

We commissioned PwC to examine New Zealand's infrastructure pricing models, which resulted in a framework of pricing principles (PwC, 2024a). PwC then assessed the performance of pricing models in the water, land transport, electricity, and telecommunications sectors against these principles. The PwC report identified three broad goals for infrastructure pricing:

- **Goal 1** – pricing should guide infrastructure investment to ensure that we can provide and maintain the infrastructure we need. This is the most important goal to get right as network infrastructure is long-lived and can impact our future choices.
- **Goal 2** – pricing should send signals to users about when, where, and how they should use infrastructure networks to maximise the overall benefits of those networks. This is the second most important goal as service levels and investment needs are highly influenced by user behaviour.
- **Goal 3** – pricing should be used to share benefits of providing networks widely through society. This should be addressed through adjustments to pricing once the first two goals are achieved.

PwC's key finding is that electricity and telecommunications pricing is well aligned with best practice principles. By contrast, pricing of land transport and water services are less well aligned (see Table 1). There are transformative opportunities to improve water sector pricing.

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[3] The extent of metering within a given council can vary. For instance, in Horowhenua District, Foxton is metered (representing 40% of the population) but other communities like Levin and Shannon are not yet metered.

[4] Local government rates are part of the cost to own and operate a rental property. As a result, we would expect rental property owners to take these costs into account when choosing whether to be landlords. If expected revenues from owning rental properties are persistently lower than overall costs, we would expect landlords to exit the market. Motu has developed a relevant model: https://www.motu.nz/our-research/urban-and-regional/housing/a-simple-model-of-housing-rental-and-ownership-with-policy-simulations/

[5] In 2020, 4,077,000 people (approximately 80%) were reportedly served by networked drinking water supplies serving 100 people or more (New Zealand Ministry of Health, 2020). A similar percentage (3,943,000 people) are connected to reticulated wastewater systems (GHD - Boffa Miskell, 2019).

Table 1: PwC's benchmarking of infrastructure sectors against best practice pricing principles

Pricing Goal	Land transport	Water	Telco	Energy
Goal 1 Pricing should guide investment	✗	…	✓	✓
Goal 2 Pricing should guide usage	…	…	…	…
Goal 3 Pricing should help share benefits	…	…	✓	✓

Key:

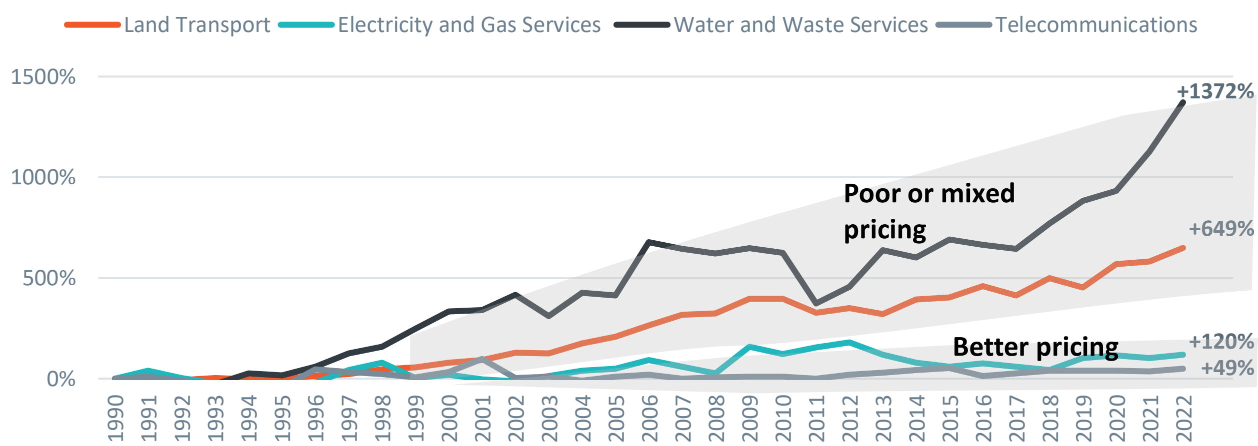
✓ *Sector currently performs well against most pricing principles*	… *Sector has mixed performance against pricing principles*	✗ *Sector underperforms against most pricing principles.*

Source: Adapted from page 8 (PwC, 2024a)

2.4 Water investment is rising more rapidly than other networks

Since 1990, capital investment in land transport and water and waste services (where pricing is poorly aligned with best practise) has risen rapidly – see Figure 1. Despite increased investment in water and transport, these sectors face both real and perceived challenges meeting service levels. By contrast, electricity, gas and telecommunication sectors (where pricing is better aligned with best practice) are generally seen as performing well, while keeping investment requirements modest.

Figure 1: Growth in inflation-adjusted capital investment, by infrastructure network



Source: Adapted from (New Zealand Infrastructure Commission, 2024a).[6]

[6] *Note: In 1990, annual capital investment was: land transport: $721m; electricity and gas: $1,198m; water and waste: $235m; and telecommunications: $1,723m. In 2022, annual capital investment was: land transport: $5,405m; electricity and gas: $2,633m; water and waste: $3,454m; and telecommunications: $2,570m. All values are inflation-adjusted 2022 New Zealand dollars.*

These large divergences in capital investment are notable because all four network infrastructure sectors had similar operating structures prior to 1990. At that time, infrastructure and services were provided directly by central or local government and prices were set directly or indirectly by political decision-makers. All sectors underwent reforms in the late 1980s and early 1990s, including the reorganisation of transport funding systems and local governments. But the electricity and telecommunication sectors experienced more fundamental reforms that resulted in a significantly different approach to pricing these networks.

There may be legitimate reasons why the water sector requires more investment levels relative to other sectors. Nevertheless, these comparisons between sectors suggest that pricing approaches may influence the amount of investment required.

2.5 How water services are priced

A variety of charging structures for water are in use across New Zealand. Each charging structure offers different benefits and challenges. As noted in Section 0, most communities are unmetered. Councils providing services to these communities are generally confined to utilising a uniform annual general charge (or targeted rate) to charge households and businesses for water services. Such charges are simple to administer, but do not signal the value of water, nor encourage conservation (Garnett & Sirikhanchai, 2018). The installation of water meters opens opportunities to employ alternative charging structures.

Where water meters have been installed, councils may utilise one or more of the charging structures summarised in Table 2.

Table 2: Charging structures available for water services (Garnett & Sirikhanchai, 2018)

Charging Structure	Description
Fixed charges (including uniform annual general charges or targeted rates)	Apply uniform charges to every property. Fixed charges can be applied in conjunction with one of the volumetric-based charging schemes below.
Uniform volumetric charges	Apply a consistent price for every cubic metre (m^3) of water consumed. Encourages conservation and allows small, low-income households to lower their bills.
Increasing block tariffs	Apply higher charges when pre-set thresholds are reached. High water-users pay a higher rate than low water-users. Further encourages conservation but may lead to higher costs for households with many people.
Decreasing block tariffs	Apply lower charges when pre-set thresholds are reached. Advantageous for bulk users but discourages conservation and limits savings opportunities for low users. Use of this scheme is in decline.
Seasonal tariffs	Apply higher volumetric charges based on consumption in peak demand periods.

