

Ohio Department of Health
Bureau of Environmental Health

Plans for Developing a Rainwater Cistern or Hauled Water Supply

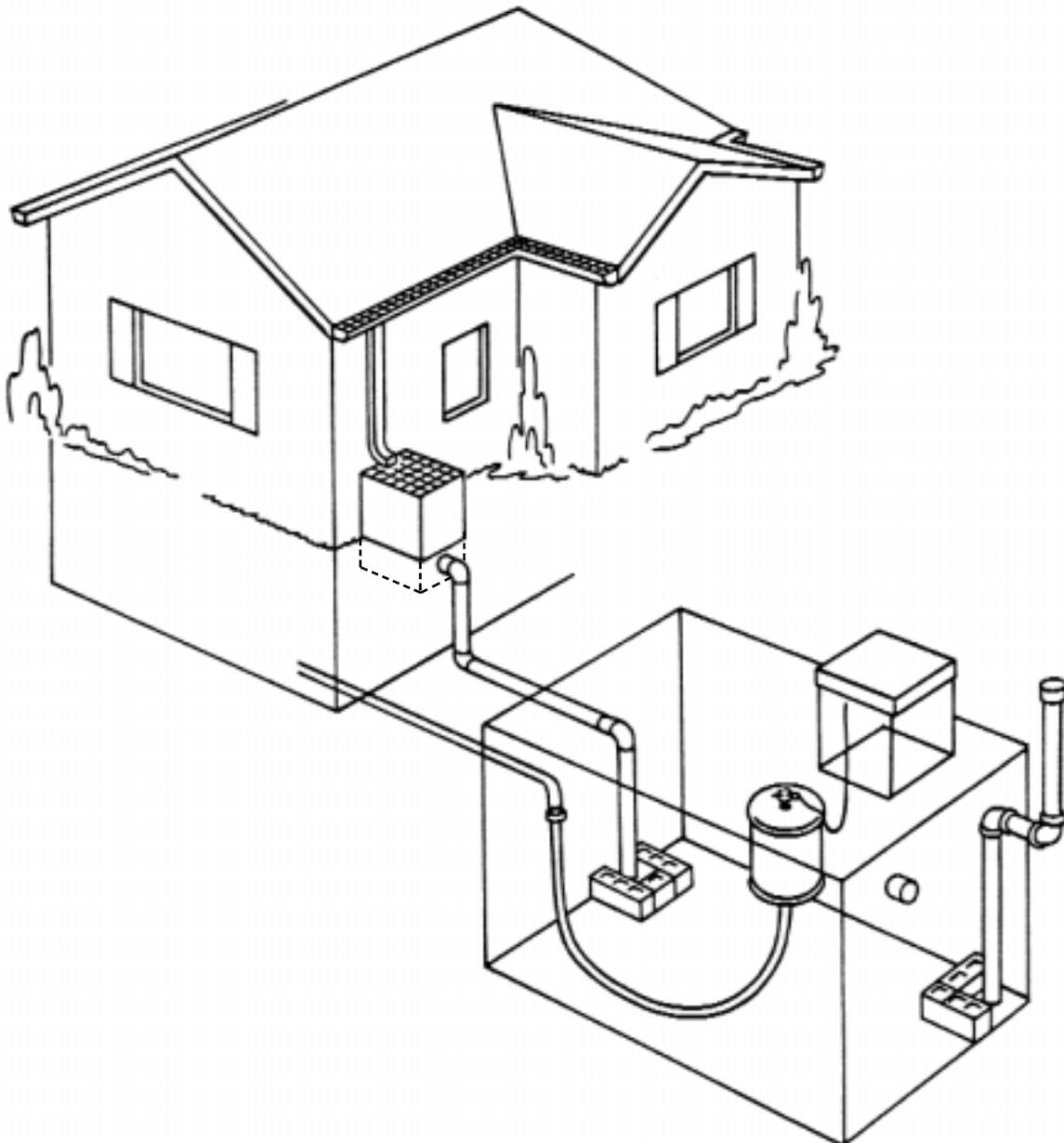
"To improve and protect the health of all Ohioans"

Bob Taft, Governor
J. Nick Baird, MD, Director of Health

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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) 3701-28-13.

