Water quality in New Zealand rainwater harvesting systems

Although tests of harvested rainwater have shown mixed results, consistently clean water is possible and is the result of good design, the right components and effective maintenance.

POTABLE WATER supply – water that is safe to drink – is a legal requirement in New Zealand dwellings. There are numerous obligations:

- The Building Act 2004 says that premises must be provided with potable water adequate for its intended use.
- The New Zealand Building Code says:
  - G1 *Personal hygiene* – buildings must have appropriate spaces and facilities for personal hygiene
  - G2 *Laundering* – buildings must have appropriate spaces and facilities for laundering
  - G3 *Food preparation and prevention of contamination* – (safe) water is required for food rinsing and utensil washing
  - G12 *Water supplies* – buildings that have water outlets, sanitary fixtures or sanitary appliances must have safe and adequate water supplies.
- The Health Act 1956 requires an adequate and convenient supply of potable water to any dwelling that is being built, rebuilt, sold or rented.

Beyond legal requirements, drinkable water is a matter of public expectation. A 2014 New Zealand survey asked about the primary concerns people had with rainwater harvesting. Waterborne disease and water quality were the main concerns.

Water harvested from house roofs

Where system design is poor or maintenance is ignored, the quality of rainwater harvested from roofs can be reduced by microbiological or chemical contamination.

A 5-year study by the Roof Water Harvesting Centre at Massey University found a lot of contamination in harvested rainwater. The study (whose finding were published in 2006) assessed the microbiological quality of samples of rainwater collected from roofs of over 560 private dwellings.

Over half of the samples exceeded the minimal acceptable standards for contamination. Testing showed heavy faecal contamination in 41% of the samples. This probably came from birds and animal droppings or dead animals on the roof, in gutters or in the tank. In many cases, the systems were poorly designed and maintained with insufficient measures to protect the water from contamination.

"The results of this study indicate that the information on the safe collection and storage of roof-collected rainwater seems not to be reaching many users in New Zealand," the researchers concluded.

The poor quality of harvested rainwater has not generally been associated with high reported levels of illness, however. This may be the result of underreporting of gastrointestinal upsets.

A more recent study in 2015 on a smaller scale looked at rainwater harvested for emergencies by 21 homeowners in the Wellington region. Researchers tested the microbiological quality of the water over a 4-month period. Very little faecal contamination was found overall, regardless of roof type or tank location.

Water harvested from commercial buildings

BRANZ carried out a study into rainwater harvesting and greywater reuse in commercial buildings in 2015/16. As part of the study, four buildings had their rainwater quality tested every month over 1 year by the Institute of Environmental Science and Research. Samples were taken before treatment (if any).

None of the metal levels in the water posed a risk to health. In microbiology testing, no *Campylobacter* bacteria were found in the samples. 18 samples were found to contain *Escherichia coli* (*E. coli*), but 11 of these came from a building that did not have an enclosed tank – a known risk for contamination.

One sample out of 45 tested positive for *Salmonella*. The scientists calculated that, even if toilet water was ingested at every flush, the risk of *Salmonella* infection would still only be around a one in a million.

The scientists' conclusion was that "These chemical and microbial results … show that, with correct design and maintenance, a high level of water quality can be maintained before treatment or filtration."

Designs and components to produce clean water

Consistently clean water is the result of a combination of good design, specification of system materials and components suitable to the required end use and effective maintenance.

Roofs, pipework and tanks must meet the requirements of AS/NZS 4020:2005 *Testing of products for use in contact with drinking water*.

Suitable roofing materials include:

- zinc/aluminium alloy-coated or galvanised (zinc) steel, whether uncoated, factory-coated or painted
- metals such as zinc, aluminium or stainless steel
- concrete or clay tiles
- untreated timber shingles (usually imported western red cedar)
- butyl rubber
- asphalt shingles
- bitumen membranes.

Roofs should not be painted with lead or chromium-based paints or include uncoated lead flashings, treated timber or asbestos-cement roof cladding.

