Title: WELL DISINFECTION PROCEDURE
Technical Bulletin 2009-37

Disinfection of GeoExchange Water Wells[1]

Prompt disinfection is required immediately after construction, if severe flooding has caused surface water to invade, or if microbial contamination is discovered in your GeoExchange well water. This task can be carried out either by ground water professionals or by the property owner using an array of information resources available from state and local health departments and government agencies. The most commonly used well water disinfectants are sodium hypochlorite (chlorine bleach) and calcium hypochlorite (chlorinated swimming pool disinfectant).

SAFETY PRECAUTIONS: Household Bleach and Calcium Hypochlorite are highly corrosive and can cause burns, blindness, or even death, if handled improperly. Follow all manufacturer safety precautions and wear personal protective equipment when handling any chemicals.

IMPORTANT NOTE: This information is provided by Water Energy as a courtesy to our valued customers and clients. It is the responsibility of the property owner to comply with all local, state, and federal regulations when disinfecting their well and water systems. If in doubt about the method or materials, or if disinfecting large multi-well or commercial system, then refer to qualified professionals or licensed well drillers.

Before disinfecting a well it is important to ascertain, to the extent possible, that the well is located and constructed such that it is protected from contamination sources. Obtain and review all documentation associated to the well construction and water production rate. The following sections list the necessary supplies and a procedure for disinfecting Standing Column GeoExchange Wells that utilize groundwater as heating and cooling source. For residential systems, this is typically the same well used for irrigation and/or to supply potable domestic water to the household. For commercial systems, GeoExchange well(s) typically do not provide water for potable use, but may be used for irrigation.

A - Well Disinfection Supply List

- **EITHER** sodium hypochlorite (unscented chlorine laundry bleach containing 5 to 6% sodium hypochlorite) **OR** calcium hypochlorite (swimming pool granules containing 65 to 70% calcium hypochlorite-available at hardware stores and pool supply stores) in sufficient quantity to perform the disinfection as calculated from charts[1] in the appendix.
- Container(s) large enough to prepare and dispense the chlorine mixture.
- A hose long enough to extend from the point of withdrawal to below the static water level in the well.
- A funnel or connection fitting to transfer the chlorine mixture into the well through the hose.

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B - Well Disinfection Procedure

1. From the charts in the appendix, calculate the appropriate amount of chlorinating chemical needed to obtain the following concentrations in the well column: 100 parts per million (ppm) for routine disinfection; 500 ppm available chlorine for emergency post-flood disinfection; 1000 ppm of available chlorine for Iron Bacteria[4] problems.

   (*See Water Energy Technical Bulletin 2007-03 regarding Iron Bacteria)

2. Divide the appropriate amount of chlorinating chemical among three or four containers of water, mixing thoroughly to create a chlorine mixture that will be introduced to the well water.
3. Remove the well casing cap, being careful not to contaminate the cap or let any debris fall into the well.
4. Pour approximately ¼ of the total chlorine mixture down the inside of the well casing and bore, coating the walls thoroughly.
5. Use a small amount of the chlorine mixture to disinfect the well cap and other components that will be refastened to the well casing, and keep those components in a clean and disinfected location until ready to install them.
6. Place one end of the hose as far as possible into the well and pour the remaining chlorine mixture into the well. If possible, raise and lower the hose in the well to assist in mixing the chlorine solution with the well water.
7. When the full amount of disinfectant has been added, be sure that the lower end of the hose is below the static water level in the well.

   NOTE: Freefall of water back into the GeoExchange well should be prevented unless unavoidable.

8. Connect the other end of the hose to a faucet at the building that is connected to the well system and allow the well pump to circulate through the hose from the building back to the well for 2-4 hours to mix the chlorine solution with the well water and obtain the desired concentration in the water column. The deeper the well, the longer you should let the chlorinated water circulate. When ready to remove the hose from the well, allow the pump to run while you rinse the inside of the well casing thoroughly with the chlorinated water.
9. Once the well water column is thoroughly mixed, remove the hose and replace the well cap.
10. Circulate the chlorinated water throughout the distribution systems in the building by opening fixtures and valves. This includes all heat pumps, fixtures, and outlets in the building that rely on the GeoExchange well water as a source. This will ensure that all piping and fixtures are disinfected.
11. Leave the chlorinating solution in the entire water circulation system for 12-24 hours.

- NOTE: Do not operate the heat pumps or use the chlorinated water for consumption, bathing, pets, plants, irrigation, or clothes washing during the disinfection period.

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12. Flush the chlorinated water completely out of the water supply system by opening an external tap and/or the GeoExchange bleed/discharge valve. The amount of time the system takes to flush is dependent on the flow rate you are able to discharge from, and the recovery water production capability of the well. Do not attempt to discharge at a rate higher than the well can recover. To gauge how long the flush process will take, refer to the charts in the appendix to determine GeoExchange well water volume in gallons, account for the discharge flow rate, and allow for 3 to 4 well water volume exchanges for flushing. The system is considered to be flushed when chlorine odor is no longer detectable.

- NOTE: DO NOT DISCHARGE into streams, ditches, lakes, city sewer, storm drains, or your septic system.

