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Emergency Disinfection of Small Water Systems

A water system should disinfect if it experiences any of the following:

- The water system loses pressure for any reason.
- Any part of the water system is “opened up” for maintenance or repairs.
- Backflow or backsiphonage creates a cross-connection event.
- The water system experiences an acute or non-acute total coliform MCL (maximum contaminant level) violation and an exact cause of the contamination has not been determined.

If you receive an unsatisfactory routine coliform sample result, you should not disinfect until after you collect the required repeat samples. Contact your regional coliform staff if you’re not sure how to proceed.

Notify your customers first

If you normally do not disinfect your water, notify **all** your customers first. Water with high levels of chlorine can seriously affect people with unique medical needs, such as kidney dialysis patients. All water systems should maintain a list of such customers. People with aquariums or ponds that contain fish will also be especially interested in knowing that the water is to be chlorinated.

Disinfecting a well

1. Calculate the volume of water in the well. You will need to know the total depth of the well and the depth to the static water level (level of water when the pump is off). Subtract the static water depth from the total depth of the well; this is the depth of water in the well. Use the table at right to calculate the volume of water in your well.

Calculating Well Volume	
Well Casing Diameter (inches)	**Volume** (gallons per vertical foot of water)
6	1.5
8	2.6
10	4.1
12	5.9
14	8.0
16	10
36	53

2. Calculate how much chlorine to add to the well using this table (see “Notes related to the tables” on Page 4):

Well Disinfection: Amount of chlorine bleach to use				
Well Volume (gallons)	**Desired Chlorine Dosage**			
	Household Bleach (6%)			**12 % bleach**
	2 mg/L	***5 mg/L***	***20 mg/L***	***5 mg/L***
50	½ Tbsp	1 ¼ Tbsp	4 ½ Tbsp	½ Tbsp
100	1 Tbsp	2 ¼ Tbsp	9 Tbsp	1 Tbsp
200	2 Tbsp	5 Tbsp	1 ¼ cups	2 Tbsp
500	4 ½ Tbsp	¾ cup	2 ¾ cups	5 Tbsp
1000	9 Tbsp	1 ½ cup	5 ½ cups	¾ cup

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3. Pour the required quantity of bleach into a five-gallon bucket of water. Pour the bucket of chlorine solution down the inside of the well.

   Connect a garden hose that has never been used to the nearest outside faucet and circulate the water through the hose and back into the well. This will mix the chlorine with the water and the pump will draw the chlorine to the bottom of the well. After you start smelling the chlorine in the water coming out of the hose, use the hose to rinse the upper portion of the well casing with the disinfectant.

Disinfecting water in pressure tanks

You must disinfect the water in your pressure tanks or hydropneumatic tank, especially if you are doing a follow-up to a coliform MCL violation or other known contamination event. You will need to drain the water from each tank and then refill them with water containing chlorine from your well or storage tank, depending on the layout of your water system. The chlorinated water should remain in the tank(s) for at least 6 hours; 24 hours is preferred. Drain or flush the chlorinated water from the tank(s) and then refill the tank volume with untreated water. Draining the water from this tank or tanks may affect the air pressure in the tank(s) and recharging of the air maybe required.

Disinfecting a storage tank and distribution system

If you must chlorinate both your source and your storage reservoir, disinfect the source first.

1. If the contamination does not appear to be originating at the water source, you can add disinfectant just to the storage tank rather than the water source.

2. Determine the amount of chlorine that will need to be added to the storage tank, using the table below (see "Notes related to the tables" on Page 4):

Reservoir Disinfection: Amount of chlorine bleach to use				
Tank Volume (gallons)	**Desired Chlorine Dosage**			
	Household Bleach (6%)			**12 % bleach**
	1 mg/L	***5 mg/L***	***10 mg/L***	***1 mg/L***
5,000	1 ⅓ cups	6 ⅔ cups	13 ⅓ cups	1 cup
10,000	2 ⅔ cups	13 ½ cups	1 ¾ gallons	1 ¼ cups
20,000	5 ⅓ cups	1 ¾ gallons	3 ½ gallons	3 cups
50,000	13 ½ cups	4 ¼ gallons	8 ½ gallons	7 cups
100,000	1 ¾ gallons	8 ½ gallons	16 ¾ gallons	¾ gallon

   Also, see "What chlorine dose is needed?" on Page 4.

   If your distribution system is extensive, calculate the volume of water in the distribution piping and add it to the volume of the storage tank; use that total volume in the table above when determining how much chlorine to add to the storage tank. The table below shows some common water distribution main sizes and volumes per foot of pipe. Estimate the total length of water pipes in your water system and multiply the total by the appropriate value from the table. You can use as-built drawings of the water system or a simple map to help estimate pipe diameters and lengths.