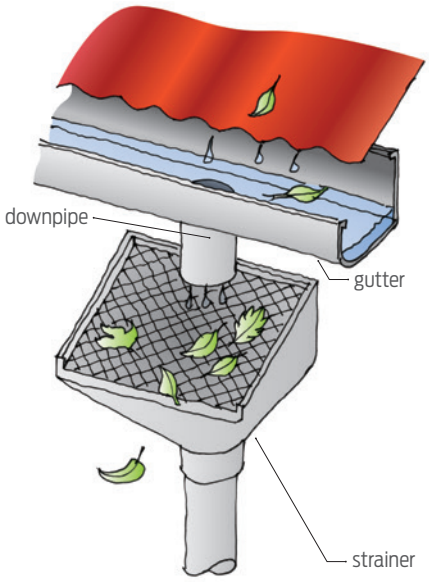
The common materials used for guttering and pipes – uPVC, HDPE, seamless extruded aluminium and zinc/aluminium alloy-coated steel – are all suitable for rainwater collection.

Filtration and treatment

Systems should be designed to keep leaves and other debris out before the water gets to the tank and include the following:

- Leaf screens installed to the gutters – the mesh in these devices sieves out larger pieces of debris.
- First-flush diverters installed as a component of the downpipes – these mechanically direct the first amount of rainfall (which washes dirt and debris off the roof) away from the tank. In areas where pollution is minimal, allow 20 litres/100 m^2 (0.2 litre/m^2) of roof area. For heavy pollution, allow 50 litres/100 m^2 (0.5 litre/m^2) of roof area. For very large roofs, such as those on commercial buildings, this could be a significant volume – perhaps 500 litres. An alternative is a rain sensor that automatically directs the first 5 mm of rainfall away from storage.

There are many options for filtration and ultrafiltration depending on the required end use of the water. Installing two different types of filter is common. The first filter is typically a cartridge filter that reduces any sediment, dirt and rust that may be in the water. This can reduce the risk of damage to the inside of household tapware and appliances and also helps extend the life of the second filter. The second-stage filter is often a carbon filter that can significantly reduce the numbers of bacteria in the water, remove some chemicals and reduce unwanted tastes and odours.



Downpipe leaf screen/strainer.

Reverse osmosis systems can be used where a higher level of water cleanliness is required.

Other treatment options include UV or ozone treatment or chemicals:

- With UV systems, water is exposed to the light from ultraviolet bulbs. This light disrupts the DNA of microorganisms such

A new 20 micron water filter (left) and the used filter it is replacing after 4 months' use.

as bacteria and viruses, stopping them from multiplying.
- Ozone treatment bubbles ozone into the water, killing microorganisms such as *E. coli*, *Salmonella* and *Listeria* and reducing pesticides and unpleasant odours.
- Chlorine is generally added to water in tablet form.
- Liquid hydrogen peroxide is added to the stored water to remove algal growths – 2 litres per 20,000 litres of stored water. It works faster than chlorine, so often no contact tank is required. Unlike chlorine, it will not leave a chemical residue or byproducts after treatment. It works over a wider pH range and does not affect taste.

Automatic treatment systems are recommended over manual systems.

Treatment systems can be installed that treat all water coming from a rainwater tank or can be installed under a kitchen bench to provide treated water from a single tap.

The selection of filtration and treatment system should consider the location of the property and likely sources of contamination. For example, houses close to a six-lane motorway or in a neighbourhood with a lot of solid fuel fires have their own contaminants to consider.

Maintenance

Good maintenance is crucial. The key elements are:

- checking that roofs, gutters and pipes are clean and free of debris
- ensuring components such as first-flush diverters are working properly
- keeping tanks clean
- following the manufacturer's recommended maintenance for filters and treatment systems
- removing overhanging vegetation and redundant roof-mounted aerials (for new builds, avoid installing roof mounted aerials).

More information

Fact sheet 1 *Rainwater harvesting systems in New Zealand houses*

Fact sheet 3 *Rainwater harvesting in non-residential buildings*

Fact sheet 5 *Benefits of rainwater and greywater systems in New Zealand houses*

Fact sheet 6 *What is holding back rainwater and greywater systems in New Zealand?*

Fact sheet 7 *Potential network savings from rainwater and greywater systems in New Zealand*

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