



Collecting
and storing
rainwater
at your home,
school, or
community
garden

Rainwater Harvesting Guide



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Table of Contents

Introduction to Rainwater Harvesting	2
Why Harvest Rainwater?	3
Reducing Pollution	
Conserving Water	
Educating the Public	
Designing Your Rainwater Harvesting System	6
System Components and Placement	
Sizing Your Tank	
Materials Needed for Your System	
Where to Get Supplies	
Building Your Rainwater Harvesting System	12
Constructing Your Platform	
Installing Your Tank	
Anchoring Your Tank	
Plumbing Your System	
Leaders and Downspouts	
Winterizing Tees and Diverters	
Filtration Systems	
Overflow Systems	
Rain Gardens	
Drip Irrigation	
Aesthetics	
Signage	
Maintaining Your Rainwater Harvesting System	
Seasonal Maintenance	
Frequently Asked Questions	24

COVER: GrowNYC's Governors Island Teaching Garden (top) and a rainwater harvesting system at the New York Harbor School (bottom)

About this Guide

THIS RAINWATER HARVESTING GUIDE will teach you how to design and build a system to collect and store rainwater for a school, community garden, or your own backyard. By building your own rainwater harvesting system, you can help conserve water, reduce pollution in our ecosystems, and educate others about the environmental benefits of rainwater harvesting.

Since 2001, GrowNYC's Garden Program has worked to build and maintain rainwater harvesting systems in community gardens across New York City. This work has included constructing low-cost rainwater harvesting systems, leading educational workshops for community groups, and assisting community gardeners in identifying alternate water resources. The New York State Department of Environmental Conservation recognized GrowNYC's rainwater harvesting efforts with The Environmental Excellence Award in 2006.

Research, writing, and photos for this guide were contributed by Lars Chellberg, Spencer Harbo, Julia Leung, Lenny Librizzi, and Mike Rezny. Additional green infrastructure resources, guides, and videos are available at www.grownyc.org/green-infrastructure

Introduction to Rainwater Harvesting

Rainwater Harvesting (RWH) is the practice of collecting and storing rainwater for future use. RWH techniques have been used by many different cultures throughout human history, with ancient cisterns dating back thousands of years. The practice of rainwater harvesting has been declining as urbanization has demanded a more centralized water supply system. But, due to water pollution, drought, and increasing



Rainwater harvesting tank at Garden of Happiness in the Bronx.

water demands from a growing population, rainwater harvesting has once again become an important component of our built environment and a way to help create more resilient and sustainable cities.

Today, rainwater harvesting techniques are being used in urban parks, community gardens, and other outdoor spaces to conserve water and reduce pollution. RWH systems come in many different shapes and sizes. They can be

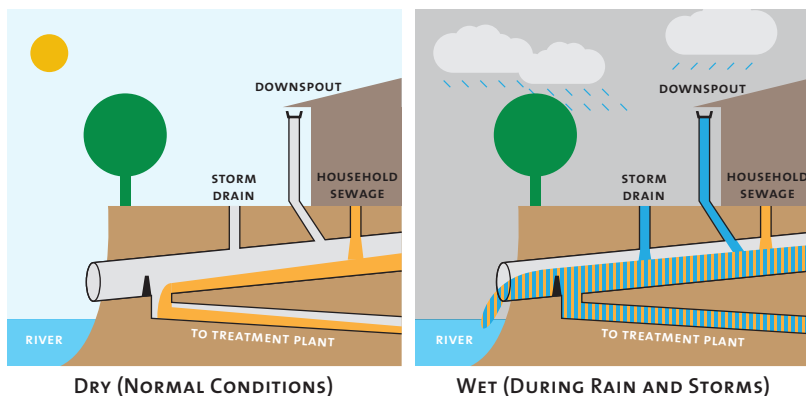
anything from a simple plastic barrel collecting from a building's gutter, or a complex underground storage system incorporating bioswales and rain gardens. Most of the RWH systems in New York City's community gardens range in size from 300 to 1,000 gallons but can be as small as 60 gallons or as large as 10,000 gallons.

