

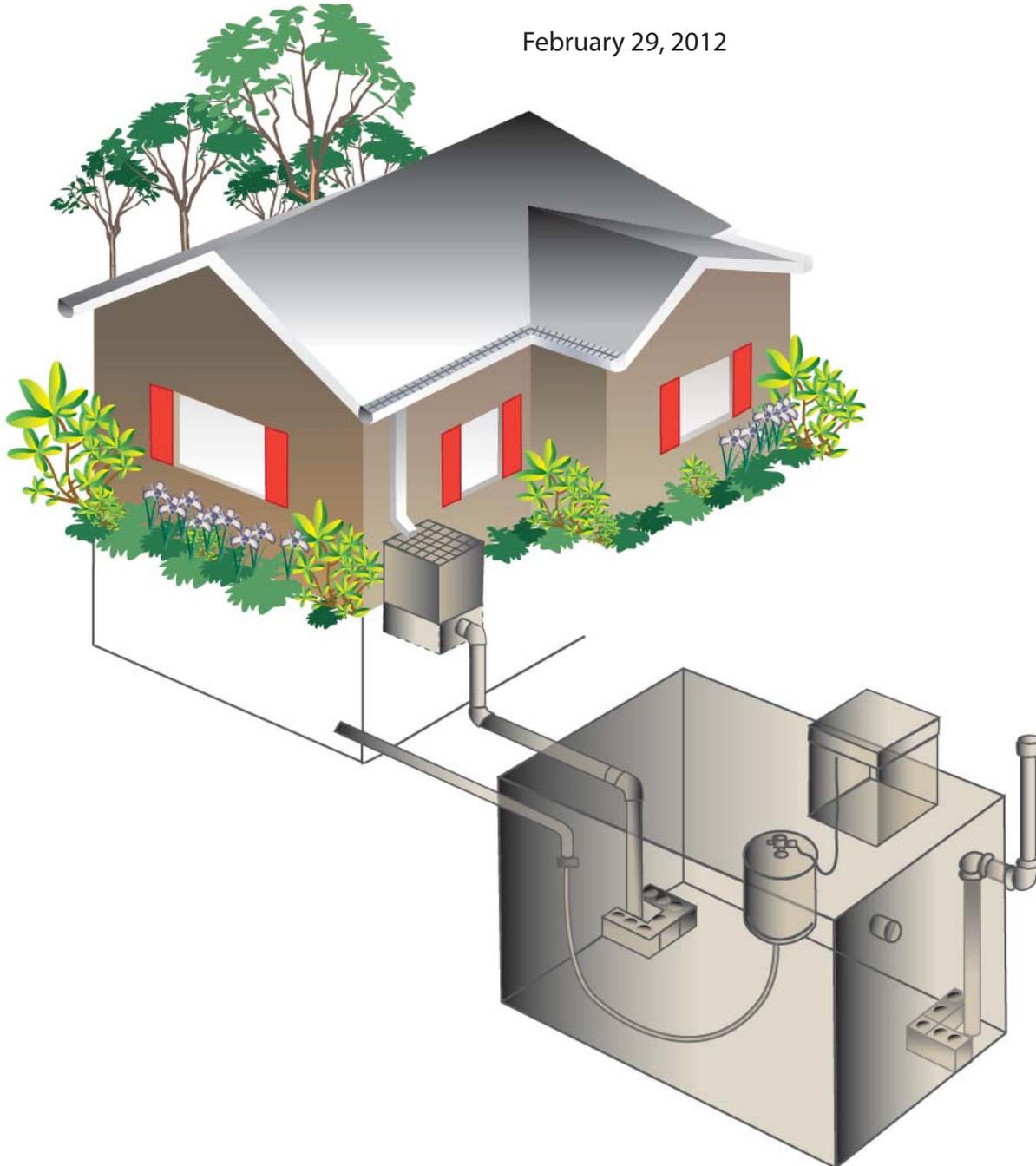


Ohio Department of Health
Bureau of Environmental Health

Plans for Developing a Rainwater Cistern or Hauled Water Supply

“To improve and protect the health of all Ohioans”

February 29, 2012

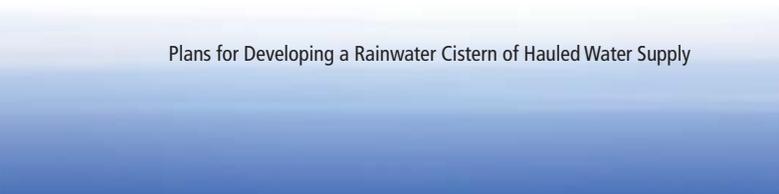


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The construction of rainwater cisterns and hauled water storage tanks used as private water supplies in Ohio is covered in Ohio Administrative Code (OAC) 3701-28-12. Cistern and hauled water tank configurations may vary by contractor and do not necessarily need to correspond with all of the examples provided in this document as long as it is constructed in compliance with the Rules. Contact your **local health department for the necessary permits and for additional information.**

A cistern is a type of water system that collects rainwater off of a roof and channels it through gutters to a collection tank for storage until used by the household. Cisterns may also be referred to as a rainwater catchment or rainwater harvesting systems. A hauled water storage system is not designed to collect water off a roof but is simply a water tank that is refilled exclusively by truck deliveries from OEPA regulated public water supplies. Water haulers must comply with OAC Rule 3701-28-16 before they can deliver water to private drinking water cisterns or hauled water storage tanks. Local health departments inspect these water hauling trucks annually for compliance with OAC Rule 3701-28-16.

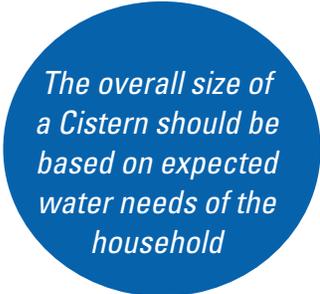
Cisterns and hauled water storage tanks may be used where ground water is not available or is impractical to treat for home use. Cisterns are required to have continuous disinfection in accordance with OAC Rule 3701-28-15 in order to make the water sanitary for potable uses. Hauled water storage tanks are not required to have any additional treatment.

Sizing Your Cistern or Hauled Water Storage Tank as a Private Water System

In Ohio the *minimum* required size of a cistern is 2500 gallons and the *minimum* required size for a hauled water storage tank is 1000 gallons when used as private water systems. However, the overall size should be based on the expected water needs of the household. The ideal storage capacity of the cistern can be calculated based on the longest drought period within the last 50 years. A safety factor of 25 % is then added to that.

