**Greenville County Technical Specification for:**

# WQ-18 RAINWATER HARVESTING

## 1.0 Rainwater Harvesting

### 1.1 Description

Rainwater Harvesting BMPs are generally used to retain a predetermined volume of rooftop runoff. Rain Barrels are applicable to residential and small commercial sites. Cisterns are usually larger making them more applicable to commercial/ industrial sites as they can be placed under lots or other impervious surfaces. Dry Wells function as infiltration systems to control runoff from building downspouts or as modified catch basins to catch direct surface runoff.

### 1.2 Rainwater Harvesting Components

Rainwater Harvesting is the collection and storage of rainwater for later use. The basic components of a Rainwater Harvesting system are:

- Catchment surface (roof, patio)
- Conveyance system (gutters and downspouts)
- Storage (Cistern or storage tank)
- Delivery system (gravity fed or pumped to end use)
- Treatment & Purification (leaf screens, filters, first flush bypass, etc.)

#### 1.2.1 General Design Requirements

Estimating the supply of rainfall is based on catchment area, rainfall amount and system efficiency. When calculating the catchment area, use the projected area or roof footprint, not surface area. The footprint is calculated as the horizontal surface area covered by the collection surface regardless of the pitch of the roof (length times width of the roof from side to side and front to rear). If only one side of the structure is guttered, only the area drained by the gutters is used in the calculation.

**Conveyance System:** The conveyance system generally refers to the gutters and downspouts. Pay special attention to the sizing and maintenance of gutters and downspouts to minimize overrun and loss of capacity due to debris. Install gutters to slope towards the downspout and ensure the outside face of the gutter is lower than the inside face to encourage drainage away from the building wall. Install debris filters in the gutters, downspouts, or entrance to the storage container.

**Storage:** The sizing of Rain Barrels and Dry Wells is determined by the supply of rainwater, demand, aesthetics, personal preference and budget. A number of methods are used for sizing Cisterns. One simple way is by quarterly demand. Calculate the demand for water over the three month period of highest use. While demand gives the amount of water needed, supply is governed by the amount of rain that actually falls. Therefore, the tank is sized so the supply of rainwater meets or exceeds the demand and in turn, the demand is not unreasonable based on the rainfall history of the area. Also due to gutter losses, first flush and other losses, most rainfall collection systems are assumed to be between 75% to 90% efficient.

The volume of water harvested can be estimated from the following equation.

$$V = P \times CA \times EFF \times 0.62 gal/in/ft^2$$

Where V is the volume of rainfall harvested in gallons, P is the rainfall depth in inches (average annual, monthly, quarterly, etc.), CA is the catchment area in square feet, and Eff is the system efficiency expressed as a decimal (0.75 to 0.90).

**Delivery System:** The delivery system is either be gravity fed or pumped. If the storage device is high enough, a gravity system is used, however with underground systems this is usually not the case. An operating pressure of 20- to 30-psi is generally required for irrigation. Water gains 1-psi for every 2.31-ft of vertical height so to generate 30-psi, the tank needs to be located 70-ft above the outlet. As that degree of separation is impractical, systems are generally pumped using a bladder tank or on demand pump.

Bladder tanks are similar to systems used by well owners. Water is pumped into a pressurized tank which provides a limited volume of pressurized water for instant use. The tank is refilled by the pump as needed with a one way check valve between the pump and tank to keep the tank pressurized. The pumps are generally ¾ to 1-HP pumps and the typical bladder tank holds 5 to 10-gallons. On-demand pumps eliminate the need for a pressure tank. These pumps combine a pump, motor, controller, check valve, and pressure tank function all in one unit. They are self-priming and are built with a check valve incorporated into the suction port. As pumps push water rather than pull it, they are sited as close to the Cistern or storage tank as possible.

**Treatment and Purification:** The level of treatment needed for harvested rainwater is based upon its intended use. Limited treatment (filtration) is needed for irrigation applications; a higher treatment level including disinfection can be performed in addition to filtration to make the water potable. No Federal or State standards currently exist for harvested rainwater quality, although State standards may be developed in the future. Rainwater harvesting for potable drinking water systems is not currently allowed for Greenville County.

