Your Health and Cisterns — A USVI Comprehensive Guide

March 2025

In the US, the Center for Disease Control and Prevention (CDC) as well as the Virgin Islands Department of Health (VIDOH) are responsible for providing guidance on cistern use to protect public health. This brochure consolidates helpful information for the US Virgin Islands (USVI) population that relies on rainwater harvesting.

Cistern Water and Your Health

Rainwater is harvested for use in the USVI due to limited freshwater sources. For this brochure, rainwater use is defined as the collection, treatment, and storage of rainwater for general household purposes.

An estimated 90% of homes in USVI have active cisterns which depend on the collection of rainwater via a rainwater catchment system for their potable water supply.[1] A rainwater catchment refers to an area (e.g., roof) where water is collected and directed into a cistern (reservoir or storage tank) through the gutters and downspouts (Figure 1).

Most cisterns rely on rainwater harvesting but some water is delivered to homes by trucks and stored in cisterns. Regardless of whether a cistern is supplied water from a rainwater catchment system or from a water hauler, water stored in cisterns can collect debris and contaminants.

Common sources of cistern contamination include decaying leaves, animal feces, and dander, which may contain parasites and other harmful microorganisms.

Other, less common contamination sources include man-made and natural events, such as chemical releases (like the Limetree Bay Terminal oil mist incident)[2] and known seasonal phenomena (like Sahara Dust).[3]

While you can see sediments, you might not notice other contaminants like metals, organic compounds, inorganic compounds, bacteria, viruses, and parasites. These toxins may not affect you right away but, if left untreated, they can cause major health problems.[4]

According to the VIDOH Cistern Water Study conducted in 2019, "80% of cistern water samples collected directly from the cistern and 58% of cistern water collected from the kitchen tap indicated the presence of Escherichia coli (E. coli) contamination; and other VIDOH studies found that 18% of households drink their cistern water directly."[1]

Even when cistern water is not used for drinking, people consume and come in contact with cistern water in many ways, such as bathing, brushing teeth, cleaning wounds, cooking, and washing produce. These activities may expose you to potentially harmful chemical or microbial contaminants. (Figure 1).

To minimize your exposure to possible contaminants, keep your cistern system **clean**, **protect** your water from contaminants, and **maintain** the water quality.

Clean. Clean your system often and thoroughly, so you are prepared to receive good clean water. This consistent care is key to a long system life.[5]

Protect your system. Divert water away from cistern storage during a severe weather event to minimize debris coming in with stormwater.[5]

Maintain. Keep an emergency supply of clean, safe water. In addition to the cistern water, this emergency supply should be stored separately. Store approximately 1 gallon of water per person per day for drinking and sanitation. Ideally, store a 2-week supply.[6] At minimum, store the equivalent of at least 3 days' worth of water.[6, 7] Be prepared — check the Virgin Islands Territorial Emergency Management Agency's website, https://vitema.vi.gov/, for weather alerts.