Why Harvest Rainwater?


Reducing Pollution:

New York City and other urban environments are covered by the impervious surfaces of buildings, streets, and sidewalks. Because of all the infrastructure in cities, water cannot easily be absorbed into the ground when it rains. Instead, it runs across pavement, picking up oil, street debris, and other contaminants along the way. Many older cities, including NYC, use a combined sewer system where the same pipes are used to transport both storm water and household waste to sewage treatment plants. These pipes overflow when treatment facilities are overwhelmed during storms, releasing combined storm water and sewage into surrounding bodies of water in what is known as a combined sewer overflow (CSO). Untreated sewage from CSOs can carry disease-causing pathogens and nutrient-rich organic material that are harmful to both humans and the environment.

Because of all the infrastructure in cities, water cannot easily be absorbed into the ground when it rains.



Combined sewer overflow occurs during heavy rain events.



Using rainwater for activities like urban agriculture can help conserve water resources.

Conserving Water:

In addition to reducing pollution, collecting rainwater can also help to conserve a precious and limited resource. Instead of relying on our public water supply to water grass, trees, or a garden, individuals and cities can use readily available rainwater that is collected and stored on site. This practice can help relieve the stress that we put on our reservoirs, while also helping residents and city governments save money on water costs.

Educating the Public:

An additional benefit of rainwater harvesting practices is the potential to educate the public about water pollution and conservation issues. Many city residents are not aware of where their water comes from or where it goes after they use it. RWH systems that are visible to the public provide opportunities to engage residents in conversations around the issues we face with pollution from CSOs, how much water we use in our homes, gardens, and cities, and the strategies we can all use to reduce our water consumption and help conserve this limited resource.

By starting with rainwater harvesting in our neighborhoods, we can help lead a path forward to healthier ecosystems and sustainable water management in New York City and beyond.

While the installation of a single RWH system may not alone have a significant impact on water conservation or pollution, rainwater harvesting can be an important element of conserving our freshwater resources and keeping our local waterways clean. Other pieces of this puzzle may include installing permeable pavement, adding green roofs to buildings, and separating stormwater and wastewater systems to prevent CSOs. By starting with rainwater harvesting in our neighborhoods, we can help lead a path forward to healthier ecosystems and sustainable water management in New York City and beyond.

Educating New York City students on Governors Island



Designing your Rainwater Harvesting System

During a rainfall event, water from a nearby gutter flows into the downspout. Instead of the water flowing directly into the sewer system, the rainwater is diverted into a pipe that flows into the storage tank. Frozen water can lead to a cracked tank or pipes, so it's best to divert water to the sewer or overflow in the winter when rainwater is generally not needed for garden usage.

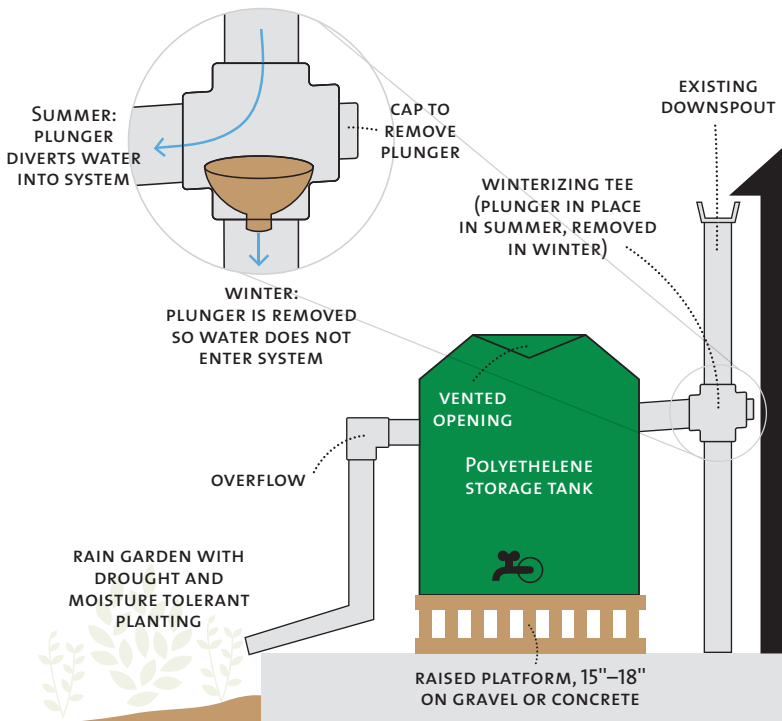


Diagram of a typical rainwater harvesting system.