Use gross filtration to screen out large contaminates like leaves and other debris. A number of filters are available including:

- Leaf Screens: a wire mesh screen placed above the entrance of the downspouts to strain out leaves and other debris
- Leaf guards: ¼" wire screen in a wire frame that fits along the length of the gutter. These are usually only necessary in areas with tree overhang.
- Downspout funnel: A PVC or galvanized steel box fitted with a brass screen installed in the downspout above the highest level of the storage tank. This allows for easy cleanout and maintenance.
- Strainer Basket: a spherical mesh basket place in the entrance of the downspout to strain out debris.
- Filter Sock: a nylon sock that fits inside the downspout to catch leaves and other debris.
- Charcoal Filter: A charcoal filter at the bottom of the downspout to filter debris and other contaminants.

## 1.3 Rain Barrels

Rain Barrels are aboveground storage vessels that capture runoff from roof downspouts during rain events and store that runoff for later reuse for irrigating landscaped areas. Rain Barrels are low-cost, effective, and easily maintainable retention devices applicable to residential and commercial/ industrial LID sites. Rain Barrels operate by retaining a predetermined volume of rooftop runoff; an overflow pipe provides some detention beyond the retention capacity of the Rain Barrel.

### 1.3.1 Rain Barrel Design Requirements

The size of the Rain Barrel is a function of the rooftop surface area that drains to the barrel, as well as the inches of rainfall to be collected. Use the volume calculation in the Rainwater Harvesting section of this Specification to determine the total required storage volume based on the water quality rainfall depth. Select appropriately sized Rain Barrel which can retain the calculated storage volume. The storage volume can be increased by connecting barrels. In addition to selecting appropriately sized barrels; all Rain Barrels meet the following design requirements and guidelines.

- Include filtration screens on all gutters draining to Rain Barrels to prevent clogging with debris.

- Rain Barrels are equipped with a drain spigot that has a garden hose threading, suitable for connection to a drip irrigation system.
- Provide an overflow outlet that does not backup the conveyance system to bypass runoff from large storm events.
- Rain Barrels are designed with removable, child-resistant covers and mosquito screening on water entry holes.
- Install barrel using the instructions that came with the barrel.
- Install the barrel and secure on a stable foundation.
- Elevate the barrel to allow the water to drain out by gravity flow

### 1.3.2 Rain Barrel Maintenance

Periodic maintenance activities for Rain Barrels include removing debris that collects on inlet screens, leaf guards, or other filtering devices; if the debris includes roofing materials, place it in the trash; if the debris is mainly dirt and vegetation, place it in a green waste container. Annual maintenance activities include cleaning the barrel; do not dump water in the barrel onto a driveway, sidewalk, or street; clean the barrel over lawn or other permeable area.

## 1.4 Cisterns

Cisterns are roof water management devices that provide retention storage volume in underground storage tanks. On-site storage of stormwater also provides an opportunity for water conservation and the possibility of reducing water utility costs through rainwater harvesting. Cisterns are applicable to residential, commercial, and industrial LID sites. Commercial and industrial sites may require larger-capacity Cisterns due to the size of rooftops, the amount of imperviousness of the drainage area, increased runoff volume and peak discharge rates for. Individual Cisterns can be located beneath each downspout, or storage volume can be provided in one large, common Cistern.

### 1.4.1 Cistern Design Requirements

In most cases, it is not practical to capture all of the water quality treatment volume using Cisterns as the required volumes may be impractically large. The effectiveness of a Cistern for reducing runoff volumes and peaks depends on the Cisterns effective storage capacity which varies depending on storm frequency and use rates of harvested rainwater. Cistern applications approved by Greenville County Land Development Division are required to meet following design requirements.

- Provide Cistern size, layout, drainage calculations, and harvested rainfall usage plan.
- Ensure Cisterns are equipped with an overflow which discharges into an appropriate area that is not a septic field and does not affect the foundation of any other structures.
- Place Cisterns on a stable, level pad of sufficient strength to support Cistern with a full tank of water. When the condition of the soil is unknown, enlisting the services of a geotechnical engineer may be in order to ensure the stability of the soil supporting the full Cistern weight.
- The highest level of the Cistern is at least 1-ft lower than the lowest downspout outlet to prevent surcharging of the gutter system.
- Anchor underground systems into the ground to guard against flotation if the soil becomes saturated and the tank is empty.
- Position the Cistern such that runoff from other parts of the property or from the tank overflow does not undermine the pad. Check the pad or bed after intense rainfall events.
- Cover all vents with mosquito screening to discourage breeding of mosquitoes.
- Above ground Cisterns are opaque, either on purchase or painted later to inhibit algae growth.
- Do not use containers previously used to store toxic materials as Cisterns.

