Rainwater Recycling in the Lone Star State

By Jack Holmgreen

Rainwater harvesting system provides alternative to well water

Rainwater harvesting and storm water recycling are similar processes, but rainwater harvesting usually involves collecting water from cleaner surfaces, such as roofs, while storm water typically is ground-level runoff. Both require collecting, storing and conserving rain for later use.

Harvesting and storing rainwater is not a new idea. While the origin of rainwater catchment systems is not known precisely, historical evidence suggests structures for holding runoff water date back to the third millennium B.C. Structures have been found in numerous locations, including Israel, India, Greece, Italy, Egypt, Turkey, Mexico and the U.S. Many Asian and Middle Eastern countries, as well as island communities and some parts of the U.S., still rely on some type of water catchment.

There are several reasons for harvesting rainwater today, including low-cost irrigation, augmenting the municipal water supply, water and soil conservation, aquifer recharge, and flood control. It is also desirable to use rain because of the high quality and softness of the water and the relative absence of contaminates such as disinfection byproducts (chlorinated hydrocarbons), endocrine disrupting compounds (antibiotics and hormones), heavy metals, agricultural chemicals and the chlorine-resistant microbes that are increasingly appearing in groundwater and tap water. Rainwater collection systems are cost-effective and easy for the average homeowner to maintain, and are easier to install and use than wells or surface ponds.

The 20,000-gal tank farm is hidden from the house by a stand of oak trees.

Residential Reuse in Texas

In some areas of Texas, Arizona and Nevada, regulations require the installation of a rainwater collection system in order to obtain a building permit for a home. Population growth and limits on how quickly centralized systems can meet rising demands have made rainwater an attractive alternative source for domestic water. SparkleTap Water Co. has been building whole-house potable rainwater systems since 1987, some with no backup supply such as a well or municipal water source.

One such project took place in New Braunfels, Texas, in 2009 for a client building a 5,600-sq-ft home with a detached garage apartment. There was a well on the property that delivered water with 115 parts per million (ppm) hardness, 550 ppm TDS, 0.5 NTU turbidity, and small amounts of sulfur, iron and tannins. The owner originally sought treatment to correct the well water problems, but soon became convinced that rainwater would be a better choice for his primary domestic water source.

SparkleTap Water Co.'s first step was

Table 1. Rainwater Harvesting System Sizing Calculator

Raw Data (Change to fit project conditions)	
Catchment area (sq ft)	5,675
Monthly indoor demand (gal)	4,500
Monthly outdoor demand (gal)	500
Water in storage tank to begin (gal)	0
Tank Size (gal)	25,000

to interview the owners to determine their goals and expectations. The couple had a teenage son living with them at the time, but expected him to leave for college soon, so it would primarily be only the two of them living in the house. With that information, SparkleTap Water Co. determined that the collection surface was large enough to supply the water needs for the entire household during average rainfall years.

Next, SparkleTap Water Co. discussed outdoor water uses, such as irrigation of landscape beds, trees and the onsite hydroponic greenhouse. The owners were conscious of the high water demands of traditional landscapes and turf grass, so they opted for a xeriscape of native grasses, trees and shrubs with no turf at all. This would allow them to grow a large amount of vegetables in the hydroponic greenhouse, which would be fed by a separate tank with rainwater collected off the garage. This plan meant that all rainwater collected from the roof of the main house could be reserved for indoor water use.

Storage was designed to take advantage of the sloping site and natural landscape by hiding the main 20,000-gal tank farm behind a stand of oak trees downhill from the house. A single 5,000-gal tank would be located closer to the house to supply the treatment system and another 5,000-gal tank would supply the greenhouse. A total 30,000 gal of capacity in six aboveground fiberglass tanks would provide an adequate water supply for a family of four for about five months without any rain.

Table 1 provides an example of determining system sizing, and Tables 2 and 3 (see page 22) demonstrate a system's storage levels in regular and drought conditions. In each scenario, the system begins with water in the tank.

To keep the tank near the house supplied with water, a submersible pump was installed in the tank farm, and all of the tanks were equalized through 4-in. PVC collection pipes leading downhill from the 14 downspouts, which had been fitted with primary filters to eliminate leaves and debris. Level controls signal the pump in the tank farm to refill the house tank when it is half full. An electronically controlled pressure booster pump then

Harvested water flows through a sediment filter, an activated carbon prefilter and finally a backwashing ultrafilter.

picks up water from the house tank and delivers it to the treatment system inside the house.

