Flooded Wells & Disinfection

If a well has been flooded, you can't simply chlorinate the well from the surface and expect zero coliform. There are just too many variables such as,

1. The type of aquifer. If a well was completed in coarse gravel verses fine sand, wouldn't you expect the coarse gravel would more easily take more flood water and allow the water to transmit deeper into the aquifer? See Fig 1. A well with an high Specific Capacity (a more Permeable aquifer) will allow deeper penetration into the aquifer and may be more difficult to clean than a well with a low Specific Capacity.
2. The Static Water Level. Expect a well with a 5' static level to take less water than a well with a 40' static level. It is the opposite of available drawdown in a pumping well which is the distance from the static level to the top of the screen. A well with a 5' static level has less head against the formation, therefore less head pressure and will take less flood water.
3. The amount of time the well was flooded. A well that was flooded for 3 days would potentially take more water than a well that was flooded for 3 hours.
4. The location of bacteria. The location of the bacteria is impossible to determine whether they are on the ID of the casing and screen or well out into the formation. Wire brushing the ID of well casing, screen or open borehole can be critical to success.
5. The type of bacteria. Just because a well is flooded, does not necessarily mean there is E. coli or fecal coliform in the surface water flooding the well. You might suspect that there is quite a variety of bacteria. These can include common soil organisms (most are non-pathogens); Opportunistic pathogens (OP); and a high potential for protozoa, and nematodes.
6. The amount of physical debris and the location of this debris. Physical debris which can include silts, organic debris, leaves, small animals, etc. can easily flow into a well when flooding. This physical debris can attach to the side wall of the casing/screen and make it very difficult to remove any bacteria with chemistry. Wire brushing will help prior to disinfection. This debris can lodge well into the formation (depending upon length of flooding and Permeability) causing blockage and fluctuating coliform numbers and intermittent presence of E. coli.

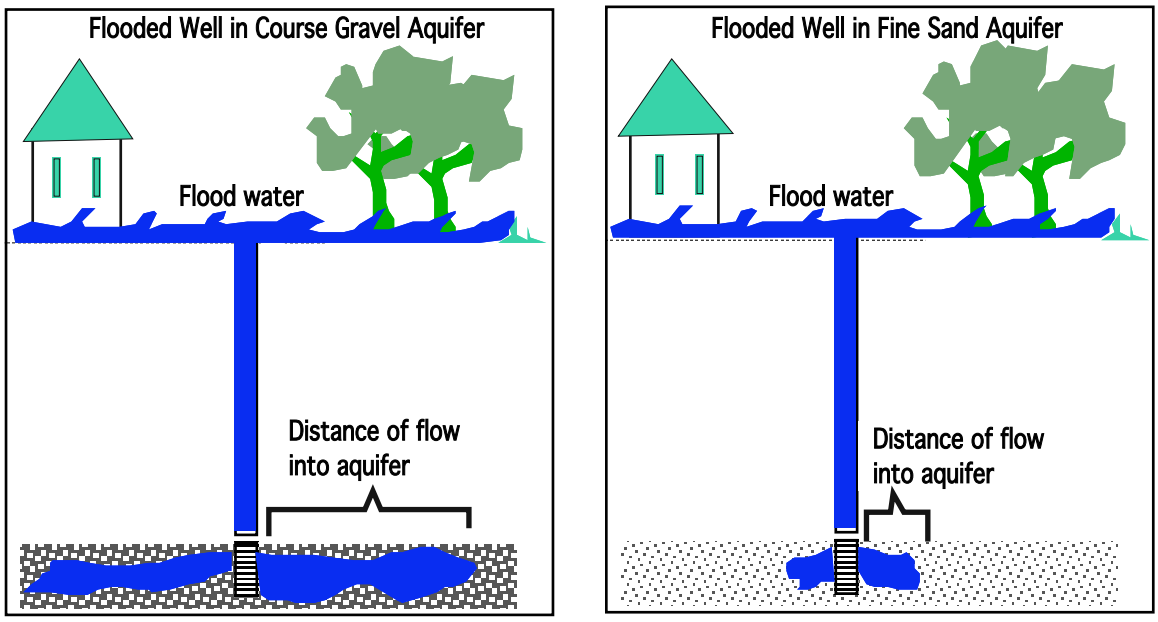

Fig 1

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Simple information needed from the well owner or from well records.