### 1.4.2 Cistern Maintenance

The following maintenance guidelines are required for all Cistern applications:

- Inspect Cisterns, associated pipes, and valve connections for leaks.
- Clean gutters and filters of debris that has accumulated and is obstructing flow into the Cistern.
- Check Cistern for stability and anchor if necessary.
- Stabilize slopes in the vicinity of the Cistern using appropriate erosion control measures soil is exposed or erosion channels form.
- If Cistern is underground, ensure the manhole is accessible, operational, and secure.
- Remove sediment and debris accumulation near inlet and outlet structures.
- Remove any evidence of visual contamination from floatables such as oil and grease.
- Stabilize/repair minor erosion and scouring with gravel.
- Replace broken screens, spigots, valves, level sensors, etc.
- Clean and remove accumulated sediment annually.

## 1.5 Dry Wells

A Dry Well consists of a small excavated pit backfilled with aggregate, usually pea gravel or stone. Dry Wells function as infiltration systems used to control runoff from building rooftops. Another special application of Dry Wells is a modified catch basin, where inflow is a form of direct surface runoff. Dry Wells provide the majority of treatment by processes related to soil infiltration, including adsorption, trapping, filtering, and bacterial degradation.

### 1.5.1 Dry Well Design Requirements

The Dry Well size is determined by the Darcy equation for the water quality volume rainfall depth. In addition to sizing the Dry Well, Dry Well installations meet the following design requirements:

- Dry Wells may range from 3-12-ft in depth.
- Dry Wells completely drain within 3 days from a water quality rainfall event.
- Underlying soils have a permeability range from 0.26-0.5 in/hr.
- Backfill for drywell consist of 1 ½ - 3-in. clean aggregate surrounded by filter fabric.
- Place screens on top of roof leaders.
- Provide an overflow outlet that does not backup the conveyance system to bypass runoff from the 10 year 24 hour rainfall event.
- Provide an observation well, constructed flush with the ground surface with a cap and lock.
- Bottom of the well is a minimum of 2-ft above the seasonal high water table.

### 1.5.2 Dry Well Maintenance

Periodically inspect Dry Wells to ensure the structure allows adequate infiltration of rainwater. Remove and replace Dry Wells if infiltration rates are reduced significantly or if ponding water frequently occurs.

## 1.6 IDEAL Modeling

To facilitate use of the IDEAL model, the table below shows how to represent this BMP and BMPs similar to this one. It lists the parameters needed to successfully run the model and the parameters that affect the trapping efficiency of the BMP.

**Table 1: IDEAL Modeling Guide**

| Cistern Modeling in IDEAL | | |
|---|---|---|
| What to Model as in IDEAL | Cistern | |
| Similar BMP | Rain Barrel | |
| Specifications Needed for IDEAL | Size of the cistern or rain barrel | |
| | Specifications of the pipe entering the cistern- diameter, length, slope, head on the pipe, Manning's roughness coefficient, entrance loss coefficient, bend loss coefficient, and number of bends | |
| | Use characteristics- daily water use, area to be irrigated, or size of gravity drain | |
| Parameters that Drive Performance | Feature | How Value Affects Sediment Trapping Efficiency (TE) |
| | Size of cistern | Increasing size increases TE |
| | Use | Increasing amount of water used increases TE |

## 1.7 References

City of Indianapolis. Stormwater Design and Specification Manual. 4.3 Cisterns and Rain Barrels

Low Impact Development Center, Inc. Urban Design Tools Low Impact Development. Rain Barrels and Cisterns

Pennsylvania Stormwater Best Management Practices Manual Chapter 6. BMP 6.4.6 Dry Well/Seepage Pit. December 30, 2006