Restoring a Flooded Well to Service

> **Warning:** Do not operate any electrical device that was flooded until it has been checked by a competent electrician. There is danger of electrical shock and damage to equipment.

> **Warning:** Disinfect water from a flooded well before using it for drinking or washing, until the well is properly restored. Water with microbes carries a risk of severe illness and even death.

Before a flooded well is returned to service, it should be checked, cleaned, and disinfected. This is for health and safety purposes, as well as to extend equipment life. Procedures to properly disinfect wells are in K-State Research and Extension publications: *Shock Chlorination for Private Water Systems*, MF-911 and *Shock Chlorination Treatment for Irrigation Wells*, MF-2589. In addition to microbial pathogens that cause sickness, flood water carries abrasive sediment, debris that can cause physical damage, and the everpresent risk of other contaminants.

Following the steps outlined here will help minimize damage to the pump and power unit, extend the life of the well, and protect people who use the water. Choosing not to follow these steps may result in illness of people and animals, cause equipment damage, and is more likely to result in increased cost in the end. Thus, it is important to follow the steps described here.

Assess what happened. Check the well and power unit for inundation, damage, and inflow of flood water. Determining what happened helps establish what needs to be done to restore the well after a flood. If possible, establish the maximum height of the flood water from nearby high water marks. If flood water overtopped a well casing, even one that has a good sanitary seal, polluted water likely entered the well and disinfection is essential. When flood water overtops an open well, much water enters, carrying considerable sediment into the well. This sediment must be removed. If flood water covered electrical or mechanical equipment not designed to be submerged, the equipment must be dried, cleaned, and checked before use. Identify and repair all damage to the well casing and components caused by floating debris or shifting materials.

Did water and sediment enter equipment? Most electrical and mechanical components are not designed to be submerged in water. This includes the electric motor, controls, drive shaft, gear box, and internal combustion engine. If the water level was over these components, obtain assistance from competent electrical and mechanical service providers for evaluation and cleanup. Taking shortcuts may result in electrical short circuits that could shock or electrocute people and decrease the life of the mechanical components because of moisture, rust, and lubrication failure. Because submersible pumps are designed to be under water, they should not be affected by a flood, unless damaged by sediment or abrasive material suspended in the water.

Did sediment enter the well? If flood water overtopped an open well, sediment entered. Obtain assistance to remove the pump and clean out the sediment. Well drillers have the equipment, knowledge, and skills to clean sediment from a well. Sediment can reduce the well yield, harbor disease-causing pathogens, increase wear of the pump, and reduce cooling of the pump motor. Removing sediment may involve a process a lot like developing the well after it was initially drilled. When the sediment has been removed and the equipment checked, reinstall the pump and remove water until all traces of sediment are gone and the water is clear.

Repair damage to casing. The well casing must be watertight from the top edge, at least a foot above the ground, to the well screen. It is especially important that it prevent entry of water into the casing because the water would contain contaminants.

Disinfect the well and water system. The next step is to shock chlorinate the well and water system to kill bacteria. The greatest concern is about pathogenic microbes in drinking water; however, a wide range of bacteria, including iron bacteria, enters all wells. If iron bacteria is not removed, it can reduce the well's capacity and shorten its life. The amount of water and chlorine required to treat flooded irrigation, livestock, and domestic (drinking water) wells is shown in Table 1. Treatment figures are based on providing a chlorine dose of at least 500 mg/L (parts per million, ppm) for domestic and 200 mg/L (ppm) for irrigation or livestock wells.

We recommend shock chlorination following the guidance in *Shock Chlorination for Private Water Systems* as part of regular annual domestic-well maintenance.

A flooded well should not be used for drinking without emergency disinfection (boil for at least three minutes or add eight drops of fresh household bleach per gallon, mix, and wait 30 minutes). Only after cleaning and testing negative for bacteria is water considered safe to drink, free of indicator bacteria.

Irrigation wells can be used after the 24-hour chlorine holding time and the chlorine is flushed. However, we also strongly recommend an end-of-season shock chlorination as part of the regular maintenance program for both irrigation and livestock wells.

Test water for bacteria. Public water suppliers regularly test for total coliform bacteria to show that bacteria are not present and thus the water is safe to drink. The water sample should be collected at least a week after the shock chlorination when the well is used for purposes other than drinking.

Any flooded well should not be used for drinking until the water test result shows no bacteria. To collect a good sample, follow directions supplied by the laboratory or the procedure in Extension publication *Taking a Water Sample*, MF-963. If the test result still contains bacteria, repeat the shock chlorination procedure and test again. Wait for at least three weeks before doing a third or subsequent shock chlorination. Getting all bacteria out of a flooded well may take considerable time, effort, and expense. However, groundwater is not an environment where these bacteria normally thrive so be patient, they will eventually die.