Ohio experiences about 37 inches of rainfall per year. Monthly average rainfall can vary greatly. It may rain as much as seven inches in an above normal wet month and as little as zero in other months. The Hydrologic Atlas for Ohio (1991), Water Inventory Report 28, provides additional information on average annual rainfall across Ohio for a 50 year period (1931-86). A copy of this document can be obtained from the Ohio Department of Natural Resources, Division of Water or at http://www.dnr.state.oh.us/water/pubs/fs_div/fctsht11/tabid/4094/Default.aspx

Seven inches of rainfall on a 1500 square foot roof will yield about 6300 gallons. Most of this water would be wasted if the storage capacity of the cistern were the minimum 2500 gallons. Therefore it is recommended that a cistern to be used as the primary water source for a year round residence should have at least a 6000 gallon to 10,000 gallon capacity using one or more tanks. It is very likely that a cistern water supply will have to be supplemented from a hauled water delivery company.



The overall size of a Cistern should be based on expected water needs of the household

The cistern may also be sized based on the following roof areas:

Roof Area in Square Feet	Gallons Capacity of Cistern
Less than 1000	2500 to 5000
1000-1500	7500
1500-2000	10,000
2000 or more	12,500+

Water use estimates may be based on the following averages:

- Typical home use 60 gallons per person per day. Cistern users are generally more conservative with water usage.
- Estimated annual use family of four would be about 87,600 gallons.
- Garden or lawn watering to apply one inch for 1000 square feet – 625 gallons per day.

To estimate the potential yield, calculate the rainfall (monthly or yearly) in inches multiply 0.6 times the square footage of the roof catchment area.

Annual Rainfall Yield in Gallons for Various Roof Sizes

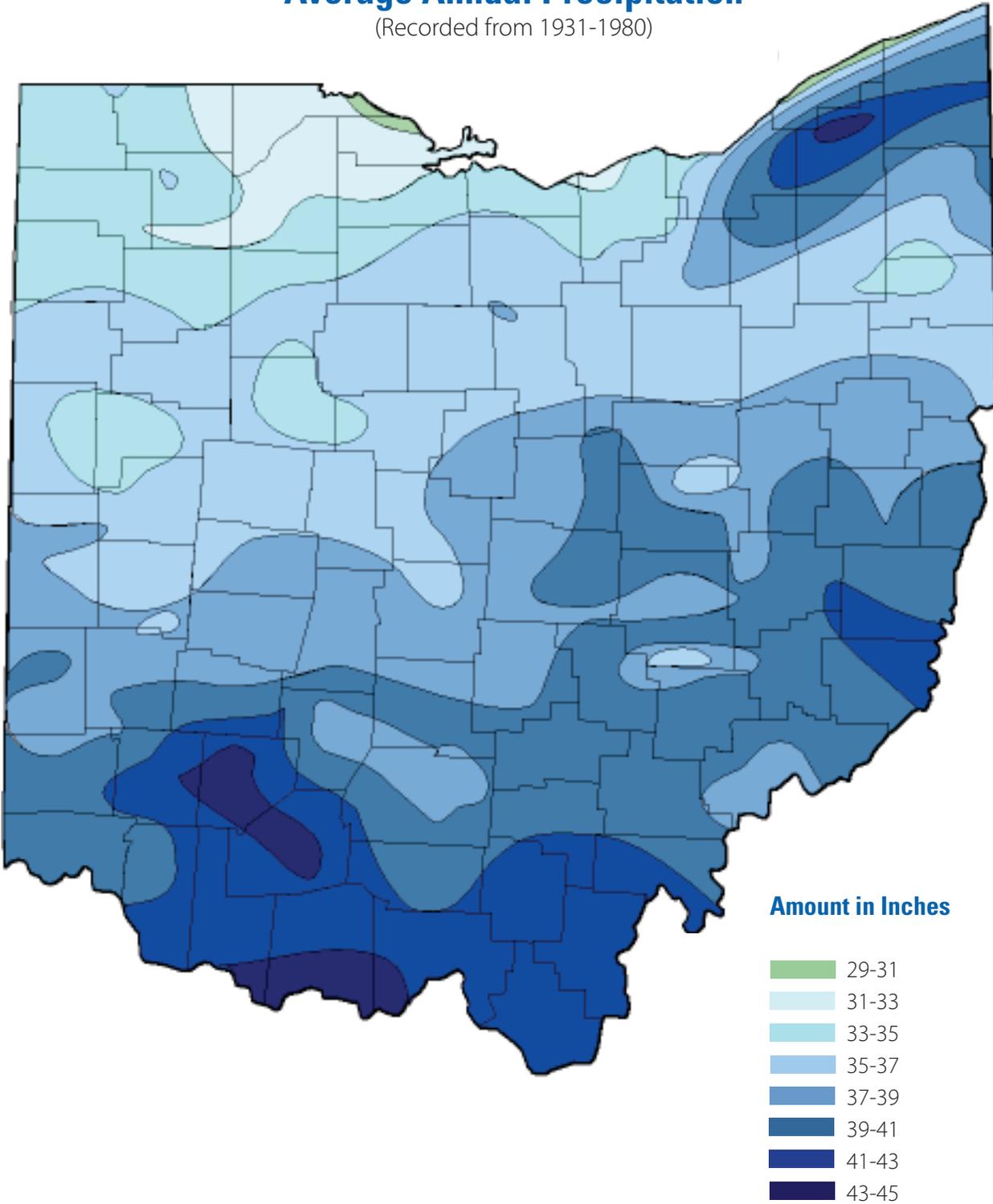
Roof Area Square Feet	Rainfall In Inches	28	32	36	40	44	48	52	
1000	24								
		13483	15730	17978	20225	22472	24719	26966	29214
1100		14832	17303	19775	22247	24719	27191	29663	32135
1200		16180	18876	21573	24270	26966	29663	32360	35056
1300		17528	20450	23371	26292	29214	32135	35056	37978
1400		18876	22023	25169	28315	31461	34607	37753	40899
1500		20225	23596	26966	30337	33708	37079	40450	43820
1600		21573	25169	28764	32360	35955	39551	43146	46742
1700		22921	26742	30562	34382	38202	42023	45843	49663
1800		24270	28315	32360	36405	40450	44495	48540	52584
1900		25618	29888	34157	38427	42697	46966	51236	55506
2000		26966	31461	35955	40450	44944	49438	53933	58427
2100		28315	33034	37753	42472	47191	51910	56629	61349
2200		29663	34607	39551	44495	49438	54382	59326	64270
2300		31011	36180	41348	46517	51686	56854	62023	67191
2400		32360	37753	43146	48540	53933	59326	64719	70113
2500		33708	39326	44944	50562	56180	61798	67416	73034