System Components and Placement:

Rainwater can be collected from the roof of a building, shed, or other structure. All rainwater harvesting systems should have four main components: (1) a collection surface; (2) gutters and a downspout; (3) a storage tank; and (4) an overflow system.

The first step of your RWH system construction is to make a plan drawing. The plan drawing considers the location of the downspout and the amount of space available. Here are some issues that should be considered in your planning:

- The best place to position your barrel is against a stable wall, on level ground, close to the downspout.
- Gravity moves water downhill. Be sure there is available space for a downward pitch in all gutters and pipes. Consider the height of the tank when doing calculations.
- The overflow pipe should be positioned near the top of tank, and can lead into a rain garden if possible.
- The spigot should be at the barrel's lowest point.

RWH tanks should be positioned in a stable part of the garden where they can easily be hooked up to a downspout and accessed for water.



- If there is not already an existing roof to collect from nearby, a shed, shade structure, or other outbuilding can be constructed. Plans can be found online or at your local hardware store. One possible design is a winged structure. Visit our website (www.grownyc.org/gardens) for plans to design your own winged shade structure.



The roof of this winged shade structure pitches toward a central gutter that leads into a rainwater tank.

Sizing Your Tank:

The proper size of your RWH tank is determined by two factors:

1. The surface area of the roof, which determines how much water can be collected, and
2. The size of the garden and types of plants, which will give you a general idea of how much water is needed.

Generally, rainwater systems can collect approximately 0.5 gallons of water per inch of rain.* For example, a 10x12' roof will collect approximately 60 gallons of water from one inch of rain: 120 ft² x 1 in. x 0.5 gallons per foot = 60 gal.

Catchment Area (ft ²)	x	Rainfall (inches)	x	0.5 (gallons per ft)	=	Harvested Water (gallons)
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Use this formula and your region’s average rainfall numbers, combined with your estimated water needs, to determine the approximate size of your rainwater harvesting system. Pay attention to the slope of the roof and location of your downspout to determine which part of the roof is your catchment area.

**The conversion factor from catchment area to gallons collected is 0.623 (one cubic inch) per square foot. We use 0.5 gallons per square foot here because most systems will collect only 75-90% of the water that falls on a catchment area.*

Materials Needed for Your System:

While every rain water harvesting system is different, they all have similarities in how they are designed and constructed. Here is a list of materials you may need to build your RWH system:

Rainwater Storage System:

- Tank(s): for storing rainwater.
- Bulkhead fittings: to connect your tank(s) to your plumbing.
- Platform material such as treated lumber, plastic lumber, or concrete blocks: for elevating your tank(s).
- Eyebolts and rope or cables: to secure the tank(s) to your platform.
- Spigot: to distribute stored rainwater to a watering can or irrigation system.



This tank is anchored to a wooden base with eyebolts and rope. A spigot is connected by a bulkhead fitting.

Gutters and Plumbing:

- Gutter, with hangers, fasteners, and sealant: for connecting and mounting your gutter system.
- Downspouts (leaders), and bends (PVC or aluminum): for bringing water from the gutter into the system.
- Appropriately sized PVC pipe and fittings: for carrying water from the leader into your tank(s).
- PVC cleaner and cement: for permanently connecting PVC pipes to each other.
- Teflon plumbers tape: used on bushings, spigots, and bulkhead fittings to lubricate and seal threaded parts.



Some of the tools needed for installation.