Charging structure does not require a water meter (orange) — Charging structure requires a water meter (blue)

In practise, where volumetric charging is applied, water service providers often employ a mix of fixed and volumetric charges. The most appropriate charging mechanism will vary from community to community. The charging structure selected is most likely to gain support if developed in consultation with ratepayer and user representatives. Once developed, a charging structure need not remain static but can be modified to ensure that charges continue to meet their objectives and adapt to changing circumstances.[7]

In the next section we explore the role that volumetric charging could play in reducing the amount of water used and the amount of investment required to keep up with demand.

[7] Drought or other scarcity events may represent one of these changing circumstances. While the practise of increasing prices when water is scarce (scarcity pricing) is not yet in widespread use internationally, the impact of climate change may necessitate it in future. Water meters introduce the option for scarcity pricing to recover increased costs during times of water scarcity and to incentivise greater conservation (American Water Works Association, Seventh Edition).

3. Volumetric charging provides signals to users

Water meters and volumetric charging are sometimes viewed as imposing new bills on already overstretched ratepayers. But where volumetric charging is introduced, the uniform annual charge for water within a rates bill should reduce.[8] Volumetric charging serves a role beyond revenue collection as it reduces demand by sending a price signal to consumers. Reduced demand leads to lower operational costs (through reduced treatment and pumping) and can defer the need for expensive capital upgrades.

While a range of opportunities exist to reduce water demand, (including the use of greywater recycling and water-efficient devices), this section examines the role pricing can play in reducing demand.

3.1 Price signals reduce demand

New Zealanders use a lot of drinking water when compared with other OECD countries. High consumption increases the cost to provide water services, as more infrastructure needs to be provided to abstract, treat, and distribute a larger volume of water.

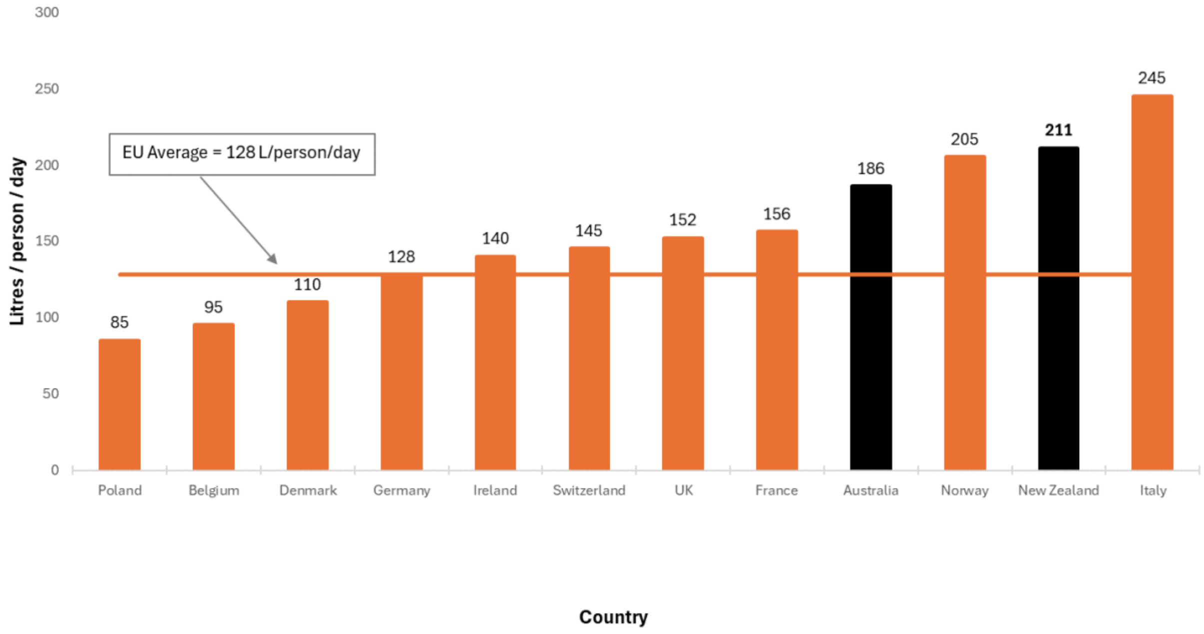
Figure 2 compares New Zealand's average per capita consumption with Australia and a range of European countries. At 211 litres per person per day, New Zealanders consume considerably more water per capita than many other OECD countries. By comparison, the average consumption across Europe in 2017 was 128 litres per person per day (EurEau, 2017). For context, the World Health Organisation recommends a minimum of between 50 to 100 litres per person per day for personal and domestic uses (United Nations, n.d.).

Volumetric charging can be effective at discouraging excessive use of drinking water. For instance, a global study examining the effects of volumetric charging in 102 countries found that consumption-based tariffs lead to lower consumption per capita (Zetland & Gasson, 2013). These lower consumption figures are reflected in Figure 2, where many OECD countries make greater use of volumetric charging (OECD, 1999)[9].

[8] While lower rate bills benefit homeowners, the impact on renters is more ambiguous and would depend on the extent to which rates reductions are passed through into rental costs. A 2023 study identified that wage growth and supply/demand balance have the greatest impact on rents. The costs to landlords, like mortgage rates (and presumably council rates), have less bearing on rental costs (Bentley et al., 2023).

[9] A 1999 OECD review found two-thirds of OECD countries apply volumetric charging to 90% or more of their residential customers. While dated, the application of volumetric charging is expected to have grown since that time.

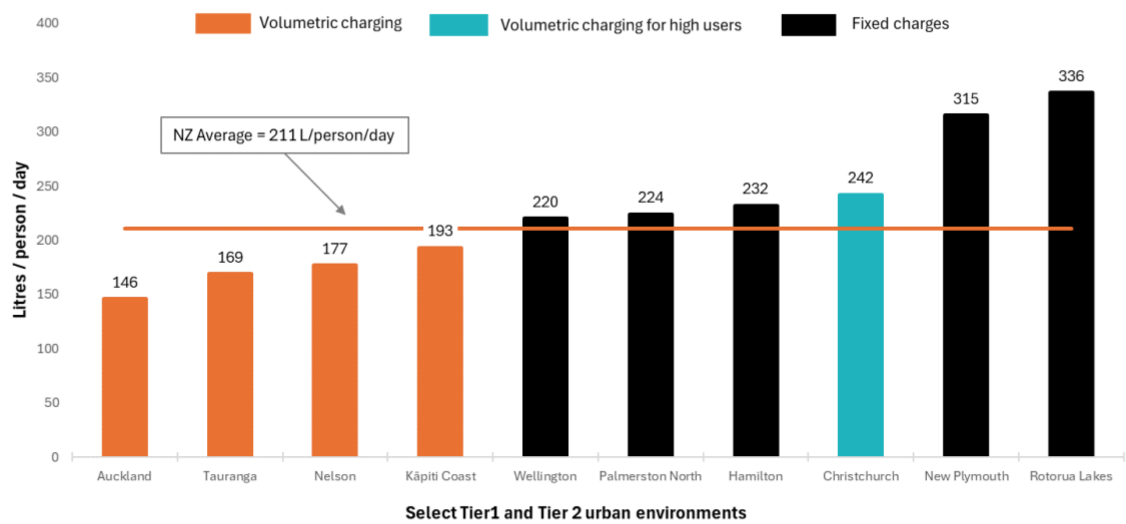
Figure 2: International residential water consumption (L/person/day)



European data: Europe's water in figures: An overview of the European drinking water and waste water sectors (2017 Edition).
Australian data: Australian Bureau of Statistics
New Zealand data: Water New Zealand

New Zealand data similarly demonstrates an association between volumetric charging and lower consumption. Figure 3 compares residential water consumption for large, fast-growing urban councils in New Zealand.[10] Some of these councils have volumetric charging, while others do not. The four councils with volumetric charging enjoy the lowest water consumption, while five of the six councils with highest water consumption apply only fixed charges.