Morgan Powell, Extension Engineer, Water Quality

Danny Rogers, Extension Engineer, Irrigation

Judy Willingham, Assistant Extension Specialist

Table 1. Chlorine Dose and Water Needed to Disinfect Wells after Flooding

	Domestic Well	Livestock Well	Irrigation Well
Casing inside diameter (inches)	5-6	5-6	18
Feet well screen and gravel pack* treated by 1000 gallon of water	11.4 ft screen	11.4 ft screen	8 ft screen
Chlorine** (gallons household bleach) per 1000 gallons water	10 gallons	4 gallons	4 gallons

* This treats the inside of the well casing, the well screen, the gravel pack, and the aquifer formation for a radius of about 3 feet outside of the well screen. The total volume of water needed for treatment is the feet of saturated well screen divided by the feet of treatment using 1000 gallons of solution. The first tank of water can come from the flooded well but additional tanks must come from another clean water source.

** This chlorine mix is based on making a concentration of at least 500 ppm for domestic wells and 200 ppm for irrigation and livestock wells. A stronger dosage is permissible.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF2733 June 2006

K-State Research and Extension is an equal opportunity provider and employer. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, as amended. Kansas State University, County Extension Councils, Extension Districts, and United States Department of Agriculture Cooperating, Fred A. Cholick, Director.

Shock Chlorination for Private Water Systems

A safe and adequate drinking water supply is important for everyone. Our very lives and our world depend upon it. The owner or user of a well or spring must understand that location and construction are essential requirements for a safe water supply. Also, routine maintenance, repair, and protection are just as important to keep the supply safe. Shock chlorination is an essential component of well maintenance and is necessary following any work on the well.

Annual shock chlorination for preventive maintenance is one of the best practices to help ensure a safe water supply with a minimum of problems. Shock chlorination involves disinfecting the well or spring, plumbing system, and in some cases the gravel pack and adjacent aquifer. Chlorine is the recommended disinfectant because it is readily available, inexpensive, effective, easy to use, and has a positive residual effect. The procedure can be done by the well owner, user, driller, or other service provider.

Bacteria enter as the well is drilled, the spring is developed, any time the well or plumbing system is opened for service or repair, and when outside water or contaminants enter the system as a result of a flood, defect, or backflow. Disinfection is the only practical way to remove bacteria that make water unsafe for drinking and to minimize future problems. Shock chlorination should be done:

- following construction or repair of all wells or springs,
- following opening of any part of the water system,
- following a flood or other event when non-potable water may have entered the well or spring,
- anytime water has an organic or bad taste or smell,
- whenever a water test is positive for bacteria, and
- at least annually, as a part of system maintenance.

Preparation and Precautions

Before shock chlorinating a well or spring, it is important to verify the integrity of the water source. Shock treatment only temporarily benefits a well that does not meet well construction standards. Bacteria usually enter very near the well or spring (usually within 50 feet) so protection near the source is essential for safe water. Hand-dug wells and springs are very difficult to protect because it is nearly impossible to seal the system to prevent entry of water, insects, animals, and soil. The well must allow air to enter, yet prevent entry of animals, insects, debris, and surface water. See K-State Research and Extension publication *Private Wells – Safe Location and Construction*, MF-970, for current construction standards. Good construction criteria include:

- The well casing or spring collection pipe is sealed to the surrounding soil.
- Surface slopes away from the well or spring in all directions for at least 20 feet and there is no ponding within 50 feet. Greater distances are better.
- The well casing extends at least a foot above the ground surface or the highest flood level.
- The casing is watertight and has an approved sanitary well seal.
- A watertight pitless adapter makes the connection to the waterline below the frost level.

Prior to treatment, inform everyone who may use water that it is being treated and should not be used. Provide temporary alternative drinking water for the house and put a reminder on each faucet. Take special precautions for children and elderly persons in the household. Livestock will most likely refuse to drink strongly chlorinated water so provide them an alternate supply.

To prevent damage to equipment, remove, bypass, or disconnect all water-treatment equipment such as water softener, reverse osmosis, and filter units. Most pressure tanks are captive air type and have a rubber bladder to contain the water. High chlorine concentrations may damage this bladder. Check with the manufacturer about possible damage to any equipment in question. After the chlorine is flushed from the system, there is often enough residual chlorine to disinfect the water treatment equipment, such as a softener, as it is returned to service.