Tools:

- Drill with appropriate bits: to make tank openings and for fastening gutter parts.
- PVC saw and hacksaw: for cutting PVC, gutter, and downspouts. This can also be done with a reciprocating saw and appropriate blades.
- Hole saw or jigsaw: if you need to make larger tank openings to install bulkhead fittings.
- Tin snips and hacksaw: to cut aluminum gutter when needed.
- Crimping and cable-cutting tools: if you are using cable instead of rope to tie the tanks down.

Where to Get Supplies:

Rainwater tanks and plumbing materials can be purchased locally to avoid high shipping costs. If you can't find local tank suppliers, search online for regional suppliers. Other materials and the tools to build your system can be found at most local hardware stores.

In New York City, 60-gallon barrels are available for free in select neighborhoods through the Department of Environmental Protection (DEP).

In New York City, 60-gallon barrels are available for free in select neighborhoods through the Department of Environmental Protection (DEP). You can contact your local elected official to find out if your neighborhood is giving out these rain barrel kits or reach out to GrowNYC (www.grownyc.org) to learn more about where to get barrels and other materials.



DEP rain barrels at a Brooklyn school garden.

Building Your Rainwater Harvesting System

Constructing Your Platform:

- The first step to installing a RWH system is building a platform for your tank. Platforms keep tanks level, make it easier to access water, and increase pressure to hoses and irrigation systems.
- A stable arrangement of cinder blocks makes a great platform for 60-gallon tanks but is not ideal for larger tanks as the blocks can easily shift.
- Pressure-treated 4x4" lumber laid out in alternating rows is a great option for a platform.
- Be sure that your platform is strong enough to withstand a lot of water. Tanks are light when empty, but a full tank can weigh thousands of pounds. Better to overbuild a strong platform than to underbuild a platform that will buckle under the weight of a full tank.
- Level and compact the soil where the tank will sit. A few inches of compacted crushed stone is optional and helps with leveling and drainage beneath the platform.

12



Alternating rows of 4x4" lumber makes a great base for any size tank.

Installing Your Tank:

- Tanks for home or community gardens are most commonly made from polyethylene plastic. Tanks can also be made from cement, metal, ceramic, even flexible bags.
- The tank system includes the spigot, the inflow pipe, the overflow pipe, the lid and the platform the tank rests on.
- A variety of connections, or bushings, can be used to connect the spigot to the tank. Use as few reducer bushings as possible to connect the spigot.
- Some tanks come with bulkhead fittings installed for the inflow and overflow plumbing. For those that don't, a hole saw can be used to cut the needed hole in the barrel.

Anchoring Your Tank:



Tanks should be securely tied to your platform, whether using rope or steel cable.

- Tanks and barrels are light when empty and should be secured to the platform to prevent movement and tipping.
- For smaller barrels, nylon rope tie-downs are a quick and easy method to secure your tank. Braided 3/8" rope is best for this application. The rope crosses the top of the tank or barrel and is tied to 1/4" or 3/8" eye bolts screwed into the wood base (see photo).
- With large tank systems it is generally preferable to utilize a steel cabling tie-down system. A loop is made to fit so that it can sit near the top of the tank without sliding down. From this loop, four additional cable pieces extend downward to eye bolts at the base of the tank.
- You will need 3/16" cable and 3/16" aluminum swage sleeves for cable attachment, steel turn buckles for tensioning the cable, steel eye bolts for attachment at the base, and 3/16" steel thimbles to protect the cable where it contacts turn buckles and eye bolts. You will also need a dedicated cable cutting tool and a swage tool.

Plumbing Your System:

- PVC (polyvinyl chloride) is common plumbing material in RWH systems because it is inexpensive, durable, and easy to assemble. PVC plumbing is also very customizable. The same pipes and connections can be used for many different functions.
- It is best to lay out your plumbing system before installing. This can be done in the aisle of your hardware store to ensure that you'll have everything you need when you build your system.
- To join PVC pipes together, use PVC-specific cleaner and cement. PVC cleaner, generally called primer, removes dirt and melts the surface for ultimate adhesion. After the pipe is clean, you can use PVC cement to join the two pieces together.
- Only apply cleaner and cement to the outside part of the male piece and the inside part of the female piece.



