WATER HARVESTING FOR COMMERCIAL & EDUCATIONAL BUILDINGS

INTRODUCTION

"Water Harvesting" is the collection, storage and treatment of rainwater, stormwater, greywater, and other on-site water sources for non-potable applications like toilet flushing, irrigation and cooling tower make-up. The idea is to help reduce the burden on the municipal drinking water supply while helping to reduce stormwater run-off. Rainwater is usually collected from rooftops and stormwater from parking lots and other surfaces. Greywater is collected from showers and lavatories. Typically rainwater and other sources collected by commercial-scale reuse systems must be treated to meet minimum regulatory requirements set up by the local municipality.

BACKGROUND

Since the end of the dam building era in the 1970's, responses to drought in California have typically focused on the demand-side. For example, the California Plumbing Code has been upgraded to require low flush toilets, low-flush urinals and low-flow showerheads. Reliance on emergency drought responses such as water restrictions, water demand charges and fines for exceeding allocations are, of course, only demand-side stopgap measures that do little to permanently change the culture of water use. Typically when a water crisis ends, water conservation practices are reset to "default usage rules" even though severe droughts are known to be cyclical events in California.

There is a growing consensus State-wide that the end of the era of inexpensive and readily available municipal water in is in sight. It is a certainty that future municipal water demand will increase substantially in accordance with projected California population growth and increasing urbanization. For example, California's population increased by 10 million between 1980—2000 and will increase by another 14 million by 2030, reaching 48 million. The concern is that demand-side responses to water shortages may no longer be sufficient to guarantee municipal water supply during droughts.

Recently policymakers in California are shifting their attention on finding long-term solutions on the supply side of the water resource issue. Publically-funded water development megaprojects (major dam projects State-wide water re-distribution proposals) still hold some potential to augment the supply of "new" water (natural water), the reality is that most of the abundant new water sources have been exploited long ago. As such, many municipal-scale water projects are focused on unconventional supply-side options, such as tertiary treatment of wastewater to meet potable water standards and building seawater de-salinization plants. While these new water development projects will contribute to long-term solutions, future municipal water supply remains uncertain. Regardless of future water availability, costly infrastructure investments for these new water development projects will ensure expensive municipal water rates in the future.

Fortunately building facility managers can employ a number of on-site solutions to increase their self-sufficiency, reduce their exposure to future municipal water shortages and to minimize the rising costs of expensive municipal water. One potential solution that has very old historical roots is rainwater harvesting.

BENEFITS OF RAINWATER HARVESTING

Rainwater harvesting extends the primary available water supply without impacting the facility's water allocation. This is particularly beneficial as "insurance" during periods of water shortage. The capture of rainwater from roofs and hard surfaces can help mitigate stormwater runoff provided that sufficient storage capacity is available. Rainwater is substantially free of salinity and other salts; therefore it may have better quality than the municipal water supply, especially in hard water areas. Soft rainwater is beneficial for irrigating plants and for washing clothes.

WHAT ARE THE AVAILABLE TREATMENTS FOR HARVESTED RAINWATER?

The level of treatment for rainwater for commercial-scale harvesting systems depends on State and local regulations and on the potential contaminants from run-off surfaces. While a raindrop is almost pure, contact with any hard surface will expose it to some contamination. Rooftop runoff is generally considered the best collection surface, but limits the harvesting potential. Adding stormwater run-off from hardscapes and "softscapes" increases the collection potential, but adds complexity in properly treating and preparing the water for reuse.

First flush or pre-filtration is the first step in treatment. In a first flush pretreatment, a rainwater control system senses the rainfall and diverts the first few minutes of run-off, which generally is collected from rooftops, to minimize contaminants and debris entering the storage system. This wastes some water, but greatly reduces overall contamination in the storage tank. Other mechanical methods for pre-filtration include vortex filters, cascade filters and specialized separators for large surface stormwater systems.

Captured water is further treated before application with one or more additional steps to remove fine sediment, contaminants and pathogens. This is accomplished with fine screen filters, bag filters, multimedia filters and other steps to remove suspended solids greater than 5-10 microns. Organic filtration or other absorption materials may be beneficial to remove hydrocarbons (motor oils) and organic material if water is collected from parking lots. This organic filtration can be surprisingly low-tech and inexpensive. Rainwater can be filtered through a vegetated swale before it enters a subsurface cistern.