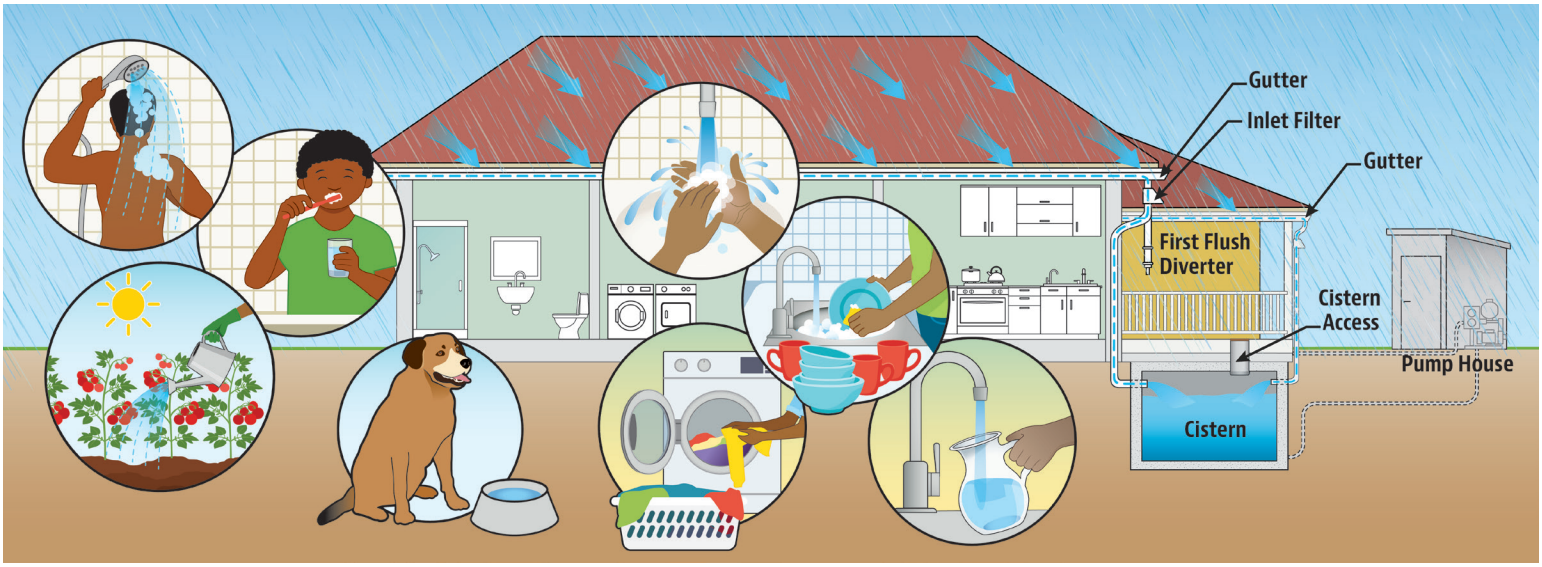


Figure 1. People consume and come in contact with cistern water in many ways, so preventing cistern contamination is critical. Proper disinfection and treatment of stored water is vital to protect water quality and public health.

Cistern Types and Water Treatment

Rainwater harvesting system designs vary depending on daily water needs and available rainfall as well as collection area constraints.[8] Selection of cistern volume and treatment methods are often dependent on household size, cost, and maintenance. A cistern should be large enough to provide a household with drinking water for 3 months.[8]

Select and Measure Your Cistern Volume

Annual Water Needs (gallons)	20,000	40,000	80,000	120,000	160,000	200,000
Recommended Cistern Size (gallons)	5,000	10,000	20,000	30,000	40,000	50,000

When installing a new cistern, proper sizing, and efficiency of catchment should include consideration of roof type and construction materials (e.g., wood, sheet metal, solar). The USVI code V.I. Code tit.29, § 308 (2019) further specifies that cisterns shall be located at a point free from flooding, and that "an overflow of cross-section area at least equal to the combined cross-section areas of all inlets shall be provided on each cistern."

If your home already has a cistern, determine the size and/or volume of the tank. If you do not know when your cistern was last drained, cleaned and disinfected, that should be completed first and establish a routine practice for future operation and maintenance.

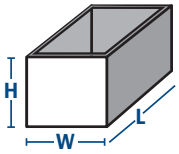
In the USVI, a typical rainwater harvesting system consists of an underground storage tank (i.e. cistern) with design features and at least one type of treatment system to remove contaminants from the water supply.

Contaminants will get into the water. Selecting and adding design features to the cistern system can help remove these contaminants prior to treatment and ensure good-quality cistern water. Design features such as diverters, roof water filters, gutter guards, and water force breakers can help prevent contaminants from entering the cistern.[8] **The first 10 minutes of a rain event produces and moves the most sediment. The use "first flush" diverters, also known as roof washers, is recommended during each heavy rainfall event to divert contaminated roof water away from the cistern (Figure 1).** Another important feature to include is design overflow, which helps prevent flooding by discharging excess water directly or indirectly to storm drains. Each of these design features help control water flow and offer the ability to select and direct water during rainwater events.

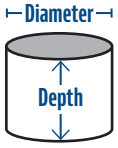
Next, selection and use of water treatment is necessary to reduce or eliminate contaminants, discoloration, and odor. Treatment dosing is usually based on volume. **Measure the volume of water in the cistern** by calibrating a measuring tape or stick.[8, 9]

These can be purchased or made with prices ranging from $8 for a self-adhering measuring tape to $170 for a telescoping measuring stick. A stick can be made by using a measuring tape and marking the intervals in inches. To calibrate a measuring method:

1. Calculate the cistern volume (capacity) by shape,[9] measure the sides and height (feet):



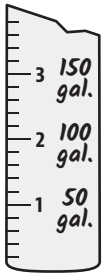
Square or rectangular shapes:
Volume (gallons) = Length (ft) x Width (ft) x Height (ft) x 7.5 (gal/ft^3)



Cylindrical or round shapes:
Volume (gallons) = 0.785 x (diameter)^2 x depth (ft) x 7.5 (gal/ft^3)

2. Divide the volume by total depth (inches). This calculation is the number of gallons/inch.
3. Mark the tape or stick at 1-inch intervals starting at one end to the total depth of the tank (#inch x gal/inch). Write the corresponding volume along side the intervals.