Rainwater cistern and hauled water tank configuration may vary by contractor and do not necessarily need to correspond with all of the examples provided in this document as long the cisterns or tanks are constructed in compliance with the Private Water System Rules. **Contact your local health department for the necessary permits and for additional information.**

A rainwater 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 rainwater catchments or rainwater harvesting systems. A hauled water storage system is not designed to collect water off of a roof but is simply a water tank that is refilled exclusively by truck deliveries from approved public water supplies. Water haulers must comply with OAC Rule 3701-28-18 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 3701-28-18.

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 3701-28-07 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 of the tank 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 storage capacity.

Ohio receives about 37 inches of rainfall per year. Monthly average rainfall can vary greatly. It may rain as much as 7 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 www.dnr.state.oh.us/pubs/hydatlas. 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 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 cistern may also 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 is 60 gallons per person per day.
- Estimated annual use for a family of four would be about 87,600 gallons. Cistern users are generally more conservative with water usage.
- Garden or lawn watering to apply 1 inch for 1000 square feet requires 625 gallons per day.

To estimate the potential yield of a roof, calculate the rainfall (monthly or yearly) in inches and 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 Inches | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 |
| 1000 | 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) | | | | | | | | | |

Installing the Cistern or Hauled Water Storage Tank

Permits

OAC Rule 3701-28-13 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 performed by a contractor registered as a Private Water Systems Contractor with the Ohio Department of Health. 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

Cisterns should be located away from sources of contamination based on the isolation distance requirements set forth in (OAC) Rule 3710-28-10. A cistern or hauled water storage tank may not share a common wall with a building and must be a minimum of ten feet from the foundation. 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 100 feet from a leaching pit or privy and at least 50 feet from all other septic systems and their components.*

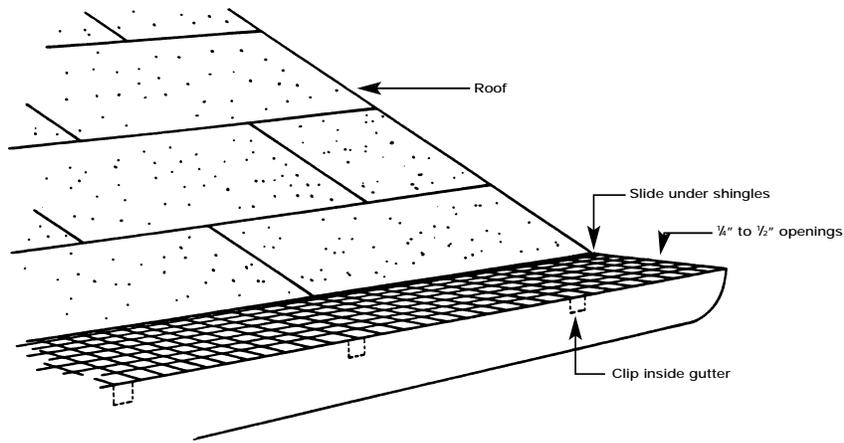
Roofs, Gutters, Downspouts, and Roof Washers

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, and metal. Composite asphalt, asbestos, chemically treated wood shingles and some painted roofs are not recommended for potable water cisterns. Lead materials should not be used anywhere on the roof where there is contact with water leading to the cistern. If asphalt shingles are used, then an additional particle filter device should be installed with the treatment system. Any roof paints or coatings should be listed on National Sanitation Foundation (NSF) Standard 61, Drinking Water System Components under protective barriers.

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 have 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) filter is recommended *to remove possible pesticide residuals* in areas where agricultural use deposition is possible.