Ohio average yields in bold

(Table by Woods and Choudhury 1991)

Average Annual Precipitation

(Recorded from 1931-1980)



Installing the Cistern or Hauled Water Storage Tank

Permits

Ohio Administrative Code 3701-28-12 describes the construction requirements of cisterns and hauled water storage tanks used as potable water supplies. A permit is required from the local health department prior to beginning construction or doing an alteration on a cistern or hauled water storage tank. When an alteration is done on an existing cistern, there is a requirement to up-grade the treatment system to comply with the current rules. *Any work done on a drinking water cistern or hauled water storage tank must be done by a contractor registered as a Private Water Systems Contractor with the Ohio Department of Health (this is not the same as a licensed plumber). This includes the excavation, the tank placement, connection to the house, and installation of the disinfection system. The local health department will have a listing of registered contractors in the area.*

Locating the Cistern or Hauled Water Storage Tank

Cisterns and hauled water storage tanks should be located away from sources of contamination based on the isolation distance requirements set forth in Ohio Administrative Code (OAC) 3710-28-07. A cistern or hauled water storage tank may share a common wall with a building as long as that is also acceptable local building or construction codes. A new cistern or hauled water storage tank may not be located within a foundation of a building. Also consider the location of trees in proximity to the roof in order to reduce debris. *A cistern or hauled water storage tank must be at least 50 feet from most septic systems (including the sewage tank) and 100 feet away from a leaching pit and privy type septic systems.*

Cisterns should be located away from sources of contamination

Roofs, Gutters, Downspouts, and Roof Washers For Rainwater Cisterns

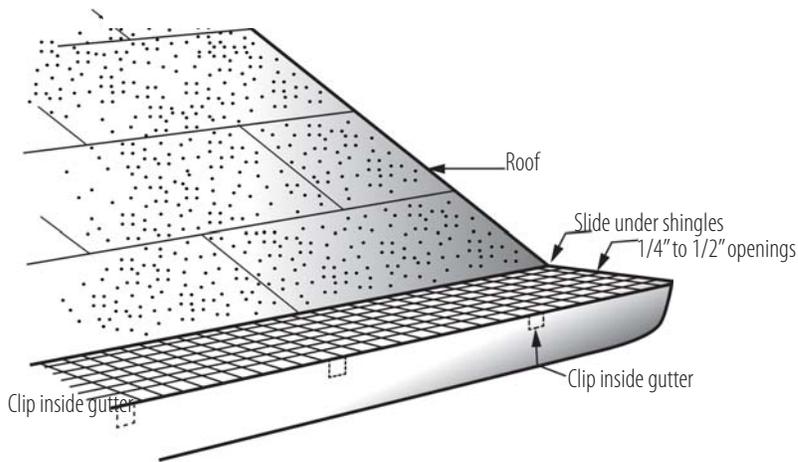
Ohio does not certify or approve roof or gutter materials for the collection of rainwater for drinking. The best roof materials for drinking water catchments are clay and slate tiles, metal, and cementitious (non-asbestos). Other roofing materials used in many parts of the world thought to be suitable for rainwater collection are asphalt shingles, corrugated galvanized steel, aluminum alloy sheeting, corrugated cement fiber sheeting, corrugated plastic, and bituminous sheeting. Lead materials should not be used anywhere on the roof where there is contact with water leading to the cistern. There should be an additional particle filter device installed with the treatment system if asphalt shingles are used.

The local industry and land use practices will also have an influence on the water quality of rainwater. Past studies of the roof and gutter catchment surfaces in urban and industrial areas had been characterized by higher levels of lead from motor vehicles. Lead levels should be currently reduced due to the elimination of lead from gasoline. Rainwater from agricultural

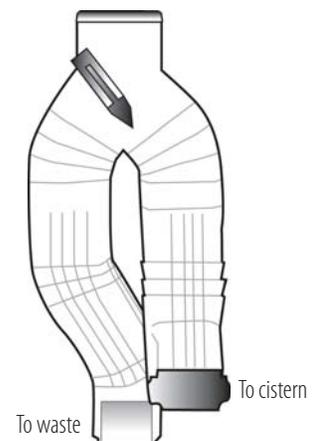
areas has also shown increased levels of nitrates and pesticides due to farm field applications. The highest quality rainwater will tend to come from rural areas with low agricultural activity. The use of a granular activated carbon (GAC) is recommended *to remove possible pesticide residuals* in areas where agricultural use deposition is possible.

Use gutter guards to exclude leaves and twigs. A roof washer / filter shall be provided for each 1500 square feet of roof area. A rainwater diverter should also be installed to clean the roof with the initial flush of rain. These diverters can be designed to have a manual lever switch inside or outside the house or set up to work automatically (see drawings).

