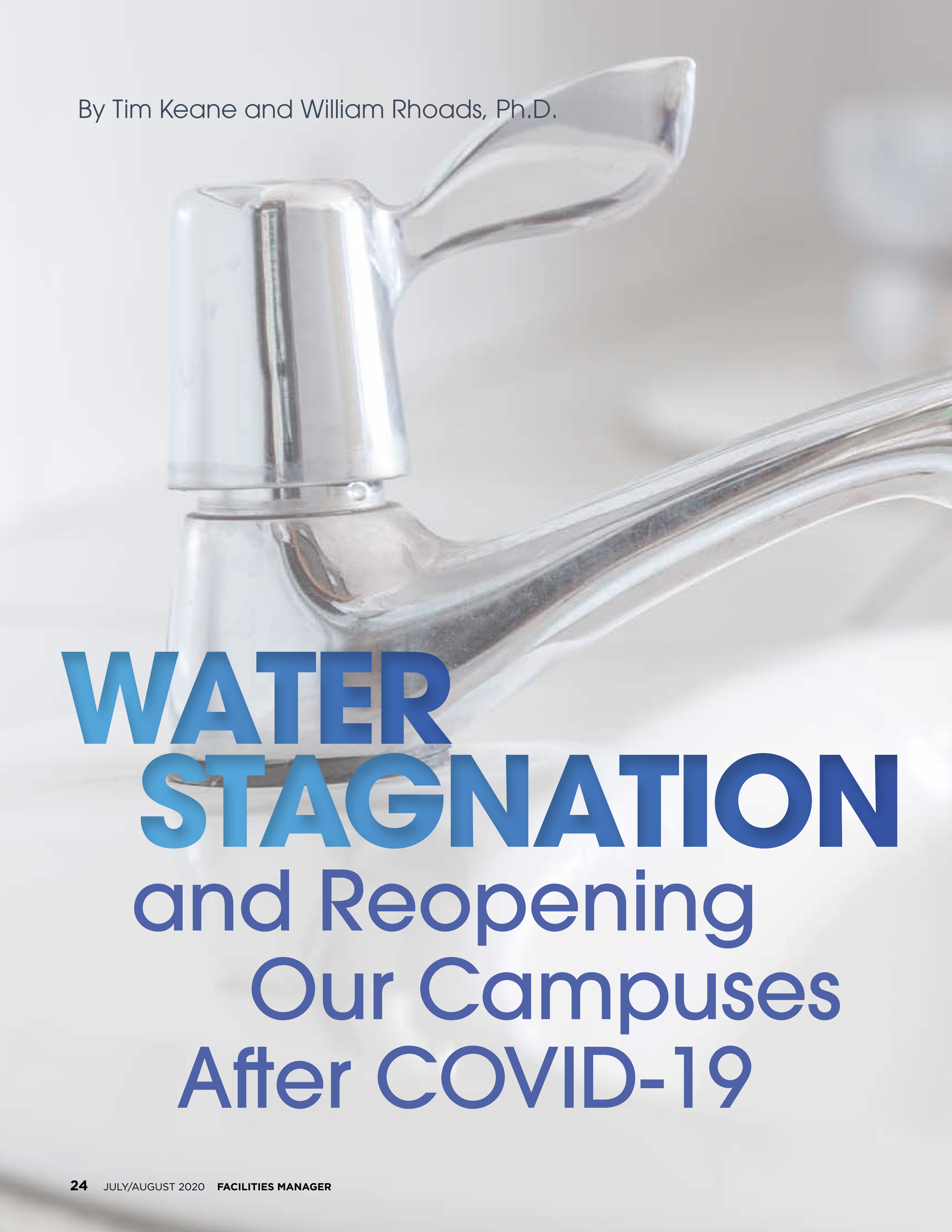


By Tim Keane and William Rhoads, Ph.D.

