



Emerging Issues of Pathogens in Plumbing and How the Water Industry is Involved

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Plumbing Systems

- **To supply water** for flushing toilets, taking showers, washing dishes and clothes, etc., and fighting fires.
- To supply **drinking water**.
- **Can the two be accomplished using the same piping system?**

What grows in plumbing systems is a growing national health issue!



State of the Science and Research
Needs for Opportunistic Pathogens
in Premise Plumbing

- ***Legionella***
- ***Mycobacterium***
- **Amoeba**
- ***Pseudomonas***
- **Other opportunistic pathogens such as fungi**

Subject Area: Water Quality



Water is not Sterile

- Drinking water is **sanitary but not sterile.**
- It is **free of primary pathogens** but it still has microorganisms in it.
- These **microorganisms can grow in water and on surfaces in contact with water**, given the right conditions.

Pathogens in Plumbing?

- We tend to refer to them as ***opportunistic pathogens*** – they cause problems for people who have weakened immune systems, such as the elderly at a Legionnaires Convention.
- They can be **ingested, inhaled, or come into contact with open lesions in skin**, or with our eyes, ears, and nose.

Pathogens in Plumbing

- *Legionella* – a bacterium that can be inhaled in droplets of water and infect our lungs
- *Mycobacterium* – similar to *Legionella*
- *Naegleria* – an amoebic protozoan that can gain entry into our nasal passageway and from there to our brain
- All are **naturally occurring** in water and soil

Rosenblatt *et al.* have reminded us that:

- The **only plumbing-associated disease requiring notification in the US is legionellosis**, a severe pneumonia caused by the bacterium *Legionella*.
- The US Centers for Disease Control and Prevention (CDC) has estimated there are as many as **18,000 cases of Legionnaires' disease annually**.
- The US Occupational Safety and Health Administration (OSHA) has estimated that Legionnaires' disease results in about **4000 deaths in the US each year**.

Controlling *Legionella*

- Although *Legionella* comes from the water, it's **the amplification to high numbers** that is the problem.
- If we **control the ecology** we might lower the risks.
- Many buildings can **install treatment systems or use a variety of operating measures** to control for *Legionella*.

Who Designs Faucets?

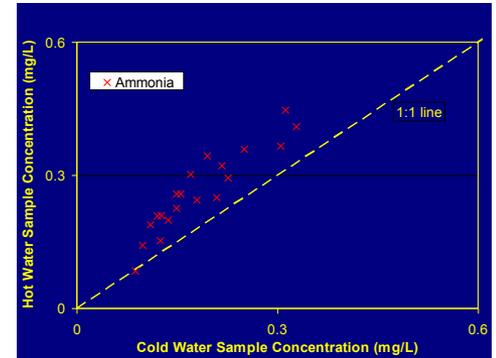
- And why do they **never consult with us?**
- Some of the more modern faucets, as would be used in hospitals where they can be turned on without using hands, have more **intricate inner parts that can promote the growth of bacteria and biofilm!**
- **Hot water** used for washing hands is constantly sitting in and contacting the insides of the faucets.

If we wanted to grow bacteria....

- **Warm** the water.
- Provide **surface area** for growth.
- **Reduce the chlorine** residual.
- **Reduce the turnover** of the water.
- Trap and **collect sediment**.
- Encourage **amoeba** to grow.
- Exactly the way building **hot water systems** are designed!

Water Quality Changes Do Occur in Plumbing Systems

- **Water temperature** warms or cools
- **Chlorine residual** decreases
- **HPC bacteria** levels increase
- **Metals** from leaching and corrosion increase
- **Ammonia** from chloramine decay increases
- **DBPs** change species
- **All of this is enhanced in the hot water systems**



Researchers have reported on water quality changes in Hot Water Systems

- **HPC was approximately 250 fold-higher** than HPC for the cold water samples.
- Increase in HPC was **accompanied by a loss of chlorine residual and an increase in pH.**
- **TOC did not change** from the cold to the hot water.
- **Total THMs increased** from the cold to the hot water.

