

Building Water Quality and Coronavirus: Flushing Guidance for Periods of Low or No Use

The scientists and engineers at the Environmental Science, Policy & Research Institute (ESPRI) and AH Environmental Consultants, Inc. (AH) developed this brief guidance material to help those who are responsible for maintaining building water systems. We have decades of water quality and treatment experience, including building water quality and operation issues, and wanted to share our insights on this topic.

As buildings have been shut down or used less frequently, building water quality degradation becomes a silent but serious issue. This document is meant as a starting point to bring awareness of the issue of water quality degradation in building plumbing when it is not used, or water use is significantly reduced. We kept this brief and provide it as a general roadmap for how to flush contaminants from the building and get the plumbing system water quality back to pre-stagnation conditions. Each building is different, and flushing will need to be tailored accordingly.

Many thanks to those who reviewed and provided suggestions to this material.

Please feel free to circulate and post this information. And stay well in these challenging times.

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What happened in my building water system while the building was out of use?

- The building water system begins at the meter where water enters the building and includes all plumbing, storage and fixtures to each distal tap.
- When the water was not used, the disinfectant in the water dissipated. Without the disinfectant, microorganisms grew on pipes, fixtures and tanks. Some of these may cause disease if they are consumed or inhaled as droplets (particularly while showering).
- The protective scale on pipes could have destabilized. Without the protective scale, toxic metals like lead can dissolve or shear off as particles and end up in water used for drinking or food preparation.
- Potentially harmful substances such as disinfection byproducts (DBPs) built up.
- Mechanical equipment such as cooling towers, boilers and pumps may not have received any routine maintenance. Backflow preventers may have missed annual test cycles.



How do I prepare the building for re-occupancy?

- The best immediate action is to flush the entire building, including all water-using appliances like ice machines and dishwashers. Flushing clears out the low quality water that accumulated during low use and replaces it with high quality water from the municipal supply. The fresh water will help mitigate the problems (loss of protective scale and biofilm growth) that emerged while the water was stagnant. If staff are available to flush, start now. Starting flushing now means less deterioration of water quality in the building and a sooner recovery to normal conditions.
- Inspect mechanical equipment such as cooling towers, boilers, pumps, backflow preventers, etc., and determine if there are any issues regarding their function.
- Other actions you could take are:
 - Clean showerheads, faucets and other fixtures that can produce aerosols that people could inhale,
 - Develop a water safety plan, a long-term plan for keeping water quality high and protecting building occupants and visitors, and
 - Collect water samples for analysis at a qualified laboratory (only recommended for buildings with specific at-risk populations like children in childcare and elderly people).
- Disinfecting buildings water systems with concentrated chlorine should be considered when there is a strong reason to believe the building is contaminated with pathogens like *Legionella pneumophila*, the bacterium that causes Legionnaires' disease, and/or the people who use the building are particularly susceptible to infections like Legionnaires' disease. Disinfectants (chlorine) are dangerous to handle and can cause serious damage to plumbing system components if used improperly. In most cases, flushing buildings with water that has normal amounts of chlorine (the chlorine already in the building water supply) is sufficient for cleaning the water system.

How do I flush a residence or small building?

The American Water Works Association (AWWA) posted recommendations for returning homes to service (as of April, 3, 2020). Those recommendations are found at <https://www.awwa.org/Resources-Tools/Resource-Topics/Coronavirus#10681543-shutoffs-and-return-to-service-guidance>. This information is reproduced below.

“Note that many homes have maintained service or even increased water use as we stay and work at home and do not need to be flushed.

- When homes are returned to service after an extended period of discontinued service (e.g., weeks or months), an adult should be present in the home to ensure that the meter works, leaks are minimized, wastewater piping is intact, and the building's plumbing is flushed. A thorough flushing process is appropriate in such situations.

Note: Social distancing protocols will need to be considered when engaging residents about customer assistance programs, managing lead, and other steps in returning service to the home.

Flushing instructions provided to occupants will vary depending on the structure. This is an area of active research. However, key elements of existing protocols include:



1. Remove or bypass devices like point-of-entry treatment units prior to flushing.
2. Take steps to prevent backflow or the siphoning of contaminants back into plumbing (e.g., close valves separating irrigation systems from home plumbing, disconnect hoses attached to faucets, etc.).
3. Organize flushing to maximize the flow of water (e.g. opening all outlets simultaneously to flush the service line and then flushing outlets individually starting near where the water enters the structure).
4. Run enough water through all outlets (e.g., hose bibs, faucets, showerheads, toilets, etc.), removing aerators when possible. Typical durations in existing protocols range from 10 to 30 minutes for each outlet (duration varies based on outlet velocity).
5. Flush the cold water lines first, and then the hot water lines. Note: the hot water tank can be drained directly; it can require roughly 45 minutes to fully flush a typical 40-gallon hot water tank.
6. Replace all point-of-use filters, including the filter in refrigerators.
7. Additional precautions may be warranted if there is excessive disruption of pipe scale or if there are concerns about biofilm development. Actions that might be warranted include continued use of bottled water, installation of a point-of-use device, or engaging a contractor to thoroughly clean the plumbing system.

Residents should be reminded that if point-of-use devices are installed, POU devices should be properly installed and adequately maintained.”

How do I flush a larger building?

Based on the experience of AH and ESPRI, a single flush cannot bring the building water system back to normal operation and re-establish good water quality. Flushing requires an initial flush to get out low quality water and contaminants and then follow-up flushes that may bring the building back to pre-COVID water quality. Ongoing flushing draws particles through and out of the system and brings in disinfectant from the municipal system that can help control biological growth. The longer service is interrupted, the more the required level of effort for restoration.

