2.5 Rainwater Harvesting

Photo credit: Aaron Habig, Hamilton SWCD

Description

A rainwater harvesting system captures stormwater runoff, typically from roofs, in a cistern or other storage reservoir for subsequent beneficial use. A designated water use that produces a consistent and timely drawdown of the storage reservoir must be identified as part of the harvesting system. The system may generate a non-potable water supply for toilet flushing; landscape, garden, or greenhouse irrigation; vehicle or other washing; street sweepers; HVAC or other cooling water; industrial processes; replenishing decorative water features; or other consumptive uses. A grass filter strip or other infiltrating practice may be needed to supplement the beneficial use and effectively manage the system.

In Ohio, each square foot of roof generates roughly 20 to 25 gallons of stormwater runoff each year that could be harvested for beneficial use. Harvesting any amount of rainwater, whether opportunistically with residential rain barrels or through intensive graywater plumbing systems, conserves water resources benefits the environment and delivers financial advantages. This chapter applies to rainwater harvesting systems that supply a defined, permanent, predictable, and measurable water use.

Credits

Table 2.4.1 Credits for a Green Roof Meeting the Criteria in this Chapter

Objective	Credit
Runoff Reduction Volume (RRv)	Refer to the water balance and drawdown schedule discussion for instruction on calculating RRv credit. Use the Ohio EPA runoff reduction spreadsheet to calculate RRv credits. RRv credit may not exceed the WQv for the practice.

Planning and Feasibility

The potential long-term cost-savings of harvested rainwater in comparison to publicly supplied water usually drives the decision to select this practice rather than the stormwater management needs. A rainwater harvesting system designed solely for stormwater management is less likely to be sustained long-term.

The designer must document owner acceptance of the operation and maintenance, often intensive and manual, required of a rainwater harvesting system. If the planned water usage ceases, the system will need to be replaced with another stormwater management practice unless another dedicated water use can be determined. Systems designed with multiple dedicated water uses may be more likely to have long-term success.

A harvesting system may not store all the runoff generated from the collection area. An adequate outlet must be available to receive and, when necessary, include a practice to treat runoff bypassed by the system during large storms or extended periods of rain.

Design and install a harvesting system to meet all applicable state and local building and plumbing codes. Installation may require special licensing and inspections. Most indoor uses require complete separation from the normal plumbing with special labeling on pipes and faucets. Plumbing requirements are beyond the scope of this chapter.

Design Criteria

The focus of this chapter is crediting rainwater harvesting as stormwater management. Much of the overall system design will be influenced by the dedicated beneficial use. Detail the entire rainwater harvesting system in the storm water pollution prevention plan (SWP3) including the contributing drainage area, collection system, pretreatment, storage reservoir(s), dedicated water use distribution system (excluding interior plumbing), and any secondary infiltration practice.

Dedicated Water Use and Drawdown Schedule

To be eligible for runoff reduction credit as a stormwater management practice, a rainwater harvesting system must include a dedicated end-use to regularly drawdown the harvested water. The dedicated water use must:

- be permanent or sustainable long-term,
- be a year-round demand,
- produce a consistent drawdown that will allow for capture from most individual storm events and,
- drain to a sanitary sewer after non-consuming uses (for example, vehicle wash water).

Multiple dedicated uses or a supplemental infiltration practice designed according to the proper standard may be needed to meet these conditions. Installing rain barrels on individual residential homes can collectively provide great value but is not considered permanent infrastructure with a dependable long-term use.

From the identified water use or uses, develop a drawdown schedule on a minimum daily basis over the course of a year. Document the calculations, including the assumptions and data sources, used to determine the water demand. Design systems that irrigate on the amount of water necessary to maintain healthy vegetation without resulting in runoff of the irrigated water.

Water Balance and Runoff Reduction Credits

A water balance or budget determines the quantity of runoff from the contributing area that will be captured by the harvesting system and whether it will be sufficient for the intended use. Develop an accurate water balance in terms of annual volume that accounts for:

- runoff from the impervious collection area using a runoff coefficient of 0.95,
- water losses (first flush diversions, overflows, etc.),
- available storage reservoir capacity (excluding dead storage and freeboard),
- the drawdown schedule, and
- the capacity of any secondary infiltration practice.

Use Ohio EPA's Rainwater Harvesting Spreadsheet to develop a water balance and calculate the RRv for simple systems. If a precise supply and availability of harvested water is critical to the beneficial use, calculate a water balance using a continuous-simulation or other hydrologic model capable of evaluating precipitation records and planned withdrawals on a daily or more frequent time-step. Use the most current and local 30-year record of hourly rainfall provided by the National Oceanic and Atmospheric Administration (NOAA).

Any remaining WQv associated with the contributing drainage area (less RRv) must be directed to an designed post-construction stormwater management practice.

