BRANZ

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BULLETIN

DESIGNING WATER-EFFICIENT HOUSES

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- Water shortages are a regular occurrence in many parts of New Zealand, and climate forecasters say the future will bring longer periods of drought.
- Designs that reduce domestic water use are often inexpensive, have minimal impact on occupant lifestyle and can save money where water is metered.
- Reducing water use can also reduce energy use and give houses a smaller carbon footprint.

1 INTRODUCTION

1.0.1 Droughts are becoming more common and more serious in New Zealand. NIWA meteorologists say the 2020 Auckland drought was one of the most extreme in modern times. In 2013, lack of rainfall meant Wellington came very close to running out of drinking water. Of 30 sites around the country where soil moisture is measured, 20% have become progressively drier since the early 1970s. NIWA's research points to climate change leading to an increasing severity of drought in most areas, with severe water shortages expected to increase in frequency and intensity in regions that are already drought-prone. Some research indicates that, of all the climate change effects facing New Zealand, longer droughts may have the greatest economic impact. This is a particular challenge for areas with insufficient storage.

1.0.2 The problem of water shortages is made worse by the state of many reticulated water systems around the country. By one estimate, in mid-2020, Auckland's drinking water pipes were leaking at least 50 million litres a day – more water than the city of Dunedin uses in a day. An estimate for Christchurch put losses from leaks, broken pipes and faults for that city at around 24 million litres per day. That is roughly the equivalent of 70 Olympic-size swimming pools per week. One national review that assessed data from water providers found that, accounting for the number of connections and population, water losses in New Zealand are almost twice as high as those in urban Australia. The problems stem from lack of sufficient maintenance or planning and some services being long overdue for replacement.

1.0.3 Designers and their clients have a significant opportunity to ensure that new houses or houses being renovated are water efficient. Opportunities for water efficiency should be discussed with the client at the design stage. In areas where there is a direct charge for water use – such as Auckland or the Kapiti Coast – this can represent significant dollar savings for the client.

1.0.4 Reducing water use does not necessarily reduce occupant lifestyle. A good example is the Waitakere NOW Home – a house built in 2005 for approximately the same price as an average house but with an energy-efficient and water-efficient design incorporating water-efficient fixtures and appliances and a rainwater harvesting system. The family occupying the house enjoyed long hot showers (accounting for almost half the household water use!), yet overall, the house still used 40% less mains water than the average for houses in its locality in its first year.

1.0.5 Over a house's potential 90-year service life, water consumption accounts for an estimated 9% of the house's greenhouse gas emissions (calculated with computer modelling). Looking at a shorter period – the 30 years up to 2050 – the figure is 7%. Reducing water consumption reduces the carbon footprint of a house through reducing the energy and materials required for treating and delivering water.

1.0.6 Some options for reducing reticulated water use such as water-efficient toilets and low-flow showerheads are comparatively inexpensive, while others such as rainwater harvesting or greywater reuse systems are not cost-effective in financial terms for many homeowners. They tend to be used largely where there are no council services available or where they are mandated or encouraged by councils.

1.0.7 Occupant behaviour such as the time taken to shower clearly has a major impact on water use but is beyond the scope of this bulletin.

2 WATER SUPPLY DESIGN

2.0.1 The primary concern for water supply design in a house will always be the health and safety of the occupants, but beyond that, there are opportunities to reduce consumption of reticulated water through efficient design.

2.0.2 Decisions around room layout and pipework layout and specification of appliances and fixtures can have a significant impact on water use over the serviceable life of a building.

2.0.3 The Building Code requires that sanitary fixtures and appliances have adequate water supply at an adequate flow rate. Flow rates are crucial. A flow rate that is too high will result in water being wasted, and a flow rate too low will mean that sanitary fixtures and appliances don't work properly. Acceptable Solution G12/AS1 Table 3 sets out acceptable flow rates to sanitary fixtures.

2.0.4 Generally, pipe runs should be as short as possible. Pass pipes close to fixtures to minimise the number of branches and unnecessary elbows, tees and joints. Having longer pipe runs and more fixtures will reduce flow rate, increase heat losses and increase use of materials.

2.0.5 Locate the water heating system to reduce the length of pipe runs to fixtures. Longer hot water pipe runs require more water to be drawn off before hot water is discharged. Consider installing a separate point-of-use water heater for fixtures that are more than 10 m from the main water heater.

