



Virginia Household Water Quality Program: Shock Chlorination: Disinfecting Private Household Water Supply Systems

Brian Benham, Professor and Extension Specialist, Biological Systems Engineering, Virginia Tech

Erin James Ling, Senior Extension Associate, Biological Systems Engineering, Virginia Tech

Private water sources such as wells and springs are not regulated by the U.S. Environmental Protection Agency (EPA). Although private well construction regulations exist in Virginia, private water supply owners are responsible for providing maintenance for their water systems, monitoring water quality, and taking the appropriate steps to address problems, should they arise.

The EPA public drinking water standards are good guidelines for assessing your water quality. “Primary drinking water standards” apply to contaminants that can adversely affect health and are legally enforceable for public water systems. “Secondary drinking water standards” are nonregulatory guidelines for contaminants that may cause nuisance problems such as bad taste, foul odor, or staining.

Testing your water annually and routinely inspecting and maintaining your water supply system will help keep your water safe. For more information, visit the Virginia Household Water Quality Program website at www.wellwater.bse.vt.edu.

What Is Shock Chlorination?

Shock chlorination is a process of disinfecting a private water supply and plumbing system by circulating a concentrated chlorine solution throughout the system.

When Should Shock Chlorination Be Used?

Bacterial contamination in water cannot be seen, tasted, or smelled by human senses, and health-related symptoms caused by bacterial contamination can occur some time after exposure. Shock chlorination is required following well construction and is recommended following a positive total coliform water test or any maintenance or repair of a private water supply system. Additionally, private water supply systems should be shock chlorinated after any flooding or if another obvious means of water contamination is present in your area.

Although shock chlorination will address bacteria present in your water system, if a continuous source of contamination persists — a malfunctioning septic system or a pathway for surface water to enter a well, such as a loose well cap or cracked casing — bacterial contamination will continue to be a problem. Steps should be taken to identify and address the source of contamination.

What Precautions Should Be Taken When Shock Chlorinating?

While an accomplished do-it-yourselfer can shock chlorinate his or her own private water supply system, the process can be challenging. If your water supply system needs to be shock chlorinated, consider contracting a licensed and certified well driller to do it for you. Should you decide to shock chlorinate your water supply system yourself, there are several precautions to keep in mind.

- **Your water pump is electric.** To prevent an electric shock, turn the pump circuit breaker off before removing the well cap or cover. You will need to turn the power on during Step 3 of the shock chlorination process (below), but be sure to turn the pump circuit breaker off again before replacing the well cap or cover (Step 4). Wear waterproof rubber boots.
- **Concentrated chlorine solutions like those required to shock chlorinate a private water system can be dangerous.** It is important to wear appropriate clothing, including goggles, a protective apron, and rubber gloves and boots. The area where the chlorine solution is to be mixed and added to the water supply must be well-ventilated.
- **It is critical to plan ahead and have a 12 to 24 hour supply of nonchlorinated water to use for drinking and cooking during the shock chlorination process.** It is important **NOT** to use any water from your supply system during the shock chlorination process.
- **Shock chlorinating a water supply system can potentially damage system components such as pressure tanks, water softeners, filters and filter media, and other treatment devices.** Check with component manufacturers before shock chlorinating your water supply system to determine how to bypass or protect this equipment if necessary.

If you decide to perform the shock chlorination process on your system, the remainder of this publication outlines the process.

The Shock Chlorination Process

The two sources of chlorine most often used for shock chlorination are (1) plain, unscented, liquid chlorine bleach (sodium hypochlorite) containing 5.25 percent available chlorine; and (2) soluble calcium hypochlorite tablets or powder containing 65 to 75 percent available chlorine.

For Wells

1. **Clean and open.** Turn OFF the electricity to the pump. Remove all loose or foreign debris from around the well house/wellhead. Remove the well cap or cover. If the well cap is in need of repair or is not a sanitary, sealed cap as required by the Virginia Water Well Regulations, consider having it replaced at this time.
2. **Calculate, mix, and pour.** The amount of chlorine needed to disinfect your water supply system depends on the volume of water to be treated. To determine the amount of plain, unscented, liquid bleach (table 1) or calcium hypochlorite pellets or powder (table 2) needed to produce the chlorine solution to disinfect your water supply system, you must know (1) the diameter of the well, and (2) the depth of water in the well. If you don't already have this information, you will need to determine it.