This RWH system on Staten Island required various PVC pipes and connecting pieces.

- It is important to hold the two pieces together for 20 seconds after applying the cement because they may move apart. After 20 seconds, the two pieces will be permanently joined, so double check all lengths and angles before joining.
- Use a hard, level surface such as a concrete floor to help you align pipes. A felt-tip marker is often useful to indicate the points where one pipe must meet the other.
- Use bushings and reducer fittings when it is necessary to transition from one size pipe to another.
- When using threaded bushings and connections, plumber's tape is necessary to lubricate the threads. Roll the tape starting at the end of the male thread bushing towards the middle. Two or three wraps are sufficient.



Elbows were used several times for this system.



A rubber coupler was used here to connect two pieces of piping.

- Pairs of 45° elbows can produce almost any twist or angle desired.
- It is also possible to shorten the PVC pipe by cutting and reconnecting it with a rubber coupling. Rubber couplers also allow disconnection at points where that might be desirable.



This leader is pitched so that water will flow into the tank.

Leaders and Downspouts:

- Once your system is designed and the tank platform is in place, you can begin connecting your leaders, which are the series of pipes that lead to your tank.
- Remember to put a downward pitch on all pipes. During installation, use a level or have someone visually check that all of your pipes are pitched. It's important that harvested water travels through pipes that are pitched toward the tank.
- There are several ways to connect your leader to your tank. Insert the existing downspout into a PVC fitting or connect the downspout directly to the rain barrel.
- It is a good idea to anchor pipes to your platform or nearby structure. Pipes that are directly against the wall of a building can be secured to the wall using plumber's strap, brackets, and specialized leader straps attached with concrete screws.

Winterizing Tees and Diverters:

The purpose of the winterizing tee is to allow the water to be directed away from your tank during freezing temperatures, which can cause tanks and pipes to break. A simple winterizing tee can include a removable plunger head. The plunger head directs water toward your tank when it is installed and allows water to flow straight into an overflow pipe when it is removed. Store-bought diverters may include a filter system that catches debris when in use (see photo).



A winterizing tee with a built-in filter.

tank clean and your gutters or plumbing from becoming clogged.

Filtration Systems:

Rooftops are prone to collect leaves and particulate matter. Rain carries all this debris with it as it enters the gutter and downspout. Gutter screens, downspout caps, and other filtration devices help to keep larger particles from entering your tank. These devices should be installed to help keep your

Overflow Systems:

- When the tank reaches capacity, the overflow pipe directs water away from the tank back to the sewer or designated overflow area. Whenever possible, your overflow can be sent to a rain garden to percolate into the ground and recharge underground aquifers.
- Install a bulkhead fitting near the top of the tank (but not at the very top) where an overflow pipe can be positioned.
- Be sure that the overflow pipe is not directed toward buildings, water-sensitive structures, or other areas where unwanted water can pool.
- The overflow pipe should be the same diameter as the inflow pipe so that it doesn't create a "bottleneck" during heavy rainfalls.

The overflow pipe on this system leads away from the adjacent building to prevent flooding.



Rain Gardens:



Guiding an overflow pipe into a rain garden.

- Instead of sending water back into the sewer, you can direct the overflow into a rain garden or bioswale. These are situated in a low area of the garden that will absorb rainwater and storm water. Rain gardens can provide habitat for pollinators, other insects, and birds. They can also be turned into works of art and help to improve the aesthetics of your RWH system.
- Rain gardens should always be at the lowest area of the garden so that water will naturally flow there.

- Dig a deep trench and fill it with 5 inches of gravel to increase percolation. Cover this area with burlap or landscape fabric so that soil will not move downward into the gravel.
- Cover fabric in 6–12 inches of soil. Install plants that like both dry and wet conditions.
- Native plants are encouraged because they are more tolerant to local climate and soil conditions. You can check online or landscape design books for a list of rain garden plants that are native to your area.

Drip Irrigation:

- In gardens or other outdoor spaces, it is important to manage our water usage effectively. Using sprinklers to water plants, especially on sunny days, is an inefficient way to irrigate. Plants only need to be watered at the roots. By supplying small amounts of water to the base of plants, drip irrigation systems help reduce water use. Since the water is applied directly to the soil, evaporation is reduced.