3 WATER HEATING SYSTEMS

3.0.1 Acceptable Solution H1/AS1 references NZS 4305:1996 *Energy efficiency – Domestic type hot water systems*, which requires (among other things) that the hot water pipe to the kitchen sink is insulated. BRANZ recommends that all hot water supply pipes are insulated for their full length and that these insulated pipes run within the thermal envelope where possible to further reduce heat losses. This will reduce water lost while residents wait for hot water to run from the tap. Use purpose-made, preformed insulation a minimum 13 mm thick.

3.0.2 The actual type of water heating system specified has relatively little impact on water use – it has a much bigger impact on energy efficiency and carbon footprint. The keys to reduced hot water use are:

- shorter pipe runs and insulated hot water pipes
- low-flow showerheads that use less than 9 litres of water per minute (see 4.0.7)

- bathroom hand basin tap flow rates no greater than 6–8 litres per minute (see 4.0.7).

3.0.3 Many appliances that use hot water such as dishwashers and most front-loader washing machines typically heat their own water. They have one water connection to cold water so do not normally affect household hot water use. Top-loader washing machines commonly connect to both hot and cold water.

4 APPLIANCES, FIXTURES AND FITTINGS

4.0.1 The New Zealand Water Efficiency Labelling Scheme (WELS) applies to tapware, washing machines, dishwashers, toilets (and urinals) and showers. By law, the labels must be displayed at the point of sale (Figure 1). They show:

- a star rating (up to a maximum of 6 stars, or 3 stars for showers) indicating how efficient the product is compared to others
- a water consumption or water flow figure in litres per minute for taps and showers and litres per wash for washing machines and dishwashers – for toilets, the labels show litres per half flush, full flush and average flush (the average of four half flushes and one full flush).

4.0.2 Where possible, specifying an appliance of at least 4 stars is recommended. The water savings can be considerable:

- Assuming one 8 kg load per day, a 3-star washing machine will use about 43,000 litres while a 4.5 star will use about 25,000 litres over a year. Specifying the appliance with the higher star rating can save 18,000 litres per year.
- For a dishwasher, assuming one wash per day, a commonly available 3-star WELS dishwasher uses just under 17 litres per wash while a 4.5 star uses just under 13 litres per wash. Specifying the appliance with the higher star rating can save 1,460 litres per year.

Figure 1. WELS label.

4.0.3 With washing machines, be aware that the water consumption figure given on a label may be for the 'eco' or 'water-saving' setting of the appliance rather than the normal cycle.

4.0.4 There is a big difference in water usage between front-loading and top-loading washing machines:

- For a normal cycle, front-loading washing machines typically use around 50–70 litres per wash, with some as high as 86 litres.
- For a normal cycle, top-loading washing machines typically use 110–140 litres per wash, although a few use less and a few use substantially more – up to 180 litres or even 199 litres per wash.

4.0.5 Several brands of dishwasher use just 11–12 litres of water on a normal cycle, with a few models using as little as 9 litres. Many dishwashers have an 'eco' mode that uses less water and energy. The trade-off is a longer wash time and a less-intense wash, and the dishes generally take longer to dry.

4.0.6 Toilets can account for almost 20% of water used in a house. Specify a dual-flush toilet that uses 6/3 litres or, even better, 4.5/3 litres. Rainwater or treated greywater can also be used for flushing.

4.0.7 Bathroom water use can also be reduced:

- For mains pressure systems, specify low-flow showerheads that use less than 9 litres of water per minute and still deliver a comfortable shower. Specifying a 3-star WELS-rated showerhead with a flow of 8.5 litres per minute rather than a shower delivering 14 litres per minute (assuming three showers per household per day for an average time of 7.8 minutes) equates to a saving of around 47,000 litres per year.
- Specify aerators/flow restrictors on taps used for hand washing. These relatively inexpensive devices can reduce water flow by half or more, down to 12, 8 or 6 litres per minute. Aerators are not suitable for taps on baths where a larger volume of water is required.

4.0.8 Where possible, householders should compost organic kitchen waste rather than using a kitchen waste disposer in the sink. One waste disposer manufacturer in the United States says its machines use an average of 5 litres of water per day or 1,825 litres per year.

4.0.9 Good water supply design and specification can also result in a house achieving a higher score in rating tools such as Homestar. This gives homeowners an independent measure of their home's efficiency and sustainability and can be a useful marketing tool if and when they choose to sell. For a 6 or 7 Homestar rating (using the Homestar v4.1 checklist), requirements include:

- toilets must be dual flush with no more than 4.5/3 L cisterns

- all bathroom hand basin tap flow rates must be no greater than 6 litres per minute.