13. After 7 to 10 days, sample water for coliform bacteria. If bacteria are detected, repeat disinfection procedure as many times as necessary until bacteria are no longer detected. If water becomes contaminated again after a short time, it is important to identify and remove the source of contamination.

Conclusion

Whether maintained by professionals or the property owner who has access to approved procedures, there are significant responsibilities associated with GeoExchange well ownership. Well owners should adopt a multi-barrier approach to safeguard their well water from contaminants that includes regular monitoring for waterborne pathogens and prompt disinfection when needed. It's a responsibility that can mean the difference between illness and health for families relying on private well water, and help to guarantee the performance and viability of their GeoExchange Well System.

End Notes:

[1]Materials and charts were adapted by permission from the following sources:

- "Disinfecting Private Wells." Water Quality and Health Council, 7 April 2009, <http://www.waterandhealth.org/newsletter/private_wells.html >
- "Water Well Disinfection Procedure." September 2006, American Ground Water Trust, 7 April 2009, <http://www.agwt.org/info/pdfs/disinfect09-06.pdf>

[2]Use fresh bleach that does not contain detergent or other additives.

[3]Calcium hypochlorite is highly corrosive when wet. Handle with extreme caution. Dust will irritate or damage eyes, nose, mouth and skin.

[4]For more information about Iron Bacteria, refer to Water Energy Distributors Technical Bulletin #2009-03

APPENDIX – Chlorination Concentration Charts

NOTE: For Wells Deeper than 200' water column, add quantities from the appropriate depths in the charts below.

Chart A: Quantities of Liquid Household Bleach[2] (5-6%) Required for Well Disinfection

Values are rounded to nearest ¼ increment [C = cup; Q = quart; G = gallon]

Depth of water in well (feet)	Well Diameter											
	4 inches				6 inches				8 inches			
	Volume of Water in Gallons	Volume of Bleach for Disinfection			Volume of Water in Gallons	Volume of Bleach for Disinfection			Volume of Water in Gallons	Volume of Bleach for Disinfection		
		Routine Disinfection	Emergency Post-Flood	Iron Bacteria[4]		Routine Disinfection	Emergency Post-Flood	Iron Bacteria[4]		Routine Disinfection	Emergency Post-Flood	Iron Bacteria[4]
10	**6.5**	0.25C	1.25C	2.5C	**14.7**	0.5C	2.5C	5C	**26.1**	.75C	3.75C	7.5C
20	**13**	0.5C	2.5C	5C	**29.4**	0.75C	3.75C	7.5C	**52.2**	1.75C	2.25Q	4.5Q
50	**32.5**	1C	5C	2.5Q	**73.5**	2.25C	3Q	1.5G	**130.5**	4.5C	1.25G	2.5G
100	**65**	2C	2.5Q	5Q	**147**	4.5C	1G+1.75Q	2G+2.5Q	**261**	0.5G	2.5G	5G
150	**97.5**	3C	3.75Q	7.5Q	**220.5**	1.75Q	2G+3C	4G+6C	**391.5**	0.75G	3.75G	7.5G
200	**130**	1Q	1.25G	2.5G	**294**	2.25Q	2.5G+3.75C	5G+7.5C	**522**	1G	5G	10G

Chart B: Quantities of Dry Calcium Hypochlorite Pool Chemical[3] $Ca(ClO)_2$ (67%) Required for Well Disinfection

NOTE: Follow calcium hypochlorite directions carefully, dissolving in water before adding to your well. Dropping crystals or tablets directly into the well will not mix evenly for adequate disinfection.

Values are rounded to nearest ¼ increment [T = tablespoon; C = cup]

Depth of water in well (feet)	Well Diameter											
	4 inches				4 inches				4 inches			
	Volume of Water in Gallons	Volume of $Ca(ClO)_2$ for Disinfection			Volume of Water in Gallons	Volume of $Ca(ClO)_2$ for Disinfection			Volume of Water in Gallons	Volume of $Ca(ClO)_2$ for Disinfection		
		Routine Disinfection	Emergency Post-Flood	Iron Bacteria[4]		Routine Disinfection	Emergency Post-Flood	Iron Bacteria[4]		Routine Disinfection	Emergency Post-Flood	Iron Bacteria[4]
10	**6.5**	0.5T	2.5T	5T	**14.7**	1T	5T	10T	**26.1**	1T	7T	15T
20	**13**	1T	5T	10T	**29.4**	2T	0.5C+2T	1.25C	**52.2**	3T	0.75C+3T	1.5C+6T
50	**32.5**	2T	0.5C+2T	1.25C	**73.5**	3T	0.75C+3T	1.5C+6T	**130.5**	5T	1.5C+1T	3C+2T
100	**65**	3T	0.75C+3T	1.5C+6T	**147**	6T	1.75C+2T	2.5C+4T	**261**	0.75C	3.75C	7.5C
150	**97.5**	4T	1.25C	2.5C	**220.5**	0.5C	2.5C	5C	**391.5**	1C	5C	10C
200	**130**	6T	1.75C+2T	3.75C	**294**	.75C	3.5C	7C	**522**	1.25C	6.25C	12.5C