1. Diameter of the well
2. Static Water Level
3. Total depth of the well
4. pump capacity

Simple procedures for well calculations

1. Calculate the amount of water in gallons per foot for the diameter of the well.
2. Subtract the static level from total depth of well equals footage of water in the well.
3. Multiply the gallons per foot of water for the diameter times the total footage of water equals to volume of water in the well.
4. Multiply the total volume times 50 or better, 100 times for total volume of water to pump from the well.
5. Divide that total volume (50-100 times) by the pumping rate of the pump to get an approximate time of pumping to get rid of flood water.
6. Have the well owner pump the well to waste for that time prior to the contractor even going to the site.

Example: A 6" diameter well, 125' total depth, with a 15' static level, and a 10 GPM pump. 125' td - 15' SWL = 110' total column of water. A 6" diameter = 1.5 gal/ft. 110' water column x 1.5' = 165 gallons. Divide 165 gallons by 10 GPM = 16.5 minutes multiplied by 50 times = 825 minutes or 13.75 hours. Better yet, do 100 times or 28 hours of continuous pumping. This will attempt to remove flood water, bacteria, and potentially some physical debris.

A more detailed procedure for well calculations

Note: If you know the Specific Capacity (GPM per foot of drawdown) of the well while pumping and the amount of time the well was flooded. This is based upon the concept that a well will take similar volumes to the pumping capability. Calculate the distance from the static level and the flood level. Multiply that footage by the pumping Specific Capacity of the well. Example: Flood level 6" above the ground surface with a static level of 27', a Specific Capacity of 2 GPM/foot of drawdown pumping 15 GPM, and a flood condition of 4 hours. 27' SWL + 0.5' = 27.5'. Multiply 27.5 x 2 GPM/ft of dd = 55 GPM. Multiply 55 x 240 minutes (4 hrs x 60 min) = 13,200 gallons. Multiply that total volume (13,200 gal) by 50 volumes = 660,000 gallons. Divide that total volume of 660,000 gallons by 15 GPM = 44,000 minutes, or 733 hours, or 30 days of continuous pumping.

Field Procedures

1. Take your first sample for E. coli/fecal coliform and coliform bacteria. An option is to have the well owner take the sample. You may just get lucky with "Absent" for coliform and a Negative for E. coli/fecal coliform after the initial pumping.
2. If "Present" for coliform; pull the pump; wire brush the well casing, screen, or open bore hole; and airlift all debris from the very bottom of the well. Debris can hide bacteria.
3. Clean the pump of all debris. Replace the drop pipe or column pipe if encrusted with mineral deposits. Reset the pump, disinfect the well with 100 ppm solution, and re-sample. For disinfection, calculate the volume of the well. Multiply by at least two times the volume of the well if not 4-5 times the volume of the well. The total volume of chemistry is more critical than concentration. Mix an even batch of chemistry and flood the well. The first volume will displace the well volume and subsequent volumes will go well into the formation.
4. Surge if possible to move chemistry. Let set overnight. Pump to surface discharge until there is no chemistry residual. Take your sample.

5. Have your laboratory test for MPN (Most Probable Number) of coliform, NOT just "Present" or "Absent" . You may need a comparison of severity as you will probably be taking several samples over time. Use the numbers for comparison and direction.
6. Evaluation of severity. Numbers of coliform below 15 colonies/100 ml of water is fairly good. Whatever the number, you at least have a starting point for comparison to future samples. If coliform is present, have the well owner pump the well for several days and retest. If the MPN declines, you are heading in the right direction.
7. Continue pumping until the MPN count is less than 10 colonies/100 ml. You may then have a chance that some form of disinfection will work.

Concerns with continuing "Present" for coliform or high MPN counts.

Expect several failures hopefully, with continually declining coliform numbers as MPN with time. If failures continue with high MPN numbers, check out some of the following,

Sample point

If you have been sampling from any point in the piping system, move to the well head and sample directly from the well. This will remove any potential for problems in the piping. If the MPN counts are substantially lower suspect piping problems. Pressure test for losses.

ID of bacteria.

Multiple failures may be due to the identity of bacteria due to flooding conditions. There are many Opportunistic Pathogens that are a health concern to people with a reduced immune systems. They can cause issues with stomach cramps, diarrhea, etc. They will often show "Present" on coliform test kits. Identification of specific families may include Pseudomonas aerogonosa, Aeromonas hydrophila, or any of the Enterobacter, and Citrobacter families. These bacteria are often tied to surface water and can follow flood water into a well.

Heterotrophic Plate Counts (HPC)

A normal aquifer will generally have an HPC of less than 60 colonies/ml of water. If this number is significantly higher, there may be other issues. See "Timed" Testing.