Pathogens in Plumbing

Come in at low numbers and then amplify to higher numbers:

- In biofilm**
- In association with other microorganisms, such as amoeba**
- In the sediment of tanks**



Green Building Design: Water Quality Considerations

Web Report #4383

Subject Area: Water Resources and Environmental Sustainability



Will plumbing issues get better?

Green Buildings

Water Age

Greatly increased due to:

- **Reduced water demand**
- **Low flow fixtures**
- **Conservation**

Water Temperature

Ideal for *Legionella*

> 20° C

< 52° C

- **Bacterial numbers 10-100 times higher**
- **Recirculation of water helps support growth**

Green Buildings

Total Chlorine Residual

- Does not make it to the end points
- **Chlorine decay is greatly increased**
- Compared to houses, which have no problem getting chlorine to all taps
- Hot water systems tend to have no residual

Flushing?

- Easy to flush a home and restore chlorine residual
- **Long flushing times, greater than an hour, are needed** to begin to see chlorine residuals in buildings
- Hot water systems are not practical to flush

Does the incoming chlorine residual matter?

- **Hot water systems will eliminate** even high chlorine residuals; so reducing water age and maintaining good temperatures to deter growth is a responsibility of the building managers.
- Also, **using proper faucets and showerheads** will help deter biofilm growth at the endpoints.

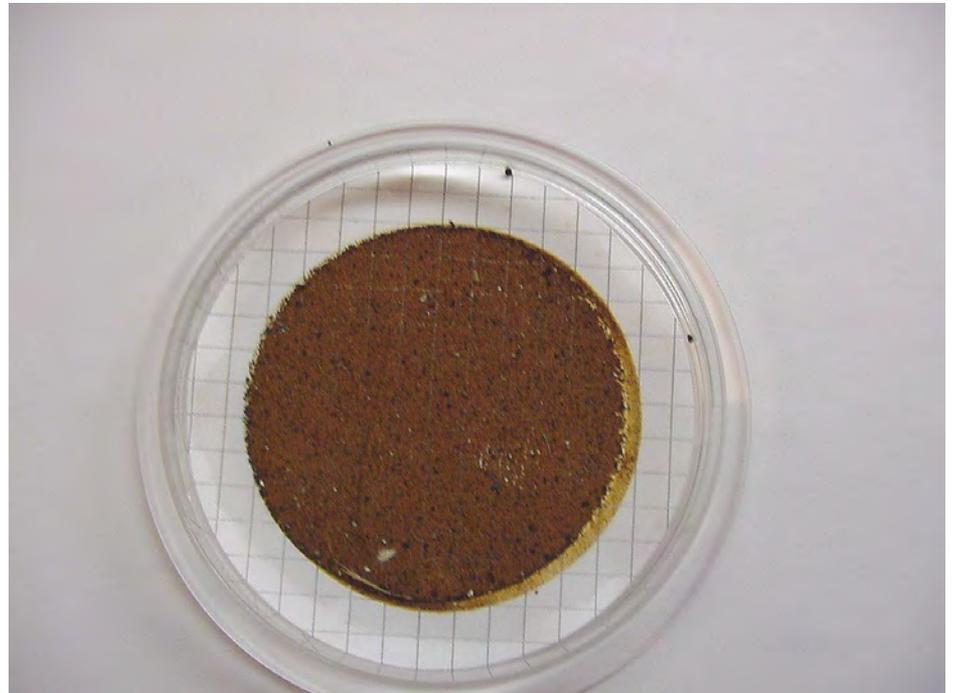
What about chlorine residual in cold water plumbing?

- **In households**, we generally do not find it an issue - the residual entering the cold water system appears to be adequately maintained in homes that turnover their water regularly.
- **Many buildings** are designed to reduce the chlorine residual with long lines, warmer water, storage tanks, etc. Building managers need to develop operating plans.

