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Groundwater, Wells, and Coronavirus

COVID-19 is not a reason by itself for home treatment systems and bottled water.

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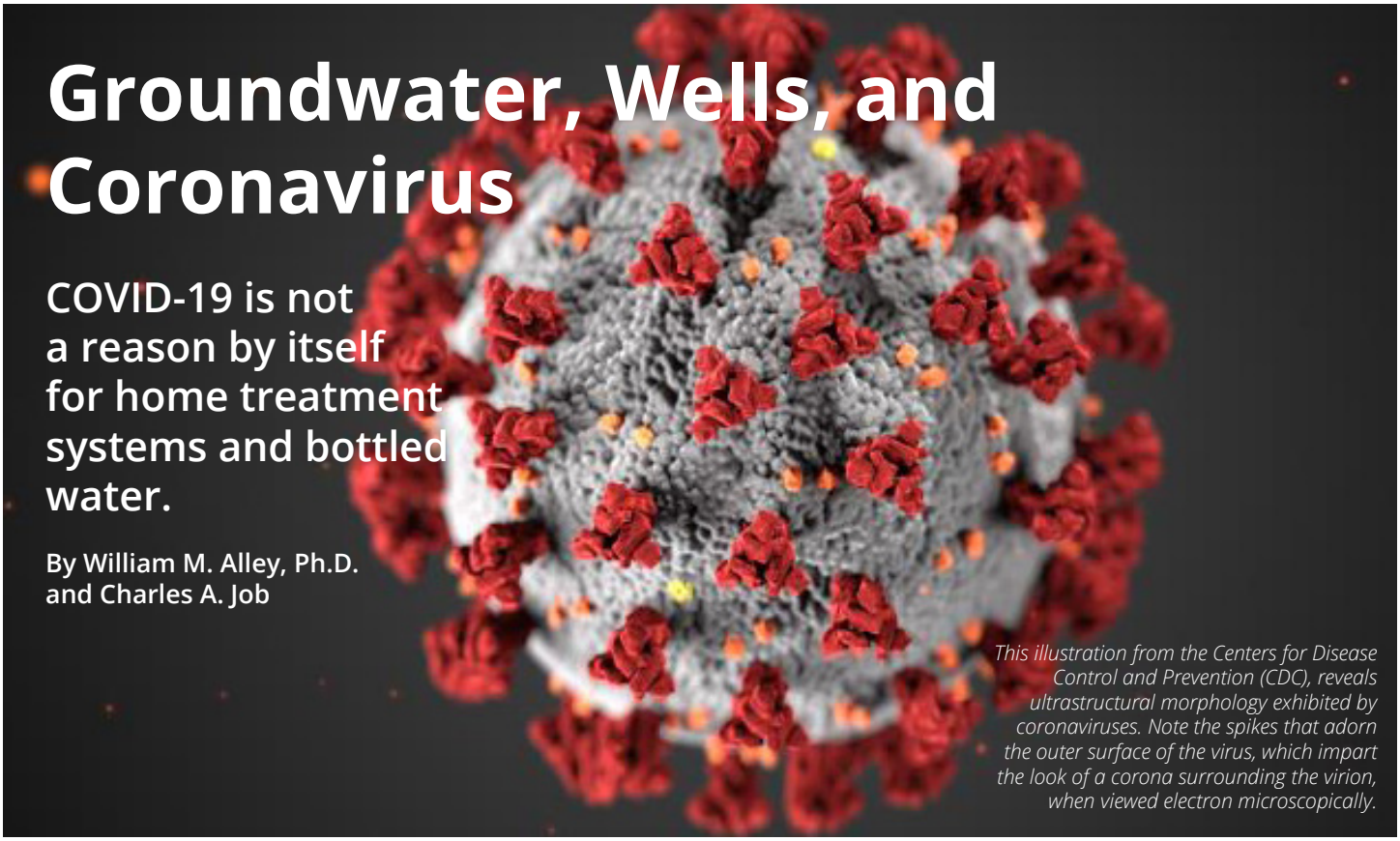

This illustration from the Centers for Disease Control and Prevention (CDC), reveals ultrastructural morphology exhibited by coronaviruses. Note the spikes that adorn the outer surface of the virus, which impart the look of a corona surrounding the virion, when viewed electron microscopically.

