Rain Harvesting
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Improving water quality with First Flush Water Diverters

Preliminary results from the Roof Water Research Centre at Massey University (New Zealand)

Executive Summary

Stan Abbott of Massey University in Wellington, New Zealand, was commissioned by the New Zealand Government's Ministry of Health to investigate **measures that can be taken to improve the water quality from rainwater harvesting systems**. Abbott established New Zealand's most sophisticated Roof Water Research Centre (RWRC) on campus and thousands of samples were taken from a series of different systems.

Abbott concludes from the preliminary results that the **quality of the water improves dramatically with the use of first flush water diverters**. These findings reinforce the importance on diverters and screened downpipe rain heads in overall system design.

The RWRC at Massey University

Scope of Study

The purpose was to **establish which products and systems were effective in safeguarding roof-collected rainwater against contamination**. The work involved extensive microbiological analysis of roof-collected rainwater samples, including the determination of sedimentation rates as well as the retention and reduction times of organisms under a variety of conditions.

In Australia, over a million people depend on rainwater for all of their water requirements, and in New Zealand more than 10% of the population do likewise. This is traditionally the case in rural and regional areas that are not serviced by municipal town water supplies, however rainwater systems are increasingly being installed in urban environments with water used for both internal (laundry, toilet flushing, hot water systems) and external purposes (garden irrigation, pool top ups, etc). Roof-collected rainwater is widely regarded as a good quality water source and many in the general public have the perception that rainwater is "pure". Whilst the risk of disease arising from roof-collected rainwater consumption is low, it is critical that rainwater is collected and stored via a properly maintained tank and roof catchment system. Many of the roof water supplies surveyed in New Zealand studies revealed major deficiencies in the use of rainwater catchment systems and components, so Abbott's study was commissioned.

In Abbott's study, the systematic evaluation of microbial inactivation and removal in roof-collected rainwater will underpin evidence-based recommendations to consumers so that health risks can be managed by them through the appropriate use of cost-effective prevention and control measures.

Methodology

The RWRC at Massey University is situated approximately 3 km from the centre of Wellington city and is positioned 30 metres from a major arterial road and is adjacent to 2 bus stops. The catchment surface of the RWRC comprises a galvanised iron roof and copper and PVC gutters with a roof area of approximately 200m^2 consisting, on one level, of north and south panels and at a lower level, a smaller west facing panel. While the entire roof area is free of overhanging trees, there are a number of pine and pohutukawa trees surrounding the centre.

Six rainwater tank systems were installed. Water from the catchment surface was directed to the tanks through PVC downpipes which were fitted with **screened downpipe rain heads** which incorporated two debris screens (6mm and 0.955mm stainless steel).

Products incorporated into the various systems studied included two Tank Vacuum Systems (bottom overflow), a calmed inlet device, and a 300mm diameter chamber First Flush Water Diverter. A control tank was included in the study as well as a system which incorporated two tanks in series.

First Flush Water Diverter (manufactured by Rain Harvesting Pty Ltd and sold in NZ by Marley). The diverter uses a 1.5m section of 300mm diameter pipe as the diverter chamber, providing a flush volume capacity[1] of 126 litres. The diverter includes a dependable ball and seat mechanism to close off the chamber once full of the first most contaminated rainwater, and also utilizes a 1.25mm diameter Slow Release Control Valve ensuring the unit drains and resets automatically after rainfall.

Since 12/10/2005 a total of 1700 roof-collected rainwater samples were collected for baseline microbiological analysis. 100ml water samples were collected aseptically from all four taps of each tank in appropriately labelled sterile 120ml plastic bottles. Water samples from the first flush diverter were also collected. All water samples were placed on ice packs in a chilly-bin and transported to the laboratory, usually within 30 minutes, and processed within 2 hours of arrival in the laboratory.

There were 25 sampling events from 12/10/2005 to 20/07/2006. The total rainfall for the entire sampling period was 1262.7 mm.

[1] Although there are different views on the volume of water that should be divertered using first flush devices (for example the World Health Organisation recommends 20-25L), consideration should be given to site specific issues including (1) roof catchment area, and (2) the amount of roof pollutants. A rule of thumb is to diverter between 0.5mm – 2mm of the first rainfall.

All the samples were analysed for Total coliforms and Escherichia coli using the Colilert™ system (IDEXX Laboratories, Westbrook, Maine, United States).

Findings

The **samples from the tank fitted with the First Flush Water Diverter consistently yielded low to zero *Total coliforms* and *Escherichia coli* throughout the study**. In contrast however, in the majority of the water samples taken from the first flush diverter high levels of *Total coliforms* were found. The *Escherichia coli* counts were overall not as high as the *Total coliform* counts but one sample from the First Flush Diverter was negative for *Escherichia coli*.