   For example, a 5000 gallon cistern that is 100 inches tall will contain 50 gallons/inch.



Manual chlorination with diluted chlorine is the simplest form of treatment. Always ensure adequate ventilation exists for safety during the use of chlorine! **Use only unscented liquid household chlorine bleach** for disinfecting drinking water. Chlorine is effectively used to kill bacteria and viruses. Proper dosing and testing are critical to ensure the safety of your water. Purchased bleach can contain varying concentrations of sodium hypochlorite. Table 1 provides example dosage measurements for chlorine bleach containing from 5%–9% sodium hypochlorite.

For manual chlorination, use Table 1 to determine the amount of liquid bleach (% sodium hypochlorite) to add per gallon of water to disinfect the water supply.

Note: Useful chlorine dosage notes can be placed alongside the various volumes on the calibrated measuring stick for quick reference.

Table 1. Chlorine Dosing Examples[10]

Storage Tank Gallons	Storage in Quarts	Ounces		Teaspoon		Drops
		chlorine bleach (unscented) or % sodium hypochlorite				
		5.25%	8.25%	5.25%	8.25%	Estimated 5%–9%
10,000	40,000	25.5	16			
5,000	20,000	12.5	8			
1,500	6,000	3.8	2.4			
250	1,000			4	2.5	
100	400			1.5	1	
5	20					40
1	4					8
0.25	1					2

Bacteria and other organic matter (often recognizable by the presence of a strong odor) can usually be oxidized and removed by blending unscented household chlorine bleach or sodium hypochlorite into the cistern water to produce an approximate 1-2 mg/L (parts per million or ppm) concentration.[11] The World Health Organization recommends a residual chlorine level of 0.2-0.5 ppm for normal domestic use.[10, 11] The target chlorine concentration of 1-2 ppm is greater than the recommended residual chlorine level of 0.2-0.5 ppm because chlorine

concentrations will decrease over time and it is important to maintain an adequate residual chlorine level at all times.

The residual chlorine concentration should be measured weekly, to determine when to add more chlorine. The quickest and simplest method for testing residual chlorine is using a litmus indicator test. Following the manufacturer's instructions, a tablet of DPD (diethyl paraphenylene diamine) is added to a sample of water, coloring it red. The strength of color is measured against a standard colors list on a chart which corresponds to the chlorine concentration.[11]

The process of disinfection by chlorination, leads to the potential formation of undesired substances, known as disinfection by-products (DBPs). Exposure to DBPs through pathways like drinking, bathing or swimming has been linked to health risks. Safe removal of DBPs can be achieved through additional treatment methods.[12, 14] The most common treatment methods for typical cistern systems include filtration and ultraviolet (UV) light systems. Because cisterns have been commonly used in the USVI for decades, older systems may have been retrofitted with one or more treatment methods. Table 2 describes a comparison of the more common treatment methods.

Table 2. Treatment Method Comparison

Treatment Method[14]	Treatment Method Effectiveness against Different Contamination Types			Cost Benefit	Products or Equipment Requirements	Disinfection By-Products[12] Disinfection by-products (DBPs) are formed when disinfectants like chlorine interact with natural organic materials in water. Chronic exposure to DBPs may increase the risk of cancer.	Frequency: Operation & Maintenance
	Bacterial Contamination	Chemical Contamination	Solids and Sediment				
Manual Chlorination[11]	Effectively kills microbial contamination as well as odor forming bacteria within 24 hours.	Does not remove chemical contaminants.	Does not remove solids.	Very low cost	Liquid bleach, powdered bleach, chlorine tablets	When chlorine interacts with natural organic materials in water, it can form trihalomethanes (THMs), haloacetic acids (HAAs), and chloroform, among others. Other treatment methods are needed to remove these DBPs.	Needs frequent chlorine measuring to adjust dosing, 2x weekly. Water should be treated for 12–24 hours before it is considered sterile. The greater the volume of water being treated the longer the dosing exposure period needed. Cleaning and maintenance include solids removal/periodic flushing.
Boiling tap water before consumption	Effectively kills pathogenic bacteria, viruses and protozoa.	May partially remove some volatile and semi-volatile chemical contaminants, but is not a recommended treatment method for chemical contamination.	Settling before and after boiling can effectively remove larger solids. May have some metals removal if sediment is removed.	High cost due to energy usage.[13]	Household pots and pans	Boiling is effective at removing volatile DBPs but ineffective at removing non-volatile DBPs.[15]	Each use
Three-stage Filtration (sediment filter, carbon filter, and UV)	The most optimized and effective method of removing contaminants from the cistern water supply is using a combination of treatment methods such as manual chlorination in conjunction with a three-stage filtration system. This treatment system removes large particulates with the sediment filter, removes organic chemicals with an activated carbon filter, and eliminates pathogens with the UV lamp.			Moderate cost Installed at point of use or in larger systems, prior to pump.	Filtration system installation including filters and UV bulb.	Water filters that use carbon filter media are the best solution to remove excess chlorine and its by-products. Using a three stage filter at the end of a treatment process minimizes the formation of other DBPs.	Replacement of sediment filter, carbon filter, and UV lamp according to manufacturer's recommendations.