Shock Chlorination Procedure

Because shock chlorination only temporarily benefits poorly constructed wells or springs, inspect to confirm that construction protects it from contamination before a well or spring is shocked. Make all needed repairs before proceeding. If the water source cannot be protected from bacteria, continuous disinfection of the water is needed. Also, verify that the water source is protected by good management, adequate maintenance, and removal of direct contamination routes such as abandoned wells and cross connections. If surface water has entered the well or when other situations suggest, refer to the section, Procedures for Unusual Conditions.

Step 1. Preparation. Essential supplies include clean water hose(s), a clean 5-gallon mixing bucket, a clean container for the sanitary seal, the chlorine dose, and tools to remove the sanitary seal. A large clean tank is needed if a tank of chlorine will flow into the well or spring. The chlorine dose depends on the amount of water.

Calculate the water volume by multiplying the volume per foot for the casing diameter (Table 1) by the depth of water (well depth minus the depth to water). If the well was drilled after 1975, a well log should be available and will have the well depth and depth to water at the time the well was drilled. If a log is not available and the depth is not known, it should be measured. See K-State Research and Extension publication *Measuring Depth to Water in Wells*, MF-2669. Add the volume of water in the pressure tank and water heater and allow for plumbing pipes using the volumes shown in Table 2. Sum these to determine the total water volume to be treated. Find the chlorine dose, calculated to produce a chlorine concentration of 500 mg/L or ppm, from Table 3.

Remember to bypass, disconnect, or remove water treatment components that can be damaged by chlorine. The exchange media, polystyrene beads, of ion exchange units (water softeners and anion exchange) will be damaged. Set the valve to the bypass position. Reverse osmosis systems could be seriously damaged and should be disconnected. Remove the sediment, carbon, and combination cartridge filter to avoid any damage and replace the empty filter case during shock chlorination.

Step 2. Remove the sanitary well seal (or cap) and clean it to remove debris, dirt, and oil. Place it in the clean container. Clean visible mold, fungus, and debris from the interior of the casing and from the exterior of pipe, wires, and other components inside the casing. Trying to disinfect dirty components greatly reduces the effectiveness of shock treatment.

***Table 1.** Volume of Water in Wells*

Inside Diameter of Casing (Inches)	Volume of Well Per Foot of Casing	
	gal/ft	ft³/ft
2	0.16	0.02
3	0.37	0.05
4	0.65	0.09
5	1.02	0.14
6	1.47	0.20
8	2.61	0.35
10	4.08	0.55
12	5.88	0.79
14	8.00	1.07
16	10.44	1.40
18 (1.5 feet)	13.22	1.77
24 (2.0 feet)	23.50	3.14
30 (2.5 feet)	36.72	4.91
36 (3.0 feet)	52.88	7.07

Note: *27 ft³ = 1 cubic yard*

***Table 2.** Volume of Water in Small Diameter Pipes*

Diameter (Inches)	Volume (Gallons/100 ft)	Ft³/100 ft of Casing
0.75	2.29	0.31
1.00	4.08	0.55
1.25	6.38	0.85
1.50	9.18	1.23

***Note:** For 2-inch and larger diameters, see Table 1*

Step 3. Mix and introduce chlorine. Mix the correct chlorine dose with several gallons of water. If dry chlorine is used, thoroughly mix it with warm water until the chlorine is completely dissolved. Pour the chlorine mixture into the well while moving completely around the perimeter so that it runs down the inside of the casing. Dose the complete inside surface of the casing, wires, and pipes.

Step 4. Attach the hose to the closest water tap or hydrant supplied by the well and place the other end of the hose into the top of the well casing. Turn on the faucet to circulate water from the well through the plumbing and hose, and then back to the well. After a strong chlorine smell is detected, place enough chlorine solution in the container to cover the sanitary well seal. Thoroughly disinfect the inside of the well by slowly rotating the hose around the inside of the casing and continue flushing for at least 15 minutes. This allows the chlorine solution to wash down the interior wall of the well casing, the exterior of the pump column, and the wiring.

Keep the recirculation hose flowing continually while the chlorine dose is distributed through the whole water system in step 5.

Step 5. Distribute the disinfectant. Open the next closest tap to the well, and let the water run to waste only until a strong odor of chlorine is detected. Close that tap and proceed to the next closest tap and open it until a strong chlorine smell is detected. Continue, tap by tap, throughout the entire distribution system (inside and outside) including faucets, tubs, showers, toilets, and hydrants. Do all the cold water outlets first and then the hot water faucets until the chlorinated water is distributed throughout the entire water system. If at any time the strong chlorine odor is not present, return to Step 3 and add half the amount of chlorine used for the initial treatment to the well, and then resume this step.