Treatment consists of a 10-micron gradient density sediment filter followed by an activated carbon prefilter and a backwashing ultrafilter that is NSF-certified for the removal of bacteria, viruses and cysts down to 0.002 microns. This treatment method produces water

Table 2. Storage Levels for 25,000-Gal Capacity System With Average Rainfall in Austin, Texas

	Indoor demand (gal)	Irrigation demand (gal)	Total demand (gal)	Average rainfall (in.)	Collection surface size (sq ft)	Collection coefficient (gal/sq ft)	Efficiency factor	Rainfall collected (85% efficiency)	End-of-month storage (gal)
January	4,500	0	4,500	1.97	5,675	0.62	0.85	5,892	1,392
February	4,500	0	4,500	2.40	5,675	0.62	0.85	7,178	4,069
March	4,500	500	5,000	2.91	5,675	0.62	0.85	8,703	7,772
April	4,500	500	5,000	3.81	5,675	0.62	0.85	11,395	14,167
May	4,500	500	5,000	5.01	5,675	0.62	0.85	14,984	24,151
June	4,500	500	5,000	3.12	5,675	0.62	0.85	9,331	25,000
July	4,500	500	5,000	2.04	5,675	0.62	0.85	6,101	25,000
August	4,500	500	5,000	2.07	5,675	0.62	0.85	6,191	25,000
September	4,500	500	5,000	2.67	5,675	0.62	0.85	7,985	25,000
October	4,500	500	5,000	3.76	5,675	0.62	0.85	11,245	25,000
November	4,500	0	4,500	2.70	5,675	0.62	0.85	8,075	25,000
December	4,500	0	4,500	2.64	5,675	0.62	0.85	7,896	25,000

Table 3. Storage Levels for 25,000-Gal Capacity System With Four-Month Drought

	Indoor demand (gal)	Irrigation demand (gal)	Total demand (gal)	Average rainfall (in.)	Collection surface size (sq ft)	Collection coefficient (gal/sq ft)	Efficiency factor	Rainfall collected (85% efficiency)	End-of-month storage (gal)
January	4,500	0	4,500	1.80	5,675	0.62	0.85	5,383	833
February	4,500	0	4,500	2.11	5,675	0.62	0.85	6,310	2,694
March	4,500	0	4,500	2.36	5,675	0.62	0.85	7,058	5,252
April	4,500	0	4,500	2.98	5,675	0.62	0.85	8,912	9,664
May	4,500	0	4,500	4.27	5,675	0.62	0.85	12,770	17,935
June	4,500	500	5,000	0.00	5,675	0.62	0.85	0	17.935
July	4,500	500	5,000	0.00	5,675	0.62	0.85	0	7,935
August	4,500	500	5,000	0.00	5,675	0.62	0.85	0	2,935
September	4,500	500	5,000	0.00	5,675	0.62	0.85	0	0
October	4,500	0	4,500	2.94	5,675	0.62	0.85	8,793	2,227
November	4,500	0	4,500	2.00	5,675	0.62	0.85	5,981	3,709
December	4,500	0	4,500	2.10	5,675	0.62	0.85	6,281	5,489

with zero detected coliform, 11 ppm hardness, virtually zero TDS and barely detectable calcium, silica and chloride. There were no trihalomethanes or volatile organic compounds detected by the National Testing Laboratory using the same analytical methods approved for compliance by the U.S. Environmental Protection Agency.

Rainwater collected and treated in the same way and then bottled won the gold medal in the purified category at the 2011 Berkeley Springs International Water Tasting Contest, where judges compared it to high-quality premium drinking water from around the world. Some attendees stated it was "the best water they had ever tasted."

Making the Case for Reuse

In many cases, when rainwater goes unmanaged it becomes a nuisance and can cause damage to structures and foundations. In urban areas, rain often creates flood hazards and washes gross pollutants into bayous, streams and rivers, contributing to the contamination of lakes and estuaries. Impervious surfaces prevent rain from infiltrating the soil, causing aquifers to become depleted and costing billions for infrastructure improvements that could have been avoided. With proper rainwater and storm water management, many of these problems can be solved, while also reclaiming a useful and valuable resource.

Rising population and static extant water supplies require some different approaches to the allocation of this critical resource to maintain the quality of life that many take for granted in the existing culture of over-consumption and undervaluation of clean, safe water.

One of the main obstacles to implementing rainwater harvesting more widely is the reluctance of many municipal and rural water districts to adopt an older, decentralized approach after 50 years of centralized management of water resources. The key is to have current public water supply protection training, and to use the proper backflow device for connection to the municipal supply. Most inspectors want to see a reduced pressure principal device, but some insist on a fixed air gap to partially fill the cistern during times of drought. Each district has its own preferred method.

In the long run, there is no alternative to clean, locally obtained drinking water. In the apt words of a Texas pioneer, "whiskey is for drinking and water is for fighting." Rain, on the other hand, is for enjoying—at least as long as we are able to collect it. *wqp*

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