- For most urban RWH systems, drip irrigation is not practical because of a lack of water pressure. However, small gravity-fed drip systems can be created.
- Drip systems require periodic maintenance. If you install a drip system, remember to check regularly for leaks and broken connections.

Aesthetics:

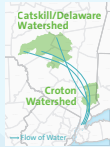
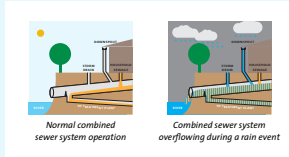
- Although rain barrels and plumbing may be considered unsightly, there are creative steps that you can take to improve the aesthetics of your rainwater harvesting system. Using good plumbing techniques and a thoughtful design layout are some of the easiest ways to make your RWH system aesthetically pleasing.
- A trellis system with vining plants makes a nice screen to obscure tanks and plumbing and has an added benefit of keeping tank water cool.
- RWH systems can also be painted or decorated in other ways.
- Placing your RWH system next to a shed or other structure makes it possible to integrate the system with your existing garden design.
- Adding a rain garden or other vegetation around your system can help to create a natural aesthetic for your rainwater harvesting system.



THIS GARDEN HARVESTS RAINWATER

Rainwater Harvesting Helps Prevent Pollution...

New York has a combined sewer system, which collects rainwater and sewage in the same pipes. When it rains, these pipes can overflow, dumping polluted water into our rivers and streams. Every drop we capture counts!



...and Conserves Water

New Yorkers use nearly one billion gallons of freshwater from upstate reservoirs every day. Capturing, storing, and using rainwater in places like this garden can help conserve this limited resource.

Tank Tips:

- ◆ **Keep the lid on**, unless cleaning or fixing the tank, to prevent mosquitos from breeding.
- ◆ **Use the water regularly** to help keep the tank clean and odor-free.
- ◆ **Drain completely before winter** and keep the spigot open to prevent breaking.



To learn more, visit www.grownyc.org/rainwater



GrowNYC's signage for rainwater storage tanks.

Signage:

The water stored in your tank is not potable and should only be used for watering plants in your garden. A sign can be placed on your tank to let the public know that water collected is not for drinking. You may also want to include signage to let people know about your rainwater harvesting system, its purpose, and its impact on your community and the environment. Examples can be found on our website (www.grownyc.org/rainwater) or online.

Maintaining Your Rainwater Harvesting System:

If properly built and maintained, your rainwater harvesting system will last many years. Even the smallest tanks can help to capture thousands of gallons of water over their lifetime. However, because they are built in outdoor environments, a rainwater harvesting system is not something you can build and walk away from. It is important to make sure there are no leaks in your system and that you take care of the materials to prevent breaking, contamination, or excessive wear-and-tear.

- A variety of rainwater systems can be constructed for the same downspout and roof. Due to possible leaks between connections, it is generally better to have a single barrel rather than multiple barrels.

- Freezing water will break your system. Remember to drain your rain barrel and adjust your winterizing tee or diverter to send water to your overflow, or away from the tank, during the winter months. Cracks in your system will occur when leftover water freezes and expands.
- In general, tanks will be kept clean by using the collected water regularly. However, if significant sediment accumulates in the tank, the tank can be disconnected and washed out.
- Always keep the lid or screen on your tank closed to keep mosquitos from entering and breeding in the tank.

This multiple-barrel system required more maintenance than the single-barrel system that replaced it (below).



Seasonal Maintenance:

To guarantee year-round functioning of your RWH system, the following seasonal maintenance schedule is recommended:

Spring (March-April)

- Clean any leaves and debris from gutters, leader inlets, and rooftop.
- Repair any leaks in your plumbing from the previous year.
- Inspect and clean barrel tops to remove any debris.
- Check the lid to make sure it is securely closed.
- Inspect ropes/cables to ensure that barrels are secure to the platform.
- After the last frost, redirect roof water from your overflow system (sewer, splash pad, rain garden) back into your tank.
- Close your spigot to start collecting rainwater.



