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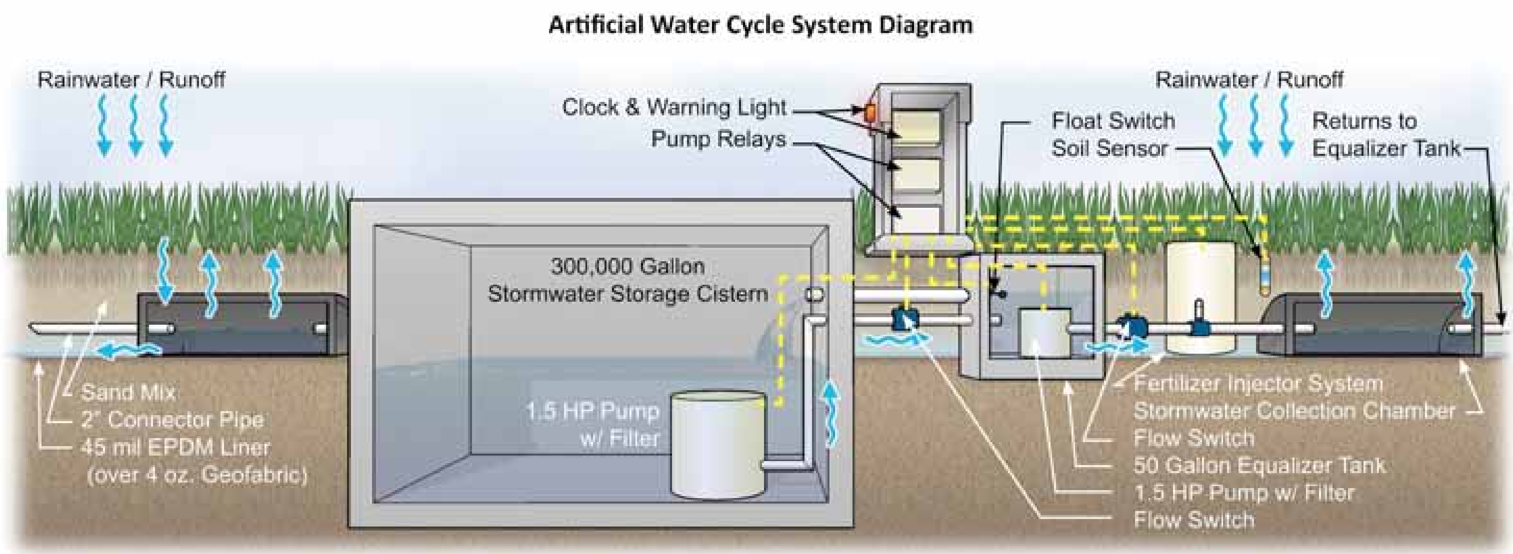

Depiction of stormwater recirculation system components. (Image credit: Chad Kennedy)

With construction of the new Maze Animal Hospital outside the City of Modesto, Dr. Michael O'Brien had a vision of using only captured stormwater to irrigate a 3.6 acre site in Stanislaus County, California. The project, which began planning in February 2010 and actual construction began in the summer of 2011, is truly innovative and progressive given the limited annual precipitation in the region.

One of Dr. O'Brien's main goals is to obtain LEED Gold Certification, the third level certification tier in a four tier green rating system organized and run by the U.S. Green Building Council. In order to do so, water conservation in tandem with the cleaning and reuse of stormwater were chosen as project defining methods for attaining this goal. During the design phase, many subsurface irrigation technologies were researched, but Firestone's EPIC™ (Environmental Passive Integrated Chamber) was the most integrated stormwater, water distribution and plant growth system that remained relatively cost efficient.

The concept of water conservation through stormwater collection is a fairly foreign concept in California's Central Valley due to the frequency and time of year when most rainfall occurs. The design team estimates that an average year producing 11 inches of rain (based on local weather averages) will produce 292,500 gallons of on-site stormwater run-off. Utilizing an integrated stormwater and water distribution system will allow for all on-site stormwater to be captured, cleansed, stored and reused for irrigation and emergency fire purposes regardless of where it falls on the site. This system delicately combines the complicated biological and mechanical systems of plant physiology, soil and nutrient availability, water distribution, weed suppression, sewage treatment, and stormwater quality into a

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Installation of trench and chambers to collect all stormwater surface flow from parking lots and walkways. (Photo credit: Chad Kennedy)

relatively simple and efficient water conservation program, more appropriately described as an artificial water cycle.

