when it rains, it stores

by Anne V. Sonner

Rainwater Harvesting: Green Technology for Water Reuse

A new Green technology on the plumbing market offers help for our planet, as well as our pocketbooks. "Rainwater harvesting," also called "rainwater catchment" and "rainwater collection," involves collecting and storing rainwater for landscape irrigation and other non-potable uses. Rainwater harvesting saves drinking water, a substance that is getting scarcer and more expensive with the world's increasing population, pollution and global warming. And in some countries, rainwater is the only drinking water.

As Tim Pope, president of the American Rainwater Catchment Systems Association (ARCSA), said at their September 2008 conference, "Drought happens, and after the lakes and streams and aquifers start declining, people naturally look back to the skies for help. It makes perfect sense to save the rain for the days and months when it doesn't fall."

Dave Viola, IAPMO's director of Special Services, spoke at the ARCSA conference. "We're seeing a dramatic increase in the number of manufacturers with innovative products in this field," he said. "Right now there are no plumbing regulations, requirements, or standards, so IAPMO is stepping in to help."

Actually, rainwater harvesting is not new, it's just gaining in popularity in some parts of the United States and the world. Cisterns were used thousands of years ago to supply water for homes and baths in ancient cities, and many people in rural areas without public water utilities have always collected rainwater from their roofs into rain barrels. Rainwater harvesting systems are more sophisticated now. They can be used for large commercial installations as well as for homes; and there are new safeguards to improve water quality.

If you are an inspector, you may run into rainwater harvesting systems. As a homeowner, you may wonder if such a system could work for your property. This article presents current information on rainwater harvesting, much of it from presentations at the ARSCA conference.

Different Kinds of Water

Just so we're all on the same page, here are a few definitions some the different kinds of water:

Rainwater, as you might have guessed, is water that comes from rain or other precipitation.

Black water is toilet waste.

Greywater, as defined in the *Uniform Plumbing Code*®, is untreated household wastewater that has not come into contact with toilet waste. Greywater is from showers, tubs, bathroom sinks, washing machines, etc.

Reclaimed water (also called recycled water), defined by the *UPC*, is water that has undergone tertiary treatment by a public agency. The biggest use for reclaimed water is landscape irrigation.

Potable (drinking) water is treated to a higher standard than reclaimed water. In much of the United States, potable water is used for all water uses, including landscape irrigation.

How Rainwater Harvesting Systems Work

To decide if it is practical to install a rainwater harvesting system, you first have to determine your water needs and the amount of rainwater available for harvesting. This calculation takes into account the roof catchment area and rainfall during each month of the year, for average and drought years. Peak flows from storms should also be included in the calculations. Then the cost of the system must be compared to the potential water savings.

The simplest rainwater harvesting system is roof water draining into a rain barrel.

With a little guidance, a homeowner can install a simple system with gutters transporting the rainwater from the roof through a downspout into a rain barrel or other storage tank. Some municipalities and states provide written how-to information and workshops, and installation and maintenance instruction can be found on rainwater harvesting websites.

Larger systems use multiple tanks or large cisterns. These systems have controls and gauges, pumps, and may filter and disinfect the water. The more complex systems are designed by engineers who specialize in this type of construction.

Experts at the ARCSA conference presented extensive and detailed information on rainwater harvesting system design. Here is a brief summary of the basic components in a rainwater harvesting system. New products are available to increase the efficiency of these systems.

1. A roof.
2. Gutters around the edges of the roof to catch the rain.
3. Strainers or "rain heads" to keep leaves and other debris on the roof from entering the downspout to the storage tank.
4. Some systems have a "first flush water diverter," an automatic device that catches and removes the water from the roof during the beginning of a rain. (This water contains the most contaminants from the roof surface.

← *A 2000 gallon galvanized metal cistern used for rainwater catchment for irrigation purposes.* (Photo by IWS, watercache.com)

Removing the "first flush" greatly improves the water quality of the collected water.)

