RAINWATER HARVESTING

For Small Nurseries and Home Gardens

Fundamentals of Rainwater Harvesting

Harvesting rainwater is a conservation technique to combat increased water demand, water quality issues and scarcity of water resources. Harvested rainwater can be used for nonpotable purposes, such as irrigation, washing or flushing, and is especially useful under drought conditions. The primary components of planning and implementing harvest designs include rainfall-capturing systems, vessels for water storage and dedicated end-use for the water. There is a wide range of supplies for each of these components adaptable to the size needs of the growing operation. Prior to designing your rainwater setup, assess the materials and resources currently available to optimize the collection, storage and delivery system. Figure 1 shows the typical flow of water through a rainwater harvesting system, and this publication details the corresponding description for each step.

1. SURFACE AREAS FOR COLLECTION

1. Surface Area
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2. Leaf Screen
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3. Gutter System
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4. First Flush Diverter
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5. Primary Filtration
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6. Storage Tank
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7. Delivery System

Figure 1: Flow of water through a rainwater harvesting system.

Rooftops are the most common surface areas for rainwater harvesting. Examples include a greenhouse, left, and a residential home. Photos by M.P. Hayes

There are many surface areas where rainwater can be collected with the most common being homeowner's rooftops or nursery greenhouses. The structure that is used dictates the setup of your catchment system and determines the materials needed for the project. For instance, rooftop collection areas can modify existing gutters or drainage systems to divert water directly to a storage tank for use. All types of roofs can be used to collect water, but one should pay attention to debris that may come from asphalt and shingles compared to other materials like metal roofs. Leaf screens can be placed on gutter systems to prevent clogs and large debris from reaching the storage container. This will add an area of emphasis for cleaning and maintenance during the year. The slope of the roof will also affect environmental contaminants. Steep roofs will have a quick first flush of possible contaminants that will be alleviated by the diverter before entering the storage tank. If the roof is flatter, it may have a more delayed flushing of contaminants and make removal more difficult.

2. LEAF SCREEN

Leaf screens are used to remove debris that comes off roofs and could result in contamination of the stored water. These mesh screens are typically ¼-inch-square wire frames that fit on the gutter to prevent large pieces of debris from entering the collection systems. The use of leaf screens is encouraged even if trees are not surrounding the catchment surface. Installation of mesh screens will require additional maintenance throughout the year to clean obstructions to let water flow into the gutter systems.

3. GUTTER SYSTEM

Existing gutter systems can easily be transitioned to collected rainwater. Standard residential gutters are 4 to 6 inches wide while commercial building gutters can range from 6 to 12 inches depending on surface area drainage. Downspouts for gutter systems will correspond to gutter volume. In areas of typical rainfall, downspouts are spaced every 25 feet. For downspouts, every 100 square feet of roof area provides 1 square inch of downspout area (e.g., a 2-by-3-inch downspout is 6 square inches and can accommodate runoff from a 600-square-foot roof). Newly installed gutters and downspouts should be sized based on runoff from a 100-year storm event. While aesthetics may not be a major factor, the final installation of the gutters is important to minimize future maintenance. Gutter hangers should be installed every 3 feet to bear the added weight from debris, buildup and clogs from leaf screens.

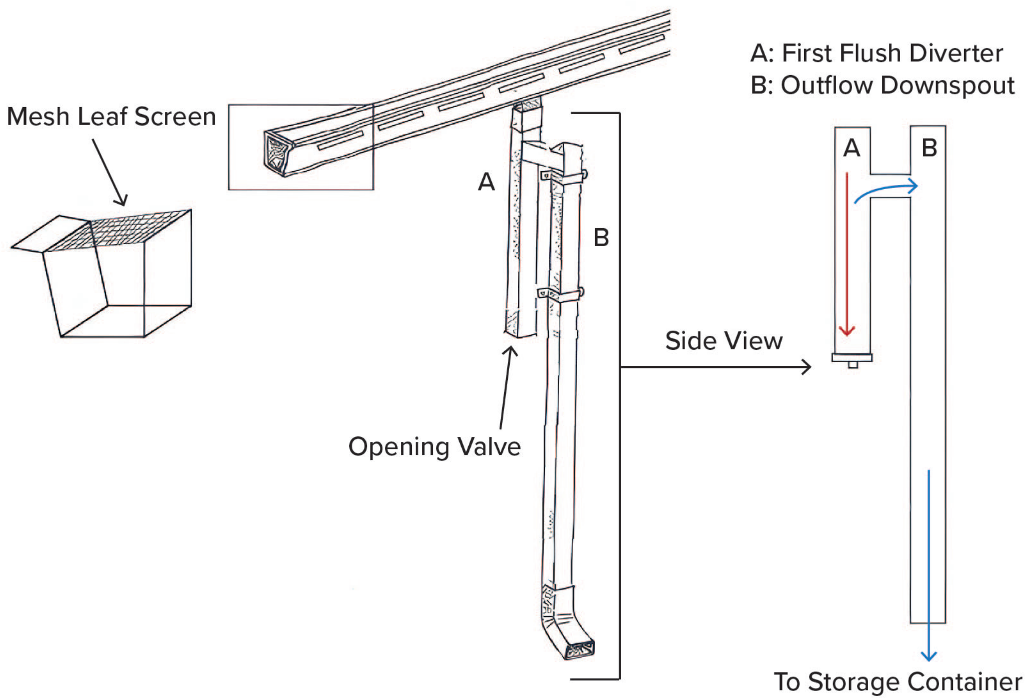

Figure 2: Schematic of leaf screen, gutter system and first flush diverter. Diagram by M.P. Hayes