Example of Gutter Guard



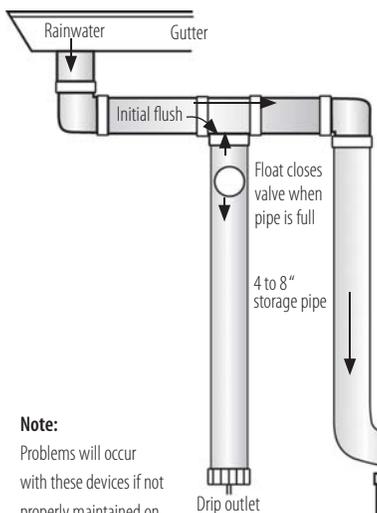
Simple Manual Diverter



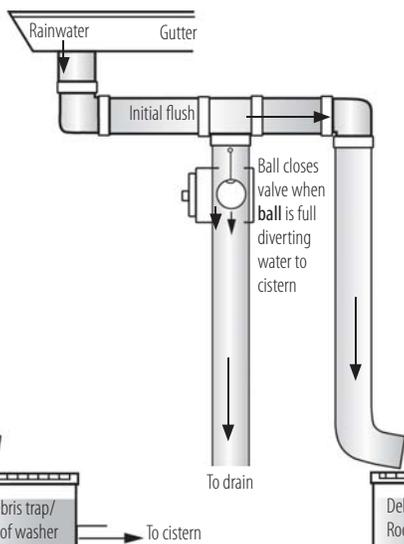
Not to scale

Examples of Automatic Diverters

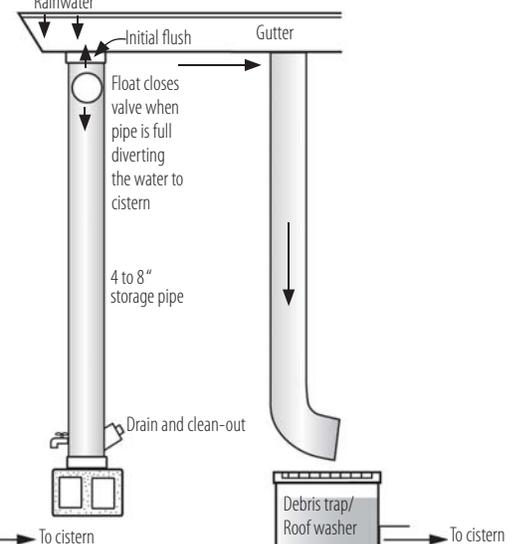
Example A Manufactured



Example B Manufactured



Example C Home Built

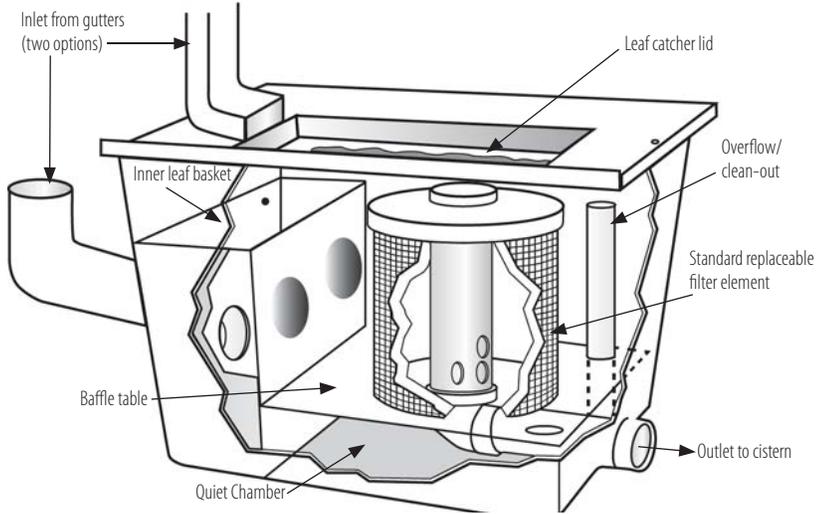


Note:
Problems will occur with these devices if not properly maintained on a routine basis.

Examples of Filtering Roof Washers

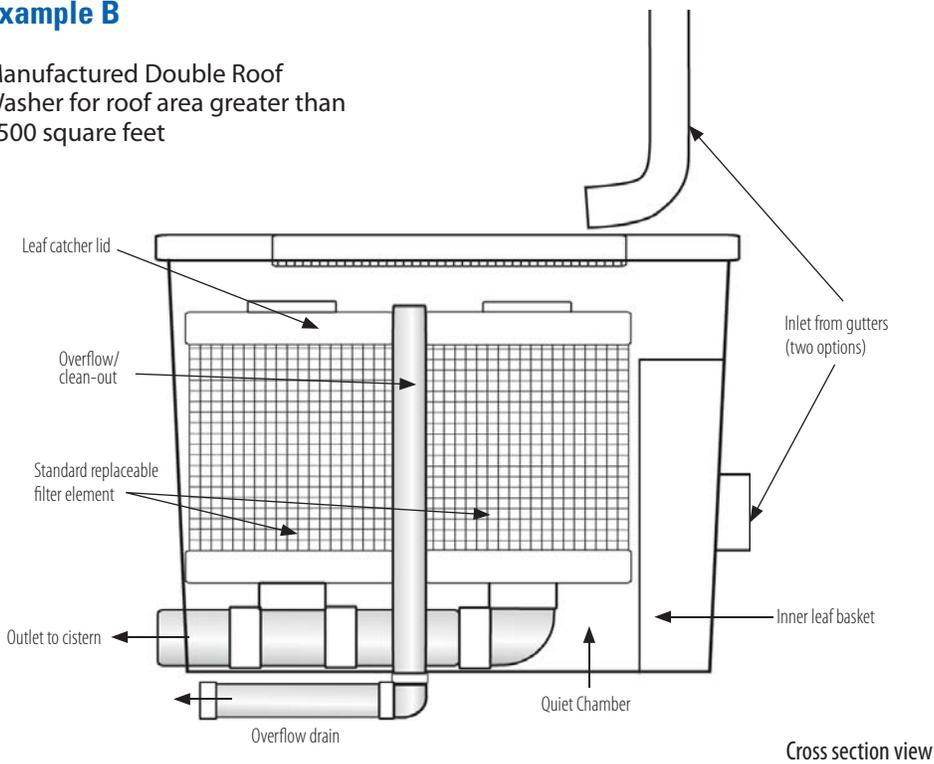
Example A

Manufactured



Example B

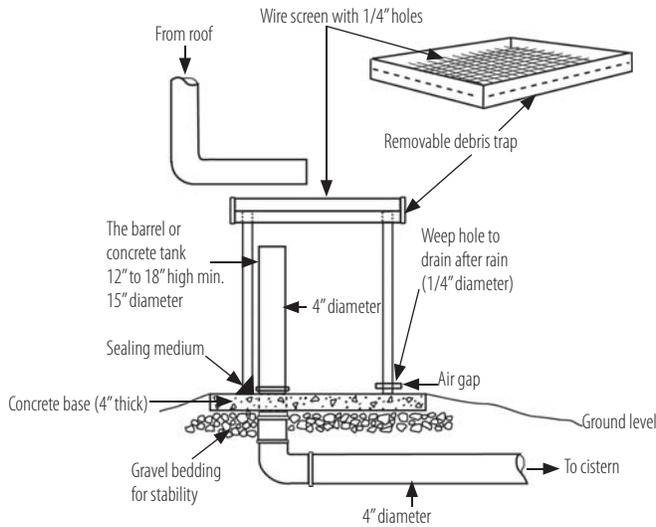
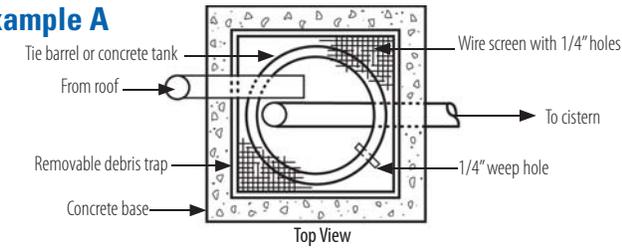
Manufactured Double Roof Washer for roof area greater than 1500 square feet