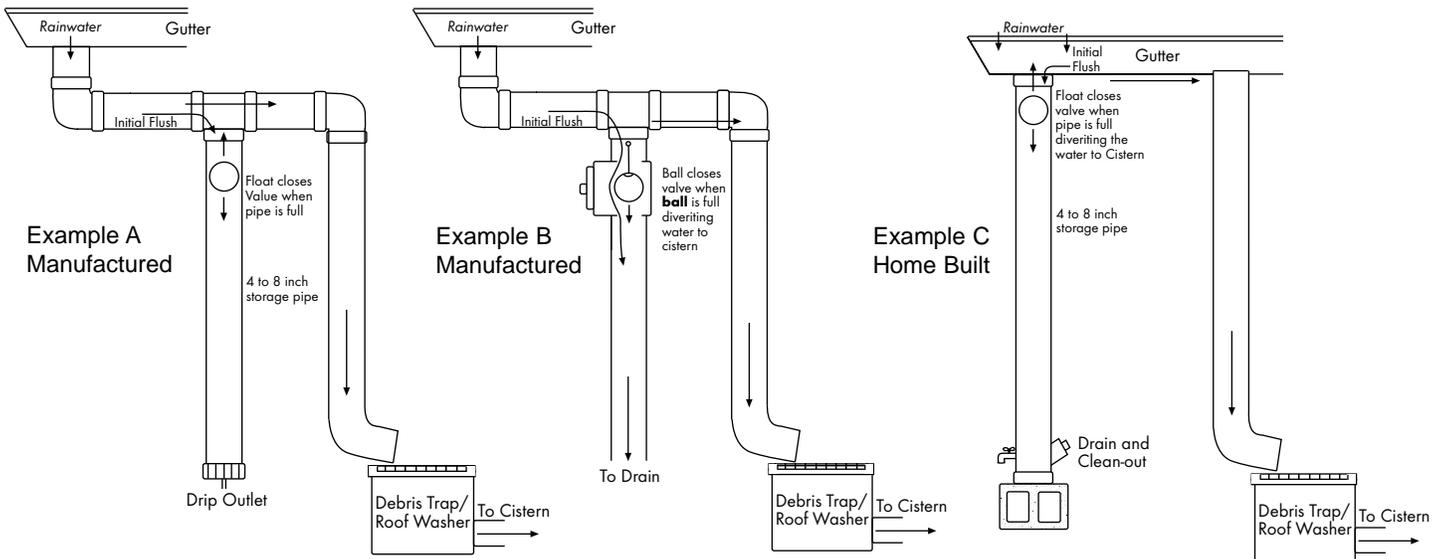
Gutter guards should be used to exclude leaves and twigs. A roof washer / filter shall be provided for each 1500 square feet of roof area. A rainwater diverter should also be installed to clean the roof with the initial flush of rain. A minimum of ten gallons of rainwater per fifteen hundred (1500) square feet of roof must be diverted from each rainfall event. These diverters can be designed to be automatic or have a manual lever switch inside or outside the house. Examples shown on the following pages provides schematics on the construction of manufactured and home-built diverters and roof washers.

Example of Gutter Guard



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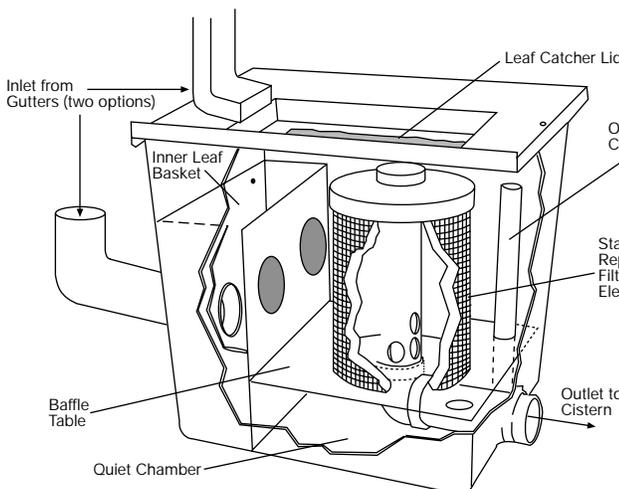
Examples of Automatic Diverters



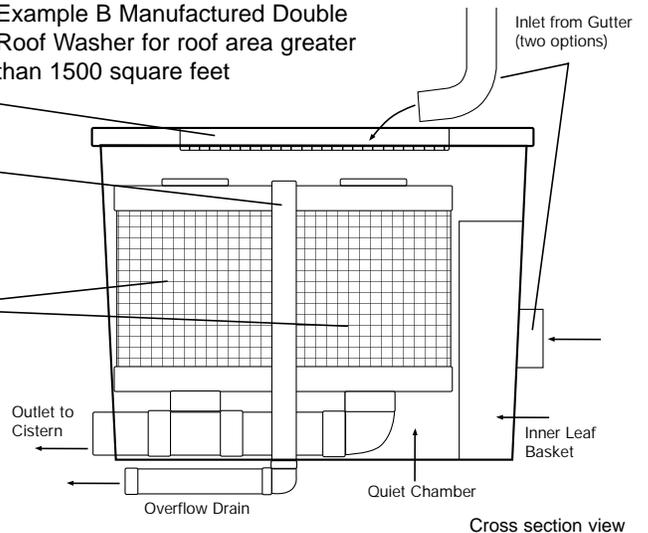
Note: Problems will occur with these devices if not properly maintained on a routine basis.