The coronavirus that causes COVID-19 (officially known as SARS-CoV-2 but referred to here as the COVID-19 virus) has not been detected in drinking water in either private wells or public drinking water systems.

Human feces would be the most likely source of the COVID-19 virus in drinking water, but according to the World Health Organization, "the risk of catching COVID-19 from the feces of an infected person appears to be low."[1]

Filtration and disinfection methods used in most municipal drinking water systems should remove or inactivate viruses. Despite the low risks, the question has arisen about the vulnerability to COVID-19 of homeowners with private wells and those who rely on untreated public groundwater supplies.

We address this question for private well owners by reviewing (1) viruses in groundwater in general and specific characteristics of the COVID-19 virus as it relates to groundwater, (2) septic systems as a potential source of COVID-19 virus to private wells, and (3) treatment systems for private wells.

Viruses in Groundwater

In general, groundwater contains fewer microbial contaminants (pathogens) than surface water, yet the biological integrity of groundwater cannot be taken for granted.[2] Approximately half of all waterborne disease outbreaks are associated with contaminated groundwater.[3]

Many of these outbreaks are from wells that serve businesses or small water systems that do not require water disinfection and have minimal microbial monitoring requirements. People drinking from household wells also can become exposed to waterborne pathogens, but these outbreaks are less well documented.

Pathogens can be introduced to groundwater through septic tanks, leaking sewers, and land applications of livestock manure and septage, among other sources. Groundwater contamination also can occur from poor well design and construction.

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▶ *VIRUS, continued from p. 1*

A proper sanitary seal around the well casing is essential to block contaminants that might migrate from the land surface down the outside of the casing (well annulus) to the water table, bypassing the unsaturated zone that naturally helps cleanse groundwater.

Human enteric viruses (those that replicate in the intestinal tract of humans) are among the microbial contaminants of greatest concern in well water. Common enteric viruses are shed in human stool in enormous numbers and commonly tied to disease outbreaks.[4]

Reduction of pathogens in the subsurface generally relies on three processes: filtration, adsorption, and die-off/inactivation.

Filtration results when the pathogens are too large to fit through the soil or aquifer pores and cracks. The extent of filtration depends on the type of soil and rocks through which groundwater flows. For example, silts are more effective at trapping microorganisms than sands.

Filtration reduction also depends on the size of the organisms. Physical removal by pores is less effective for viruses than other pathogens because of the very small size of viruses.

Adsorption occurs when the microorganisms become attached to particles, which removes them from the water or at least delays their transport. Virus adsorption onto sediment grains is considered the primary removal mechanism in soils and groundwater, with a complex dependence on the chemistry of the sediment and water.

Travel time can be important because viruses lose their infectivity with time in the subsurface, dependent on temperature, pH, and other factors.

Soils have been found to be effective at virus removal. Rates of removal and restriction are dependent on soil texture, composition, and reactions occurring within the soil layer. At the same time, wells in certain types of aquifers, such as karst and fractured rock, are susceptible to enhanced virus transport.[5]

The COVID-19 Virus

The COVID-19 virus is a respiratory virus that spreads by droplets from coughs and sneezes and by contact with contaminated surfaces. Coronaviruses are enveloped, single-stranded RNA viruses that range from 0.060 to 0.220 microns in size. Enveloped viruses are less stable in the environment than nonenveloped viruses.[6]

The COVID-19 virus has been detected in the feces of some patients diagnosed with the coronavirus. The amount of virus released from the body (shed) in stool and whether the virus in stool is infectious are not known.