When chlorinated water is throughout the distribution system, shut off all taps, remove the hose, and cap the well with the sanitary seal. Allow the chlorine to remain in the system for at least 12 hours, but preferably 24 to 72 hours. Longer contact times will result in more thorough treatment. Do not use any water during the disinfection time.

Step 6. Flush the system after the chlorinated water has been in the system for the desired disinfection time. Do not allow a large dose of chlorine to enter the home wastewater system or reach plants that you do not want

Table 3. Computing Disinfectant for Total Volume of Treated Water

Total Volume of Water		Amount of Product Needed to Disinfect[a]			
		Liquid Chlorine (Fluid Ounces)		Dry Chlorine (Dry Ounces)[c]	
Gallons	Cubic Feet	5.25%[b]	10%	65%	70%
25	3.34	32	17	3	2
50	6.68	64	33	5	5
100	13.37	127	67	10	10
200	26.74	254	133	21	19
300	40.11	381	200	31	29
400	53.48	508	267	41	38
500	66.84	635	334	51	48

[a] *To produce a dose of 500 milligrams per liter (mg/L) or parts per million (ppm)*
[b] *Standard household bleach (sodium hypochlorite)* [c] *Calcium hypochlorite*

damaged. Rather, direct the hose to a gravel drive or road. Open outside taps and flush the system until no chlorine odor is detected. Flush the system tap by tap, leaving inside faucets until last to minimize the amount of chlorine that enters the wastewater system.

Step 7. Wait, then test the water. After using the water for a week or two, verify bacteria safety by a water test. Before collecting the sample, test the water (as discussed on page 4) to make sure it does not contain chlorine. Samples may be collected by the health department or the homeowner. They should be sent to the laboratory the same day. Samples for bacteria tests must be in sterile containers from the laboratory. For procedures, see K-State Research and Extension publication *Taking a Water Sample*, MF-963. Tests for total and fecal coliform bacteria should begin within 24 hours of sample collection.

Procedures for Unusual Conditions

The procedures described in Steps 1 through 7 are adequate for typical well conditions. Occasionally, well construction, pump placement, flooding, or other conditions require special procedures. Some problems can only be corrected by following these alternative procedures. If coliform bacteria persist after repeated, thorough shock chlorinations, consider continuous disinfection as an alternative method to ensure safe water.

Pump above bottom of well. Normally the pump intake is near the bottom of the well. However, in some situations the pump may be above the bottom. This creates a space below the pump where water does not circulate and the normal chlorine dose will not reach. An alternative procedure is required to get the chlorine below the pump intake. If the well screen extends to the bottom, mixing a tank of chlorine solution and allowing it to flow into the well, as described below, is an excellent way to disinfect the space below the pump. Chlorine pellets that sink to the bottom of the well can be used to disinfect the dead space even when the well screen does not extend to the bottom.

Add tank(s) of chlorine dose to the well. When contaminated water has entered a well, as from a flood or damaged casing, a more extensive shock chlorination procedure is required. If the well has been flooded, check for sediment and follow the procedure described on page 4 under Wells with Sediment. Mix the chlorine solution in a clean tank (preferably of food-grade materials) that has never held contaminants. Add to the casing diameter an allowance to get water through the gravel pack and into the aquifer formation. Adding 12 inches to the well diameter forces water about 12 inches outside of the well screen. Adding at least 12 and up to 30 inches or more to the casing diameter is recommended. The more added, the further the chlorine goes into the groundwater formation. The volume of water per foot of depth is obtained as in Step 1 (Table 1), using as diameter the casing plus the 12 to 30+ inches. Again multiply by the depth of water to get the total volume of water to add.

Fill the tank with water and mix the strong chlorine solution following doses in Table 3. Then allow the chlorine solution to flow into the well. Repeat the process taking water from a clean well until the total volume has been added. This forces chlorinated water through the well screen, gravel pack, and into the aquifer formation surrounding the well. The chlorinated water should remain in the well for up to 72 hours, but at least for 24 hours.

Three or more times during the holding time, pump out a tank full of water, and then let it flow back into the well. This mixing of the chlorine solution dislodges some of the bacteria and renews the chlorine in contact with bacteria. If a strong chlorine odor is not detected, add more chlorine to the tank before letting it flow back into the well. If the water becomes too murky with residue, pump the contents to waste until the water clears and repeat the chlorination process.