Examples of Filtering Roof Washers

Example A Manufactured



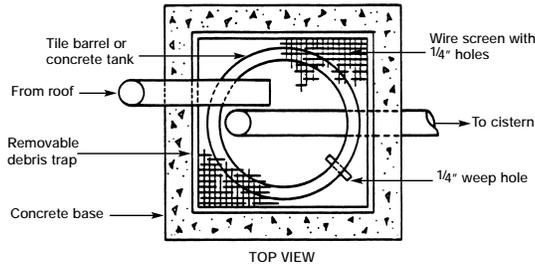
Example B Manufactured Double Roof Washer for roof area greater than 1500 square feet



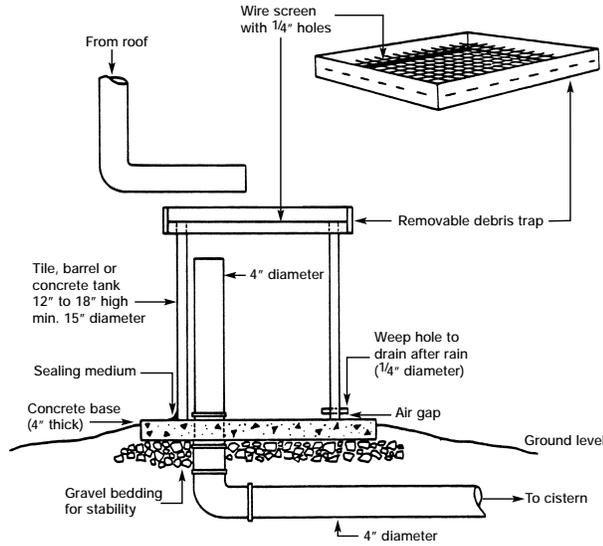
Cross section view

Examples of Home Built Roof Washers

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



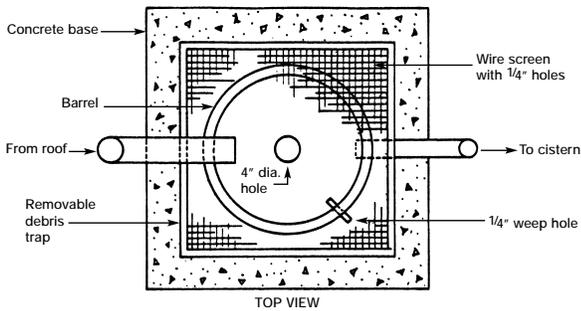
Example A



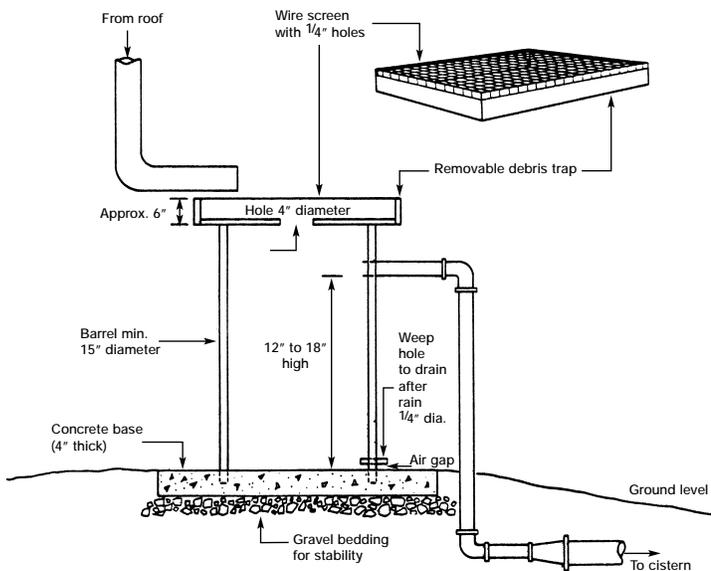
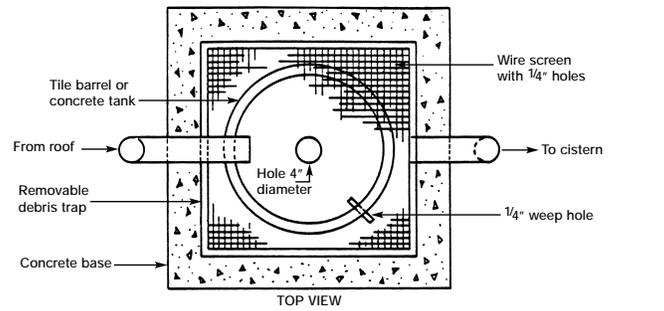
Note: Problems will occur with these devices if not properly maintained on a routine basis.