4.0.10 While ensuring that new houses in New Zealand are water efficient is important, there are also gains to be found in retrofits. The BRANZ Water End-use Efficiency Project in 2014 identified that the largest savings during retrofits were achieved by installing low-flow showerheads and water-efficient washing machines.

4.0.11 Dripping taps should be fixed without delay. A leak of just 10 drips per minute from a single source is a loss of 3 litres per day or 90 litres per month. The 2015 BRANZ House Condition Survey, involving over 500 randomly selected houses, found leaking taps or showerheads in 7.5% of owner-occupied houses and 5.6% of rental houses. The numbers can be extrapolated to dripping taps or showerheads in 147,000 houses across New Zealand – a significant loss of water.

5 RAINWATER HARVESTING

5.0.1 Domestic rainwater harvesting systems collect rainwater, typically from a roof, and store it for use. That use may be just watering the garden or, with filtration and chemical treatment, flushing the toilet (Figure 2). With a higher level of treatment, rainwater can provide for every need, including drinking water, food preparation and bathing.

5.0.2 Installation of many tanks will not require a building consent. There is an exemption for tanks up to 35,000 litres sitting on the ground (and certain limits apply for smaller-volume tanks supported above the ground). Depending on circumstances, a resource consent may be required. A building consent will be required for connecting rainwater pipes into a house that also gets mains supply water. A registered plumber must be used and a backflow prevention device installed to prevent the mains water system from being contaminated.

5.0.3 Rainwater collection tanks provide all houses with resilience benefits as an emergency water supply. Beyond this, the economic case for installing them varies around New Zealand, largely as a result of the different ways local authorities charge for water. In many cases, payback periods can be very long, making a system uneconomic.

