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College of Agriculture, Food and Environment
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Homeowner's Guide to Rainwater Harvesting: Rain Barrels and Beyond

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Stormwater runoff is one of the many water quality and quantity challenges in urban settings. Urbanization increases the proportion of impervious surfaces (surfaces that prevent rainfall from soaking into the ground, such as roofs and driveways) in a landscape. Greater amounts of impervious surfaces increase the volume of stormwater runoff to storm sewers and local waterways. As stormwater flows across impervious surfaces, it can transport pollutants to nearby streams and rivers.

One strategy for reducing stormwater runoff from a residential property is through water harvesting for beneficial reuse. Water harvesting can come in many forms and is a scalable concept. This publication will explore the opportunities and challenges associated with three systems for residential water harvesting: 1) rain barrels; 2) high-volume, above-ground tanks; and 3) cisterns or other large-volume, below-ground tanks. The information presented is intended to support decision-making for you as a homeowner in evaluating the potential for installing a water-harvesting system at your residence. Additional references and resources are provided at the end of this document to offer more insight and guidance on the topics covered within this publication.

Water-Harvesting Potential Analysis

One of the first steps to take when evaluating the potential for rainwater harvesting for beneficial reuse at your residence is to estimate how much water can be harvested from one or more roofs on your property. This can be accomplished by using the following simple procedure for estimating the water yield from your roof that would result from a one-inch rainfall event.

How to estimate water yield

Example: How much water could be collected from a 2,400-square-foot roof during a one-inch rainfall?

1. Determine the roof area and calculate the volume of water hitting the roof during a one-inch rainfall as measured in cubic feet, using a conversion factor of one inch of rainfall equaling .083 feet.

2,400 square feet of roof area x 0.083 feet of rainfall = 199 cubic feet of water

2. Convert cubic feet of water to gallons by using a conversion factor of 7.48 gallons per cubic foot.

199 cubic feet x 7.48 gallons per cubic foot = 1,489 gallons of water (if 100 percent of rainfall is captured)

3. Account for some loss of water during the collection process by applying a coefficient. In this example, a coefficient of 0.95 projects that 95 percent of the rainfall is likely to be captured.

1,489 gallons x 0.95 = 1,415 gallons of water

Result: The estimated amount of rain to be collected during a one-inch rainfall from a house with a roof measuring 2,400 square feet is 1,415 gallons.

The resulting value from this estimation procedure is the potential water yield from your roof during a one-inch rainfall event. This value will be needed to aid in sizing your potential system design in comparison to the potential water needs assessment that you will conduct in the next step. It is important to evaluate historic rainfall data by month to evaluate the suitability of a specific-capacity water-harvesting system to meet your needs. If you plan to use harvested water for watering landscaping plants or gardens, it is critical to evaluate monthly rainfall trends during the growing season (roughly April through October in Kentucky) versus the expected water demand. Determine the expected average inches of rainfall by month and multiply this value by the result from the water-harvesting potential analysis of a one-inch rainfall event to estimate total potential monthly yield from the roof or other catchment.

Needs Assessment

A method for estimating supplemental irrigation water need that your water-harvesting system may be able to provide is to determine the inches of supplemental irrigation water your planned landscape or garden plants will need over a specified period during one of the months of highest-expected water use. This can be accomplished by subtracting the expected rainfall from the water demand in inches for a given plant in your landscape or garden. For example, most vegetable crops require roughly one inch of water per week from rainfall or irrigation, or from a combination of the two. Convert the amount of additional water needed (beyond that supplied by rainfall) over the desired time period from inches to feet and multiply that needed amount by the area of the landscape or garden plants requiring supplemental irrigation. The result will provide an estimate of the volume of required supplemental irrigation water in cubic feet, which can then be multiplied by 7.48 to convert it to gallons of supplemental irrigation needed. This estimate could help provide insight into sizing your water-harvesting system based on a needs assessment. Compare the water-need estimate with your water-harvesting potential from the previous section and determine the feasibility for a water-harvesting system to potentially address your supplemental water needs. These values can also be utilized for guiding decisions on storage volume and system design as detailed in the following sections.

A rain barrel used for residential rainwater harvesting.
Photo by: Lee Moser

How to estimate supplemental water need

Example: How much supplemental water would be needed for a 10-foot-by-20-foot vegetable garden planted with crops that require one inch of water per week?

1. Determine the area of the garden.

10 feet x 20 feet = 200 square feet

2. Estimate the volume of supplemental irrigation needed by subtracting the average precipitation per week from the garden's weekly water requirements. For this example, we will estimate approximately 0.75 inches of water expected from precipitation per week.