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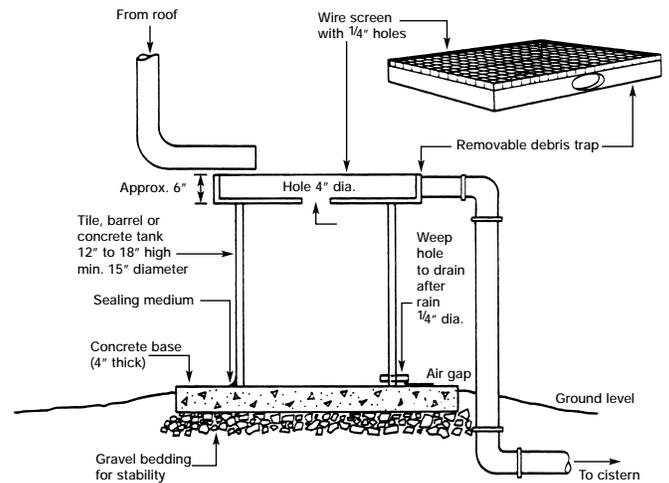
Example B



Example C



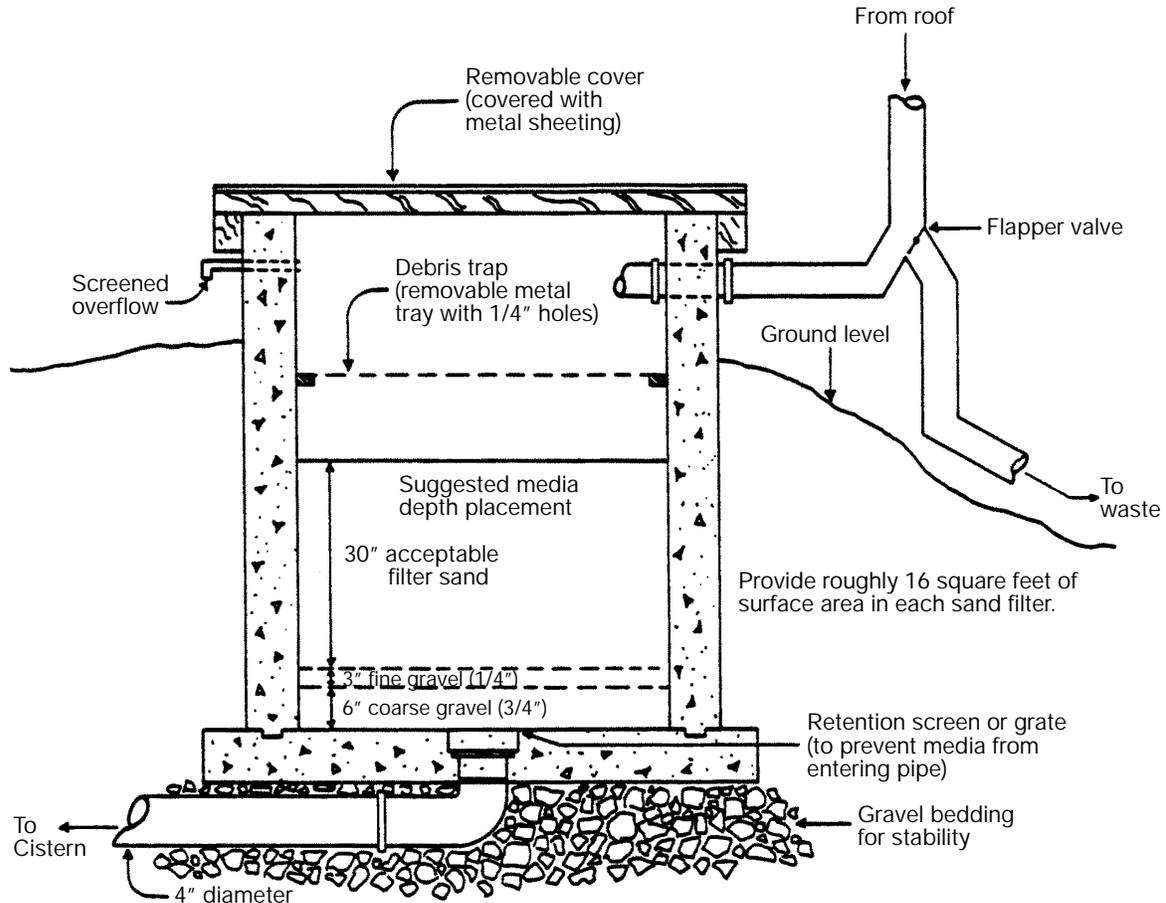
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Example drawing of an optional Cistern Sand Filter