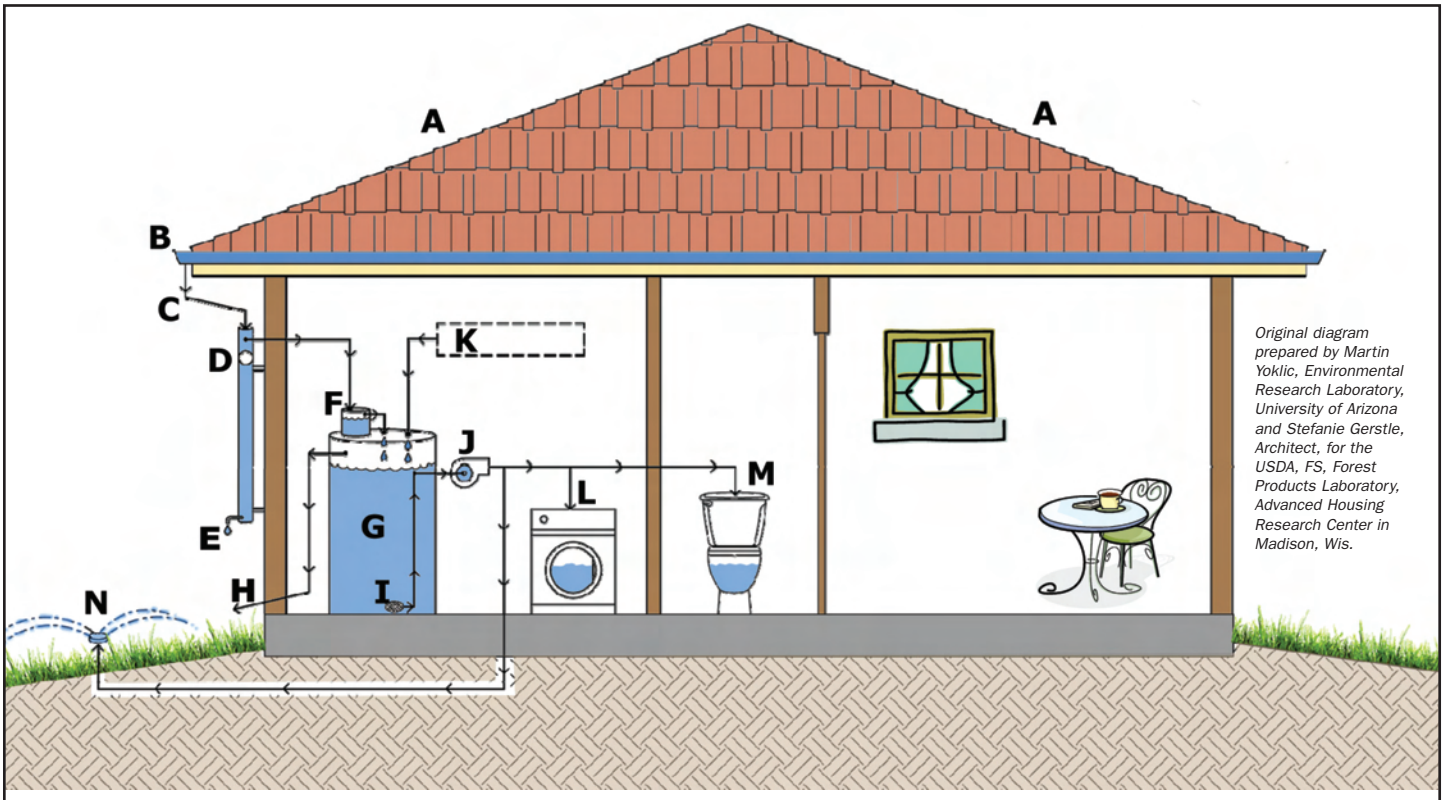
5. A downspout from the gutters to the tank(s).
6. A water storage tank. This can be a rain barrel, a system of multiple tanks or large cisterns made of a variety of materials. Cisterns can be above or below ground. The size and type of water storage container depends on the amount of anticipated water collection, space available, budget and aesthetics. Water storage tanks need to be covered to prevent contamination and mosquito breeding.
7. Filtration systems and disinfection systems may be desired or required, depending on the water use.
8. Plumbing and pump system to deliver the rainwater to its destination, such as to the yard for landscape irrigation. Rainwater that will be used inside the home will need a separate plumbing system for delivery, separate from the potable water system. If the potable and non-potable supplies are connected, the potable water must be protected by airgaps and/or backflow preventers. In some situations, the rainwater will need to be supplemented with potable water when demand exceeds the available rainwater.
9. Water level monitors help monitor water usage.