WATER STAGNATION and Reopening Our Campuses After COVID-19

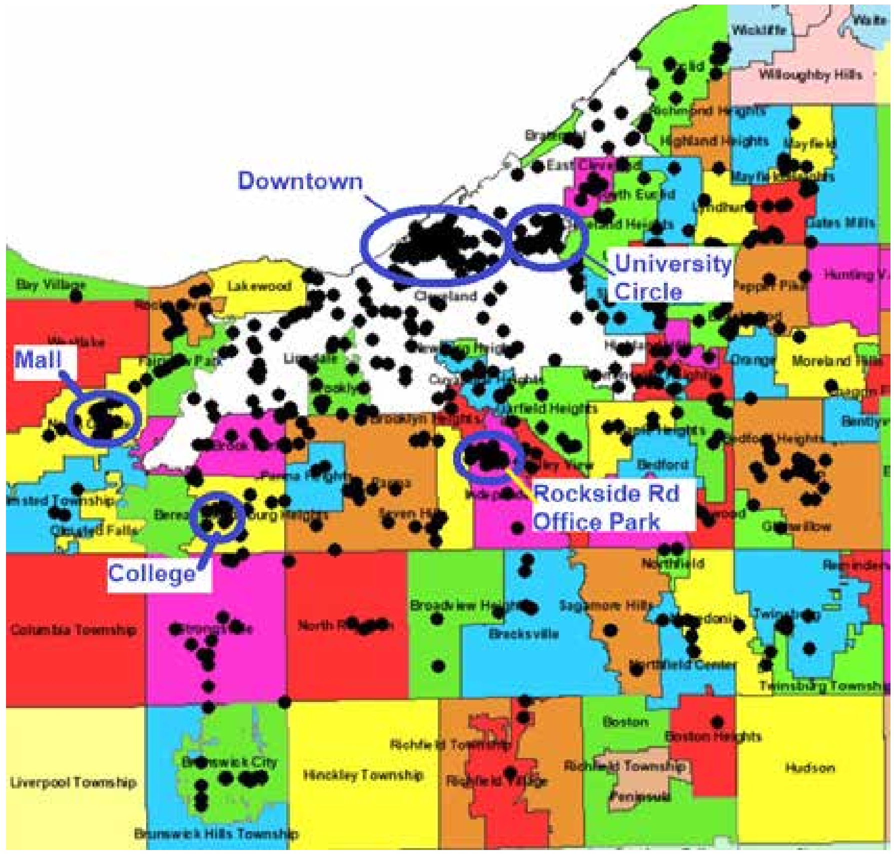
There is widespread concern that systemic water stagnation caused by low building occupancy due to COVID-19 social distancing efforts will cause the development of water-quality problems, including the growth of opportunistic pathogens. We recently coauthored a paper titled "Considerations for Large Building Water Quality after Extended Stagnation," which applies to COVID-19 response.[1] The paper outlines the concerns over water-quality changes in building plumbing systems and highlights some of the considerations for their prevention and/or remediation.

While academic institutions experience widespread stagnation annually during summer months, it is suspected that COVID-related stagnation is more extensive and of longer duration than normal. It is unknown how longer-term water stagnation will impact water quality, but a precedent of concern is the high percentage of Legionnaires' disease outbreaks commonly associated with construction and renovation projects that can sit for weeks to months. To address this concern, public health guidance issued by the U.S. Centers for Disease Control and Prevention (CDC), the U.S. Environmental Protection Agency (EPA), and individual state departments of health (e.g., from Washington State Department of Health) recommend actions that can be taken to prevent or remediate potential water-quality issues that may have developed during COVID-19 shutdowns.

A particular challenge is the unknown impact shutdowns will have on municipal water systems. An American Water Works Association (AWWA) webinar titled "Returning to Service: Addressing Water Quality in Buildings with Low or No Use"[2] included a presentation by Alex Margevicius of the Cleveland Division of Water that showed the impact of COVID-19 on water-use reductions. In the figure that follows, the black dots represent customers with dramatic water-use reductions. As water demand across the entire water supply system decreases, water quality delivered to individual buildings may have less residual disinfectant and may require more flushing than normal to establish "fresh" water quality at the entry point to individual buildings.

This three-part article explains 1) why waterborne disease issues pertain to large academic institutions, 2) the utility and limitations of long-term water management, and 3) what can be done now to decrease potential issues from developing prior to widespread university reopenings.