(May be used in place of roof washer)



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

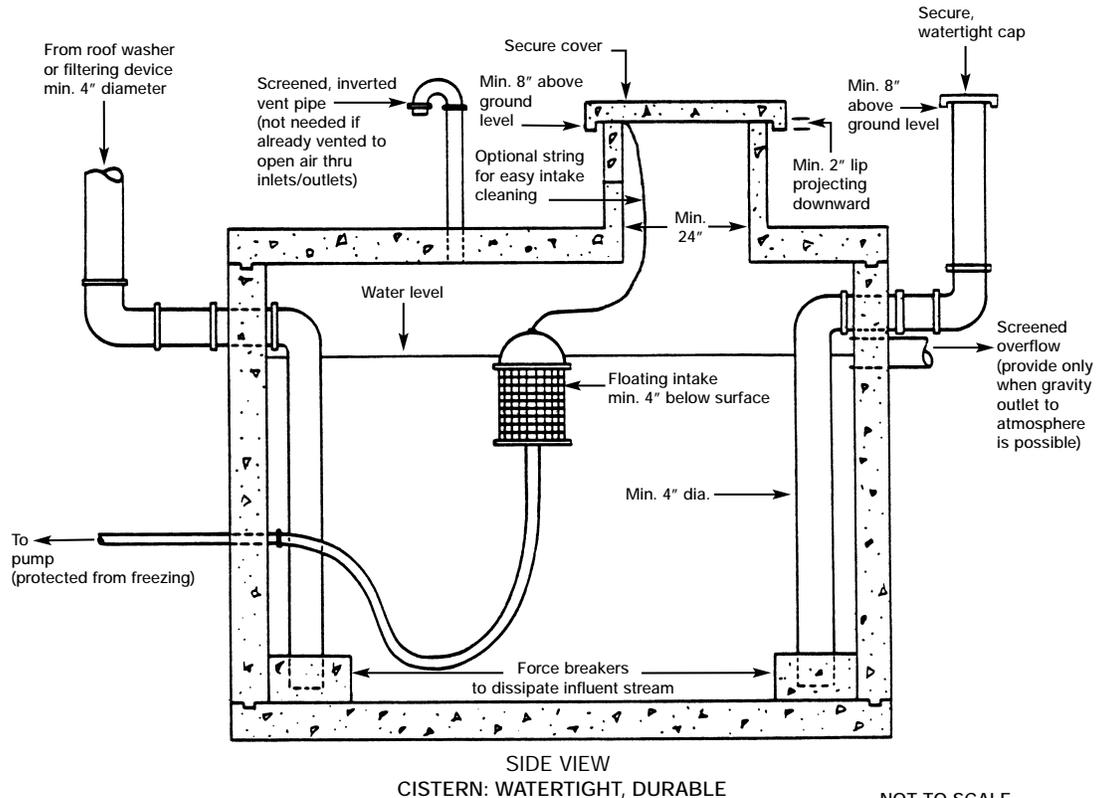
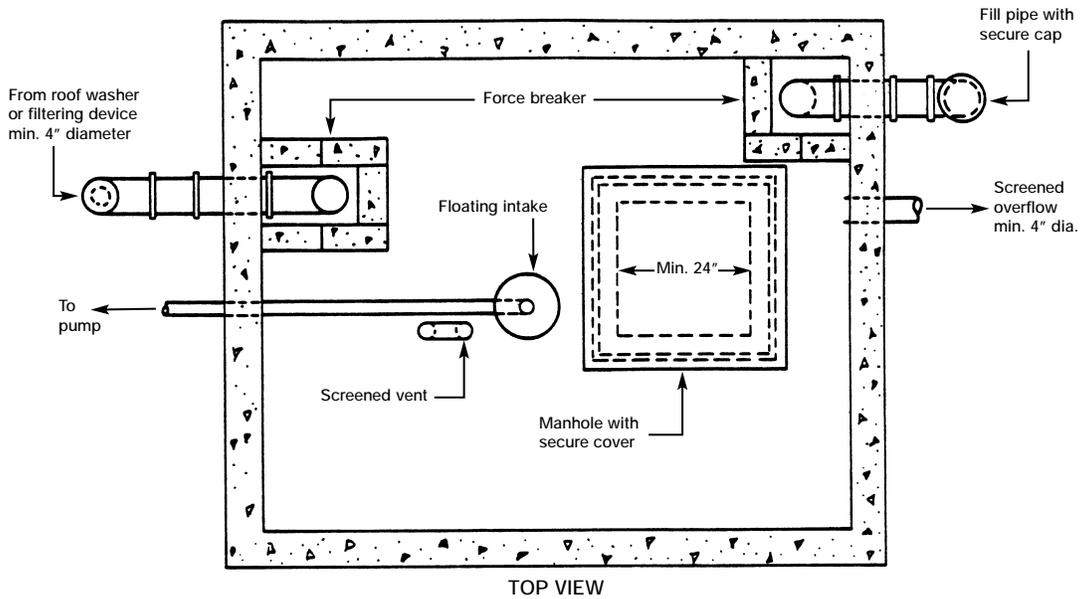
Maintenance of Gutters, Downspouts, Debris Traps, Roof Washers and Cistern Filters