Heath Issues — Is Harvested Rainwater Safe to Drink?

Some people consider rainwater to be "pure" because it comes from the sky. They use it in their yards and homes, and maybe even drink it, with no problems. However, research studies in various parts of the world indicate that rainwater can contain contaminants.

At the ARCSA conference, Stan Abbott, director of the Roof Water Research Centre at Massey University in Wellington, New Zealand, presented reports on the microbiological health risks of roof-collected rainwater and how to minimize the risks. Dr. Dennis Lye, a research microbiologist for the U.S. Environmental Protection Agency (EPA), presented a report on chemical contamination and rooftop materials.

What contaminants can be in rainwater? Bacteria, fecal particles, organic matter from plants and animals, heavy metals, petroleum hydrocarbons, pesticides and a variety of other pathogens and chemicals. Rainwater can become contaminated from pollutants in the water itself, from birds and other animals on rooftops, from the roofing materials and even from airborne particles. Bacteria can grow when the water in storage tanks is physically "dirty," giving it nutrients to multiply in the tanks, especially in countries with warm



Original diagram prepared by Martin Yoklic, Environmental Research Laboratory, University of Arizona and Stefanie Gerstle, Architect, for the USDA, FS, Forest Products Laboratory, Advanced Housing Research Center in Madison, Wis.

Non-Potable Water Harvesting System Components

A: Catchment Area
B: Gutter
C: Transport
D: First Flush Filter
E: Bleed Valve
F: Secondary Filter
G: Storage Cistern
H: Overflow Pipe
I: Float Valve
J: Pump/Controller
K: Municipal Supply
L: Clothes Washing
M: Toilet Flushing
N: Landscape Irrigation

climates. Build-up of organic sediment at the bottom of tanks can also be a problem.

Abbott reviewed many international studies and concluded that, "The risk of contamination of drinking water supplies with microbiological pathogens can be minimized by modern approaches to water management, but continues to be a major pubic health concern." He added that, "Evidence of actual disease outbreaks resulting from drinking roof-collected rainwater polluted by pathogens is rare."

Countries set their own clean water standards. In the United States, the EPA sets drinking water standards, with maximum amounts of chemical contaminants in public water supplies specified in the Safe Water Drinking Act. To help both developed and developing "third world" countries, the World Health Organization (WHO) has developed clean water standards for the world. However, even in the United States, rural water systems not connected to public water systems, including individual wells and rainwater systems, are largely unregulated.

Suggestions on prevention of water contamination in these systems include: cleaning rooftops, cleaning leaves and other debris out of gutters, installing first flush water diverters, covering tank inlets with filters to prevent insects, frogs, and other animals entering the tank, covering the tanks to prevent the growth of algae, microorganisms, and mosquitoes, and vacuuming out sediments in the bottom of the water tank. Tanks, gutters, screens and all systems components should be inspected and cleaned at least annually or preferably twice a year. Rainwater used for drinking can be tested, disinfected and filtered. Lye recommends education and certification of individuals associated with the governing and approval of rainwater harvesting systems.

One of the studies stated that "a good system design that is properly operated and maintained is the simplest and most effective means of ensuring good water quality, while water treatment (including on-site chlorination, boiling the water, filtration, solar water disinfection and UV sterilization) is mainly appropriate as remedial action if contamination is suspected."

Abbott concluded, "The use of alternative water sources such as roof-collected rainwater can be part of the solution to diminishing water resources, but accurate communication of the health risks of contaminated roof water is necessary so that the consumers can manage the risks themselves. Roof water users by and large want and need more information pertaining to their drinking water supplies, but improvements are necessary in the dissemination of this information by health professionals and local authorities. This includes correct and up to date information on how to minimize contamination of roof-collected rainwater by sensible preventative and management procedures."