Figure 3: Residential water consumption for a selection of tier 1 and 2 towns and cities (L/person/day)



Source: Benison, T., & Talbot-Jones, J. (2023). Urban water security: Assessing the impacts of metering and pricing in Aotearoa New Zealand (Motu Working Paper)
Note that water consumption data for New Plymouth pre-dates introduction of volumetric charging there. In Rotorua Lakes, seven of their ten water treatment schemes serve rural-residential and farming supplies, contributing to higher consumption per capita data.

[10] Councils were chosen based on the tier 1 and tier 2 councils listed in the National Policy Statement on Urban Development, which face similar conditions around urban growth and population density (New Zealand Government, 2020).

Results for Tauranga (with volumetric charging) and Hamilton (with fixed pricing) illustrate the impact volumetric charging can have on consumption. Despite their similar population density and climate, per capita water usage in Tauranga is 27% lower than in Hamilton (Benison & Talbot-Jones, 2023). Where volumetric charges have been introduced, peak water consumption has been estimated to reduce by up to 30% (New Zealand Productivity Commission, 2019).

Water is a necessity for life. But in places where water scarcity is not a significant constraint, people have choices about how efficiently to use it. For example, consumers can choose water-efficient household appliances and fixtures, or rainwater tanks for gardening to reduce demand on drinking water.[11] Volumetric charging provides financial benefits for households who can reduce their usage. These financial benefits can stem from both lower water bills and lower energy bills (through reduced hot water use) (Cooley et al., 2022).

3.2 Usage information alone is less effective

In some overseas jurisdictions, non-pricing methods are employed to reduce water use, like sharing consumption information with households. Typical information strategies include benchmarking consumption against neighbourhood use, or alerts when consumption exceeds the household's typical use (suggesting a leak). The use of these non-pricing tools aims to nudge water users toward demand reduction.

This non-price approach relies on consumers using this information to take water conservation steps (Simis et al., 2016). These steps might include leak repair, the installation of water-efficient appliances or being more conscious about usage. While New Zealanders recognise the importance of water, many also see water as plentiful, and expect to use it freely, without restriction (Ministry for the Environment, 2009). Research in Wellington identified public support for water conservation, but found action is less likely until a crisis emerges (Ministry for the Environment, 2009). When charges are not linked to usage, there is no financial incentive to conserve.

Consumption information alone is not enough to reduce demand over the long-term. For instance, a Queensland-based study showed that while consumer-education strategies can reduce demand, the results are short-lived, with demand rising to pre-study levels just 12 months following conclusion of the information campaign (Fielding et al., 2013).

The greatest benefits from information sharing comes when behaviour-shaping consumption data or water conservation tips are coupled with volumetric charging. An international review found that information-sharing coupled with pricing signals can reduce water consumption by 5.5% beyond what can be achieved with metering alone (Liu & Mukheibir, 2018).

3.3 Outdoor-use restrictions also have limitations

Councils often rely on outdoor water-use restrictions, such as sprinkler bans, to limit water-use during dry summer months. But an exclusive reliance on rationing forgoes opportunities to improve network efficiency and encourage water conservation. Water restrictions every second or third summer may not provide sufficient incentive to invest in more water-efficient gardens, including use of mulch, micro-irrigation or drought tolerant plants. Outdoor water restrictions also overlook the potential for indoor water conservation and provide no incentive for innovation or the use of water-conserving technologies (Mansur & Olmstead, 2007). This lack of incentive means that once restrictions are lifted, residents

[11] In economic terms, there is a price elasticity of demand for water, meaning that increased prices will cause people to use less water, and vice versa. This is estimated to fall in the range of -0.2 to -0.3, meaning that, holding other factors constant, a 10% increase in overall water charges will lead to a 2% to 3% reduction in usage (Economic Growth and Demand for Infrastructure Services, n.d., p. Table 2). The structure of water charges can also affect how price-responsive people are to charges (Sebri, 2014).

typically return to their previous consumption behaviour. In some instances, the announcement of water-use restrictions in New Zealand can lead to *increased* consumption (RNZ, 2024).

Depending on their design, outdoor water-use restrictions can have other unintended costs. For instance, restrictions that ban sprinklers can cause some people to switch to time-consuming hand-watering. Hand-watering creates different costs for households while not necessarily reducing consumption as much as intended. An Australian study which places value on time spent hand-watering found that households that choose to hand-water may incur time costs ranging between AU$347 and AU$870 per season (Brennan et al., 2007).

When compared with outdoor use restrictions, volumetric charging provides users with a signal:

- to reduce more than just outdoor water consumption
- to invest in water-efficient appliances and fixtures
- to invest in more water-efficient gardens
- that endures longer than a time-limited outdoor-use restrictions
- doesn’t unduly impinge on the those who would prefer to pay for their outdoor water use than spend time hand-watering.

4. Volumetric charging as a signal to water service providers

The previous section highlights the role that volumetric charging can play in reducing water demand among consumers. Reduced water demand can also enable a range of financial, operational and environmental benefits. On the financial front, water metering and volumetric charging can reduce costs for water service providers by deferring investment demand and reducing operation and maintenance costs. Volumetric charging can also improve customers' visibility of service costs, increase accountability of water service providers and improve investment practices.

In this section we examine the impact water meters and volumetric charging can have on water service provision. The opportunities we consider include:

- cost savings achieved by delaying (or avoiding) the need for investment and reduced operational cost
- improved management practices through access to data and improved accountability for water service providers
- environmental benefits through reduced demand on fresh water sources.

4.1 Cost savings

As noted in Section 2.1, many water service providers face challenges with financial sustainability. In this section we start by examining the role that volumetric charging can play in supporting financial sustainability through reduced costs and improved efficiency. We specifically examine how reduced water consumption and leakage can ease both capital expenditure and operating costs.

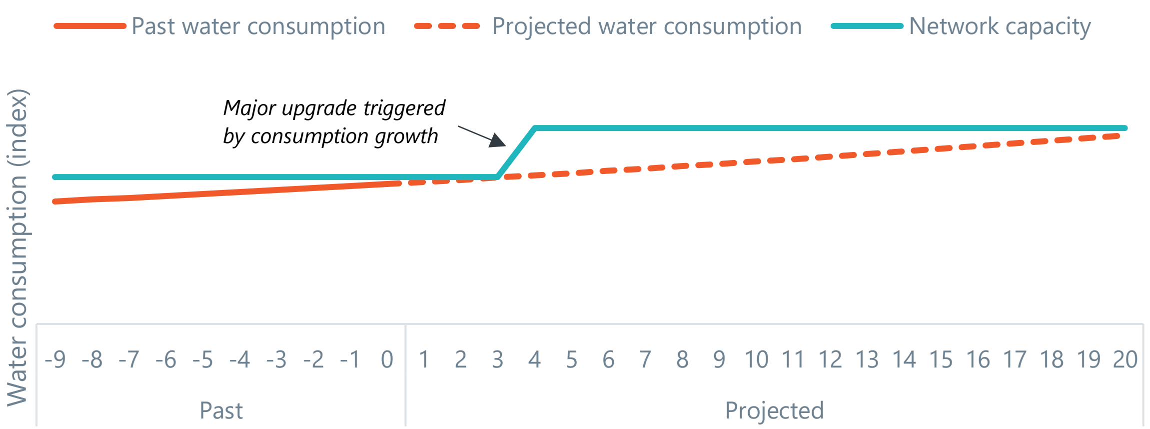
4.1.1 Delaying or avoiding investment demand

Water metering and volumetric charging can help water service providers delay or avoid investment that might otherwise be needed (Office of the Controller and Auditor-General, 2018; Benison & Talbot-Jones, 2023). These tools do so by improving leak detection and stimulating water conservation, both of which decrease the amount of water that has to be supplied.