Operation and Maintenance

Rainwater harvesting systems need routine maintenance throughout the year and special care during seasonal or emergency events. Whether you are performing routine maintenance, preparing for an emergency, or cleaning up after an environmental event, it is always important to follow good management practices for protecting water quality.

Good management practices include the following key steps:

Clean – Make sure your rainwater catchment and cistern are clean before you use them.

Protect – Select a treatment system that is best for you to protect the water quality.

Maintain – Learn and perform the recommended monitoring and maintenance. All cisterns include access points for cleaning, inspection, repair, and sampling for periodic water quality testing.[5, 8, 11] Know where your access points are and how to maintain your cistern.

Every rainwater harvesting system is unique; maintenance needs may vary according to system design and environmental

conditions (e.g., extreme weather events). System maintenance guidelines are summarized in Table 3.

The rainwater harvesting system should be inspected every three months for structural damage to ensure that all cistern parts and components are in good working condition. In the first year of operation, more frequent inspections can help determine whether your system is functioning properly and whether the selected treatment method is sufficient for the average rainwater load in your area. Throughout the life of your system, inspect your system at all stages of operation: water collection, storage, and treatment.

You should inspect your rainwater harvesting system weekly to identify blockages, sediment buildup, and other visible contamination. Routinely clean as needed following inspections.

In addition, your cistern system should be drained, cleaned, and disinfected whenever sludge buildup is observed.[17] The cistern may also need to be cleaned and disinfected after disasters (e.g., extreme rain or flooding).[5]

Routine water quality testing should be performed to measure residual chlorine and bacterial colonization (this is a cistern owner's cost). EPA recommends using a certified laboratory to analyze regulated drinking water contaminants, including oil related contaminants.[16] In the event of any positive test results, contact your closest DOH. https://doh.vi.gov/

Table 3. System Maintenance Guidelines

Activity	Frequency
Inspect Inspect inlet structures, outlet structures and storage areas for trash and sediment accumulation. Remove floating debris and scum build-up.	Monthly for 1st year, after installation, determine ongoing maintenance frequency
Routine Cleaning Clean out roof, catchment system and gutters, gutter screening, first-flush diverter, and catch basins to reduce sediment load to the cistern. Clean intermediate sump boxes, replace filters, and otherwise clean pretreatment areas in directly connected systems. Remove sediment and debris from cisterns according to the manufacturer's recommendations or the site-specific maintenance plan.	Weekly or when visible
Cleaning & Disinfecting Brush the inside surfaces and thoroughly disinfect. To disinfect your cistern: 1. Add three cups of 5%–6% bleach for every 100 gallons of water in the cistern 2. Open each faucet and run the water until you smell chlorine (bleach). 3. Turn off all faucets and allow the solution to remain in the cistern and plumbing for at least 12 hours. **Do not use or consume this water!** 4. Drain all water from the cistern, then allow to be refilled with new water. 5. Open and run the faucet until you do not smell chlorine. 6. Treat stored water as usual.[5]	Every 3-5 years at a minimum, and as needed after extreme storm events.
Inspect for Structural Damage Inspect the cistern and supporting structures (diverters, gutters, screens, fences) for cracks and signs of wear.	Quarterly
Sampling & Testing pH and chlorine Bacteria and other contaminants Test sediment for toxicants in compliance with current disposal requirements if land uses in the catchment include commercial or industrial zones, or if indications of pollution are present.	As needed, at minimum after chlorine treatment Annually or as needed
Maintain records of inspections and maintenance activity Note equipment repairs, costs, and frequency for wear, adjust inspections as needed.	Ongoing

QUESTIONS? — CONTACT US

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United States Environmental Protection Agency (EPA) - EPA's toll-free hotline: (866) 462-4789, Email: StCroix@epa.gov

Limetree Bay Refinery: (340) 692-3495, Email: communications@lbenergy.com

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