1 inch of water required - 0.75 inches of rainfall = 0.25 inches of supplemental water needed

3. Convert the water measurement from inches to feet.

0.25 inches x 1 foot/12 inches = 0.021 feet of water

4. Multiply the feet of supplemental water needed per square foot by the total area of the garden.

0.021 feet x 200 square feet of garden = 4.2 cubic feet of supplemental water for entire garden

5. Convert 4.2 cubic feet of water to gallons, using a conversion factor of 7.48 gallons per cubic foot.

4.2 cubic feet of water x 7.48 gallons per cubic foot = 31.42 gallons of supplemental water needed

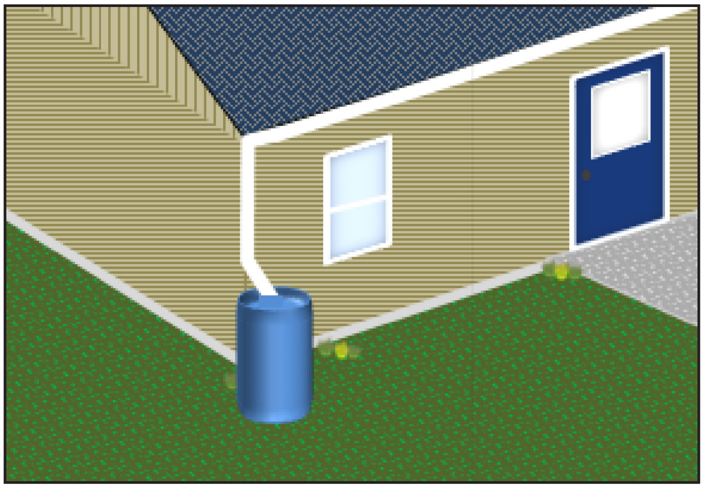
6. Add additional volume to serve as reserve capacity. Assuming the size of your catchment area can provide the amount of supplemental water required on average per week, you would want to size your storage tank to hold this volume of water with approximately 25 percent additional volume in reserve, if possible. To calculate the supplemental water needed with additional reserve capacity, multiply 31.42 gallons by 1.25.

31.42 gallons x 1.25 = 39.28 gallons of water storage capacity

Result: An estimated 39.28 gallons of supplemental water storage capacity would be needed to fill the example garden's weekly irrigation needs.

Designs to Consider

General characteristics of three residential water-harvesting systems are presented in the following section for consideration. Compare this information with the estimate of the water-harvesting potential of your roof and a general idea of the water needs assessment for your desired use to determine which type of system might be suitable for your situation.



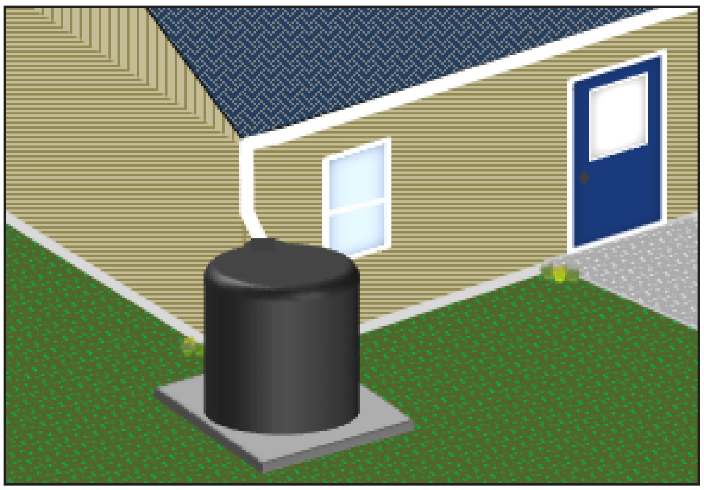
Rain Barrels

Pros

- Easy to assemble and easy to move, if necessary
- Comparatively low-cost
- Aesthetically appealing in many situations
- Multiples can be connected to increase capacity

Cons

- Comparatively low volume (most in the range of 55 gallons or less per barrel)
- Low-pressure gravity feed systems may limit distribution potential
- Potential to harbor insects
- Regular utilization needed to achieve a stormwater quantity benefit
- Winterization required



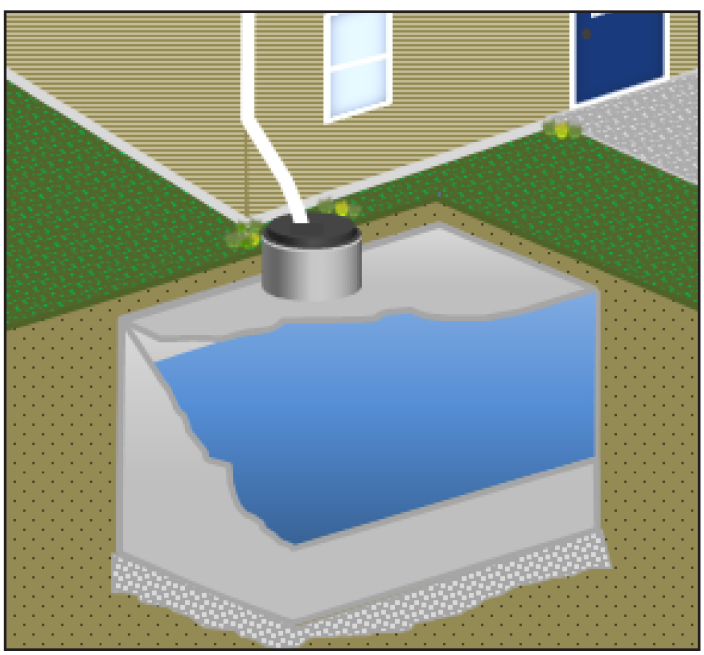
High-Volume, Above-Ground Tanks

Pros

- Comparatively high volume (can be in the range of hundreds of gallons to multiple thousands of gallons in capacity)