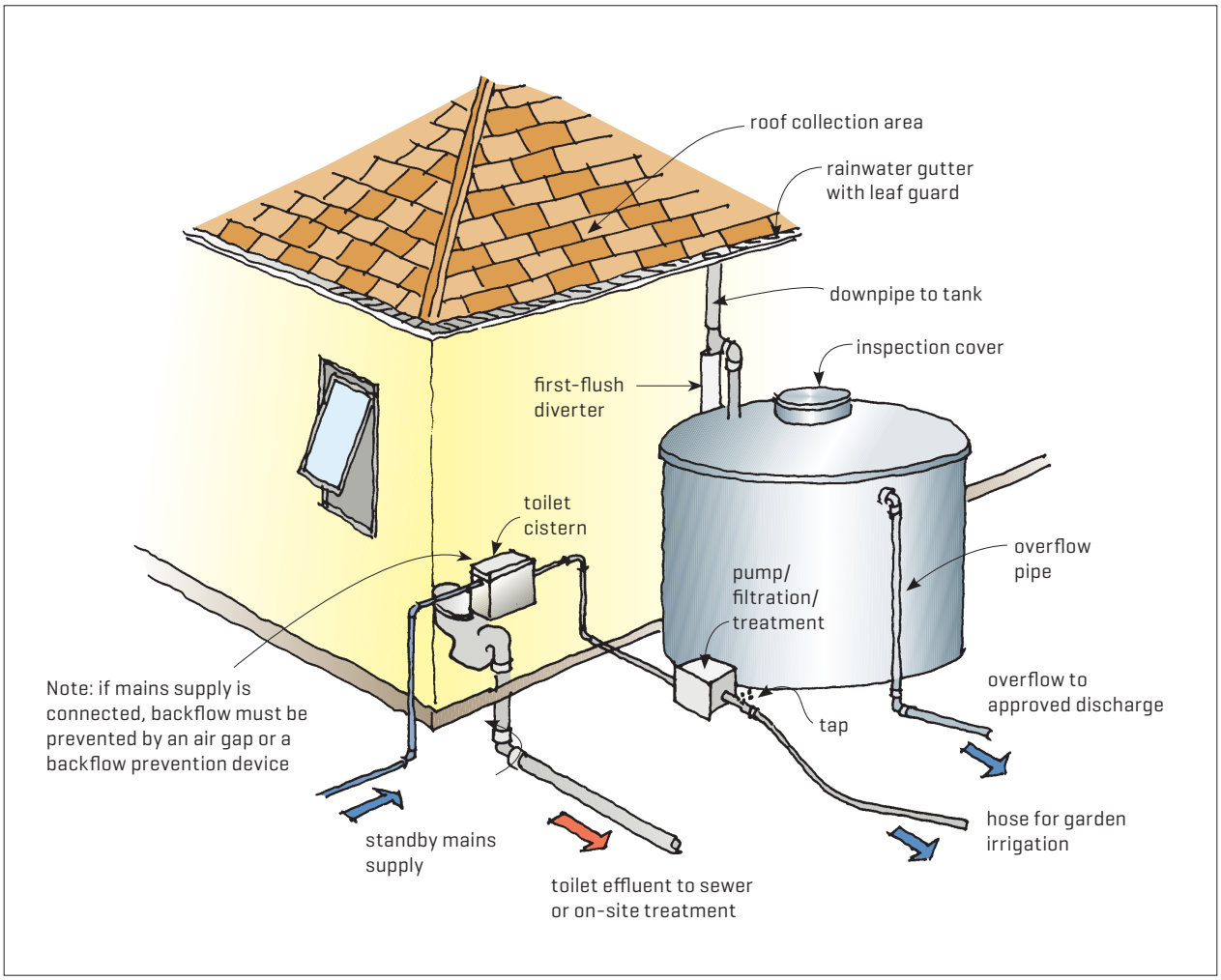

Figure 2. Simple schematic design of one rainwater harvesting system for toilet flushing and garden irrigation. Some councils prefer the town supply to go to the water tank, with the top-up valve sitting above the water level with an air gap. Schematic designs of other systems can be found at www.level.org.nz/water/water-supply/mains-or-rainwater/storing-rainwater/.

5.0.4 A number of rainwater harvesting systems installed in houses in New Zealand have been monitored. Beacon Pathway reported on the use of a 13,500 litre rainwater harvesting tank installed in the Waitakere NOW Home and used by the occupying family:

- The tank supplied 47% of the home's water needs in the first year.
- The occupants used an average of 100 litres of mains supply water per person per day in the first year (40% less than the average in surrounding Waitakere City).

6 GREYWATER SYSTEMS

6.0.1 Greywater is the wastewater from baths, showers and bathroom hand basins. Some definitions include laundry water too. It can usually be used instead of mains water for subsurface garden irrigation and (with treatment) toilet flushing. Mains supply water is still used for drinking, cooking and bathing in most systems.

6.0.2 At least a basic form of treatment is recommended for all greywater systems – for example, to filter out lint from fabrics if laundry water is being used. If the system stores greywater for toilet flushing, it will usually need chemical treatment too.

6.0.3 A bypass can allow greywater to be diverted to the local authority sewer system – for example, when greywater may contain faecal matter from washing babies' nappies. While BRANZ recommends a bypass, local authorities have mixed views about this, and some do not allow it. Untreated greywater in the greywater system must be used within 24 hours.

6.0.4 Greywater systems installed in New Zealand are typically proprietary systems. They require monitoring and regular maintenance such as filter cleaning.

6.0.5 Kapiti Coast District Council requires new houses to incorporate either water collection tanks or greywater systems to help with a regional water shortage and to help manage the costs of providing water. An estimated 68% (160 litres/per person/per day) of residential water demand in the area is water available for greywater reuse in garden irrigation and/or toilet flushing. This represents a potentially significant proportion of a household's daily water use that does not need to be provided for by the council's water supply network. Other benefits of a greywater system include:

- reducing the volume of wastewater that goes to local authority or on-site treatment facilities, reducing pressure on those facilities
- providing water for gardening when there are prohibitions on using mains supply water for irrigation
- contributing to resilience in terms of drought or natural disaster.

6.0.6 There are currently no national guidelines or standards covering greywater reuse in New Zealand. While some local authorities have guidelines in place, others have none and some do not permit greywater systems to be installed where houses are connected to a council wastewater system. Some public health authorities do not support the use of greywater.

6.0.7 A number of greywater systems installed in houses in New Zealand have been monitored. Beacon Pathway reported on a system in the New Zealand Housing

Foundation's HomeSmart Home occupied by a family. The system supplied water for flushing two toilets:

- On average, the system saved 23 litres of water per person per day and 42 m³ of water annually.
- Household usage of reticulated water was reduced by 20%, from 255 m³ to 213 m³ per annum.
- The system removed 115 litres of wastewater per day from the waste stream.