Examples of Home Built Roof Washers

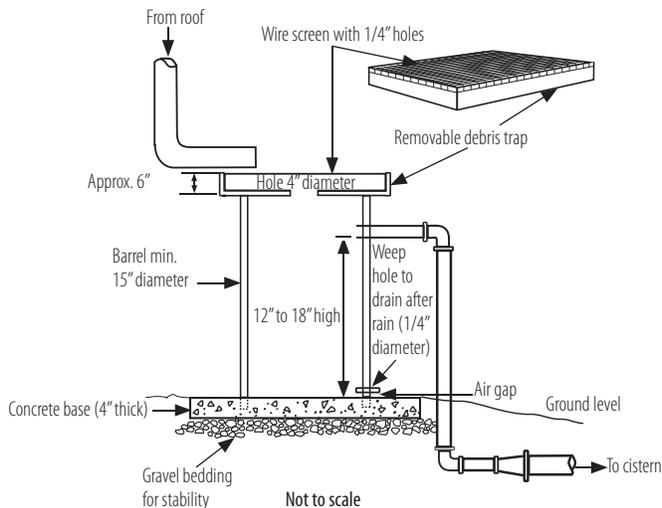
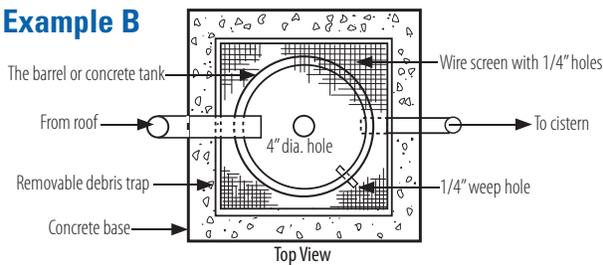
Example A

A roof washer/filter shall be provided for each 1500 square feet of roof area.

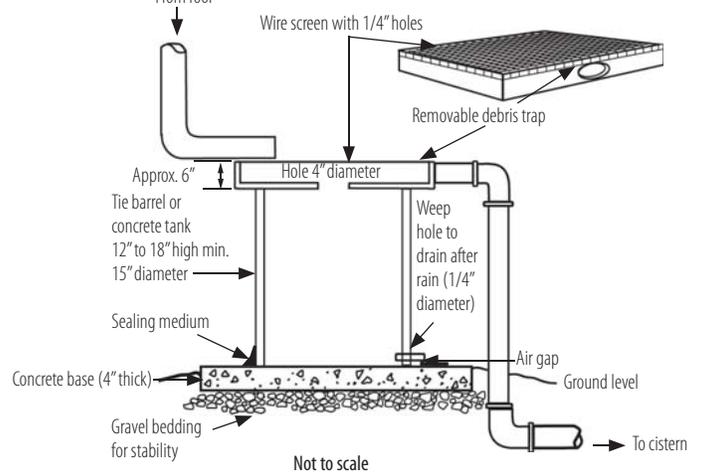
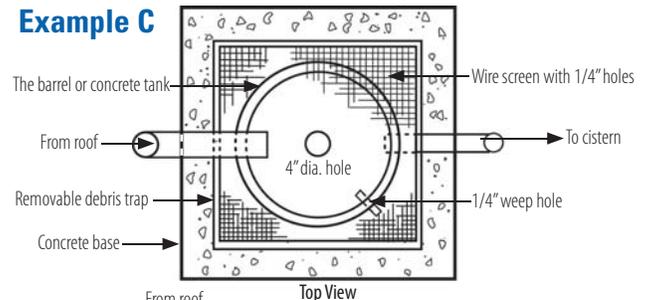


Note: Problems will occur with these devices if not properly maintained on a routine basis

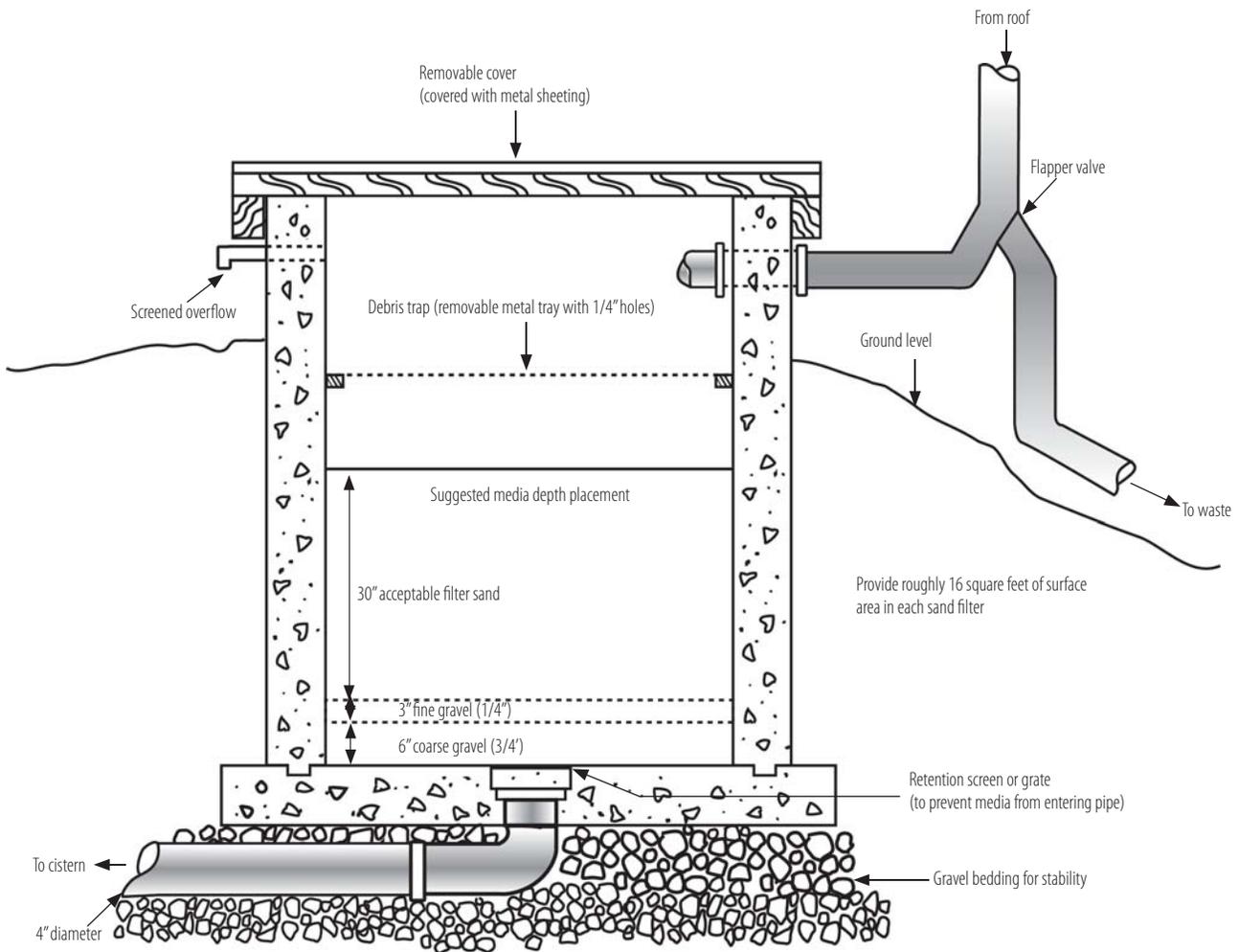
Example B



Example C



Example of Drawing of an Optional Cistern Sand Filter



Note: Problems will occur with this device if not properly maintained on a routine basis.