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 in the 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 drawings of a Concrete Cistern



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The interior of the tanks used as cisterns 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 approved products can also be found 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 tops must be manufactured 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 above the ground surface. 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. The overflow outlet needs to be installed with an atmospheric break of four to eight inches to prevent back-siphonage. 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 thousands of an inch installed to exclude small animals and insects. All vents shall be inverted. Cisterns and hauled water storage tanks with inlets and outlets to the open air need not be vented.

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 or other watertight cap should be placed on the pipe when not being used for filling.

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.

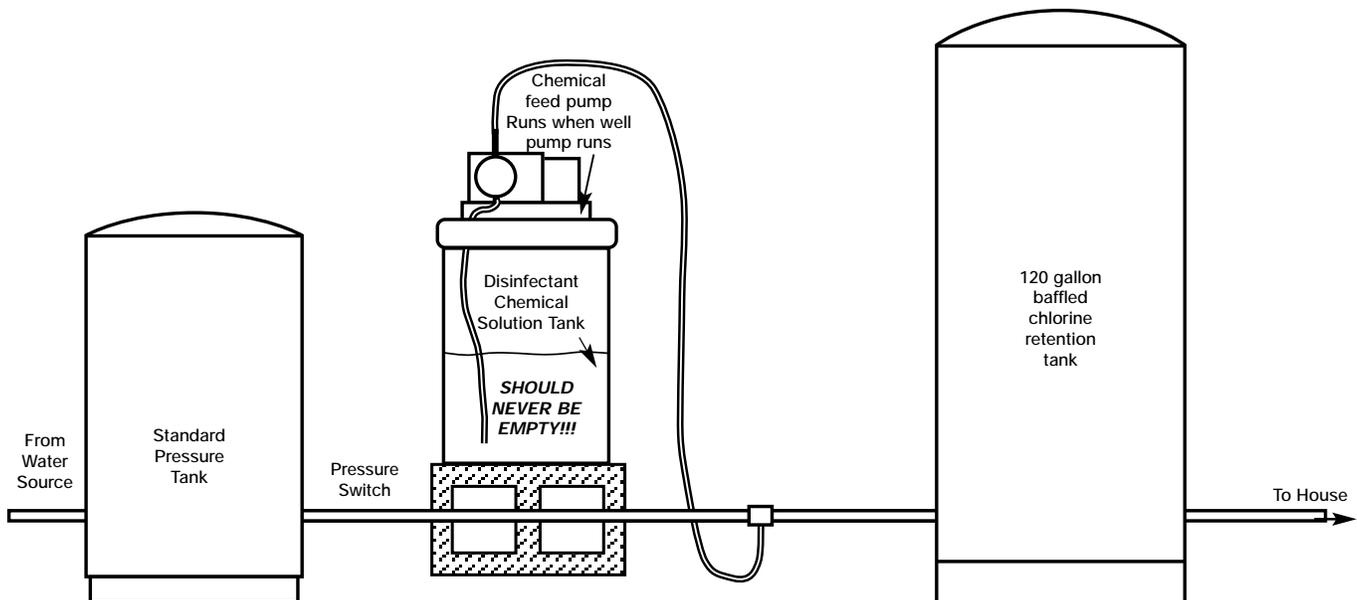
1. The intake could be attached to a floating filter device that maintains the opening to the intake below the water surface. A jet pump would be located in the house to pump the water to the pressure tank.
2. A submersible pump may be used as the water intake. The pump should be placed so as to maintain 12 inches from the bottom of the tank.
3. Alternative intake designs may be used where water is not taken from any less than four inches from the water surface and twelve inches from the bottom of the tank.