Rainwater Harvesting in the United States

According to ARCSA President Tim Pope, states with semi-arid climates, including Texas, New Mexico and Arizona, are the current leaders in rainwater harvesting because their climates have "forced them to be innovative regarding water conservation." A recent drought in the southeast United States has led to "enormous growth for rainwater harvesting businesses in states such as Georgia, North Carolina and South Carolina." Pope also commented that California is experiencing an extended drought and looking for ways to increase its water efficiency. Here is a look at what is being done in rainwater harvesting in some states:

Texas – Death, Taxes and Drought

In his ARCSA conference talk, "Rainwater – How to Catch It and What to Do with It Texas Style," Billy Kniffen,

Cisterns come in many sizes and are made with a variety of materials.
(Photos by Billy Kniffen, of Texas AgriLife Extension Service)

water specialist for Texas AgriLife Extension Service (a part of Texas A&M University), explained what's happening in Texas. Rainfall in Texas varies from a low of fewer than 10 inches per year in the western part of the state to a high of 60 inches per year in the east. Population growth in Texas is expected to increase while the water supply is expected to decrease. Kniffen said there are only three things certain in Texas: death, taxes and another drought. Texans use 8-9 billion gallons of water per day, but the aquifers are only recharged at the rate of 4-5 billion gallons per day. Conclusion: "Conservation is the easiest and cheapest way to make our water use sustainable," Kniffen said. Rainwater is used for various types of irrigation, livestock and wildlife, and non-potable uses in the home. An added benefit to rainwater harvesting is that it reduces storm water.

Kniffen reported on a variety of rainwater harvesting systems constructed in Texas, including a 2000-house "all-green subdivision" built in 2007 in Georgetown that uses rainwater harvesting and energy-saving heating and cooling systems. Other green home developments are being built in other communities.

The state of Texas charges no sales tax on rainwater harvesting system supplies and some counties offer rebates. Also, Texas law prohibits homeowner associations from banning rainwater harvesting, though it can require cisterns to be screened from view.

New Mexico – The First State to Adopt Green Building Codes

"An amazing amount of water can be collected from just a few rains, making [rainwater harvesting] technology suitable even for climates like New Mexico's. … As water rates rise, droughts occur and water supplies are stressed by high demands, rainwater harvesting is sure to increase," New Mexico's Water Conservation Program Website states.

"As water rates rise, droughts occur and water supplies are stressed by high demands, rainwater harvesting is sure to increase"

New Mexico is the first state in the nation to adopt mandatory green building codes, effective July 1, 2008, according to J.T. Baca, Mechanical Bureau chief for the state of New Mexico. Though rainwater harvesting is not mandatory at this time, the state strongly encourages its use. Baca said all the departments are helping people who want to do rainwater harvesting. "The systems must meet the intent of *UPC Chapter 11* on stormwater drainage and they must meet local environmental requirements," he said. Baca participated in a task force that developed a user manual for New Mexico residents on rainwater harvesting systems. "The manual is very comprehensive," Baca said, "and can be used by lay persons as well as engineers designing systems."

Rainwater harvesting is used a lot in New Mexico, considering. "I wish we could do more, but we're in a desert," Baca

Photos by IWS, watercache.com

The downspouts connect to the underground collection piping and delivers the rainwater to the storage tank (by gravity, no pumps).

said. "There's not a whole lot of rain, but we take advantage of the rain we can get for the benefit of our landscaping."

See the January/February 2007 issue of *Official* for an account of the La Pradera subdivision, near Santa Fe, which incorporates both rainwater harvesting and reclaimed wastewater. Baca worked with the contractors, inspectors and the developer, modifying *2003 UPC Appendix J*.

New Mexico even has a community of "Earthship" homes – innovative, fully sustainable homes with solar power and water reuse systems, and constructed with walls of dirt-filled tires.

Hawaii – Lots of Rain, Lots of Rainwater Harvesting

The island of Hawaii, which is the largest, but not the most populous, of the state's eight major islands, uses rainwater harvesting almost exclusively in its rural subdivisions. Rainwater harvesting is also used in one area of Maui and in scattered locations on the other islands.

Rainwater harvesting has been used for more than 100 years for several reasons. First, most of the rural area is spread out, and lacks the infrastructure of municipal piped water. Second, rainwater is viable and meets all their water needs. In fact, many residents prefer the quality and taste of rainwater to other water. Others consider having to collect and process their own water a bother.