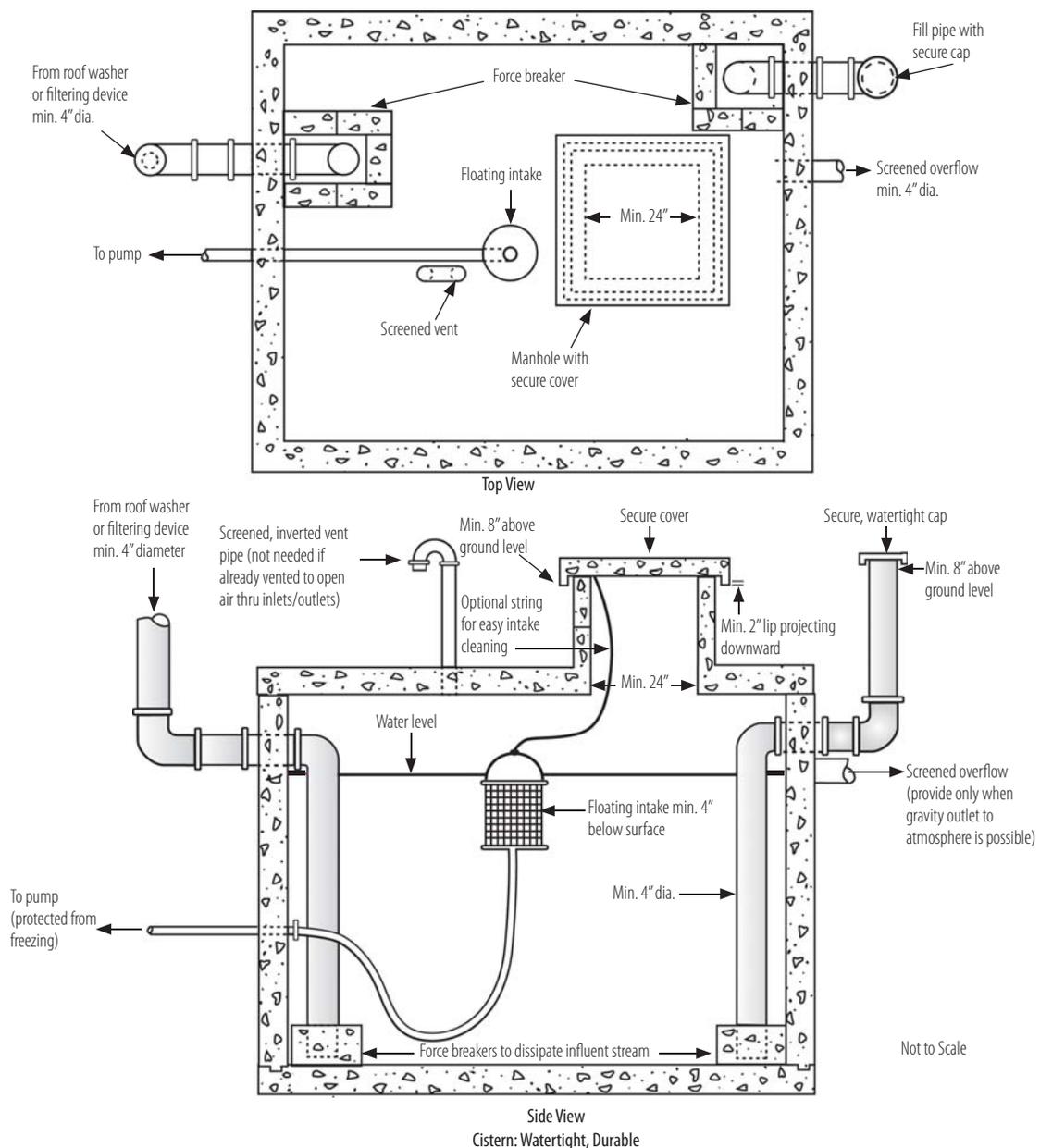
Maintenance of Gutters, Downspouts, Debris Traps, Roof Washers and Cistern Filters

It is critical to routinely maintain gutters, downspouts, debris filters, roof washers, and cistern sand and gravel filters. Weep-hole drains and overflow drains need to be kept clear to allow free drainage. Failure to maintain the cistern roof washers, diverters and debris traps will allow them to plug, overflow and cause rainwater to be wasted. When sand and gravel cistern filters are used, the filter media must be cleaned to prevent plugging by partially removing the top layer of filter media. The best time to do this is when the water flow through the filter has become very slow. Replace the top of the filter bed with the same depth and type of media.

Tanks

Cisterns and hauled water storage tanks are placed below ground to minimize the chances of the water supply freezing in the winter. The bottom of the excavation shall be continuous, smooth, and free of rocks. The bottom of the excavation should have at least four inches of sand or a similar granular fill material. The tank must be set level in the excavation and at an adequate depth to prevent frost heave. The back fill must be free of large rocks and debris and be graded so that water drains away from the tank.

Example Drawing of Concrete Cistern



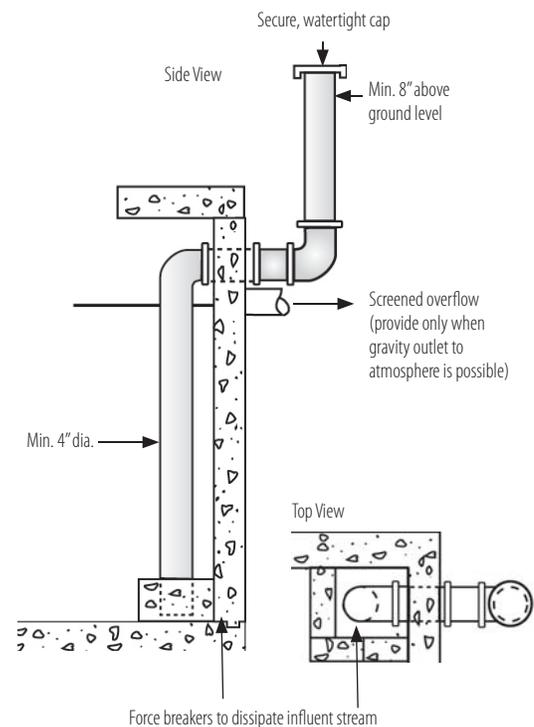
The interior of the tanks used as cistern and for hauled water storage should be made of a smooth and watertight material. These materials can be plastic, fiberglass, or concrete. Plastic and fiberglass material must meet National Sanitation Foundation (NSF) Standard 61 and comply with FDA 21CFR 177.1520. Listings of NSF certified products can be found at www.nsf.org. Concrete used for cistern and hauled water storage tank construction must meet ASTM C-913 which means it has a material strength rating of at least 4000 psi, which is the concrete industry equivalent standard used for water tightness. However, concrete by its nature, still has some porosity. The interior of a tank may be sealed with liners or other sealing materials that meet NSF Standard 61. These products can also be checked at www.nsf.org.