Abbott concludes from the preliminary results that the **quality of the water improves dramatically with the use of first flush diverters**.

The RWRC at Massey University

The Rain Alert™ wireless tank level monitor is fitted to a tank system at the RWRC and transmits a reading of tank levels to a Receiver located in the Engineering Faculty over 150m from the tank.

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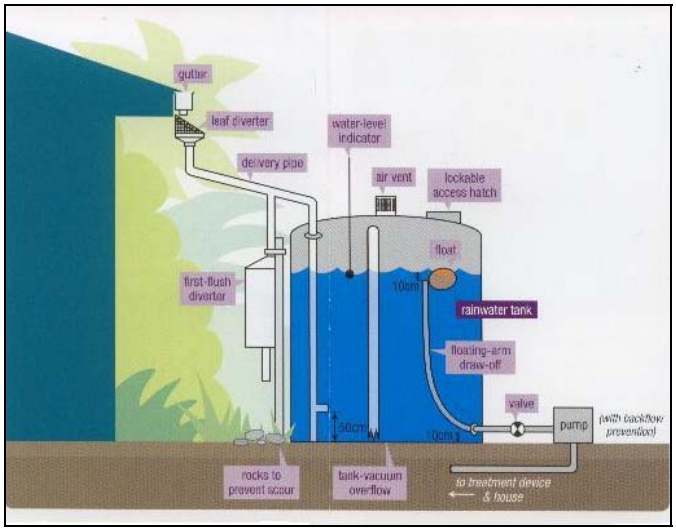
Preferable Rainwater Harvesting System Design

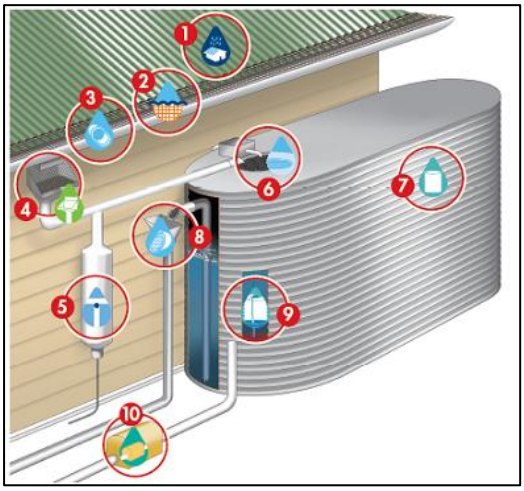
Many authorities in Australia and New Zealand have made proactive efforts to educate the trade and consumers about preferable rainwater systems design, installation and maintenance.

For example, the Rodney District Council (on the north island of New Zealand, just outside Auckland) includes many products as critical for including in overall system design (pictured).



Source: Rodney District Council – Rainwater Tanks (2006 consumer brochure)

Rain Harvesting Pty Ltd is a manufacturer and wholesaler of rainwater goods, including the Leaf Eater® rain heads and First Flush Water Diverter included in the Massey University study. Rain Harvesting has also developed guidelines for creating complete rain harvesting systems that deliver good quality water for use both inside and outside the home.



1. Check **ROOF SURFACE** is suitable for collecting quality rainwater.
2. Install **GUTTER MESH** (such as Blue Mountain *all steel* Mesh™) to prevent leaves and debris from blocking gutters.
3. Fit **GUTTER OUTLETS** from the underside of the gutter to prevent obstruction of water flow.
4. Fit **RAIN HEADS** to downpipes to stop gutters blocking. Rain heads deflect leaves and debris & keep mosquitoes out of pipes that hold water ("wet" systems).
5. Install **WATER DIVERTER/S** to prevent the first flush of most contaminated rainwater from entering the tank.
6. Ensure a **TANK SCREEN** is installed at tank entry point to filter water and keep mosquitoes and pests out.
7. Choose a **WATER TANK**. Consider annual rainfall, roof catchment area and water usage when determining its size.
8. Attach **INSECT PROOF** SCREENS or FLAP VALVES to the end of all pipes to the tank screen (for 'wet' systems) and to TANK OVERFLOW OUTLETS to keep mosquitoes and pests out and ensure tank is vented properly.
9. Utilise a **TANK "TOP UP"** system (if required) to automatically top-up the tank with mains water when water levels fall to a designated minimum level.
10. Select a **PUMP SYSTEM** (if required) to distribute water for use inside or outside the home.

References

Abbott, S.E., Caughley, B.P., Ashworth, J, Douwes, J. (2006). *A Systematic Evaluation of Measures for Improving the Quality of Roof-Collected Rainwater. In* Proceedings of NZWWA's Annual Conference. Christchurch Convention Centre, October.

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