Most municipalities now will require rainwater to be sanitized before it is exposed to the public to remove any potential pathogens including algae, parasites, Legionella bacteria and viruses. While the risk of making someone sick with harvested rainwater is low, it is advisable to treat the water to protect public safety. Ultra violet (UV) sterilization is a low-maintenance method to sanitize because it does not require chemicals. This can be done by exposure to UV right before it is withdrawn for use or by ongoing exposure to UV in a re-circulating tank. Chlorination is another sanitation option which is more similar to municipal water treatment, but adds chemicals to the water and requires regular ongoing service attention. One advantage of chlorine over UV sanitation is that water treated by chlorine has a residual level of the chemical that continues to protect water from re-contamination downstream to plumbing fixtures.

RAINWATER STORAGE OPTIONS

Storage capacity is designed to balance the supply and demand of rainwater or stormwater. A wide range of above-ground and below-grade storage options are available and include polyethylene, fiberglass or steel tanks that sit on surface pads and concrete, fiberglass and other methods for storing water below grade. Space availability and cost are big factors; storage can cost from $1.50 to $3.00 or more per gallon installed, so determining the optimum storage amount is a key consideration.

A well-designed rainwater system will match the quality and quantity of available harvested rainwater with the intended end use. Unfortunately, our seasonal rains in California make it very expensive to store enough rainwater to last through our dry season. Even a very large amount of storage may be completely empty by June or July. Often the best bet we can hope for here is to replace 50-75% of the irrigation demand with harvested rainwater. Adding cooling condensate can extend the value of the system by supplying water to the system during the irrigation months. In California, a growing number of municipalities are requiring stormwater detention based on the amount of permeable surfaces in a development and expected runoff in a rain event. This required detention cost can help offset the rainwater harvesting system cost and improve the system ROI (See below).

MONITOR & CONTROL SYSTEMS

Rainwater harvesting treatment processes and storage processes for commercial sized systems are often monitored and controlled by programmable logic controllers. The units can monitor system mechanicals and help diagnose potential system problems. These systems control the entire process from harvesting, treatment and storage monitoring. The systems can interface with other building automatic systems which provide condition monitoring and performance monitoring. Increasingly, local information can be shared with a website "dashboard" interface so that the system information can be remotely accessed by service personnel or shared with students or the public.

HOW DOES STORMWATER HARVESTING DIFFER FROM RAINWATER HARVESTING?

Both rainwater and stormwater begin with rain. Rainwater is usually cleaner because it is collected from hard surfaces, such as roof areas; stormwater is more contaminated with silt, fertilizers, road salts and debris because it comes in contact with the ground, often in parking lot areas. This means that harvested stormwater usually requires more filtering and treatment, but it can still make an excellent harvested water resource. Once the stormwater is treated, it can be used for on-site for irrigation, toilet flushing and water cooling towers.

The installation of stormwater harvesting in some cases can turn a liability ("sunk" cost) into an asset with a relatively small incremental investment. Consider a hypothetical high school modernization project built in an urban setting. The project will add a new parking lot and new buildings which increase the imperviousness on the site. The school has high summer water bills due partly to irrigation requirements for sizeable recreational areas (sports fields). As part of the building permit approval, the school is required to invest $500,000 to install a 400,000 gallon stormwater detention cistern to manage increased stormwater runoff. This school might benefit by investing an additional $50,000 to install a stormwater harvesting system to use the cistern for stormwater retention rather than detention. The detention system has a zero return on investment ROI), but a stormwater retention system would provide life-cycle ROI in water costs by providing treated stormwater for flushing toilets and for irrigation of sports fields during the summer season. (Sophisticated stormwater control systems can ensure that sufficient stormwater detention capacity is maintained if regulations won't allow retention cisterns to count for required detention capacity.)

Note: stormwater detention systems merely detain and regulate the flow of stormwater to offsite conveyance systems (gutters, storm drains, etc.); stormwater retention systems keep the water on-site and prevent it from entering and loading offsite systems.

SUMMARY

Commercial facility managers who want to supplement their primary water source with on-site water should start with specific objectives. They should evaluate all available options based on site-specific parameters. Rainwater harvesting, stormwater harvesting, condensate harvesting, and greywater recycling are potential on-site solutions for augmentation of primary municipal water. While these strategies are not mutually exclusive, each approach will likely require separate collection technology, different levels of treatment and possibly methods of storage.

DSA
DIVISION OF THE STATE ARCHITECT
DEPARTMENT OF GENERAL SERVICES

REFERENCES & RESOURCES

Wahaso http://wahaso.com, "Rainwater Harvesting Systems", "Stormwater Harvesting Systems"