Experience in flushing and maintaining buildings has shown that there are some general principles for an effective flushing strategy. In general,

- Flushing should proceed uni-directionally, that is from the service entrance to the periphery of the plumbing system (distal points).
- Some buildings have water treatment systems like filters and water softeners at the building water supply. Those treatment systems were installed for a reason and should not be bypassed. Those treatment systems need to be cleaned, flushed and maintained as part of bringing the building back into use.
- Building water systems have a variety of places where water is stored. At a minimum, they should all be identified, drained, and flushed with clean cold water, after the building cold water service is properly restored. These include, but are not limited to:
 - Hot water storage (some buildings have more than one type of heating system and hot water storage),
 - Hot water recirculating loop(s),



- Humidifiers,
- Ice machines,
- Dishwashers,
- Cooling towers, and
- Ultrapure water storage (membrane filtration).

Before flushing, sketch out the building water system to the best of your ability and identify:

- the water supply,
- zones or branches with a common water supply (e.g., a branch to a wing of a building or a set of branches served by the same riser),
- the faucet nearest the starting point of the zone and the most distant faucet or use for each zone,
- water heaters and recirculating heated water loops, and
- appliances and water-using features (e.g., hot tubs).

Parts of the water system that are most important to flush because they have the greatest opportunity to make people sick include:

- faucets used for drinking water or food preparation,
- drinking fountains,
- ice machines and refrigerators with ice makers,
- showers,
- kitchen sink sprayers,
- water features that generate aerosols (fountains, spas, etc.),
- parts of the water system that are used by children, and
- components of the water system used by elderly people and susceptible people.

However, it is also important to identify and flush as many other water outlets as possible - utility sinks, hose taps, piping in place to serve any future installations, removed water taps - to remove contamination in the piping.

Initial flushing and cleaning. The initial flush clears out contaminants that accumulated during stagnation and draws in fresh, high-quality water to the piping. Cleaning of fixtures removes contaminants from the complex internal structures at the point of discharge. Complete the initial flushing and cleaning steps before resuming normal building operation:

- Clean fixtures.
 - Clean showerheads.
 - Replace/maintain point of use filters.
- Flush zone-by-zone. Zones are branches of the building water system with a common source or parts of the building water system served by a common riser.
- The first zone to flush is the one nearest the building supply. Flush zones progressively outward from the supply.
- In each zone, flush the cold water plumbing first and hot water second.



- Begin flushing at the point of use (POU) nearest to the origin of the zone. Aerators and other flow restrictors are removed at the POU nearest the beginning of the zone and the tap is opened wide.
- Open other taps on the same branch, moving from the faucet nearest the origin to the most distant POU tap. Continue flushing until the final POU tap is flushed for at least 5 minutes AND the cold water temperature at the final POU tap is steady.

Drain hot water tanks on the first flush after resumption of flow. If draining is not possible, hot water flushing time depends upon the size of water heater tank. Maintain the water heater temperature. DO NOT turn the heater off as water temperature is critical to prevent microorganisms from growing in the heater and being disseminated in aerosols.

Ongoing flushes. Ongoing flushing can repair destabilized scale and control biofilms. Re-stabilizing scale and controlling biofilms is an ongoing process. In the best case, ongoing flushing is conducted for about 12 weeks – the duration needed for protective scale to re-stabilize and for lead borne on particles to be thoroughly washed from the plumbing system. This is the duration recommended in an industry standard (AWWA) on flushing related to lead. In some cases, longer flushing duration might be required. Monitoring for problematic organisms like *Legionella pneumophila*, the bacterium the causes Legionnaires’ disease, for lead and for disinfectant are the best ways to assess whether flushing is working and how long it should continue. Even when the building water system has recovered from a lengthy stagnation, flushing is a best practice, is easy and it has proven water quality benefits. Recommendations for ongoing flushing include:

- *Make sure each POU tap is opened at least once per day.* Some POU’s are used frequently during normal building operation. Others might be used less frequently and might need to be opened intentionally.
- Flush the full building once per week during ongoing flushing. Full building ongoing flushes proceed the same as the initial flush except water tanks do not need to be drained and hot water flushing times are the same as cold water flushing times. Still flush the cold and hot water systems separately – cold first and hot second.
- During ongoing flushing, it is a good idea to measure the water quality of water coming into the building and at some taps in the building. Many building operators will not have the equipment or the ability to make measurements. ***Even if operators cannot measure water quality, they should still flush the building.***
 - For those who can measure water quality, the most important measurements to make are the concentration of disinfectant (chlorine) in the building supply and the concentration of disinfectant in the cold water of the most distant tap of each zone after that tap is fully flushed. By comparing the disinfectant in the distant taps to the disinfectant in the building supply, you can tell whether the disinfectant is protecting the whole plumbing system. There is no benefit to measuring the disinfectant in the hot water system. At elevated temperature, disinfectant dissipates.
 - There are many other water quality measurements you can make. We do not recommend making those measurements, other than for chlorine, unless there is a compelling reason and unless you can understand what the results mean and what to do about them.



Long-Term Risk Management: Implement a Water Management Plan (WMP)

- To maintain high quality water in a building at all times, building owners and operators should implement a WMP that follows industry recommendations, such as ASHRAE 188 (2018) or similar to continually reduce the risk of infections due to water quality degradation.