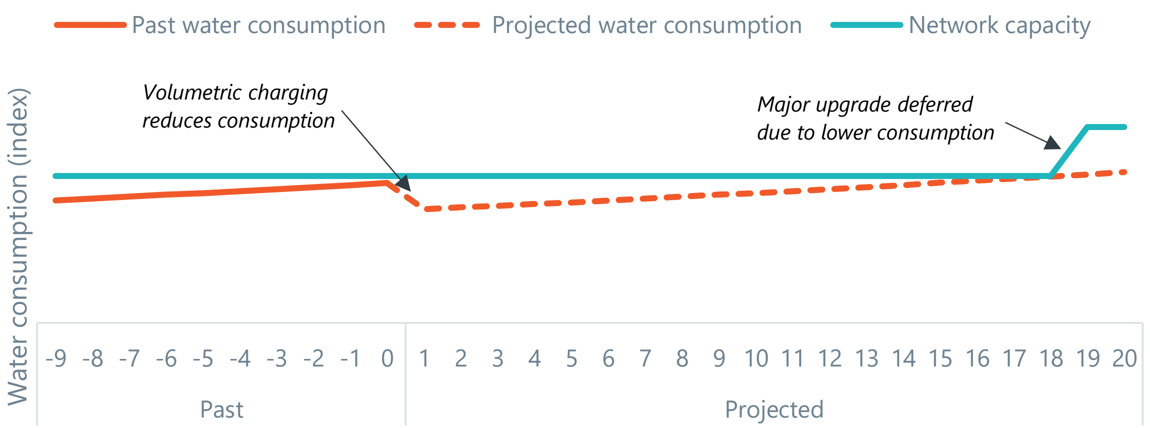
Figure 4 shows a hypothetical example of how water metering and volumetric charging can help to defer investment. When water use (the orange line) is rising over time, for instance due to population growth, this may trigger a need to increase network capacity (the teal line). Introducing volumetric charging reduces water use (bringing down the orange line), which defers the date at which capacity upgrades are needed.

Figure 4: Hypothetical impacts of water metering on investment demand

Approach A: Increase water network capacity to accommodate growth



Approach B: Use volumetric charging to reduce consumption and defer investment



Case studies in New Zealand demonstrate that volumetric charging can reduce both water demand and investment costs (the effect depicted in Figure 4).

For example, New Plymouth District Council has commenced installation of 26,000 smart meters in their community (*Water Meters - our goal: saving water and money*, 2024). Reduced water demand, through leak detection, has already allowed the indefinite deferral of an $4m anticipated pump station and pipeline upgrade (*Water meters paying off for NPDC ratepayers*, 2024).

In 2009, Kāpiti Coast District Council faced the prospect of significant investment to meet water demand. But the introduction of volumetric charging in 2014 has allowed council to defer construction of the proposed $30m Maungakotukutuku Dam by an estimated 40 years (New Zealand Productivity Commission, 2019).

In Tauranga, the introduction of volumetric charging allowed the deferral of the Waiāri Water Supply Scheme by more than 10 years, despite high population growth. Some wastewater upgrades were similarly deferred by at least five years. The net benefits of this deferral was estimated at $53.3m in 2009 terms (Foundation for Research, Science and Technology, 2009). A separate independent review of outcomes in Tauranga estimated that volumetric charging has reduced average household costs by at least 40% than they would otherwise have been (Sternberg & Bahrs, 2011).

In Brisbane, the introduction of water meters in 1998 decreased household consumption by 36% effectively delaying a planned $36m upgrade of the city's major water treatment plant (1998 dollar terms) (Higgs & Worthington, 2001).

Several New Zealand councils are experiencing housing growth and the use of volumetric charging can increase the number of dwellings that existing water and wastewater networks can support (The New Zealand Productivity Commission, 2015). Indeed, opportunities to leverage volumetric charging to defer investment are greatest when water networks are experiencing growing demand which would otherwise trigger major new capital investment. Where councils have sufficient spare storage and network capacity, and are experiencing limited growth in water consumption, then the cost of introducing water meters may be larger than the financial benefits. The costs and potential benefits of implementing water meters will differ between councils and should be assessed through a rigorous business case process.

New investments needed to meet water quality or discharge standards may be unavoidable. The need to add protozoa barriers to drinking water treatment plants is a case in point (*Taumata Arowai releases list of supplies without protozoa barriers and next steps*, 2023). Even so, reducing water demand provides opportunities to downsize these new investments.

4.1.1.1 The impact of improved water network leak detection

Abstracting, treating and distributing water to consumers is expensive and yet on average, 22% of total drinking water that is produced nationally, is lost due to leaks (New Zealand Infrastructure Commission, 2022). Many communities across the country suffer leakage rates well above this average, in some cases approaching 50% (Boyack, 2023; Ireland, 2022). International performance varies widely, but well performing North American and European cities experience leakage rates below 14% (Laspidou, 2014).

Reducing leaks can be an attractive option for water providers. For instance, an analysis of data from over 800 U.S. water utilities found leak reduction was more economically efficient than developing alternative water sources (Rupiper et al., 2022).

Water meters are a valuable tool to support leak detection efforts with or without volumetric charging. Meters provide the data needed to assess the extent and locations of system leakage. Without this data, it may be harder for councils to identify where network leaks are occurring or fix them in a timely manner. The same goes for leaks on private property. Unmetered homeowners are often unaware of leaks on their property or have little incentive to address them.