Cons

- Large and often difficult to move
- Aesthetically undesirable for some homeowners
- Require winterizing
- Moderate to high cost
- Likely to require some site preparation prior to installation
- Usually reliant on gravity feed, which can limit distribution potential



Cisterns or Other High-Volume, Below-Ground Tanks

Pros

- Comparatively high volume (can be in the range of hundreds of gallons to multiple thousands of gallons in capacity)
- Underground location helps regulate water temperature

Cons

- Pump required to distribute water
- Comparatively high cost
- Extensive excavation and site preparation required for installation
- Inability to move after installation (essentially permanent)
- Some components will likely require winterizing, depending on design

Siting and General Precautions

There are several precautions that should be considered prior to starting any water-harvesting project:

- Homeowners should check on any state and local ordinances, as well as neighborhood or homeowners association restrictions, that may prevent or limit residential rainwater harvesting.
- It is important to remember that water is heavy. Water weighs approximately 8.34 pounds per gallon. Any system that you design should take this into consideration.
- Site preparation may be necessary to accommodate the loads generated by large volumes of water.
- Elevated storage containers should be avoided, if possible, to avoid the risk of tipping and crushing accidents.
- Choose opaque containers and locate them out of direct sunlight to discourage algal growth.
- Non-potable water signage should be affixed to all rainwater-harvesting storage containers, and the water that is captured should only be utilized for non-potable purposes (no human consumption of harvested water).
- Always call 811 to check for utility lines in the project area prior to excavation.

Operation and Maintenance

The specific operation of each system is unique to the design and will depend on the end use of the harvested water. It is a best practice to document the design and operation of your system in case another individual may use the system. Producing a drawing of your system with all valves, pipes, and end-use points of the harvested water identified is an excellent way of documenting and communicating important operational information about your system.

Routine maintenance is required on any water-harvesting system. To maintain the integrity of the system components and the quality of water in the system, the following maintenance considerations should be observed:

- Ensure that your roof, gutters, and downspouts are free of debris to avoid potential contamination from material that may deposit in these areas.
- Barrels, tanks, and cisterns should be cleaned as needed. It is recommended that rain barrels be emptied every five to seven days to discourage algal growth. If excess debris builds up, algal growth becomes evident, or insect or pest issues become apparent, it is time to drain and clean the system.
- Install screens over inlets to reduce the amount of debris and the potential for insect or pest intrusion.
- Consider adding a clarifier or first-flush diverter to your system to further reduce potential contaminants in the system.
- Drain tanks and lines for winter to avoid freeze-thaw damage to tanks, pipes, valves, and fittings.
- Affix a "Non-potable Water" sign to water-harvesting tanks and ensure that the harvested water is only used for non-potable purposes. The harvested water is unfit for human consumption.

Summary

Residential rainwater harvesting has the potential to help address stormwater quality and quantity issues in urban areas. The three options presented in this publication should not be considered an exhaustive list of potential water-harvesting system designs. When assessing the feasibility of a design to meet your needs, it is important to consider the potential water yield from your roof, the water requirements of your non-potable water project, project budget, and the overall operation and maintenance requirements of the system in consideration. Homeowners should investigate state and local ordinances as well as potential homeowners association restrictions prior to constructing water-harvesting systems on their properties.

References and Further Reading

Building a Rain Barrel (HENV-201) http://www2.ca.uky.edu/agcomm/pubs/henv/henv201/henv201.pdf

Understanding the Water System (IP-1) http://www2.ca.uky.edu/agcomm/pubs/ip/ip1/ip1.pdf

Water Quality for Kentucky: Cisterns for Kentucky (IP-4) https://www2.ca.uky.edu/agcomm/pubs/ip/ip4/ip4.htm

Parts of a Cistern Water System (ENRI-203) http://www2.ca.uky.edu/agcomm/pubs/enri/enri203/enri203.pdf

Choosing Cistern Material and Location (ENRI-204) http://www2.ca.uky.edu/agcomm/pubs/enri/enri204/enri204.pdf

Cleaning a Cistern (ENRI-205) http://www2.ca.uky.edu/agcomm/pubs/enri/enri205/enri205.pdf

Reducing Stormwater Pollution (AEN-106) http://www2.ca.uky.edu/agcomm/pubs/aen/aen106/aen106.pdf

Off the Grid: Ultra-low Pressure Drip Irrigation and Rainwater Catchment for Small Plots and High Tunnels (HO-120) http://www2.ca.uky.edu/agcomm/pubs/HO/HO120/HO120.pdf-Stormwater (HENV-203) http://www2.ca.uky.edu/agcomm/pubs/HENV/HENV203/HENV203.pdf

Saving Water at Home (HENV-601) http://www2.ca.uky.edu/agcomm/pubs/HENV/HENV601/HENV601.pdf

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