GROWING KNOWLEDGE

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An ongoing series provided by Oregon State University in collaboration with the United States Department of Agriculture and in partnership with the Oregon Association of Nurseries

Rainwater harvesting systems for the Willamette Valley

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The recent trend toward more extreme periods of drought has been a shock to residents of the Pacific Northwest. Many are able to maintain their landscapes at high levels only through heavy summer watering.

This has forced people of the Pacific Northwest, and people from all around the world, to rethink their water-use strategies, as the global trend has shifted toward greater sustainability.

One potential mitigation strategy for cool-humid regions, such as Oregon's Willamette Valley, is to use rainwater harvesting systems to supplement traditional supplies. They are a logical choice for this climate zone. Although the average annual precipitation (42.7 inches in Corvallis, Oregon) is sufficient for the majority of crop production, this precipitation occurs almost exclusively in a nine-month period spanning from fall to spring. Irrigation is still required for at least three months of every year.

Our research evaluated two rainwater-harvesting systems for use in the Willamette Valley — an aboveground cistern and a belowground AQUABLOX™ matrix storage system (Figure 1). Each of these systems was set up to collect water from a roof outfitted with two identical, seamless gutters. Each gutter was fitted with a first-flush diverter — a downspout attachment that prevents particulates from entering the system (Figure 2, next page).

Figure 1. Two rainwater-harvesting systems were built at the Oregon State University's Oak Creek Center for Urban Horticulture. A pond-less waterfall system (foreground) was built next to an aboveground cistern system (background).

Aboveground system (cistern)

The aboveground system evaluated in this project was a polyethylene cistern, which represented a fundamental, low-budget system. System components include a 5,000-gallon cistern, tank gauge, floating outtake and siphon-style overflow piping.

In an attempt to keep the aboveground system as simple and carbon-neutral as possible, the pumping method used in this study was pedal power — specifically, a pump powered by the pedals of a stationary bike. However, the system could easily be adapted to an electronic pump. The aboveground system also has the benefit of being able to pump out water using gravitational forces. The total budget for this system was $3,083.

Subsurface system

The second system — an underground plastic-matrix storage system that recirculates using an aboveground waterfall feature — represents the high-tech end of the spectrum (Figure 3, page 29). This pondless waterfall storage system includes the following components: subsurface basin (4,000-gal) with structural-matrix of AQUABLOX™, ethylene propylene diene terpolymer

(EPDM) pond liner, protective geotextile underlayment, recirculating waterfall feature fed from a submersible pump, water level gauge, overflow piping, external pressure pump for dispersal, and a sump pump placed outside the tank for flood prevention.

The matrix of structurally supportive plastic blocks used in this system was topped with a permeable weed-barrier cloth and covered in round river rock to sit flush with the ground surface. The open top allowed rainwater to enter the system from the surface, thus adding to the rainwater harvesting potential.

At the surface of the pondless system, piping was installed to send excess rainwater downhill from the subsurface system. Excess dirt from the excavation was mounded next to the basin and shaped into a recirculating waterfall feature. This provided constant circulation of the stored water, thus keeping it oxygenated and clean. The budget for the second system was $12,775.

Figure 2. Seamless gutter with first-flush downspout diverter allowed the first several gallons of each rainfall event following an extended dry period to bypass the storage basin. The first flush of rainwater carried the majority of the particulate accumulated on the roof in the previous dry spell, and sent it to the storm drain as the same as a standard gutter. The diverter sealed off automatically after the first flush and started re-directing the rainwater to the cistern.

Findings and conclusions

The chief advantages of the aboveground system were simplicity and robustness. Installation took very little effort, and costs were low.

For downsides, the system takes up a decent amount of space and doesn't provide any aesthetic benefits. The stored water can also become stagnant. Even though the tank had been painted black to eliminate light from entering the water column, there was still a significant layer of slime on the inner walls of the cistern and on the floating outtake. While this had no impact on the function of the tank in the first year of operation, it was decidedly a problem that the water quality decreased (via biomass accumulation) during the storage period.

The subsurface storage system was considerably more expensive than the cistern system, at $12,775 for product and excavation services. The majority of the cost was associated with the Aquablox matrix; however, structures like these are a necessary component for maximizing subsurface storage capacity.

Another deterrent to the pond-less waterfall system is that electricity is required to power the recirculating waterfall; thus adding to the total cost of the Aquablox system. However, there is no denying the aesthetic benefit of a recirculating waterfall feature, and when considering the fact that the water remains clean throughout the storage period, it may be worth the cost.

Aboveground systems are a good choice for retrofits of existing freestanding homes, particularly in cases where aesthetics are less of a concern or the cistern's effect on site lines can be mitigated. In addition, the large amount of space taken up by the cistern precludes its use where space is limited or where space is reserved for other uses.

In contrast, subsurface storage systems are a good choice for confined spaces or where an aboveground cistern would significantly impact aesthetics. They might be more widely appropriate when installed as part of initial construction where they can be integrated into overall building design and construction, which would reduce the per-unit cost.

For more extensive detail pertaining to the above ground cistern and below ground AQUABLOX system, reference the following publication: Olsen, C. A. Kowalewski, M. Gould and J. Lambrinos. 2017. Evaluating Two Rainwater Harvesting Systems in an Urban Setting in Oregon's Willamette Valley. Journal of Green Building. 12(1):1-10.

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Figure 3. The pondless waterfall storage system makes use of EPDM pond liner and protective geotextile underlayment, with Aquablox providing structural support for the pond so it can be buried under gravel. PHOTO COURTESY OF LAKE WASHINGTON INSTITUTE OF TECHNOLOGY