Many cisterns are cast in two or more sections. When these sections are joined, the joining and sealing materials must be non-toxic and meet NSF standard 61. Cast openings in walls or top in a manner to insure a watertight connection. Manhole openings must be a minimum of 24 inches in diameter to provide easy access for cleaning. The manhole opening should be 8 to 12 inches from the ground. The manhole cover shall have watertight edges that project downward at least two inches. The cover must be secured to minimize the danger of contamination, accidents, and unwarranted entry. The cover can be secured by bolting or having sufficient weight (65 lbs.) that children cannot lift the cover.

A cistern tank must be installed with an overflow to drain excess water to the outside when rainfall exceeds the capacity of the cistern. A hauled water storage tank may or may not have an overflow installed based on the water hauler having the ability to control the filling process. All overflows and vents must have a fly screen animal guard of 43 thousandths of an inch installed to exclude small animals and insects.

Refill Pipe

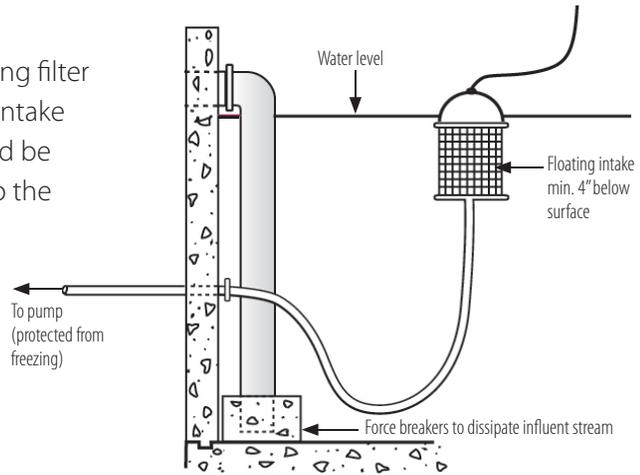
There is a strong likelihood that water will have to be hauled in to a cistern to supplement the household supply during drier times. The fill pipe should be of sufficient size to dissipate the in-coming water and minimize turbulence. This can be done by using a 4 inch PVC pipe that extends close to the bottom of the cistern with force breakers (cast or movable blocks) around and below the refill pipe. These force breakers help to dissipate the incoming water to reduce stirring up sediment deposited on the floor of the cistern or hauled water tank. A PVC cap should be placed on the pipe when not being used for filling. (Also see drawing on page 9.)



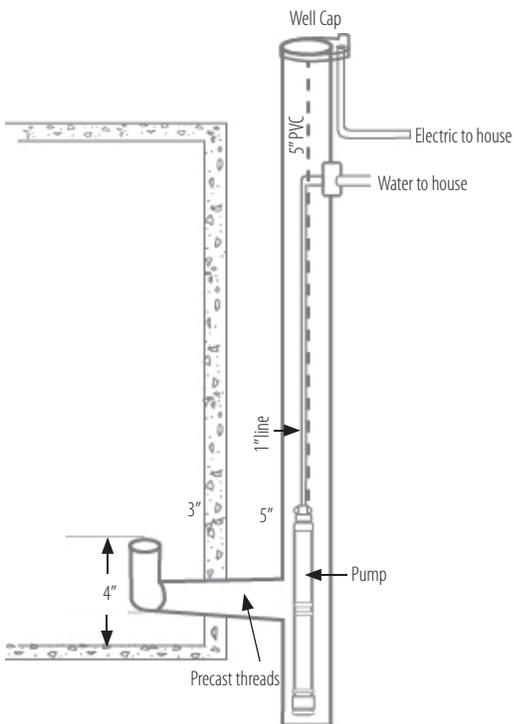
Water Intake into House

The water intake to the house must be designed so that water is not pumped from the bottom of the tank where debris can accumulate or skimmed from the surface where floating debris can be present. This can be accomplished in several ways. (Also see example drawings of cistern cutaway side view on page 9.)

1. The intake could be attached to a floating filter device that maintains the opening to the intake below the water surface. A jet pump would be located in the house to pump the water to the pressure tank.



Example of Alternative Intake



Side View

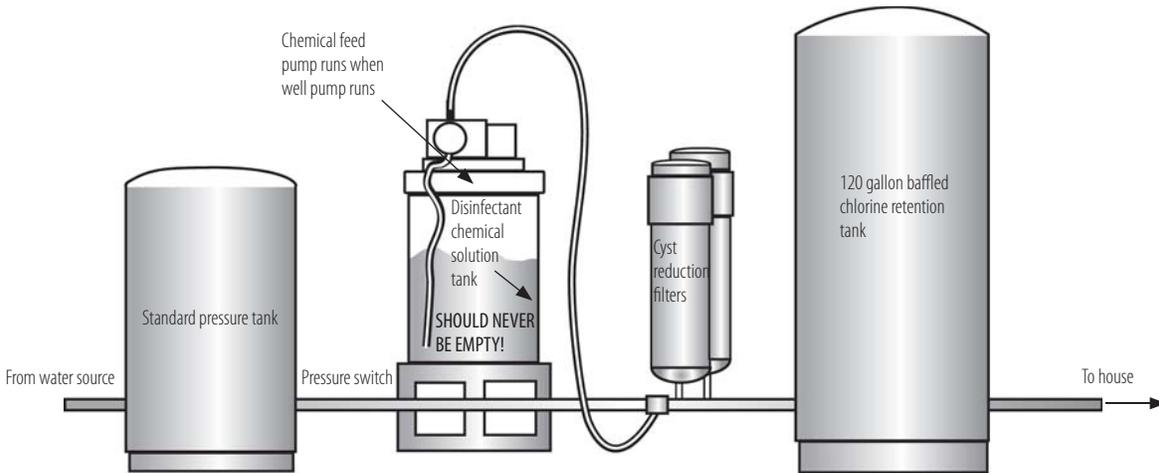
2. A submersible pump may be used as the water intake. The pump should be placed so the pump intake is at least 4 inches from the bottom of the tank.
3. Alternative intake designs may be used as long as water is not taken from any less than four inches from the water surface and 4 inches from the bottom.