In Virginia, if your well was constructed after 1992, you should be able to find a Uniform Water Well Completion Report on file with your local Department of Health office. In addition to other information, this report contains the "total depth of well" and "static water level." To calculate the depth of water in your well, subtract the static water level (from top of well to water's surface) from the total depth of well. For example, if the total depth of well = 130 feet and the static water level (from the top of the well to water's surface) = 30 feet, the depth of water in the well is 100 feet (130 feet – 30 feet = 100 feet).

Using the calculated depth of water and the well diameter or casing size (also found on the Uniform Water Well Completion Report), refer to either table 1 or 2, depending on the source of chlorine being used.

If your well was constructed before 1992 but you know the well drillers who constructed it, contact them. Well drillers often keep records of all the wells they drill. If you can't find any records about your well, we recommend contracting a licensed and certified well driller to assist you in taking the appropriate measurements to determine the volume of water to be treated.

The best way to introduce chlorine into the well is to combine the necessary amount of bleach or dissolve the calcium hypochlorite pellets or powder with fresh water in a clean 5-gallon plastic bucket. Pour the chlorine solution in the bucket into the well (figure 1). Note: for some deep or large diameter wells, the volume of liquid bleach needed to disinfect the well will be greater than 5 gallons. In these cases, pour the bleach directly into the well.
3. **Circulate.** Connect a clean garden hose to the outdoor faucet nearest the well. Place the end of the hose in the well and open the spigot. Turn the power to the pump back on. Let the water run from the hose into



Figure 1. Determine the amount of chlorine bleach or calcium hypochlorite needed, mix, and pour the chlorine solution into the well. Source: Minnesota Department of Health. www.health.state.mn.us/divs/eh/wells/waterquality/disinfection.pdf.



Figure 2. Circulate water in the well and wash down the inside of the casing. Source: Minnesota Department of Health. www.health.state.mn.us/divs/eh/wells/waterquality/disinfection.pdf.

the well until a strong odor of chlorine is detected coming out of the hose. Using the hose, wash down the interior of the well casing for about 15 minutes (figure 2). Keep in mind that only those surfaces that come in contact with the chlorine will be disinfected.

Open each faucet, first outside, then inside the house (both hot and cold), one at a time, and let the water run. Close the faucet after a strong chlorine odor is detected. Flush each toilet. If a strong chlorine odor cannot be detected, add more chlorine solution to the well.

4. Close and let stand. Turn the electricity to the pump OFF. Replace the well cap or cover, ensuring the gasket forms a seal if you have a sanitary well cap. Let the chlorinated water stand in the plumbing system

for 12 to 24 hours. Do not run any water or flush toilets during this time. Use your reserves of fresh water for all purposes.

5. Flush. After the 12 to 24 hour contact time, flush the system of the remaining chlorine. Start with the outside faucet(s). Distribute the chlorinated flush water to a gravel road or other nonvegetated area. If your home uses a septic system, limit the amount of chlorinated water going into the septic system by flushing the chlorinated water through the outdoor faucets to the nonvegetated areas. Let each indoor and outdoor faucet run until the chlorine odor is no longer noticeable.

Flushing chlorine from the water heater can be difficult. Consider draining your water heater to aid in flushing the chlorine from your plumbing system. If you choose to drain the water heater, be sure to turn off the electricity or gas to the heater to avoid damaging the unit. If desired, after flushing you may check to see that the chlorine has been eliminated from the water supply system by using a test kit that tests for free chlorine, available from home improvement stores and water supply equipment dealers.

6. Retest. Wait one to two weeks after shock chlorinating the water supply system to retest for total coliform and fecal coliform bacteria. Follow sample collection instructions carefully. If coliform bacteria are still present, continuous disinfection may be required.

Table 1. Amount of unscented liquid chlorine bleach (5.25% sodium hypochlorite) needed for shock chlorination.*

Water depth in well (feet)	Well diameter (inches)				
	4	6	8	24	36
10	3 pt	3.5 pt	2 qt	5 qt	2.5 gal
20	3.5 pt	4 pt	2.5 qt	2.5 gal	4.5 gal
50	2 qt	2.5 qt	3.5 qt	5 gal	10.5 gal
100	2.5 qt	4 qt	5.5 qt		
150	3 qt	5 qt	7.5 qt		
200	3 ½ qt	1.5 gal	2.5 gal		
400	5.5 qt	2.5 gal	4.5 gal		

*Amount of liquid chlorine bleach (5.25% chlorine) needed to produce a concentration of approximately 200 ppm. Assumes 110 gallons of water volume in home plumbing system (e.g., pressure tank, water heater, pipes).