Contributing Drainage Area

The contributing drainage area, or area from which the stormwater runoff will be collected, influences the volume and quality of water available for harvesting. In most cases, the potential for contamination from spills and leaks is reduced by limiting the contributing drainage area to roofs. A pitched roof may reduce the build-up of contaminates on the roof surface. Avoid roof materials that may leach trace metals and other toxic compounds. Membrane or metal roofs are recommended (Cabell, 2009). Collecting runoff from paved, at-grade surfaces may require pretreatment (oil/grease separator, biofiltration, etc.) and should be limited to low-risk, low-use pavement.

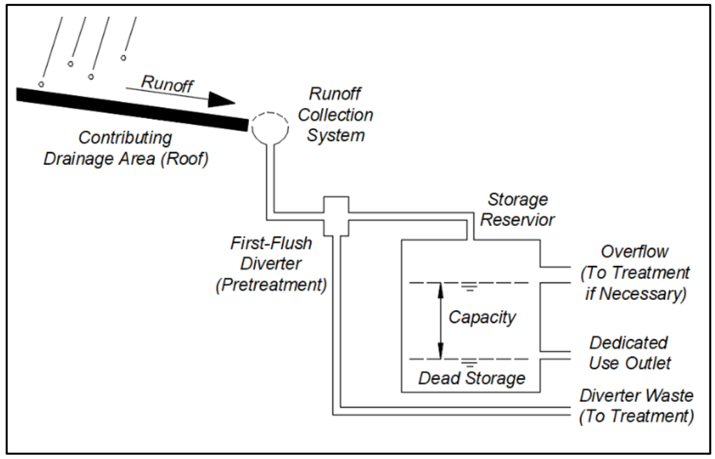

Figure 2.5.1 Schematic of a Rainwater Harvesting System (after Sample, 2019)

Runoff Collection System

The runoff collection system must have sufficient capacity to carry the design storm. Use standard sizing procedures for roof drains, gutters, and downspouts for most applications. Closed systems can further reduce the potential for contaminates to enter the system. Screens at inlets or collection points may limit clogging by leaves or debris.

Storage Reservoir

Provide a storage reservoir with the capacity to store the water volume budgeted for the planned beneficial use(s) plus any necessary dead storage or freeboard. Locate appropriately sized outlets to provide the design volume within the reservoir. An outlet directed to any secondary infiltration practices may needed to draw down storage between storm events. Provide means to completely drain the reservoir for cleaning and maintenance.

The reservoir may be above or below ground. Aboveground tanks produce hydraulic head to move water to the end use. Underground cisterns save space and regulate water temperature but must be designed to prevent flotation when empty, flooding from surface water, and conflicts with underground utilities.

Water Quality and Pretreatment

Ensure the quality of the harvested water is compatible with the dedicated end use. Laboratory testing of runoff samples may be desired if water quality is a significant concern. Consider pretreating the harvested water with a first flush diverter, roof washer, or filter system to remove sediment and other contaminates. First flush diverters should be sized to bypass 25 gallons per 1,000 square foot of drainage area (one mm of rainfall). Use a filter efficiency rate of 95 percent in design calculations.

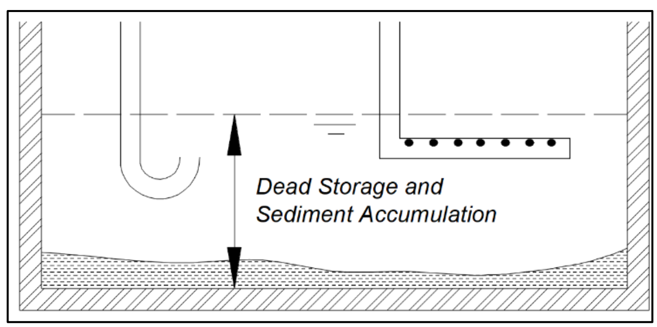

Figure 2.5.2 Illustration of Two Possible Storage Reservoir Inlet Configurations

Design a minimum of six inches of dead storage at the bottom of the reservoir to store sediment. Figure 2.5.2 illustrates inlet configurations that may help prevent re-suspending the accumulated sediment yet still oxygenate stored water, which may also inhibit the growth of harmful bacteria.

Specify proper seals for all tank penetrations and throughout the system to discourage mosquito breeding. Use screens to prevent debris, birds, and rodents from entering the reservoir. Consider a floating outlet configured draw from just below the water surface to protect from oils and floating trash. Shade aboveground tanks from direct sunlight to inhibit algae growth and moderate temperature.

Overflow

Route all flow that exceeds the capacity of the reservoir or harvesting system to a stable outlet. The reservoir overflow outlet must be equal or larger in size than the inlet. Any remaining WQv associated with the contributing drainage area after the RRv is credited must be directed to an properly designed stormwater quality management practice.

Design Considerations

Consider including a usage meter and storage reservoir water level indicator to help the landowner with managing the rainwater harvesting system.

Clearly label all faucets, hydrants, spigots, hose bibs, or other outlets supplying harvested rainwater as well as all storage reservoirs as supplying unsafe, non-potable water.

Comply with all applicable Occupational Safety and Health Administration (OSHA) and local building code. These requirements are beyond the scope of this chapter.

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