Disinfection and Treatment

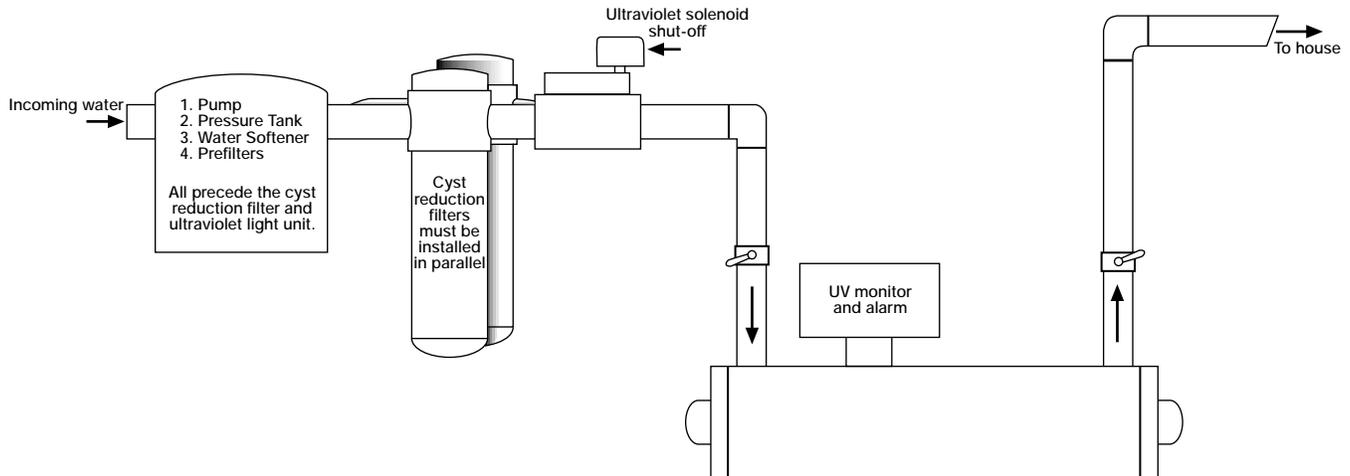
The disinfection system must be installed in accordance with OAC Rule 3701-28-09. Current acceptable methods for continuous disinfection are chlorination, iodination, ozonation, and ultraviolet (UV) light systems that meet NSF Standard 55 Class "A". A cyst reduction filter that meets NSF Standard 53 is currently required when UV is used as the means of continuous disinfection. A 1 to 2 micron cyst reduction filter is highly recommended for use with chlorination, iodination, and ozone systems. These filters are designed to remove disease causing protozoa such as *cryptosporidium* and *giardia*. The filter needs to be installed in parallel in order to maintain a flow rate capacity of at least 10 gallons per minute.

For treatment systems using chlorine for disinfection, a minimum 0.2 parts per million (ppm) chemical residual must be present in the water after 20 minutes of chlorine / water contact in the retention 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 tank should be constructed with baffles or filled with pea gravel to reduce short circuiting through the retention tank and 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 or iodine residual leaving the system. The solution reservoir must always contain chlorine or iodine solution or the household water will not be 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 a UV system is being used for disinfection, a warning device or automatic shut off solenoid is required for instances when the UV system is not functioning properly. However, the use of the automatic shut off solenoid is the preferred safety feature. (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. OAC Rule 3701-28-17 describes the startup, operation and disinfection of private water systems.

***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 and observe enclosed space entry guidelines.**

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. Let the water stand in the bottom of tank for at least 8 hours.
7. Clean or replace the floating intake filter. Roof washer filters should be inspected and cleaned twice per year.
8. Circulate the chlorine solution throughout the distribution system and let stand for at least 8 hours.
9. Evacuate the rinse water.
10. Refill the tank with chlorinated water hauled in from a public water supply.
11. If continuous disinfection is by chemical means, re-calibrate the disinfection system and check the disinfectant residual. Residuals from chlorine shall be at least 0.2 ppm, iodine at least 0.5 ppm, and ozone at least 0.1 ppm. Homeowners are required to have a chemical test kit for monitoring the type of system in use.