Estimating volume of water in the distribution system		
Pipe Diameter (inches)	**Volume** (gallons per linear foot of pipe)	**Volume** (gallons per 100 feet of pipe)
1	0.04	4
2	0.16	16
4	0.65	65
6	1.47	147

3. Draw down the level of water in the storage tank, but keep sufficient quantity for fire flow, if required.
4. Pour the chlorine into the tank as the tank is refilling, in order to get some mixing.
5. Use a blowoff, fire hydrant, or outside faucet in the distribution system to draw chlorinated water from the tank out into the distribution system. Then go to all of the faucets in the water system and flush water from them until you detect chlorinated water. Usually you can smell the chlorine, but to be more accurate, use a chlorine residual test kit to measure chlorine residual. (We recommend every water system own a chlorine residual test kit.)
6. Allow the chlorine to remain in the water system overnight (6 hours minimum, 24 hours is preferable). Chlorine needs time to do an effective job of disinfecting.
7. Use one or more outside faucets, blowoffs, or hydrants to draw water out of the water system in order to replace the chlorinated water with chlorine-free water from your source. During this process, make sure you don't damage a pump by drawing water down below a pump intake. Never discharge chlorinated water into any water body, wetland, or drainage ditch because it is extremely toxic to fish. You must dechlorinate the water prior to discharge. Depending on the chlorine levels in the water, you may also use normal water usage to replace the chlorinated water more slowly with chlorine-free water.
8. You should wait at least seven days—or until you know there is no chlorine remaining in the water—before collecting a coliform sample.* The coliform sample result will indicate whether the disinfection was effective.

   If you are disinfecting in follow-up to an acute total coliform MCL violation, you should be working with our regional office coliform or engineering staff to determine when coliform sampling should occur relative to chlorination and flushing.

   When you are collecting a coliform sample, measure the chlorine residual and note the level on the lab slip. If you are collecting a coliform sample in follow-up to emergency disinfection, a measure of zero chlorine residual is worth noting on the lab slip.

   * If you are using a chlorine residual test kit and are able to measure zero free chlorine residual throughout the water system sooner than seven days following the disinfection, you may collect coliform samples at that time.

Disinfecting a distribution system that does not have a storage tank

Some water systems don't have storage tanks and use only the well pump and a pressure tank to provide water. If the volume of water in the distribution system is greater than the volume of water in the well, then only partially disinfected water may reach parts of the distribution system when you attempt to bring chlorinated water from the well into the system.

Estimate the volume of water in your distribution system using the table above. After disinfecting the well and pressure tanks as described above, draw chlorinated water into the farthest part of the distribution system as described in step 5. Then immediately re-disinfect the well and draw chlorinated water into the distribution system closest to the well. Measure the chlorine residual with a chlorine residual test kit to make sure you have enough chlorine everywhere in the water system. Now follow steps 6 - 8.

For more information

If you have questions about disinfecting your water system, call the coliform or engineering staff at our regional office:

Eastern Region: Spokane Valley (509) 329-2100

Northwest Region: Kent (253) 395-6750

Southwest Region: Tumwater (360) 236-3030

Our publications are available online at https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm

Other references to help you disinfect water system facilities:

- American Water Works Association (AWWA) Standard C564-87, "Disinfection of Wells"
- AWWA Standard C651-92, "Disinfecting Water Mains"
- AWWA Standard C652-92, "Disinfection of Water-Storage Facilities"

These AWWA standards assume the component you're disinfecting, such as a well or storage tank, is isolated from the rest of the water system during the disinfection. For this reason, these references discuss chlorine doses significantly higher than those discussed here do. Do not use high doses if there is a chance that any water system user could consume, or otherwise use, the water.

What chlorine dose is needed?

If you suspect contamination, such as following a pressure loss due to a power outage, or in response to a non-acute MCL violation of the Total Coliform Rule, a chlorine dose of 1 to 2 mg/L is sufficient. Larger chlorine doses may be required to address an acute MCL violation, a bacteriological cross-connection event, or flooding of water system facilities. Please consult with our regional office in these cases.

Notes related to the tables

Volume of bleach needed, $V_1 = (C_2 \times V_2) / C_1$, in gallons, where:
$C_2 =$ desired chlorine dose, ppm
$V_2 =$ the volume water to be treated, gallons
$C_1 =$ the concentration of the bleach solution, ppm

You can use this formula to calculate the quantity of bleach for specific volumes other than those shown in the tables. You can also add the volumes in the tables (e.g., for 150 gallons add the bleach quantity needed for 100 gallons to that needed for 50 gallons); or extrapolate between values shown in the table.

Well volume = $7.48 \times H \times 3.14 \times (D/12)^2 / 4$, in gallons, where:
H = the height of water standing in the well, in feet
D = the well casing diameter, in inches

6 percent household bleach contains 60,000 parts per million hypochlorite
12 percent bleach contains 120,000 parts per million hypochlorite
1 cubic foot of water = 7.48 gallons
1 gallon = 16 cups
1 cup = 16 tablespoons or 8 fluid ounces
1 Tablespoon (Tbsp) = ½ fluid ounce (14.8 mL)

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