"Timed" Testing

You may want to consider doing "timed" tests in a well to understand if the problem is contained within the well or coming from an outside source. An outside source is often tied to a vertical conduit coming from a source of contamination from the surface. This vertical conduit may be some distance from the well or at the well. Physical problems even in a new well can include failed grout on the OD of the well casing, a failed fitting in the well casing, or at the connection to the horizontal piping.

Field procedure for "timed" testing

1. Let a well set for 12 hours with no pumping.
2. Sample at the well head if possible.
3. Before sampling,
    a. calculate the volume of water in the pump only, if sampling at the well. If sampling somewhere in the system, add the volume in piping to the sample point. Divide that volume of water by the GPM rate for minutes to evacuate water in pump only. Add 1 minute for domestic wells and add 2-3 minutes for large diameter wells for actual sample time.
    b. for "Aquifer" Sample, calculate the total volume of water in the well. Multiply that total volume of the well by 30 times if the well is less than 300' and 50 times if the well is greater than 300'. Divide that total volume by the GPM rate of the pump for sample time. NOTE: Volumes of all pipes are available in our brochure.

"Understanding Your Well Problems" in the "Literature" section of our web site or call for a copy.

c. call your local laboratory and ask if can do, counts of coliform, as MPN *, Heterotrophic Plate Count (HPC), and ID of bacteria on Heterotrophic Plate.

* Most important, if your lab can not or will not perform the other tests.

4. Start the pump. Take the "Casing" Sample at the calculated time, even if the water is discolored. Mark the bottle "Casing" Sample.
5. Let the pump run continuously for the calculated time as the aquifer (30 or 50 times well volume or longer) sample. Take the sample and mark the bottle "Aquifer" Sample.
6. Get samples to the lab as soon as possible.
7. Compare the numbers and/or ID between these two tests.

IF MPN counts of coliform are <u>high in the "Casing</u>" Sample and significantly <u>lower in the "Aquifer" Sample</u>, you have a chance of success.

IF MPN counts are lower in subsequent tests, you are heading in the right direction.

IF ID includes Enterobacter in the "Casing" Sample but NOT in the "Aquifer" Sample, you have a chance of success.

IF MPN counts remain high in subsequent testing, suspect larger issues.

IF any of the OP are present in large numbers and not declining, suspect issues.

IF MPN counts remain similar from the "Casing" to the "Aquifer" Samples, you may not succeed immediately. Pump the well for several days to a week and retest. Compare to see if numbers of coliform are at least, declining. If not, suspect larger issues, and continue to pump and monitor numbers.

NOTE on HPC. Normal aquifers will generally be less than 60 colonies/ml. If the HPC numbers are declining, you are heading in the right direction. Surface water will often have much higher HPC (100-300 or more).

Expect to find E. coli/fecal coliform in intermittent tests. Expect fluctuating and in some cases, dramatic changes in counts of coliform. Pumping the well for long periods of time should help. Wire brushing helps remove physical debris on the ID of the well casing and screen. Airlift from the very bottom of the well to remove that debris.

So far, I haven't even discussed,

1. the inherent failures of using more and more chlorine. The more chlorine you use, the higher the rise of pH (alkaline products), the lower the effectiveness.
2. placement of chlorine. Pouring chlorine directly into the well from the surface does not work <u>IF there are bacteria located at the bottom of the well</u> and into the aquifer as often the case in flooded wells. When chlorine hits the static level, some will immediately off-gas (odor), most will cause a dramatic oxidizing effect in the first 10' or so of water. That creates a dramatic rise in pH and the effectiveness of chlorine becomes less than 5%. This as well creates an excessive corrosive environment. Chlorine will NOT sink to the bottom of the well, set there, see bacteria into the aquifer, and go after it.
3. shelf life of liquid bleach and industrial grade sodium hypochlorite. Bleach loses approximately 20% of it's effectiveness every month. How old is your bleach? If over 3 months, it's useless. Industrial grade is at least, manufactured more frequently and in better containers.
4. the inability of granular or pelleted chlorine to go into solution when water is greater than 3 grains hard (50-60 ppm harness) of water.

Mixing chemistry in a surface tank, with a greater volume than the well; is the only way to get consistent chemistry throughout the entire well and into the aquifer where the problem most probably exists.

Cleaning flooded wells and obtaining a “Absent” test for coliform can be very difficult. When we chlorinate, and chlorinate, and chlorinate wells multiple times with massive concentrations of chlorine, and still continue to fail ..... without answers, your image and our industry image suffers. This information and these “timed” tests will allow you to understand IF you are heading in the right direction. It is critical to provide your customers with information, direction, and success. All by understanding ID of bacteria, location of bacteria, and numbers with time of pumping.

“Professionalism”. “Success” .... and it separates you from your competition.

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