Trisha Macomber, an extension educator with the University of Hawaii's College of Tropical Agricultural and Human Resources, Cooperative Extension Service, said the Hawaii island residents use harvested rainwater for irrigation of crops, some commercial facilities, drinking and all other domestic uses. It is estimated that about 20,000 homes or 60,000 people in the state depend on rainwater for their water needs. It helps that there is quite a lot of rainfall on most parts of the islands.

Macomber said the quality of the rainwater is good, but it can get contaminated from the roof collection surface, particularly from birds, geckos and rats. Therefore, water treatment is recommended. Many residents disinfect the rainwater at the point of entry into the house with UV light. It is also important to clean the collection systems regularly. "Many people do these things well," Macomber said, "and some don't."

At this time there are no codes and regulations for domestic rainwater systems on the island of Hawaii, though there is a lot of talk about it. The situation is comparable to wells in rural areas of mainland America.

However, local, state and county agencies provide education on how to take care of the systems, including the Department of Health's Safe Drinking Water Branch. Most of this outreach is done through the University of Hawaii's CTAHR Cooperative Extension Service, which has a program dedicated to educating people about water harvesting usage and safety, including testing.

U.S. Virgin Islands – Green for Centuries

Residents of the U.S. Virgin Islands get more than 99 percent of their water from rainwater, according to Marylyn Stapleton, IAPMO's Region 11 manager. And that water is used for everything, including drinking. The small amount of water not obtained from rainwater is "government water" that has been desalinized.

Each house has a catchment area on the roof. The rainwater flows from the roof to a concrete cistern beneath the floor of the house. The water is filtered before it enters the house. When asked how well this system works, Stapleton replied, "It's been working for me all my life."

Sylvanus "Roots" Bloice, a master plumber and member of IAPMO's Technical Committee on plumbing, said every single house in the U.S. Virgin Islands is built with an underground cistern, like houses in much of the mainland United States are built with basements. "We depend on rainwater pretty much," he said, adding that he has taken unofficial rainfall measurements in his own yard. The average rainfall is about 50 inches per year, 30 inches in a drought year; and 60-65 inches with major storms.

Water conservation is crucial in the U.S. Virgin Islands, Bloice said. "If your system runs low, you have to have water trucked in for hundreds of dollars, so you would not think of wasting water." Bloice noted that while green building is a current trend in the United States, in the U.S. Virgin Islands, "we have been green for centuries."

California – Harvesting Rainwater is a Piece of the Water Conservation Puzzle

California, the most populous state in the country, has had several years of drought. Some efforts are being made to harvest rainwater, but that appears to be a small part of the solution to the water shortage problem. Californians use a lot of water, from irrigating massive fields of crops to their love affair with green lawns. As a California resident, I see water wasted everywhere, every day. Here is what is happening in a few areas of California:

The City of **Santa Monica**, where the recent ARCSA conference was held, promotes rainwater harvesting by offering rebates on rain gutter downspouts, rain barrels and cisterns. The city's Website provides the rebate application, detailed instructions on installation and maintenance, and a list of equipment suppliers. The website states, "Harvesting rainwater from your rooftop protects the Santa Monica Bay, safeguards drinking water supplies and adds a little excitement into your life and landscape – and can put money in your pocket."

San Francisco, a city whose housing code contains water conservation requirements, recently launched a citywide initiative to promote the collection and re-use of rainwater for non-drinking purposes like irrigation and toilet use. "Rainwater harvesting is a simple, safe and sustainable way to help conserve our precious drinking water supplies, green our city and protect our environment," said Mayor Gavin Newsom in a press release. "This initiative alone won't end the drought or fix our climate crisis, but reviving this ancient

A 5000 gallon fiberglass rainwater collection system used for potable purposes.
(Photo by IWS, watercache.com)

Photos by IWS, watercache.com

This hybrid system collects rainwater, but will switch over to the well water tank (furthest tank in picture) when the rainwater tanks run dry.

Photo by Billy Kniffen, of Texas AgriLife Extension Service

A rainwater collection system at a greenhouse.

practice can be part of the solution to our modern challenges." The city also provides discounted rain barrels and rainwater harvesting workshops.