Pump well contents to waste until the water is clear and then do the normal shock chlorination treatment beginning with step 3 to dose the water system. Use the standard chlorine dose for the well diameter. Add the dose to the well and following steps 3 through 5 distribute the mixture throughout the system. Conclude with steps 6 and 7 to flush and verify the effectiveness.

Well with iron bacteria. Iron bacteria are a common problem, especially in alluvial wells, and are often introduced as the well is drilled. If the well is not thoroughly disinfected after drilling, these bacteria can proliferate. Unchecked, the bacteria can clog the well screen and even the gravel pack. Cleaning up a well with iron bacteria is difficult, time consuming, and sometimes even impossible. The best defense is immediate and thorough disinfection after drilling and after any service of the well or pump. The only practical cleanup that a home owner can perform is to add tank(s) of chlorine solution as described above. Acid treatment when needed should be left to the professional service provider.

In cases of a severe bacteria problem, multiple treatments may be required; the first treatment may result in much bacterial slime sloughing. In some cases it may be necessary to remove the pump and scrape bacterial slime off of the pump column and the inside of the casing. An acid treatment may be required to remove severe build up. Be sure to minimize the introduction of debris from the cleaning into the water system by opening the hydrant nearest the well. If a tap is not at the well, it may be desirable to install one.

Wells with sediment. A well that has had surface inflow either from a flood, leaky casing, or accident should be checked for sediment in the well. If more than a couple inches of sediment are found, it should be removed before doing the shock chlorination. Sediment interferes with effective shock chlorination and can harbor bacteria, insects, worms, and other contaminants.

Dug wells tend to accumulate sediment, so they should be checked annually. If the casing diameter is large compared to the pump, sediment deposits can usually be checked without removing the pump. A pipe or pump rod with an attachment to the end should work well. Lower it until resistance is noticed. This is the top of sediment. Rotate the pipe with down pressure until it will not go deeper. This should be the bottom of the well. The difference in depth is accumulated sediment. If the casing is only slightly larger than the pump, usually the pump must be removed to check the sediment.

Sediment can be removed with a bailer or pump. Since light sediment will easily be mixed into the water, it may be easier to remove with a pump. Sediment that settles readily will be easy to bail. Continue to bail or pump until the water becomes clear. It may be necessary to stir the sediment while pumping. When the sediment has been removed and the water is clear, proceed with steps 1 and 3 through 7 as described previously.

Treatment of a spring. Because springs and shallow wells are close to the surface, they are more vulnerable to bacteria contamination. Disinfection of a spring is usually more difficult than a well because the flow of water must be reversed in order to introduce the chlorine solution. Then the chlorine must be held long enough for effective disinfection. This always requires pressure and may require high capacity. Introduce a tank of chlorine solution as described previously, but under pressure. Pressure can be obtained by placing the tank at a higher elevation (maybe 10 feet) or by pumping to introduce the chlorine through the spring collection network.

Emergency Disinfection

Water that contains coliform bacteria, especially fecal coliform or *E. coli* (think feces) should never be used for drinking without disinfection. Boiling for at least 3 minutes is the most reliable emergency disinfectant because it is effective for all water, even cloudy or with organic debris. If the water is clear (no cloudiness or debris), chlorine bleach also can be used for emergency disinfection. Start with 2 drops per quart or 8 drops per gallon (3/4 teaspoon per 5 gallons or 1/4 cup per 100 gallons). After dosing, mix the water thoroughly and let it stand for at least 30 minutes.

Check the chlorine residual. The preferred chlorine test method is a DPT chlorine residual test for free chlorine. If the residual is less than 0.5 ppm, add more chlorine; if more than 2 ppm, reduce the chlorine dose. An alternate method is a sniff test: no chlorine odor, add more chlorine; faint chlorine odor, okay; or strong odor, reduce dose by 20 percent.

Safe water comes from safe wells. Safe wells are:

- located away from pollution sources and out of pollutant pathways.
- constructed to meet current standards.
- maintained annually by a check of the well and water system.
- protected from contamination by a plan that is followed.

G. Morgan Powell
Extension Engineer, Water Quality
Danny H. Rogers
Extension Engineer, Irrigation
Judith M. Willingham
Extension Assistant

Publications from Kansas State University are available on the World Wide Web at: *www.oznet.ksu.edu*

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-911 revised July 2005

K-State Research and Extension is an equal opportunity provider and employer. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, as amended. Kansas State University, County Extension Councils, Extension Districts, and United States Department of Agriculture Cooperating, Fred A. Cholick, Director