7 OUTDOOR WATER USE

7.0.1 The proportion of water that is used outside the house depends largely on the location and the season. BRANZ monitoring of water use by 51 houses in Auckland found that 17% of the water was used outdoors in summer but only 6% in winter. A separate research project monitoring 12 homes on the Kapiti Coast found that, in summer, 22.5% of water was used outdoors.

7.0.2 For clients who do not want to change their behaviour or garden style, finding an alternative to mains water for outdoor use is a good solution:

- Water harvesting with a relatively simple system does not have a high cost and may not require a building consent.
- An alternative is to install a proprietary greywater system specifically designed to supply water for subground irrigation – they are available in New Zealand.

7.0.3 The amount of water needed for garden irrigation can be reduced significantly by:

- selecting plants that require little water and the right plant for the right location to reduce plant stress
- adding organic matter to soil so it retains more water and nutrients
- adding mulch to the soil to reduce evaporation
- using an efficient irrigation system – rather than sprinklers covering large areas, install a system that supplies a smaller volume of water directly to where it is needed (Figure 3)
- watering in the evening so less water is lost to evaporation
- diverting stormwater for irrigation instead of allowing it to run into drains.

7.0.4 Finally, as a general rule, it is up to the property owner to address any problems around water supply on a property. A faulty toilet can leak 200–1,000 litres a day. A leak in the water pipe into the home will get worse and cause expensive damage if not fixed, although householders will often not be aware of the leak. In areas with water meters, the leak may significantly escalate bills if not repaired. Fixing water pipe leaks between a house and the connection where the water pipe enters the property is the homeowner's responsibility.

Figure 3. Targeted irrigation is more water efficient than sprinklers.

8 MORE INFORMATION

www.level.org.nz/water

Up-Spec: Specifying higher-performing homes
www.branz.co.nz/sustainable-building/up-spec/water-management

BRANZ Good Repair Guide: *Rainwater storage systems*

BRANZ Study Report SR382 *Drivers and barriers to rainwater and greywater uptake in New Zealand*.

BRANZ Facts Harnessing rainwater and greywater #1: *Rainwater harvesting systems in New Zealand houses* (April 2018)

BRANZ Facts Harnessing rainwater and greywater #2: *Greywater reuse systems for New Zealand houses* (April 2018)

BRANZ Facts Harnessing rainwater and greywater #5: *Benefits of rainwater and greywater systems in New Zealand houses* (April 2018)

BRANZ Facts Harnessing rainwater and greywater #6: *What is holding back rainwater and greywater systems in New Zealand?* (April 2018)

BRANZ Facts: Harnessing rainwater and greywater #7: *Potential network savings from rainwater and greywater systems in New Zealand* (April 2018)

BRANZ Facts Harnessing rainwater and greywater #8: *Microbes in residential and commercial greywater in New Zealand* (May 2020)

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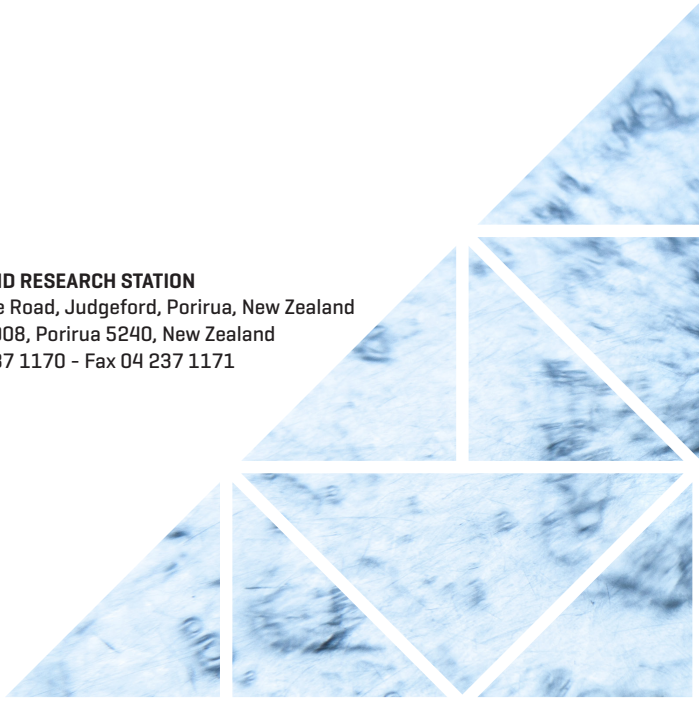

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