4. FIRST FLUSH DIVERTER

The first flush diverter routes the initial flow of water off the roof to a catchment pipe. While larger debris will be removed by the leaf screen, smaller contaminants (rocks, bird feces, dirt, moss, etc.) will be collected and kept from entering the storage tank. This pipe will need to be maintained regularly and cleaned. Opening the valve will flush contaminants and provide more volume for the first flush. It is a best practice to open the valve after each large rain event to remove concentrated contaminants and small debris. There are many types of first flush diverters with the most common being called roof washers or PVC standpipes. The diverter takes as long as possible to collect a large volume of water. The general first flush diversion should be a minimum of 10 gallons per every 1,000 square feet of collection surface for a 1" rainfall. This varies per area depending on the amount of contaminants on the roof surface, the number of dry days, the extent of tree overhang and the season. During seasons of continuous rainfall, the first flush diverters can be cleaned less frequently.

5. PRIMARY FILTRATION

The primary filter system is typically used for drip irrigation systems but is a best practice to maximize contaminant removal. Most roof washer units have 30-micron filters associated with the unit, but homemade filters can also be crafted from air and dust vent filter material. Using dust or air filters can be a practical solution and can help remove larger particulate matter and debris from rainwater, preventing clogs and damage to irrigation systems or other non-potable water applications. Additionally, filtration foam rated on a scale of pores per inch (PPI) also can be utilized. The lower the PPI, the larger the holes. Types of filters on the market include string and paper sediment filters and PPI foam filters (both in a variety of micron sizes) or to absorb more compounds. A charcoal and carbon block filter (typically rated for 1-10-micron size particles). The filter system should be positioned before the storage tank to ensure contaminants do not reach the final rainwater used for irrigation. Primary filter systems prevent sludge material from collecting in the storage tank and provide for easier and quicker periodic cleaning. The frequency of inspecting and replacing rainwater system filters depends on rainwater quality, filter type, environmental conditions and system design. In general, regular quarterly inspections of filters will help gauge maintenance needs, with design and local factors influencing the schedule.

6. STORAGE TANK

Selecting the proper size storage tank for your rainwater collection system depends on the average amount of rainfall, roof surface area, water demand for the garden/nursery and budget. There are many different products or recycled materials that can be used for water storage. Containers that have previously contained toxic materials should not be used for rainwater collection. Some commercially available rain barrels are manufactured with overflow and venting ports. The most affordable and available storage tank solutions for homeowners are 50- or 75-gallon, food-grade barrels. These barrels would require slight modifications including screens, venting ports and spigots. To follow best practices for selecting rainwater storage containers, the container should be:

1. Opaque to sunlight to inhibit algae growth.
2. Covered and have vents screened to discourage infestation by insects and other critters.
3. Accessible for cleaning and/or repair.
4. Close to the irrigation site.
5. Elevated as high as possible (without sacrificing ease of maintenance) to reduce the load on the pump.
6. Pointing the overflow outlet away from the house foundation or septic drains.
7. Placed on a stable, strong foundation due to the weight of water.

Types of opaque rainwater storage containers vary from 50 gallons, front left, to 325 gallons, middle, to 1,550 gallons, back. Photo by M.P. Hayes

7. DELIVERY SYSTEM

The two most common water delivery systems are gravity-fed and pump-fed. The use of these systems varies on the location of rainwater storage tanks, areas of water use and scale of the operation. If the water storage container is elevated higher than the watered area, gravity-fed pipes offer an easy design and low energy opportunity. If water cannot be gravity-fed, pumps can be used to move water across the site. Selecting a pump for delivery should take into consideration on-demand pumps with built-in pressure maintenance capabilities to maintain even flow during the watering process. These units will have the following components: pump, motor, controller, check valve and pressure tank. Most pumps are self-priming with specific models dedicated to rainwater harvesting. When using pumps, always incorporate filters (fine 3 to 5 microns) to prevent clogging or damage to the pump. Maintenance will be required, but using filters and self-priming pumps that can run safely if the tank is dry will prolong the life of the pump. When deciding the size pump to fit your needs, take into consideration elevation, irrigation (sprinkler, hose, etc.), length of water movement and power capacity. Smaller solar panels can be used to provide energy to low-horsepower pumps for easy use in rainwater collection systems.

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