The risk of transmission of COVID-19 from the feces of an infected person is expected to be low, based on data from previous outbreaks of related coronaviruses such as SARS (Severe Acute Respiratory Syndrome) and MERS (Middle East Respiratory Syndrome). There have been no reports of fecal-oral transmission of COVID-19 to date.[7]

Previous coronaviruses have been reported to die off rapidly in wastewater, with a 99.9% reduction in two to three days. Coronaviruses might survive for weeks in groundwater based on limited studies of water.[8]

Septic Systems and Setbacks

The main potential sources of viruses for homeowner wells are onsite decentralized wastewater treatment (septic) systems and sewer lines. Properly operated septic systems are designed to protect wells from contamination by pathogens, although outbreaks associated with septic systems continue to be reported. Particular concerns are associated with areas having high septic system densities.[9]

A key concept recognized in local building codes across the nation is "setback"—a requirement that a water supply well be at least a certain distance from a septic system or sewer line to ensure adequate time for sufficient natural degradation of chemicals and die-off of harmful organisms that may endanger well water.

The setback approach as a barrier to contamination of wells is similar to the concept of wellhead protection—to keep potential sources of contamination away from wells. Setback distances take into account the soils and subsurface geology of an area or state to enable chemical degradation and pathogen die-off/inactivation to occur.

As examples, setback distances for homeowner wells from septic leach fields in Minnesota are 50 feet except for special cases.[10] The minimum setback of a septic field from a water well in Colorado is 50 feet, but through variance the minimum setback may be 25 feet based on the hydrogeologic information for the site.[11]

The U.S. Environmental Protection Agency (EPA) expects a properly managed septic system to treat the COVID-19 virus the same way the system manages other viruses often found in wastewater.[12]

A second line of defense is well and septic system maintenance. Stormwater can pick up and carry viruses and other pathogens. During times or seasons of flooding, cracks in the well casing, riser, and apron around the wellhead can allow floodwater to enter the well and the annular space around the casing below ground.

Wells may be more vulnerable to contamination from viruses after flooding, particularly if the wells are shallow, have been dug or bored, or have been submerged by floodwater for long periods of time.[13] Well disinfection may be required to eliminate the virus, which should be followed by a water test.

Treatment

In addition to the use of setbacks for wellhead protection and maintenance of wells and septic systems, water treatment is an optional third line of defense. Distillation, ultraviolet (UV) treatment, and reverse osmosis technologies are effective at virus removal at a household level as point-of-entry/point-of-use equipment.[14]

After flooding, household water from wells can also be boiled as a means of disinfection for viruses. Boiling water kills or inactivates viruses and other pathogens by using heat to damage structural components and disrupt essential life processes of the microbes.[15]

To maximize protection, if a well has been flooded, the well water should be tested by certified/licensed laboratories and, if testing positive for fecal indicator organisms, should be disinfected by a qualified water services contractor.[16]

Conclusions

Drinking water from private wells presents a low risk for COVID-19, especially compared to direct human-to-human transmission or by touching a contaminated surface. By far and away, the best protection against COVID-19 is to follow the public health recommendations for social distancing, washing hands, and other measures.

Concerns about the COVID-19 virus in groundwater serve as a reminder of the importance of protecting against pathogens through proper care and maintenance of wells and septic systems.

The EPA, the National Ground Water Association, and many states recommend annual testing of private wells that includes indicator bacteria, analogous to an annual health checkup with a doctor.[17] Inspection and maintenance may also be needed if problems are suspected.

Some home treatment systems, but not all, are effective against viruses when properly maintained. By itself, COVID-19 is not a reason to start drinking bottled water or installing home water treatment systems.

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▼ *Transmission electron microscopic image of an isolate from the first U.S. case of COVID-19. The spherical viral particles, colorized blue, contain cross-section through the viral genome, seen as black dots.*