Summer (May-September)

- Keep the roof, gutters, and leader inlets clear of debris. Check monthly.
- Inspect pipes and connectors regularly for any damage or disrepair.
- Visit your system during a heavy rain or shortly after to check for leaks and overflow problems.
- Any water from the overflow system should drain within 24 hours of a rainfall. If puddles form, you should move the outflow pipe to a more porous site or consider installing a small rain garden.
- Inspect any screens or vents at top of your tank(s) to ensure that they are clean and intact.

Fall (October-November)

- Before the first frost, redirect roof water from your tank to your overflow system (sewer, splash pad, rain garden).
- Drain all water from your RWH system.
- Open the spigot on your tank and keep it open all winter to prevent ice from forming in your tank or plumbing.

Winter (December-February)

- Check in on your system periodically to make sure that it is not holding water, which could freeze and break your system.
- Get ready to harvest more rainwater next season!

Frequently Asked Questions

Can I use my tank to run a hose or drip irrigation?

Yes, but depending on the size and elevation of your tank, you may not get enough pressure to run water through a hose. There are low-flow drip irrigation systems specifically designed for RWH tanks. A solar or electric pump can also be used to move water through a hose.

When do I need to disconnect my tank?

You should avoid sending water into your tank when there are freezing temperatures. In New York City, that means redirecting water away from your tank from around early November through early April.

How often do I need to clean my tank?

You can keep your tank clean by regularly using the water and not allowing it to sit for too long. If you notice an odor, or bacteria growing inside the tank, you can disinfect the tank by adding a small amount of bleach (two teaspoons per 60 gallons). If your tank doesn't have an accessible opening, you can add the bleach to water and pour it into the tank through the gutter or winterizing tee.

Is the water from my tank safe to drink?

No. Because of particulate matter from rooftops and bacteria that grow in your tank, RWH systems should only be used for watering plants, washing hands, or cleaning tools.

Is the water safe to use on my plants?

Yes. Water from your RWH system will be safe to use on plants. As always, wash fruits and vegetables thoroughly with tap water (not from your RWH system) before consuming.

How big should my tank be?

A good rule of thumb is to install a tank that is half the number of gallons of the square footage of your collection surface. For example, if your rooftop is 400 square feet, a 200-gallon tank would be ideal.

What do I do if my tank isn't filling up with water?

First, check the pitch of your roof and gutter system to make sure there is enough downward slope to move water into the tank. You can check for blockages between the roof and tank, which may occur as leaves and debris accumulate. You should also check regularly for leaks in your plumbing and fix and leaks as necessary.

How do I adjust my plumbing after it's been cemented?

If you need to adjust your plumbing or replace pieces that have been damaged, you can cut sections of plumbing and reattach new pieces using rubber couplers.

What can I do if my system breaks?

Follow the seasonal maintenance schedule to ensure that your RWH system lasts for many years to come. If something breaks, you can locate the break and replace the part in question, or consult this guide for help.

How can I collect rainwater if I don't have a roof?

If you don't have a rooftop to collect water from, you can either install a shed or other small outdoor structure or use another material to guide water into your tank. Heavy duty tarps are a good alternative to rooftops and can be configured in many different shapes and sizes.

To learn more about rainwater harvesting,
visit grownyc.org/rainwater

QUESTIONS OR COMMENTS?

Contact us at gardens@grownyc.org



About GrowNYC

Established in 1970, for nearly 50 years GrowNYC has played a pivotal role in helping New York City transform for the better. We are a resource for New Yorkers, providing free tools and services anyone can use to make NYC a truly livable city, one where every person can enjoy a healthier, more sustainable life.

Three million New Yorkers participate in our programs annually. Well-known for the Greenmarket farmers' market network, we also build and maintain community and school gardens, work alongside DSNY to improve recycling citywide, and provide hands-on environmental education for all ages.

Donate, volunteer, or get involved at www.grownyc.org



This guide was produced and printed thanks to the support of the **Greenpoint Community Environmental Fund**.