Figure 1: Water-Use Reductions in Cleveland, Ohio



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PART 1. EDUCATIONAL FACILITIES ARE NOT IMMUNE TO INCIDENCE OF WATERBORNE DISEASE CAUSED BY OPPORTUNISTIC PATHOGENS

There is a misconception that waterborne disease caused by opportunistic pathogens only occurs where there are high concentrations of immunocompromised people. A large outbreak of waterborne disease is unlikely at an academic or educational institution because of the young and healthy demographic that makes up the majority of consumers there. However, these facilities are not immune to the growth of waterborne pathogens such as *Legionella pneumophila*—the cause of Legionnaires' disease and most reported cause of waterborne disease outbreaks in the United States. It is important to recognize that people with underlying health issues who are more likely to become ill after exposure to opportunistic pathogens still occupy and use water in academic buildings.

Another common misconception is that responding to just one case or even a suspected case of waterborne disease is not warranted. The disruption to daily operational and administrative activities that occur when responding to isolated or suspected cases is a fraction of the effort and expense required in responding to a second case or outbreak (not to mention having to deal with media coverage of the problem). With one case, simpler remediations can be applied, including online disinfection of building systems, minor alterations in mechanical plumbing designs, replacement of high-risk fixtures, and instituting systematic control policies to detect problems early on.

PART 2. DEVELOPING A WATER MANAGEMENT PROGRAM: ADDRESSING ENGINEERING OPERATIONS AND MAINTENANCE ISSUES

Public health recommendations focus on the development of comprehensive water management programs to address issues related to water quality in building plumbing. The core function of a water management program is to ensure that facility maintenance managers and engineers have thoroughly assessed risks found in their facility and have put a program in place to prevent issues from developing and/or detect and respond to issues before they impact public health. Key elements of a water management program as required by ANSI/ASHRAE 188, the industry standard Legionellosis prevention document, include:

1. Develop a program team
2. Describe building water systems/develop water system process flow diagrams
3. Analyze building water system hazards
4. Define control measures, control locations, and control limits
5. Conduct routine monitoring to verify control measures are met

6. Validate program control
7. Document that the program is implemented and meeting defined control measures

While the basic requirements of an ANSI/ASHRAE 188 program are clearly defined, there are many interpretations on how best to implement these programs. There are important considerations for some aspects of implementing water management programs that facility managers should consider, particularly when external parties are providing contracted or consulting services for the water management program.

Developing the program team. From central plant equipment failures, to new or alternative approaches taken by the engineering department during construction projects, to routine flushing and maintenance practices used by custodial staff, communication across team disciplines is essential and ensures that responses to potential issues are communicated and coordinated. The team should include key personnel involved in new construction, plant operation and maintenance, housekeeping, health and safety, and facilities management. If the team chooses to include a water management consultant to support decision-making, we recommend that the consultant should be a voting member of the team and have an engineering background in building water systems. Specific utility or mechanical system contractors (e.g., cooling tower contractors) should also be considered as team members.

Analysis of building water system hazards and program confirmation. The identification of potential root causes of water safety issues that should be addressed by water management programs is the most consequential step in developing a successful, cost-effective *Legionella* risk management program. While ANSI/ASHRAE 188 requires confirmation that water-quality hazards are under control, it does not require *Legionella* testing. We recommend routine collection of *Legionella* samples as part of the water management program. However, if not part of a water management program, sampling should be conducted with caution in the absence of a suspected associated case of waterborne disease.

For cooling towers, the simplest solution is to include requirements in the water treatment contract stating that the supplier must comply with applicable standards and guidelines, including ANSI/ASHRAE 188 and ASHRAE Guideline 12 related to minimizing *Legionella* growth in building systems. Many water treatment companies can effectively and efficiently manage risk in cooling towers.

Assessing risks in potable water systems is more complex due to dynamic use patterns, complexity and variability in design, direct consumer exposure to water, and the larger number of stakeholders involved in operating and maintaining these systems. Thus, sole-party management contracts—from water management team leadership to sample collection and analysis—are more difficult to execute and are fraught with potential conflicts of interest that facility managers should be aware of. The leader of the water management program team or any contracted consultant should have extensive knowledge of potable water system design, operation, and maintenance and be familiar with issues regarding *Legionella* control. It is easy for experienced facilities personnel or mechanical/plumbing/water treatment engineering professionals to learn the specific issues related to control of *Legionella* growth. However, in complex systems or where institutional knowledge or personnel are limited, it can be appropriate to hire external consultants to provide *Legionella* risk management program oversight.