Table 2. Amount of calcium hypochlorite pellets or powder (60 to 70% calcium hypochlorite) needed for shock chlorination.*

Water depth in well (feet)	Well diameter (in)				
	4	6	8	24	36
10	5 oz	5 oz	5.5 oz	14 oz	26 oz
20	5 oz	6 oz	6.5 oz	23 oz	3 lb
50	6 oz	7 oz	10 oz	3 lb	7 lb
100	7 oz	10 oz	15 oz		
150	8 oz	13 oz	20 oz		
200	10 oz	16 oz	25 oz		
400	15 oz	28 oz	3 lb		

*Amount of liquid chlorine bleach calcium hypochlorite pellets or powder (60 to 70% calcium hypochlorite) needed to produce a concentration of approximately 200 ppm. Assumes 110 gallons of water volume in home plumbing system (e.g., pressure tank, water heater, pipes).

For Springs and Cisterns

Follow the same precautions outlined previously for working with chlorine solutions.

- 1. Clean.** Remove all loose or foreign debris from the spring box or cistern. Scrub the accessible interior surfaces of the spring box or cistern with a strong chlorine solution (1/2 gallon of unscented chlorine bleach per 5 gallons of clean water). This is a good time to inspect the spring box or cistern and seal any leaks or cracks with an appropriate sealant.
- 2. Calculate, mix, and pour.** Calculate the volume of water stored in the spring box or cistern in cubic feet, (width x length x depth of water)*. Multiply the cubic feet of storage by 7.5 to get the equivalent number of gallons of stored water, then add 110 gallons to the volume of water stored in the spring box or cistern. These additional 110 gallons represent the volume of water stored in the plumbing in the house. Use 3 pints of chlorine bleach or 4 ounces of calcium hypochlorite pellets or powder per 100 gallons of water stored in the spring box or cistern. Table 3 illustrates these calculations.
- 3. Circulate.** Open each faucet, first outside, then inside the house (both hot and cold), one at a time, and let the water run. Close the faucet after a strong chlo-

rine odor is detected. Flush each toilet. If a strong chlorine odor cannot be detected, add more chlorine solution to the spring or cistern.

- 4. Let stand.** Let the water stand in the plumbing system for 12 to 24 hours. Do not run any water or flush toilets during this time. Use your reserves of fresh water for all purposes.
- 5. Flush.** After the 12 to 24 hour contact time, flush the system of the remaining chlorine. Start with the outside faucet(s). Distribute the chlorinated flush water to a gravel road or other nonvegetated area. If your home uses a septic system, limit the amount of chlorinated water going into the septic system by flushing the chlorinated water through the outside faucets to the nonvegetated areas. If desired, after flushing you may check to see that the chlorine has been eliminated from the water supply system by using a test kit that tests for free chlorine, available from home improvement stores and water supply equipment dealers.
- 6. Retest.** Wait one to two weeks after shock chlorinating the water supply system to retest for total coliform and fecal coliform bacteria. Follow sample collection instructions carefully. If coliform bacteria are still present, continuous disinfection may be required.

For more information on bacteria and other microorganisms in household water, see the following websites:

- Virginia Household Water Quality Program: www.wellwater.bse.vt.edu/resources.php.
- Virginia Cooperative Extension (VCE): <http://pubs.ext.vt.edu/category/home-water-quality.html>.
- For more information, contact your local VCE office or visit www.wellwater.bse.vt.edu.

Acknowledgements

The authors wish to thank the following individuals who reviewed this publication: Mary Anne Massie, senior water supply planner, Virginia Department of Environmental Quality; Daniel “Duke” Price, program manager, Division of Onsite Sewage and Water Service, Virginia Department of Health; Eric Rorrer, president, Rorrer Well Drilling, Christiansburg, Va.; and Carl Stafford, agriculture and natural resources agent, VCE Culpeper County Office.

* Refer to Table 3.

Table 3. Spring and cistern chlorine solution calculation worksheet.