Due to the lack of familiarity with this system, obtaining a permit from the Stanislaus County Department of Public Works was difficult for project developers, but the project was eventually approved. Original plans to harvest additional stormwater from off-site roadways to supplement on-site water collections were removed from the project as obtaining approvals through local agencies proved to be too difficult. The Stanislaus County Department of Environmental Resources (the local agency that reviews all health related issues) also expressed reservations about the system's capability to manage septic system discharges for re-use in the landscape. The septic system is designed with County approved septic tanks to which the underground chambers are connected in lieu of traditional leach lines. This design did not require the County to agree to any variations from its standard water quality requirements resulting in a smoother process. The County and the design team both agreed however, that the septic system discharge should be kept isolated from any other irrigation water sources. This was accomplished by estimating the amount of water that would flow through the system and sizing the area to be irrigated accordingly. The area irrigated by the septic system was isolated from other areas of the landscape with a lined 14" vertical curb and an emergency overflow. The County required that an additional leach field be installed that would capture any unexpected overflow from the system. This leach field is disguised on the surface as a linear, non-vegetated, inert design feature that blends into the landscape design. After many design revi-

> The project "water cycle" originates with natural precipitation. All rainwater that falls on the landscape, roof, and paved areas of the stormwater collection zones is directed to percolation trenches filled with engineered sand mixes.

Installation of septic system and leach field chambers. (Photo credit: Chad Kennedy)

sions, presentations and education sessions, the department approved the plans and the project moved forward. Despite early skepticism related to limited annual precipitation, available dispersal methods for reclaimed water and the economical limitations associated with stormwater storage, the project is moving forward.

The project "water cycle" originates with natural precipitation. All rainwater that falls on the landscape, roof, and paved areas of the stormwater collection zones is directed to percolation trenches filled with engineered sand mixes. This stormwater then percolates through 16 to 18 inches of sand being filtering and cleansed prior to reaching a waterproof lining where it is re-directed. Due to equalization pressures and chamber design, the stormwater enters underground chambers in a vertical direction. As this process occurs, an artificial water table is created. The chamber design and direction of flow into this system hinder the entry of fine particles into the system resulting in a system that does not plug over time. As the water level rises, ultimately reaching elevations of the chamber connector pipes, stormwater spills into the next string of chambers, eventually equalizing water table heights throughout the entire stormwater system. In the case of this project, chamber installations were reviewed and inspected by the County as well as manufacturer representatives throughout the construction process.

When the system reaches maximum capacity, extra stormwater is discharged into an on-site 300,000 gallon underground cistern where it is stored for future landscape and emergency fire use. The 300,000 gallons stored in this cistern is estimated to be sufficient to irrigate the entire site for a typical year. During the design process, underground fiberglass storage chambers and other storage devices were investigated, but ultimately the most economical solution was to install a subsurface concrete chamber. This 300,000 gallon cistern is a concrete structure that spans the distance of a parking lot and artificial turf dog run. Stormwater is pumped from this cistern into a smaller holding tank as necessary. The smaller holding tank contains a float switch and a small pump. When soil sensors, located on site, sense a drop in the artificial water table, the pump is activated and six gallons per minute are introduced at three locations to the same stormwater chambers that originally collected the stormwater. This small pump adds water to the stormwater chambers at a carefully selected slow rate which raises the water levels back to acceptable levels while allowing for water to move vertically through the system as well as horizontally.

In addition to stormwater capture, an isolated 2,980 square foot section of the landscape is irrigated solely from a septic system designed with the same chamber system as is used for stormwater capture. An estimated 600 gallons per day of waste water passes through a conventional septic system and is then discharged into the chambers which replace traditional leach lines. Within these chambers biological activity breaks down any solid matter that may enter the system, and nutrient rich water is distributed to the root zone of landscape plants where it is readily used. For long-term maintenance purposes two separate lines of chambers are installed with only one being active at any given time. At regular intervals the active line is switched allowing the inactive line a rest period during which breakdown of any buildup occurs. Landscape areas not within the stormwater recharge zone, or the septic zone, are irrigated with the same recaptured stormwater but by way of subsurface .9 gallon per hour in-line drip emitters at eighteen inches on center.