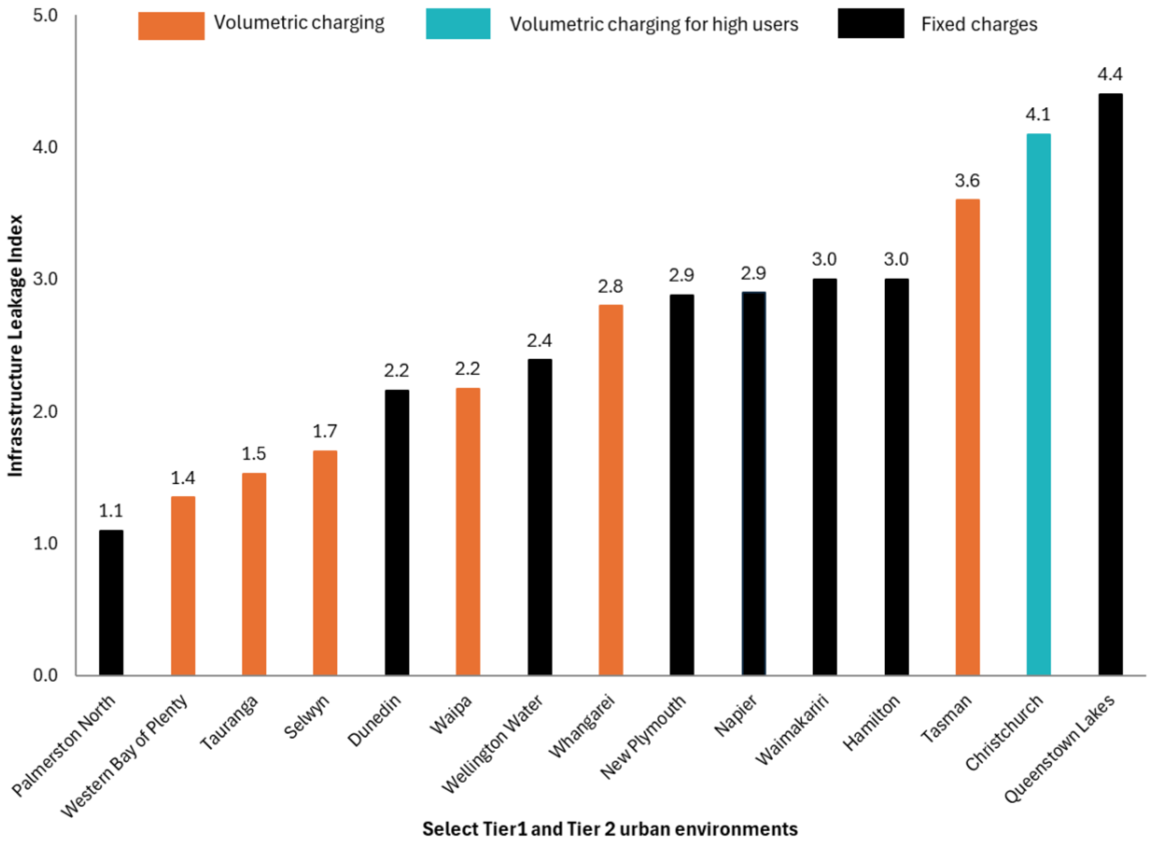
The introduction of water meters to communities in Marlborough District Council in 2019 identified leaks within 25 properties responsible for hundreds of thousands of litres lost each day (Ranford, 2020). As noted above, water meters have already helped New Plymouth District Council save 68 Olympic swimming pools of treated water a year through leak repair, despite being only half-way through their installation programme (*Water meters paying off for NPDC ratepayers*, 2024). Kāpiti Coast saw even greater benefits with 443 leaks discovered saving millions of litres a year from wastage (IPWEA, 2024).

Figure 4 depicts estimated leakage (expressed as the Infrastructure Leakage Index[12]) for a selection of New Zealand cities and regions.[13] Although there is not a perfect correlation, the data suggests that water networks with volumetric charging tend to be associated with lower levels of leakage. Indeed, recent survey responses to Water New Zealand's National Performance Review 2021/2022[14] identified

[12] The Infrastructure Leakage Index (ILI) is an internationally recognised metric used to benchmark leakage between different systems. The ILI is a ratio of real losses over unavoidable losses (McKenzie & Lambert, 2008). This metric recognises that it is often not financially viable to reduce leakage rates to zero, as all networks have unavoidable losses, irrespective of how much maintenance is undertaken.
[13] Figure 4 depicts available National Performance Review data (2021/2022) for tier 1 and tier 2 cities and regions as defined by the National Policy Statement on Urban Development. https://www.hud.govt.nz/our-work/national-policy-statement-on-urban-development
[14] The reliability of National Performance Review findings is limited by the data that individual participants have made available.

only four participants who achieved water loss levels low enough to make further leak reduction investments uneconomic. Three of these four councils use water meters and volumetric charging. Out of the seven councils with the highest rates of avoidable leakage, five exclusively use fixed charges and one applies volumetric charging only for high users.

Figure 5: Water network leakage expressed as the Infrastructure Index Leakage



Source: : Water New Zealand - National Performance Review (2021/2022)
Note that infrastructure leakage data for New Plymouth pre-dates introduction of volumetric charges there.

4.2 Reduced operation and maintenance costs

Reduced water demand can also reduce operation and maintenance costs. For instance, the Ministry for the Environment estimates that pumping and treating drinking water consumes an average of 4.4 megajoules (MJ) of energy per cubic metre of water (Ministry for the Environment, 2023). Assuming average commercial electricity tariffs,[15] it costs water service providers on average $0.23 in electricity to pump and treat each cubic meter of water it produces.

Water New Zealand's National Performance Review (2021/2022)[16] estimates that 550 million m^3 of water are abstracted annually. A 25% reduction[17] in national water abstraction and treatment could result in material reductions in electricity costs.[18] Depending on the treatment technologies used, savings in wastewater pumping and treatment costs may also be available.

[15] Assuming average commercial tariff of $0.19/kWh (Ministry of Business, Innovation & Employment, 2024), and 1 megajoule = 0.278 kilowatt-hour.
[16] The reliability of National Performance Review findings is limited by the data that individual participants have made available.
[17] Analysis of NZ data suggests a 25% reduction in water produced per capita where volumetric charging is in use. Data sourced from (Benison & Talbot-Jones, 2023) Appendix, Table 1 for tier 1 and 2 urban environments.
[18] The hypothetical electricity savings from this scale of reduction would be on the order of $32m per annum.

Other water efficiency initiatives can save more in operation and maintenance expense than they cost to implement (Cooley et al., 2022). These savings can stem from reduced electricity, chemicals, consumables, and maintenance. In New Zealand, a 2016 study modelled the potential savings available from reduced domestic consumption typically achieved through the use of low-flow fixtures and appliances, grey-water re-use, and rainwater tanks. Even when accounting for lost revenue from reduced consumption, the overall savings available to the water service provider over 30 years, yielded a benefit-cost-ratio of 1.91 (Hughes & Van Raalte, 2016). These savings stemmed from reduced operations and maintenance costs and deferred demand for investment.

4.3 Improved investment choices and accountability

In addition to the savings opportunities noted in previous sections, volumetric charging can also strengthen water service investment practices and accountability. These improved practices could, in turn, further improve investment efficiency and service quality. For instance, having a revenue stream that scales up when people use a greater volume of water can make it easier for providers to fund upgrades where needed. This increased funding certainty can improve confidence in making investment and financing decisions.

User-based charges may also help water service providers choose the best projects to invest in. Investment funding sourced mainly from user-charges, rather than general rate or tax revenue, tends to incentivise infrastructure providers to identify projects of greatest value to their customers (Glaeser & Poterba, 2021). While user fees are not the only way to lift investment scrutiny, models that directly link revenue to service delivery can help.

A direct relationship between water service providers and consumers also empowers communities to hold water service providers accountable for their performance (New Zealand Productivity Commission, 2019). This last point is often overlooked. Many unmetered New Zealanders may only be peripherally aware that they pay for water services through rates. Volumetric charging can improve visibility of water service charges, linking them more directly with service quality. Where councils choose to enable council-controlled organisations (CCOs) to deliver their water services, volumetric charging could provide a valuable tool for direct relationships between CCO and their customers.

4.4 Reducing consumption reduces pressure on freshwater sources

Reducing consumption also reduces pressure on freshwater sources and resource consents. While freshwater is viewed as plentiful in New Zealand, raw water availability is set to become more challenging as sea levels rise, rainfall patterns change and water demands increase (Ministry for the Environment & Stats NZ, 2023).