Instructions	
<p>1. Measure length and width of cistern or spring box, and depth of water. Multiply length by width by depth.</p>	<p>Example</p> $6 \text{ ft} \times 6 \text{ ft} \times 6 \text{ ft} = \underline{216 \text{ ft}^3}$ <hr/> <p>Your calculations</p> $\underline{\hspace{2cm}} \text{ length} \times \underline{\hspace{2cm}} \text{ width} \times \underline{\hspace{2cm}} \text{ depth} = \underline{\hspace{2cm}} \text{ ft}^3$
<p>2. Convert ft³ to gallons. Multiply No. 1 x 7.5.</p>	$216 \text{ ft}^3 \times 7.5 \text{ gal/ft}^3 = \underline{1,620 \text{ gal}}$ <hr/> $\underline{\hspace{2cm}} \text{ ft}^3 \times 7.5 \text{ gal/ft}^3 = \underline{\hspace{2cm}} \text{ gal}$
<p>3. Add 75 gallons to account for volume of water in home plumbing system. Add No. 2 + 110.</p>	$1,620 \text{ gal} + 75 \text{ gal} = \underline{1,695 \text{ gal}}$ <hr/> $\underline{\hspace{2cm}} \text{ gal} + 110 \text{ gal} = \underline{\hspace{2cm}} \text{ gal}$
<p>4. Calculate the amount of liquid bleach needed: Multiply No. 3 x 0.003 pints per gallon (3 pints per 100 gallons).</p> <p style="text-align: center;">– OR –</p> <p>Calculate the amount of calcium hypochlorite needed: Multiply No. 3 x 0.004 ounces per gallon (4 ounces per 100 gallons).</p>	$1,695 \text{ gal} \times 0.003 \text{ pt/gal} = \underline{5 \text{ pt}}$ <hr/> $\underline{\hspace{2cm}} \text{ gal} \times 0.003 \text{ pt/gal} = \underline{\hspace{2cm}} \text{ pt}$ <p style="text-align: center;">– OR –</p> $1,695 \text{ gal} \times 0.004 \text{ ounces/gal} = \underline{7 \text{ ounces}}$ <hr/> $\underline{\hspace{2cm}} \text{ gal} \times 0.004 \text{ ounces/gal} = \underline{\hspace{2cm}} \text{ ounces}$

Resources

Indiana Department of Environmental Management. 1999. *Well Disinfection*. www.engineering.purdue.edu/SafeWater/drinkinfo/welldisinfection.pdf.

Minnesota Department of Health. 2010. *Well and Water System Disinfection for Private Wells*. <http://www.ianrpubs.unl.edu/epublic/live/g1826/build/g1826.pdf>.

Parrott, K., B. Ross, and J. Woodward. 2002. *Household Water Quality: Bacteria and Other Microorganisms in Household Water*. VCE Publication 356-487.

Skipton, S., B. Dvorak, W. Woldt, and S. Wirth. 2008. *Drinking Water: Bacteria*. University of Nebraska-Lincoln Extension Publication G1826. <http://elkhorn.unl.edu/epublic/pages/publicationD.jsp?publicationId=968>.

Swistock, B., S. Clemens, and W. Sharpe. 2007. *Water Facts #14: Shock Chlorination of Wells and Springs*. Penn State College of Agricultural Sciences. Publication Code XH0019. <http://pubs.cas.psu.edu/FreePubs/pdfs/XH0020.pdf>.

University of Rhode Island Cooperative Extension Water Supply Program and the Rhode Island Department of Health. 2003. *Bacteria in Private Drinking Water Supplies*. Private Wells Series. www.uri.edu/ce/wq/has/PDFs/Bacteria_handout_revised.pdf.

U.S. Environmental Protection Agency. 2009. *National Primary Drinking Water Regulations*. EPA 86-F-09-004. <http://www.epa.gov/safewater/consumer/pdf/mcl.pdf>.

U.S. Environmental Protection Agency. *Private Drinking Water Wells*. EPA Web page: <http://water.epa.gov/safewater/info/well/index.cfm>.

Virginia Department of Health. 1992. *Commonwealth of Virginia State Board of Health Private Well Regulations*. www.vdh.state.va.us/EnvironmentalHealth/Onsite/regulations/FormsDocs/documents/Well-regs-7-20-00.pdf.