What Role do we play?

- **Educating customers, especially building owners and managers, on how to maintain high quality water in the plumbing.**
- **Educating customers that water for drinking should not come from hot water systems.**
- Working with our **Health agencies** to better understand the factors at play.

We have *always* been helping customers with plumbing issues



So going *beyond the meter* is nothing new

PLUMBING - DrinkTap.org



Meter to Tap

Maintaining high-quality drinking water in household plumbing



Where to get more information

- Contact your water provider or utility for more information
- US Environmental Protection Agency's (EPA's) Water Health Series and Water on Tap (www.epa.gov/safewater)
- EPA's WaterSense for helpful information on water-efficient products for the home (www.epa.gov/watersense)
- American Water Works Association's (AWWA's) consumer website, DrinkTap.org (drinktap.org)
- AWWA's brochure on household backflow prevention, *Backflow prevention is a two-way proposition*
- Canadian Institute of Plumbing and Heating has a consumer website. www.ciph.com/becausewatermatters



American Water Works Association

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Did you know that after water from your water utility enters your home, conditions in your home plumbing system can affect the water's quality? Your water utility wants to help you maintain high-quality water throughout your household plumbing system. Use this brochure yourself, or use it to work with a licensed plumber, to inspect your cold and hot water plumbing system. Identify areas for improvement for a well-designed, properly constructed and maintained household plumbing system. Follow the 10 simple tips to help ensure your tap water quality and understand how water quality is affected by the plumbing conditions in your home.

Do you have a plumbing problem?

The most common signs that your plumbing might be affecting the quality of your drinking water are changes in the water's color, taste and smell. This includes discolored water, stains on fixtures and laundry, and particles or sediment. Follow these water quality tips and contact your water utility if problems persist.

About your water service pipe

The *water service line* is the pipe that connects the water main outside your home to your household plumbing. Contact your water utility to determine if the water service pipe is owned by you or the utility. Then determine your water service pipe material. If it is lead or galvanized, you should consider replacing the pipe. A leaking water service pipe should be replaced immediately.

Top plumbing tips for homeowners

1. Learn about your tap water's quality. Review the water quality report issued every year by your water utility.
2. Use cold tap water for drinking and food preparation.
3. Maintain home water treatment systems, including filters, treatment devices and water softeners, as recommended by the manufacturer.
4. Use water taps regularly. Flush cold water taps (open the faucets) throughout your home for several minutes when water has not been used for several days.
5. Be sure the plumbing system is constructed properly, including the installation of appropriate backflow protection.
6. Replace old plumbing, especially lead-containing and galvanized plumbing material.
7. Flush cold water taps following household plumbing construction or repair.
8. Drain and flush your hot water heater annually.
9. Maintain the hot water heater's temperature as recommended by the manufacturer.
10. Take action when you experience a change in the taste, smell or color of your water, or notice particles in your water or stains on fixtures and laundry.



FAUCETS - DrinkTap.org



Clean Tap, Clean Water

Maintaining high-quality drinking water in your home



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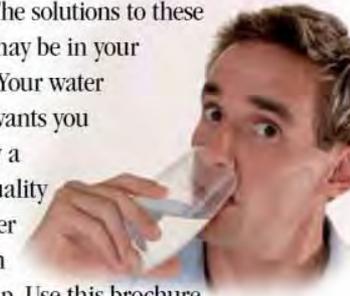


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The next time you fill a glass with tap water, take a close look at the faucet and sink. Is the sink area clean? Are there stains on the fixtures? Does the tap water have an unusual smell or color? The solutions to these issues may be in your hands. Your water utility wants you to enjoy a high-quality tap water through every tap. Use this brochure yourself, or use it to work with a licensed plumber, to inspect your faucets and water use areas, such as sinks used to tap drinking water and for food preparation, to find areas for improvement.