As artificial water cycle processes are not physically visible from the surface, the system is equipped with automated controls and fail safes to avoid overflow and low tank scenarios, maintenance inconveniences, plant loss and other errors common with manually run systems. The underground cistern is equipped with float controls and warning capabilities to inform Dr. Obrien and his staff when pumps have failed, flows are abnormal and/or tank levels are outside of pre-defined acceptable limits. Project controls will also automatically fill the small tank, distribute water through the chambers, operate a programmed schedule, monitor flows and halt systems in the event of pump or system failures. Each irrigation line is equipped with a flow sensor which measures if the pumps are functioning correctly. If a failure occurs, a master valve shuts flows down; the controller halts all programs and an LED beacon on the controller assembly flashes. This beacon is located on an assembly within the main parking lot entry for maximum visibility. A fertigation system is also tied directly into the control system monitoring and controlling levels of fertilizer injected into the two separate irrigation systems.

Veterinary hospital entrance during construction. Each layer of the system profile is visible. (Photo credit: Chad Kennedy)

Traditionally, most horticulturalists will tell you that sand is not a sound choice for plant growth media because of limited nutrient holding capacity; however, when teamed with this stormwater chamber system, an impermeable lining below the sand creates a suspended soil solution, effectively negating the need for sand particles to hold water and nutrients.

Monitoring of the system will occur regularly to maintain the system in working order. The septic system is designed with a switch box which is accessible from the surface and is used to monitor water levels and water quality. The quality of captured stormwater in underground tanks is monitored in the smaller recirculating 50 gallon tank. This tank is at grade and is accessible to facilitate efficient water sampling of either water pumped from the underground cistern or water that is recirculated throughout the chambers.

In order for this system to work properly in landscape applications, an appropriate planting media is necessary. In this case 14 inches of approved sand are specified in shrub and groundcover areas. A deeper 16 inch profile is specified around tree plantings to allow sufficient media for structural root growth and to minimize the potential for windthrow. Traditionally, most horticulturalists will tell you that sand is not a sound choice for plant growth media because of limited nutrient holding capacity; however, when teamed with this stormwater chamber system, an impermeable lining below the sand creates a suspended soil solution, effectively negating the need for sand particles to hold water and nutrients. The soil solution created is always suspended and readily available. Capillary action then takes over and essentially siphons the soil solution up the sand profile into root growth zones. Physical properties of an approved sand mix including surface area, particle size and void space, create capillary action which can draw soil solutions approximately fourteen inches vertically into the soil profile. For these reasons sand can be used successfully as a planting medium rather than a traditional loam soil.

As most sand mixes will generally have a modest level of original natural nutrients, and because winter rain events may potentially cycle out nutrients in the soil solution, a carefully managed and monitored fertilizer program should focus on subsurface water and vegetation samples. This does not infer that fertilizers should be applied more often. The opposite is actually more appropriate. The stormwater system is a closed recirculating system and will recirculate nutrients through the system until used. Monitoring efforts will be in place to avoid over fertilizing the landscape which would result in issues with salt build-up. An in-line fertigation unit is integrated into the system and will be a helpful tool as it slowly injects fertilizers made from natural seaweed into the water system.

As water will only move vertically through approximately 14 inches of the sand profile, landscape areas designated as unplanted decorative areas have an additional two inches of sand added to the original fourteen inch profile. This additional two inches of sand will keeps moisture away from the surface minimizing weed seed germination. All planted areas have three inches of mulch top-dressing to effectively accomplish the same thing.

This privately funded project is slated for construction completion this coming summer. Once the project is complete members of the project team will monitor the project. Annual inspections of the septic system, regular water tests and periodic inspections of system controls will be required and will help the team learn from project successes and adjust the system as necessary to achieve maximum performance. Manufacturer representatives will also visit the site periodically to assess performance and proactively look for issues that may arise in the future. Overall maintenance levels are anticipated to be similar to other traditional methods of stormwater, irrigation and planting management. **L&W**

by Chad Kennedy, O'Dell Engineering & Elizabeth Goers, Firestone Building Products

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