Over the 2015–2020 period, Stats NZ reports lower rainfall and reduced groundwater volumes nationally when compared with the previous five-year period (*Environmental-economic accounts: water physical stocks, year ended June 1995–2020*, 2021). In the past decade, New Zealand has experienced the highest frequency of drought conditions since recordkeeping began 80 years ago (Ministry for Primary Industries, 2021) and the National Climate Change Risk Assessment identifies the risk to potable water supplies as the most urgent threat facing New Zealand (Ministry for the Environment, 2020).

These water security challenges are occurring while water demand is growing. Indeed, with the growth of dairy farming and other horticultural demands, the amount of land under irrigation nearly doubled between 2002 and 2019 (Ministry for the Environment & Stats NZ, 2023).[19] Population growth is similarly increasing water demand in our urban areas (*National population projections: 2022 (base)–2073*, 2022).

[19] Irrigated land increased 91% from 384,000 hectares to 735,000 hectares.

In some regions, water abstraction consents exceed sustainable levels. This over-allocation of water resources limits access for new uses (Boone & Fragaszy, 2018; Challies et al., 2022). The National Policy Statement for Freshwater Management requires regional councils to phase-out over-allocations over time (Ministry for the Environment, 2024).[20] In response, regional councils and the courts are placing increasing scrutiny on applications for new or renewed water-take consents. Whether related to irrigation, industrial uses, hydropower, water-bottling or drinking water networks, approvals to increase abstraction are becoming more difficult to obtain (Eveleigh, 2022; *Heretaunga Plains Groundwater Quantity Area*, 2023; Llewellyn, 2023; Stuff, 2023; Williams, 2023).

The quality of raw water sources is also increasingly compromised due to unconsented wastewater overflows and land-use changes. Stormwater runoff resulting from these land-use changes includes fertilisers, heavy-metals, microplastics, soil and emerging contaminants (Ministry for the Environment & Stats NZ, 2023). While water quality metrics in some catchments are improving, the number of negative trends outnumber the improving trends (Gluckman, 2017). Developing new supplies and dealing with contaminants to meet water quality standards is expensive.

In addition to the cost, developing new water supplies increasingly involves competition with other users. In some instances, regional councils are actively setting expectations on water service providers to reduce demand and maintain resource consent conditions (Ponter, 2023). Taumata Arowai has similarly called for sustainable management practices (Chin, 2024). While growth may necessitate new resource consent applications, volumetric charging provides one way to demonstrate efficient use of existing allocations – strengthening the case for future allocations when needed.

4.5 Opportunities for deployment of modern technology

While mechanical meters have been in use internationally for decades, new smart metering and improved battery technologies offer additional efficiencies. Smart meters electronically record water use and can transmit data wirelessly to the water service provider. With no moving parts, smart meters have lower maintenance costs and improved accuracy. Smart meters can also streamline billing, reduce meter-reading costs and provide access to additional data.

For instance, some devices offer pressure measurement which can identify system abnormalities that may lead to pipe failure or poor customer experience. The use of real-time data can also improve modelling accuracy and operational efficiency, saving both water and energy (Laspidou, 2014; Harsh & Ichalkaranje, 2015; Daniel et al., 2022). Smart meters can also enable novel data applications, improving customer engagement and conservation efforts (Frontier Economics, 2021).

The ability to obtain more frequent readings can help consumers as well. Whereas the manual nature of mechanical meter reading lends itself to six-monthly billing, smart meters enable more regular billing. The increased timeliness of billing information allows households to monitor usage and identify leaks earlier.

Individual water service providers will need to assess both the costs and benefits of introducing smart metering technology for their particular circumstances.

[20] See NPS-FM Policy 11.

5. Distributional impacts of volumetric charging

While the introduction of volumetric charging can improve water service efficiency and reduce the need for new water supply infrastructure, it will also change how households pay for water services. A changed approach to charging can generate concerns about the financial impacts on households, particularly low-income households.

In this section we examine the distributional impacts of volumetric charging on households with different income levels. Our aim is to understand how changing from council rates or fixed annual charges to volumetric charges might affect household budgets

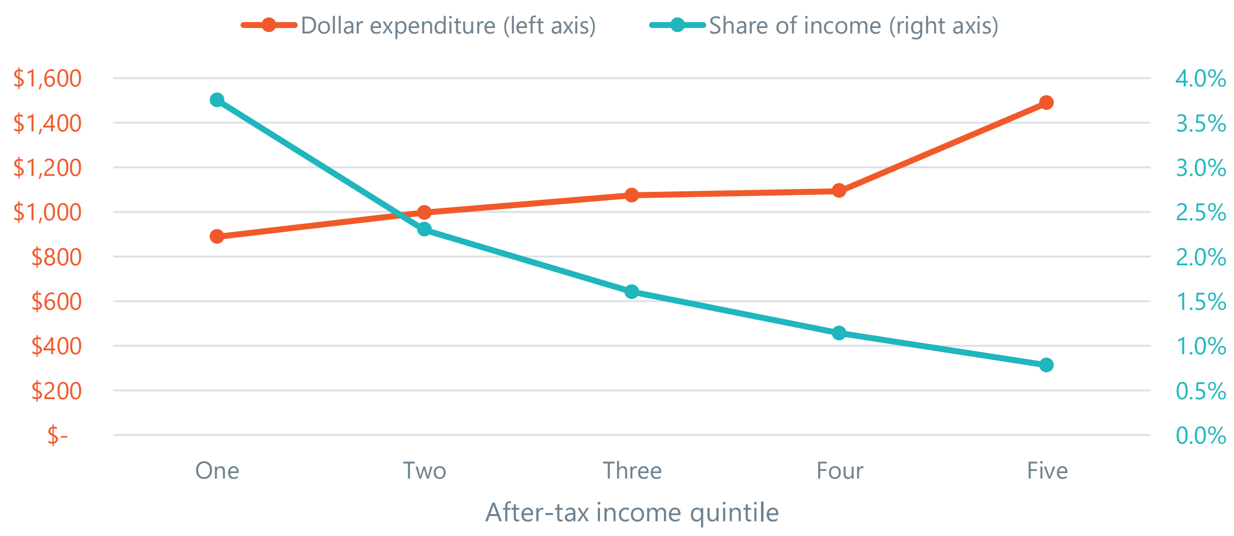
5.1 NZ households spend around $1,100 a year on water services

In 2018/19, the average New Zealand household spent around 16% of its after-tax income on infrastructure services, amounting to slightly over $13,000 a year (New Zealand Infrastructure Commission, 2023). Of this, $1,100 per year was spent on water services, equating to approximately 1.3% of the average household's after-tax income. Roughly 33% of this expenditure was for drinking water services, 54% was for wastewater services, and the remaining 12% related to stormwater services.

5.1.1 Lower-income households spend a larger share of their income

High-income households spend more on water services in dollar terms, but less as a share of their after-tax income. Figure 6 shows that the lowest-income households spent $890 dollars on water services in 2018/19, equivalent to 3.8% of their after-tax income. By contrast, the highest-income households spent $1,490. While the highest-income households pay more, their expenditure represents 0.8% of their after-tax income.