Top faucet tips for homeowners

1. Install faucets that are certified to be "lead-free" or contain no lead.
2. Clean faucet aerators and strainers regularly.
3. Clean and disinfect sinks and faucets regularly.
4. Keep sink drains unclogged and clear of materials so that the drains work properly.
5. Use cold tap water for drinking and preparing food.
6. A good time to collect fresh drinking water to chill in the refrigerator is after a lot of household water use, such as laundry and dishwashing.
7. Remove aerators and flush cold water taps (open the faucets) after household plumbing work or when water has not been used for several days.
8. Only connect water filters and other devices intended for drinking water to household faucets. Do not connect hoses or other devices to faucets for non-drinking water purposes.
9. Keep hazardous chemicals or unsanitary materials away from faucets and sinks used for drinking water or food preparation.
10. Maintain water treatment systems as recommended by the manufacturer.



Example of Education: *Contact Lenses and Water*

Contact Lenses and Water Don't Mix

Why should I keep my contact lenses away from water?

Water on your contact lenses can lead to eye damage and infection. Lenses exposed to water may swell, change shape, and stick to the eye. This can cause pain or even scratch your cornea (the eye's outer layer), increasing your risk for eye infection. Some water can also contain germs that cause eye infections.

What are some symptoms of eye infection?

Symptoms can include:

- Eye pain
- Redness
- Blurred vision
- Eye discomfort
- Sensitivity to light
- Feeling of something being in the eye
- Excessive tearing



Can I rinse or store my contacts using water?

No. Most water is not sterile and can contain germs that can lead to infection in your eyes.

How can I protect my eyes?

- Avoid contact between your lenses and water, including tap water and bottled water.
- If your contacts have touched water, take them out immediately and throw them away.
 - Disinfecting lenses overnight in contact lens solution may reduce the risk of infection, but this is not based on scientific testing.
- Do not store, rinse, or clean your contacts with water.
- Wash and dry your hands well before handling contact lenses.
- Remove your contacts before showering, swimming, or using a hot tub.
- Do not rinse or clean your contact lens case with water.
 - Clean and rinse the case with contact lens solution, then empty and dry with a clean tissue.
 - Store the case upside down with the caps off after each use.
- For those involved with swimming or other water sports, use prescription goggles.

Although it may seem easier to keep wearing contacts that have been exposed to water, the safest option is to throw them away.

What should I do if I think I have an eye infection?

If you have eye pain, discomfort, blurred vision, or redness, remove your contact lenses and call your eye doctor. Ask your eye doctor if you have any questions about caring for your contact lenses. Visit your eye doctor at least once a year to protect your eye health.

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For more information, contact your doctor, refer to <http://www.phila.gov/Health/>, or contact the Philadelphia Department of Public Health, Division of Disease Control at 215-685-6740

Water Research Foundation

- **2016 initiated a new Focus Area**
- **Called: Waterborne Pathogens in Distribution and Plumbing Systems**
 - Messaging to the Public
 - Detection and Monitoring Methods
 - Disinfection and Control Methods

We need to better understand HOW to sample plumbing?



- Where to collect samples?
- How to collect samples?
- What the data mean?
- What other information we need in order to explain the data?

We still don't know what we need to know

- Testing for **viable** organisms
- Testing for **culturable** organisms
- Testing for **disease-causing** organisms
- What do the **numbers** mean from the water testing?
- At what level is there a **health risk**?
- What levels do we **control** them down to?

What can building managers do?

- **Develop a HACCP plan** – Hazard Analysis and Critical Control Point plan.
 - **ASHRAE 188-2015**
 - **Standard 188-2015 -- Legionellosis: Risk Management for Building Water Systems (ANSI Approved)**
- **A new building code standard advanced by ASHRAE is specific to the building industry for management of the risks associated with amplified growth of and exposure to *Legionella*. Facility owners and operators should implement stronger safeguards through risk assessment and risk management practices.**

Hazard Analysis and Critical Control Point (HACCP)

- **HACCP-Based Programs for Preventing Disease and Injury from Premise Plumbing: A Building Consensus** by William F. McCoy 1 and Aaron A. Rosenblatt
- A process management framework for buildings is the **hazard analysis and critical control point (HACCP)** adaptation of failure mode effects analysis (FMEA). It has been **proven effective** for building water system management. Validation is proof that hazards have been controlled under operating conditions.