Richard Hansen, general manager and engineer at Three Valleys Municipal Water District, has a different view. (Three Valleys covers **Pomona Valley**, **Walnut Valley** and **Eastern San Gabriel Valley** in Southern California, with a mostly urban population of 710,000.) Hansen is concerned about several problems with rainwater harvesting. "With only 12 to 16 inches of rain annually, the amount of water a homeowner can catch is fairly limited given most lot sizes." Also, some homeowners do not install the proper equipment and do not maintain it adequately. Even if they do, rainwater catchment won't help much if the property uses a lot of water. "A water guzzling lawn will take far more water than most residential catchment systems can contain and the water saved will be depleted in the first month of dry weather, thus causing homeowners to have to 'switch over' their irrigation system to use their potable supplies," Hansen said. "This is, of course, a slight benefit, but so limited as to be unfeasible given the knowledge most homeowners have of their irrigation systems."

Hansen concluded, "The need is really in expertise and education. Due to health and safety reasons, harvested rainwater can be used only for irrigation and that's where irrigation efficiency and drought tolerant plantings need to be encouraged, and *supplemented* by a residential rain catchment system. Residential rain catchment systems will certainly *not* solve our water use problems. It can help those proactive, water conserving homeowners who are already cognizant of the need to conserve water. On a large scale, these types of systems will make little difference without changes in the efficiency of our irrigation systems and in our landscape preferences."

Rainwater Harvesting in Other Parts of the World

Almost every country in the world uses rainwater, to various extents. Here is what a few countries do:

Rainwater collection systems are required in all new construction in **Bermuda**.

Australia, the driest continent, is plagued by worsening droughts. According to a 2007 Australian Bureau of Statistics report, "There is a huge demand for roof-collected rainwater and it is progressively becoming an important supplement to main water supplies in many urban areas. Authorities nationwide are encouraging more Australians to use rainwater and 17 percent of households in Australia now source their water from rainwater tanks."

In **New Zealand**, 10 percent of the residents rely on roof water for their drinking water – especially in rural

areas that are not served by municipal supplies. Stan Abbott said in his presentation to ARCSA, "Even in urban areas, local authorities are now encouraging householders to install domestic rainwater tanks to new or existing houses so that the rainwater can be used as a secondary source for toilet flushing, in washing machines and outdoors for uses such as garden watering, car washing and filling swimming pools." Impediments are inconsistent regulations on rainwater harvesting throughout New Zealand and that the quality of rainwater collected in improperly maintained systems is worse than public water. However, Abbott's research concluded that proper maintenance and new commercial rainwater system components could improve the quality of stored rainwater.

Several million people in **Thailand** use rainwater tanks. A 1989 study of collected rainwater in Thailand found fecal contamination from non-human sources – animals, birds and rodents. Despite this, the study concluded that, "potentially, rainwater is the safest and most economical source of drinking water in the region because in general, rainwater contamination was only slight compared with the traditional sources and had no major health implications."

India has a huge and growing population, and severe water shortages in many areas. Indians have used rainwater harvesting as long ago as 4500 B.C. to cope with droughts and monsoons. Also, India's groundwater supplies are rapidly depleting. In the rural regions of the country there are diverse approaches to water use. Indians gather water from their rooftops, from flood run-off and from melting glaciers near the Himalayan Mountains. They use ditch technologies in the western part of the country to replenish the underground flow of water and grow crops in an otherwise desolate area.

China has the largest population in the world. It has experienced huge industrial growth in the last few years, and is experiencing severe water shortages, including in two-thirds of its cities. In 2006, Reuters reported that an official from China's Ministry of Water Resources stated, "More than 400 cities have water shortages, with 100 of them 'in serious trouble,' lacking enough water to support industry or daily life." The problem is compounded by pollution. The capital city of Beijing gets two-thirds of its water from groundwater, because it has no major rivers running through it, and the groundwater supply is "overdrawn annually." The price of water is rising sharply and a 2005 municipal regulation requires residential areas to use rainwater, not tap water, for all landscape watering. The government is sponsoring many rainwater utilization projects. "Unlike rainwater harvesting in rural areas, urban rainwater utilization isn't just important for saving water," said Che Wu, a professor with the Beijing Institute of Civil Engineering and Architecture. "It's also important in abating urban flooding, groundwater depletion and rainwater runoff pollution, as well as for improving urban ecosystems."