Disinfection and Treatment

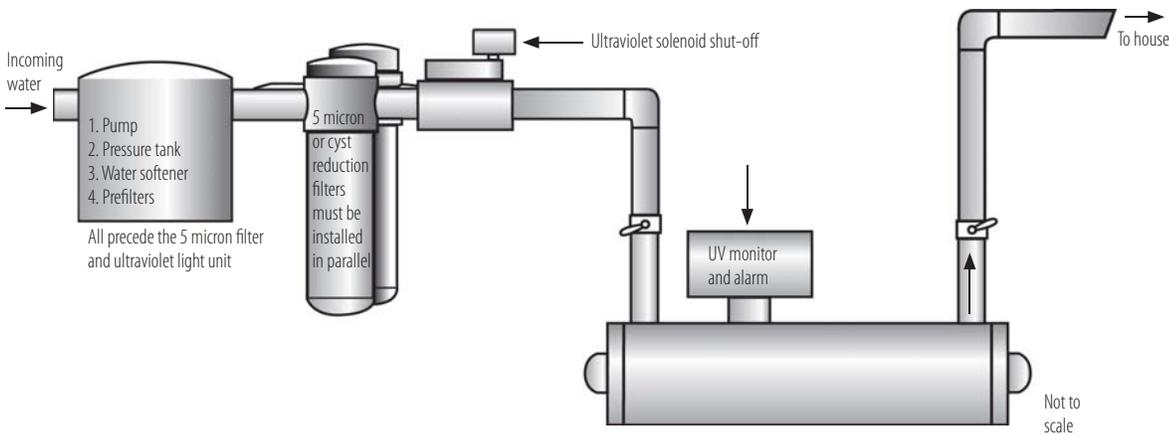
Rainwater cisterns are required to have continuous disinfection and cyst reduction. Hauled water storage tanks are not required to have continuous disinfection installed. However, any water that is delivered to a hauled water storage tank must have a chlorine residual of 0.2 ppm at the time of delivery. The disinfection system must be installed in accordance with OAC Rule 3701-28-15. Current acceptable methods for continuous disinfection are chlorination, iodination, ozonation, and ultraviolet (UV) light systems that meet NSF Standard 55 Class "A". An absolute 5 micron filter is required to be installed when UV is used as the means of continuous disinfection. A one to two micron cyst reduction filter that meets NSF Standard 53 is required to be installed with chlorination, iodination, and ozone systems and is recommended for UV systems. These filters are designed to remove disease causing protozoa such as *cryptosporidium* and *giardia*. The cyst filters need to be installed in parallel in order to maintain a flow rate capacity of at least 10 gallons per minute. Labels must be placed on each filter housing and treatment device, indicating the proper replacement filter(s) and pore size indicated as absolute microns.

For treatment systems using chlorine for disinfection a minimum 0.4 parts per millions chemical residual must be present in the water after 8 minutes of chlorine / water contact in the retention (contact) tank. When iodine is used for disinfection, the chemical residual should be between 0.5 and 1.0 parts per million after 20 minutes of contact in the retention tank. The retention (contact) tank shall have a capacity of at least 120 gallons per household and be constructed with baffles or filled with pea gravel that reduces short circuiting through the retention tank in order to increase the retention time. The private water system contractor should provide the home owner with a chemical test kit to periodically check the chlorine residual leaving the system. The solution reservoir must always have chlorine or iodine solution in it or the household water will not be getting disinfected. It is recommended that a float switch be installed in the solution tank attached to a solenoid that will shut off the water when the solution tank has gone dry. If UV is the disinfection of choice then an automatic shut off solenoid is highly recommended for instances when the UV system is not functioning properly. (See *Ultraviolet Light for Continuous Disinfection* fact sheet for more information).

Example of a Chlorine or Iodine System for Continuous Disinfection



Example of an Ultraviolet Light System for Continuous Disinfection



Procedures for Cleaning Cisterns and Hauled Water Storage Tanks*

Cisterns and hauled water storage tanks should be thoroughly cleaned periodically. How often this is done is going to be dependent on the area in which you live. Because cisterns collect rainwater off of the roof they are subject to varying amounts of potential contamination. In areas where there are large trees overhanging the roof area, or in areas where there is a lot of industrial activity, cistern cleaning should be performed more often. Cisterns in these types of areas should be cleaned every three to five years, but they may be cleaned more often if there is a desire or a need to do so. Hauled water storage tank systems that use exclusively hauled water will not require cleaning nearly as often as cisterns if care is taken when re-filling occurs.



Ohio Administrative Code 3701-28-12 (N) describes the startup, operation and disinfection of cisterns and hauled water storage tanks.

** Entering an enclosed space such as a cistern or hauled water storage tank for cleaning can be a dangerous procedure without adequate ventilation. We recommend that a qualified registered private water systems contractor carry out these procedures.*

Steps:

1. Drain all of the old water from the tank.
2. Provide adequate ventilation by use of a fan or other mechanism.
3. Enter the inside of the tank. Make sure someone is around to provide assistance if required.
4. Physically remove all debris from the bottom and sides of tank.
5. With a stiff brush or power washer, scrub the walls and floor with an unscented chlorine water solution of sufficient strength to remove any bacterial slime and mineral encrustation.
6. Leave the inside of the tank and then rinse the walls with a strong chlorine water solution of 1000 parts per million. This can be obtained by mixing two gallon of 5.25% unscented chlorine bleach per each one hundred gallons of water. Leave a foot or more of water standing in the bottom of tank. You will need enough water to re-circulate the chlorine solution through the distribution system.
7. Circulate the chlorine solution throughout the distribution system and let stand for at least eight hours.
8. Evacuate the rinse water.
9. Clean or replace the floating intake filter. Roof washer filters should be inspected and cleaned twice per year.
10. Refill the tank with chlorinated water hauled in from a public water supply. Water hauled from a public water system must have a chlorine residual of 0.2 ppm at the time of delivery.
11. If continuous disinfection is by chemical means then re-calibrate the disinfection system and check the disinfectant residual. Check the chemical residual at the sampling port just after the retention (contact tank). Chlorine shall be at least 0.4 ppm, iodine 0.5 ppm, and ozone 0.1 ppm. Homeowners are required to have a chemical test kit for monitoring the type of system in use.



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