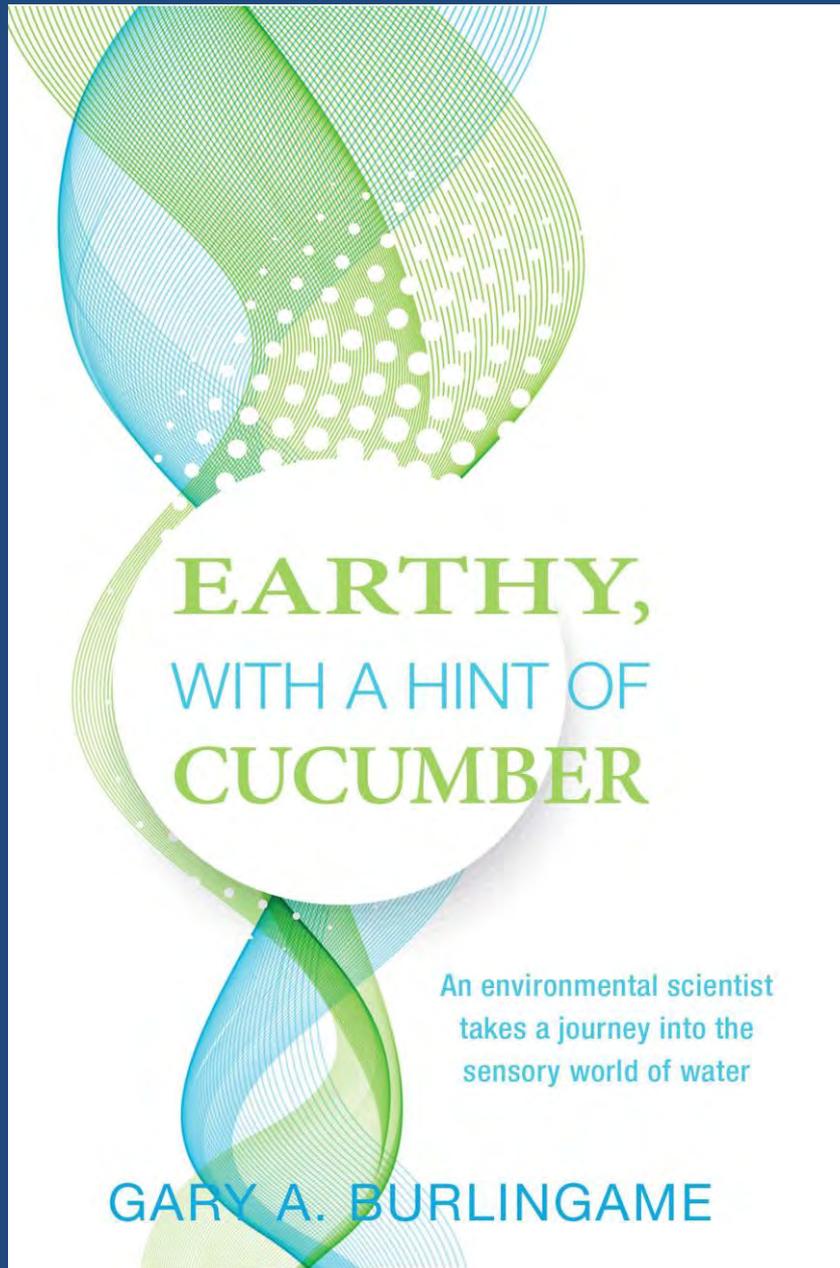


***Comments or questions, please
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For more information on research visit:

www.waterrf.org



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