Photo by Billy Kniffen, of Texas AgriLife Extension Service

Photos by IWS, watercache.com

This rainwater collection system in Denton, Texas, helped the fire station achieve a LEED Gold rating. Rainwater is stored in four 5,600 gallon tanks and used to irrigate native plant landscaping around the station. All collection pipes were integrated into the concrete slab of the rainwater tank to give a very clean appearance.

Codes and Regulations for Non-Potable Water Reuse Systems

No national plumbing or building model codes contain requirements for rainwater harvesting systems. Some local jurisdictions have adopted their own.

However, the International Association of Plumbing and Mechanical Officials (IAPMO) is leading the way. IAPMO is the author of the widely used *Uniform Plumbing Code* and other *Uniform Codes*, all based on safety and reliability.

A new chapter for the *Uniform Plumbing Code* on non-potable water reuse, which would directly address reclaimed water and graywater while indirectly dealing with rainwater harvesting systems, has been developed. This chapter has been proposed for the *2009 Uniform Plumbing Code*, replacing *2006 UPC Chapter 16*. In the proposed code change, harvested rainwater will be permitted for non-potable uses, including fixture flushing, trap priming, irrigation and water features such as ponds and fountains. The systems will be designed by licensed professionals, water quality approved by local authorities and all alternative water source piping, presumably including that for rainwater harvesting, will be required to be labeled and identified as such.

Additionally, IAPMO's Committee for the Awareness and Understanding of a Sustainable Environment (C.A.U.S.E.) and IAPMO's Green Technical Committee (TC) are in charge of IAPMO's environmental activities, including the goal of a minimum 10 percent reduction in energy and water consumption in IAPMO's *Uniform Codes*.

IAPMO GREEN™

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The IAPMO Green TC is also developing a *Green Plumbing and Mechanical Supplement*, expected to be available January 2010. The Green Supplement will be based on current research on many topics, including drainline carry capabilities of ultra-low-flow toilets, and waterfree urinals. The supplement also expands on the work that was done on the *2009 UPC* on rainwater harvesting and other alternate water source systems. The supplement will be a compilation of green requirements, sort of a transitional home until these provisions are fully accepted by the industry and are ready to be included into the *Uniform Codes*. The supplement can also augment the *Uniform Codes* and other plumbing and mechanical codes, be a resource for progressive jurisdictions adopting green programs and provide requirements and for inspectors, designers and installers.

Inspection Issues

At the ARCSA conference, engineer Jack Schultz addressed inspection issues for rainwater collection systems. "Until the lengthy code review, approval and adoption process is concluded, our industry must deal with each jurisdiction on an individual basis in order to obtain permits for what will often seem unfamiliar and even exotic construction," he said. "Unfortunately, an unfamiliar rainwater system proposal is often met with an automatic 'no' – followed by lengthy resistance – and possibly grudging acceptance."

Schultz gave guidelines on meeting legitimate concerns in the areas of land/water use/aesthetics planning, building planning and health impacts. Zoning regulations must be met. Roof structures should be structurally sound. Proposals for underground cisterns need to include excavation, grading and drainage and need to be able to handle loads above them, such as vehicles. Above-ground cisterns need be prevented from toppling in high wind or earthquakes. Fire trucks and other emergency vehicles must be able to get close to the building. There can be no possibility of cross-connection between potable water and any other water source, air gaps and backflow preventers being the principle methods for preventing cross-connections. He recommended colored pipe or markings as a way to identify non-potable water.

Schultz concluded, "Since landscape watering is such a large use of resources, use of rainwater will be encouraged by many departments so long as there is no chance of connection to a potable system." He added that building departments may or may not permit rainwater for other non-potable uses such as toilet flushing and laundry. Use of rainwater for drinking is a health issue. Filtration and disinfection would be needed to reach safe water standards.

Rainwater harvesting is one way to help save water — in a time of increasing water shortages. New systems, products, research and code development are helping consumers meet some or even all of their water needs through harvesting rainwater.

For more information on rainwater harvesting, visit the Websites below or do an Internet search on "rainwater harvesting," "rainwater catchment" or "rainwater collection." There are Websites by rainwater harvesting system designers and manufacturers of equipment, and information on how to build and maintain the systems.

www.ARCSA.org
www.ircas.org
www.harvesth2o.com
www.harvestingrainwater.com
www.rainwaterharvesting.tamu.edu