Figure 6: Annual household water service expenditure by after-tax income quintile in New Zealand (2018/19)



Source: Adapted from (New Zealand Infrastructure Commission, 2023)

5.1.2 Income levels and water service costs vary by location

Income levels also vary between rural and urban places, between small towns and large cities, and even between high- and low-density places within cities.[21] The cost to deliver water services varies by region as well. As a result, average household expenditure on water services varies between 1.2% of after-tax income in large regional centres (such as Whangārei) and 1.6% of after-tax income in high-density metro areas (such as central Wellington).[22]

There can also be significant variations in affordability between council areas with seemingly similar population density and rurality characteristics. For instance, a BRANZ study found that residents of seven rural New Zealand council areas with lower than average incomes pay water charges in excess of 3% of household income. Other council areas with similar population densities pay water charges less than 1.5% of household income (Garnett & Sirikhanchai, 2018). While the figures in the BRANZ study are not directly comparable with our estimates based on household expenditure data, they highlight the potential for significant spatial variation.

5.2 The impact of volumetric charges on household costs

The cost to provide water services is ultimately passed on to households. However, different ways of charging for water services can affect the distribution of costs between different households.

When introducing volumetric charging, councils typically reduce their previous fixed charges within council rates in order to collect the same amount of money from consumers. This means that water metering should not increase overall water service costs for a community – rather, costs will increase for high-use households, and reduce for low-use households. In Kāpiti Coast, the introduction of volumetric charging lowered costs for 75% of households, when compared with costs expected without water meters (Office of the Controller and Auditor-General, 2018).[23]

Household expenditure data suggests that an exclusive use of fixed charges increases the per-person cost of water for low-income households. This is because low-income households tend to have fewer people than high-income households (*Statistics New Zealand Household Economic Survey*, 2018), and use less water. The survey data shows that households with fewer people tend to have lower household incomes. This finding runs counter to common perceptions that low-income households tend to have more people.

International research shows that low-income households tend to be more responsive to price than high-income households (Agthe & Billings, 1987; Renwick & Archibald, 1998; Mansur & Olmstead, 2012; Wichman et al., 2016). Volumetric charges allow lower-income households to reduce their costs by managing water use, while fixed charges limit opportunities to save money on their water bills.

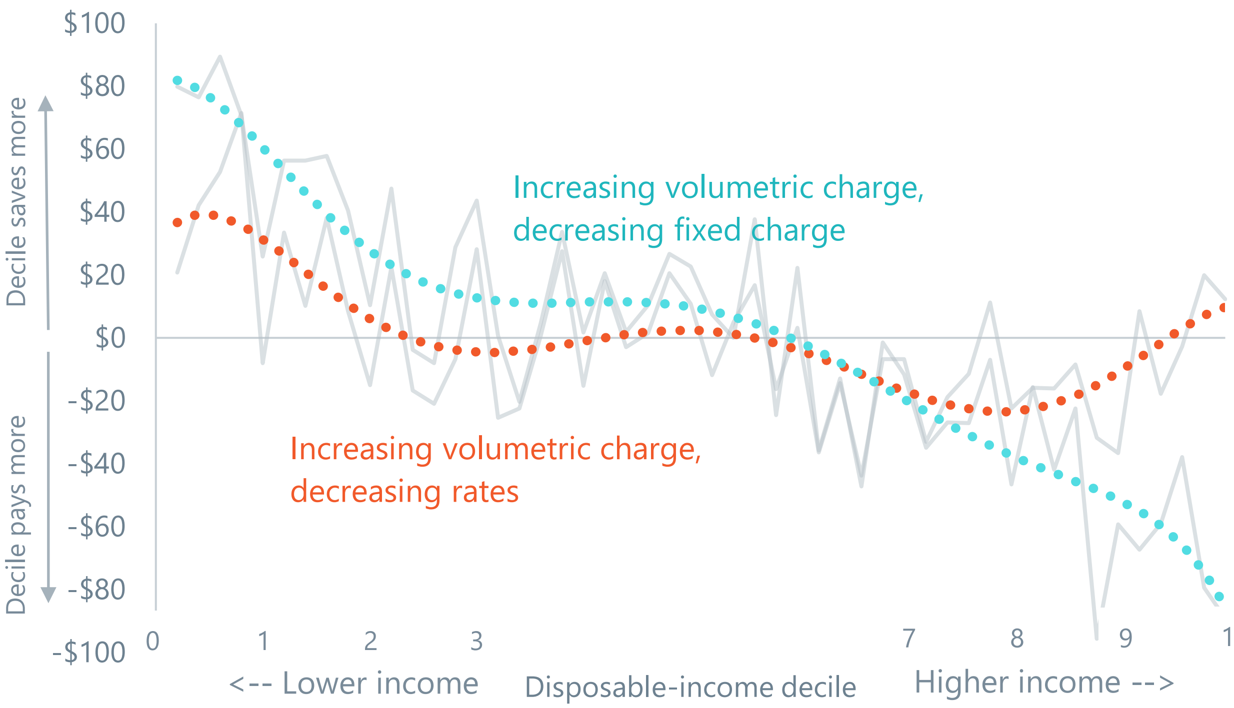
New Zealand-based modelling we commissioned supports this finding. The distributional impact of changes to the mix of volumetric charges and fixed charges was modelled using household expenditure and income data (PwC, 2024b; Sawtooth Economics & Firecone NZ, 2024).

[21] Stats NZ defines five urban area classifications: rural areas, small regional centres, medium regional centres, large regional centres and metro areas with population density quintiles ranging from one (least dense) to five (most dense).
[22] In dollar terms, households in large regional centres spend an average of $737 per annum on water services, while households in high-density metro areas spend an average of $1,373 per annum. Incomes are also higher in high-density metro areas.
[23] While the number of households expected to experience lower costs under volumetric charging is significant, the impact on *low-income households* is not specifically noted in the underlying reference.

Figure 7 shows the simulated effects of two water charging scenarios on households. Figure 7 considers the impact of increasing volumetric charges and reducing fixed charges or rates[24] while raising the same amount of revenue overall. However, these scenarios do not consider how volumetric charging might change household usage, including by reducing usage. As a result, these scenarios may underestimate the savings that low-income households may achieve under volumetric charging.

In one scenario (shown as the teal line in Figure 7) volumetric charges are increased while a fixed or uniform annual charge is reduced. In the second scenario (shown as the orange line), volumetric charges are increased, and council rates are decreased.[25] Households are ordered from lowest income households (on the left side of the graph) to highest income households (on the right side).

Figure 7: Water pricing simulations: redistributive effect of pricing policies on households by disposable income



Source: Adapted from (Sawtooth Economics & Firecone NZ, 2024)

In both scenarios, increasing volumetric charges and reducing fixed charges or rates tends to reduce overall water bills for low-income households, while increasing bills for high-income households. This reflects the fact that low-income households tend to use less water than high-income households, and hence will tend to pay less if volumetric charges are used instead of fixed charges.

These scenarios suggest that shifting from fixed charges or water rates to volumetric charges will generally improve, not worsen, affordability for low-income households. However, there will still be some low-income households that are more adversely affected. Some proportion of low-income households have more occupants and consume more water than average, meaning that volumetric charging could increase their costs. Targeted schemes to support larger, low-income households can be developed to address this concern.

The progressivity of volumetric charges can be further enhanced through use of increasing block tariffs, where volumetric charges are lower up to a certain point, and higher past this point (Garnett &

[24] The changes modelled were relatively small, by an average of $200 per household per year.
[25] While volumetric charging can be more progressive than rates or fixed charges, the benefits for renting households will depend on the extent to which rates reductions are passed through into rental costs.