Sampling potable water systems is also complex. The number, location, and types of samples collected are highly dependent on individual system features. Sample collection can be effectively executed by onsite personnel or competent technicians. If the consulting firm provides both water management program oversight and laboratory analysis, we recommend that a third-party design and validate the sampling plan, as there is a conflict of interest in generating revenue through additional laboratory analysis. We also recommend that sampling plans be focused on high-risk areas such as residence hall and gymnasium showers, or on high-risk devices such as outlets with low flow rates and thermostatic mixing.

Laboratory methodology is also important to consider. Laboratories performing *Legionella* cultures must be CDC ELITE (Environmental Legionella Isolation Techniques Evaluation) program certified and must perform culture-based analysis. Molecular-based detection of *L. pneumophila* genetic material (i.e., through polymerase chain reaction [PCR] or quantitative PCR) in cooling towers can provide near-real-time results for decision-making, particularly with new assays that can be executed while contractors are onsite. If there is a potable water outbreak and immediate results are needed, there is a value for the added expense associated with molecular testing to expedite the outbreak investigation.

For routine monitoring, molecular-based techniques can be used as a screening tool to determine which culture samples are prioritized. However, it is important to recognize that molecular testing will greatly increase costs and also detect dead cells or cells that are not culturable, potentially overestimating or confusing risk analysis. Culture testing is the gold standard for assessing risk of disease occurrence and includes established guidelines for how to respond to positives. Documenting culture results is also the best method to validate the success of a water management program from a legal liability perspective.

PART 3. WHAT TO DO NOW TO REOPEN BUILDINGS AFTER COVID-19 SHUTDOWNS

The overarching challenge for facilities in developing an effective water management program and executing public health recommendations for buildings is the time and resources involved. Given the number of demands they face while adapting to COVID-19 social distancing guidelines and other maintenance issues, most facilities will find it difficult to fully develop and implement an effective water management program if they do not already have one in place. Instead of trying to expedite the process and potentially developing an ineffective program, we recommend that facilities focus on effective auditing of building water systems now, and develop a full water management program later, as some of the other COVID-19-related responses dissipate.

Likely the most important aspect of controlling *Legionella* and other opportunistic pathogens is confirming that the main systems are operating under recommended parameters. Hot water should be generated at temperatures >140°F, temperature at fixtures should stabilize >120°F, and systems with multiple return loops should be confirmed to be balanced (i.e., evenly distributing the recirculated hot water throughout the building). The following table shows the reported *Legionella* growth temperature ranges from the recent International Association of Plumbing and Mechanical Officials (IAPMO) UPC 2021 plumbing code.

Legionella Growth Potential	Temperature (˚F)
Minimal	<77
Low	77 to 85
High	85 to 110
Moderate	110 to 120
Low	120 to 130
None	>130

Other immediate recommendations include performing routine or remedial flushing of the water systems or performing remedial disinfection. Flushing water consists of opening the outlets within the building to replace stagnant water with fresh water from the water supplier. The goal of routine flushing is to simulate normal water demand in the building and replace water frequently enough to prevent water-quality issues from developing. While this practice can be scaled up or down based on building occupancy levels, it is difficult to implement in fully vacant buildings, and there is no established guideline to define how much flushing is necessary or how frequently to flush to avoid all issues.

Tim Keane's "how-to" guide, *Developing a Building Potable Water System Flushing Program,*[3] details recommended actions when reopening buildings after stagnation. This document covers startup flushing procedures, practical tips for some critical pieces of mechanical equipment, and when to consider building system disinfection. The sections of the guide that deal with building stagnation are based on recommendations presented by ANSI/ASHRAE 188 for commissioning new buildings.

For instance, ANSI/ASHRAE 188 states that if occupancy of a new building is delayed more than two weeks but less than four weeks after it is disinfected, all the outlets in the facility should be flushed; if occupancy is delayed more than four weeks after disinfection, the need for additional disinfection, flushing, or both should be assessed. While it's unclear how this guidance applies to buildings that are not associated with new construction, these are logical benchmarks to consider when developing system-specific recommendations in the absence of other preventative actions.

There is no simple, one-size-fits-all answer, and many building managers must make decisions about their particular facility and risk factors, and what level of response is appropriate and achievable. The recommendations provided in the guide discuss methods for large, circulated hot water systems and for small, uncirculated hot water systems, and provide a solid starting point for making facility-specific recommendations.

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