Sirikhanchai, 2018; PwC, 2024b). Block tariff schemes tend to benefit lower-income households because high-income households are more likely to use very large amounts of water for things like swimming pools, spa pools, and irrigating large gardens. Many low-income households may also have smaller yards, with consequently lower demand for water outdoors (Cromwell et al., 2010).

Equitable access and water service affordability is of interest to all users, not just low-income households. In addition to addressing equity concerns there are commercial drivers to ensure support schemes improve affordability. Legislation prevents water service providers from terminating drinking water services.[26] As a result, if unaffordable services lead to unpaid bills, services must continue, but lost revenue and debt recovery costs will be borne by everyone.

5.2.1 There are ways to mitigate remaining equity concerns

Access to clean, potable water is recognised by New Zealand as an essential human right (64/292. The Human Right to Water and Sanitation Resolution Adopted by the General Assembly on 28 July 2010, 2010; 70/169. The Human Rights to Safe Drinking Water and Sanitation. Resolution Adopted by the General Assembly on 17 December 2015, 2016). Volumetric charging is compatible with this human right and has been adopted by many OECD countries. When designed well, volumetric charging can ensure affordable access for essential needs, while curbing excess water use. Human rights are enhanced through expanded access, elimination of boil water notices, and addressing pollution – all of which require financial sustainability to achieve. Where access concerns remain, water service providers may opt to include a volume of 'entitlement water' within each billing cycle (Olmstead & Stavins, 2009). That said, water entitlements may not be appropriate in all circumstances.

This report does not provide specific guidance on charging scheme design. Equity considerations in each community are different and charging schemes need to be tailored accordingly. Community participation can also play an important role in addressing local equity concerns. See *The Practical Realities of Implementing Water Metering and Volumetric Charging* (Feb 2024) for a summary of the charging design process adopted in Nelson and Kāpiti Coast. *Best Practices in Customer Payment Assistance Programs* (Cromwell et al., 2010) also offers extensive guidance on this topic.

The results of empirical analysis and real-world results suggest that when designed well, and accompanied by complementary support schemes, volumetric charging can have positive equity outcomes.

5.3 New Zealanders generally think that volumetric charges are fair

Aucklanders have a long track record with volumetric charging as universal metering was introduced in the 1980 and 1990s (Reed & Hermens, n.d.). A 2009 focus group of Auckland residents felt confident that they '...could use water as they liked...they just have to pay for it' (Ministry for the Environment, 2009).

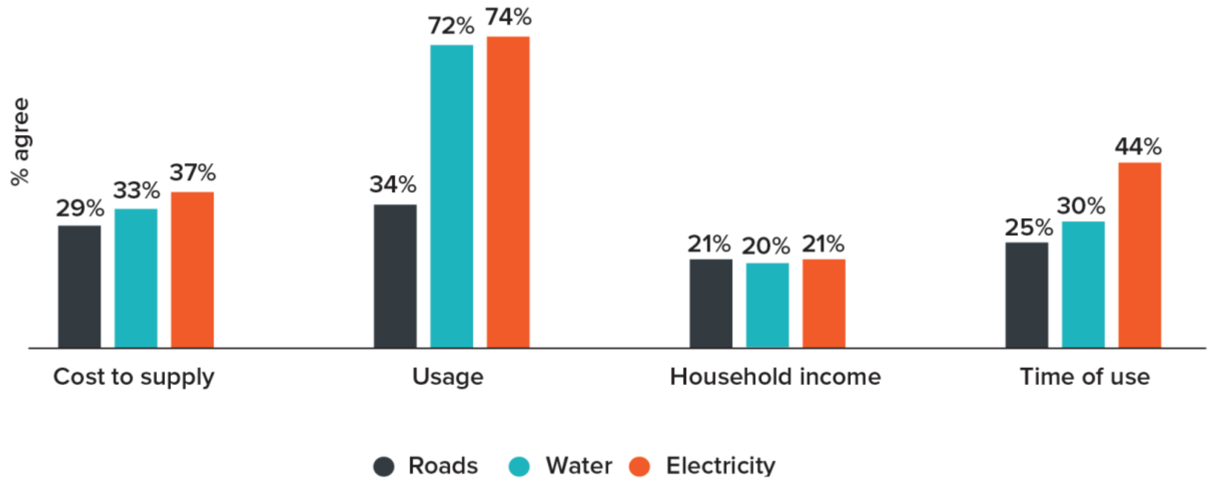
New Zealanders more broadly appear to agree. Figure 8 summarises the results of a demographically representative survey of over 3,000 New Zealanders that was conducted for the Infrastructure Commission in 2023. The survey asked respondents what they thought about the fairness of different approaches to paying for road, water, and electricity infrastructure (New Zealand Infrastructure Commission, 2024b).

Almost three in four New Zealanders (72%) felt that usage-based charges for water are fair. This result is very similar to the share of New Zealanders (74%) that felt that usage-based charges for electricity, which have been in place for over a century (Cook, 2010), are fair. While the concept of 'fairness' means

[26] See (Local Government Act 2002, 2002, Clause 130; and Water Services Act 2021, 2021, Clause 25).

different things to different people, this data suggests that the fairness and distributional issues associated with volumetric charging may be smaller than commonly assumed.

Figure 8: Survey responses on the fairness of different approaches to paying for road, water, and electricity services



Source: Adapted from (New Zealand Infrastructure Commission, 2024b)

6. Conclusion

All New Zealanders pay for water and wastewater services. But the way in which services are charged influences the quantity of services used, delivery efficiency and equity outcomes. Well-designed pricing systems should send signals to both consumers and water service providers to incentivise behaviour change and improve system efficiency. In both domestic and international settings, volumetric pricing has been shown to offer consumers and water service providers the information needed to make better use of existing resources and lift water sector performance.

Volumetric pricing can reduce household consumption by providing incentives to conserve. The financial incentives created by volumetric charging are more effective than water-use restrictions or information alone. In addition, the use of water meters and volumetric charging can enhance leak detection efforts, permit housing growth with existing assets, defer the need for capital investment, improve investment choices and increase accountability of water service providers. These benefits are widely enjoyed across OECD countries (OECD, 2010). As demonstrated in Tauranga and Kāpiti Coast, efficiencies gained from volumetric charging can also reduce the cost-of-service delivery and produce savings to ratepayers.

Contrary to some perceptions, empirical modelling shows that volumetric charges can be progressive, reducing costs for many low-income households. What's more is that the majority of New Zealanders agree. A total of 72% of New Zealanders see volumetric charging as the fairest way to pay for mains water services.

While this report has largely considered volumetric charging for residential drinking water, similar pricing opportunities exist with respect to non-residential water consumption. Pricing signals also have a role to play in wastewater services where effluent volumes and characteristics can impose significant treatment costs on wastewater treatment plant operators. Trade waste charges and their design vary considerably across the country (Khan et al., n.d.). But when well-designed, pricing can incentivise commercial, industrial and primary producers to invest in technologies that limit pollutants (Shang et al., 2022). Further research is required to examine the role pricing can play in New Zealand's wastewater sector.

We acknowledge that introducing volumetric charges comes at a cost. As such, investment decisions require consideration on a case-by-case basis to identify where volumetric charging can offer net benefits. While the challenges facing the water sector will necessitate significant investment, we must also find ways to reduce costs, defer investment demand and improve equity outcomes for users. Modifying the way we pay for water services can be part of the solution.

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