ORANGE WATER AND SEWER AUTHORITY

A public, non-profit agency providing water, sewer and reclaimed water services to the Carrboro-Chapel Hill community.

MEMORANDUM

TO: **Natural Resources and Technical Systems (NRTS) Committee**
Dave Moreau (Chair)
Terri Buckner
Quinton Harper
Ruchir Vora
John Young (*ex officio*)

THROUGH: Ed Kerwin

FROM: Ruth Rouse

DATE: May 20, 2016 – **Updated June 3, 2016 (revised Attachment)**

SUBJECT: June 8, 2016 NRTS Committee Meeting

The NRTS Committee will meet on Wednesday, June 8 at 5:30 pm in the OWASA Boardroom. Monica Dodson, Operations Supervisor, and Katie Harrold, Laboratory Supervisor, will present information on water treatment and distribution system disinfection and discuss staff's proposed path forward to improve community awareness and understanding of our use of chloramines for water distribution system disinfection. The potential impacts on privately-owned plumbing systems and appliances will also be discussed.

The agenda will include the following topics:

1. Brief staff presentation
2. Questions and answers on staff presentation
3. Discussion about improving community awareness and engagement on this topic
4. Next steps

We look forward to seeing you on June 8, 2016.

Ruth C. Rouse

Ruth Rouse, AICP
Planning and Development Manager

c: OWASA Board of Directors
Robert Epting, OWASA General Counsel

Attachment: Background Information on Disinfection and the Potential Impacts on Private Plumbing

Background Information on Disinfection and the Potential Impacts on Private Plumbing

June 3, 2016

Purpose:

At the April 28, 2016 Board of Directors meeting, the Board requested that the Natural Resources and Technical Systems (NRTS) Committee meet to discuss the use of chloramines in our drinking water treatment process. During the June 8th NRTS Committee meeting, staff will provide a presentation on disinfection; discuss the potential impacts to privately owned plumbing systems; and explain remedies for these impacts.

There are two plumbing issues in particular that some of our customers have expressed concerns: rubber degradation and dezincification. Like chlorine, chloramines contribute to the breakdown of rubber components in private plumbing. There are rubber products intended for the use in chloraminated water, which are longer lasting. This is a common issue in water systems and it is important for utilities to inform their customers on these appropriate products. A less common issue in water systems is dezincification. This is an issue related to low quality brass plumbing components. Chloramines do not contribute to dezincification.

The following provides additional details on these topics and supporting information.

Disinfection:

Disinfection of drinking water is vital to protect public health from waterborne diseases.

However, chemical disinfectants can react with naturally present organic matter in water to form disinfection byproducts (DBP)s. Exposure to high concentrations of DBPs can increase the risk of cancer. DBPs are regulated by the U.S. Environmental Protection Agency (EPA). The EPA has set DBP maximum contaminant levels for total trihalomethanes (TTHM), five haloacetic acids (HAA5), chlorite, and bromate.

Therefore, water treatment plants must provide sufficient disinfection while minimizing the formation of DBPs. Strategies used to control DPBs include optimization of the removal of naturally occurring organic matter and selecting a disinfectant that minimizes DPB formation.

The water treatment process includes two disinfection steps, primary disinfection and secondary disinfection. The purpose of primary disinfection is to kill and inactivate microorganisms, such as bacteria, viruses, and protozoa before the water enters the distribution system. Options for primary disinfectants include chlorine (free chlorine), chloramines, chlorine dioxide, ozone, and ultraviolet light (UV). Secondary disinfection is then used to keep the water safe in the distribution system and prevent bacterial regrowth. The only options for secondary disinfection are chlorine (free chlorine), chloramines, and chlorine dioxide. Ozone and UV do not provide a disinfectant residual (which is a regulatory requirement) and therefore do not protect distribution systems from bacterial regrowth.

OWASA is committed to providing safe drinking water that minimizes potential health risks. Our primary disinfection method is free chlorine in the form of liquid bleach (i.e., sodium hypochlorite). Our secondary disinfection method is chloramines. It is important to note that we maintain emergency interconnections with City of Durham, Town of Hillsborough, and Chatham County which all use chloramines as their secondary disinfectant. In order to utilize these emergency interconnections, utilities must be using the same secondary disinfectant since mixing different disinfectants can result in a loss of disinfectant residuals as well as taste and odor issues.

Until 2002, OWASA utilized free chlorine as both the primary and secondary disinfectant. Free chlorine is a strong disinfectant and highly reactive. Free chlorine readily reacts with organics to form disinfection byproducts. In 1998, the EPA proposed maximum contaminant levels for TTHM and HAA5 at 80 and 60 ppb, respectively. Public water systems

had until 2002 to make the necessary improvements to comply with these regulations. To maintain compliance, OWASA switched our secondary disinfectant from free chlorine to chloramines in 2002.

Chloramines are formed by carefully adding ammonia to water containing free chlorine. Chloramines have been safely and successfully used by water utilities for more than 90 years. Operational benefits of using chloramines include:

- Fewer disinfection byproducts— chloramines are not as reactive as chlorine, so it forms fewer regulated disinfection byproducts.
- Better protection against bacterial regrowth—chloramines are more stable and longer lasting than free chlorine, providing better protection against bacterial regrowth in distribution systems.
- Taste and odor—chloramines do not readily react with organic compounds, so many systems will experience fewer taste and odor complaints when using chloramines.
- Ease of use—chloramine technology is relatively easy to install and operate.

A potential drawback of the use of chloramines is nitrification. Nitrification results from the breakdown of chloramines and the release of free ammonia, which can become a food source for certain types of bacteria. Nitrification is controlled by optimizing the chloramination process, monitoring water quality in the distribution system to ensure early detection, and by switching to free chlorine as a secondary disinfectant periodically. We regularly monitor for nitrification and this has not been an issue in our distribution system to date.

Chloramines, like chlorine, can contribute to the breakdown of rubber components in private plumbing systems. Chloramines can react with certain types of rubber such as toilet flappers, hoses and gaskets, such as those on washing machines and hot water heaters. However, there are products available intended for use in chloraminated water, which are longer lasting. We are developing updated, detailed information on the appropriate replacement materials (commonly available at hardware and plumbing supply stores) that we will communicate to our customers via our website and newsletters.

Sources (listed oldest to newest):

Rockaway, T; G Willing; R Schreck; K Davis. 2007. Performance of Elastomeric Components in Contact with Potable Water. *American Water Works Association and US EPA*.

Larson, D. 2011. Understand Chloramine's Effect on Elastomer Components. *American Water Works Association Opflow*, 37(8): 10.

Dezincification:

Dezincification is the selective release of zinc from brass plumbing components. When these components undergo dezincification, a variety of practical consequences may occur, including blocked water lines, premature fixture failure, and leaks. Brass failures attributed to dezincification are known to occur at least occasionally all over the world and have recently emerged as a significant problem in the U.S. due to the use of inexpensive, high-zinc content brass fittings in cross-linked polyethylene (PEX) and other plumbing systems (Edwards 2011).

Brass dezincification problems have long been associated with specific alloy types (yellow, high-zinc brasses). For plumbing systems that contain these yellow, high-zinc brasses, aggressive water qualities have been identified which may initiate and support dezincification. These water qualities include, high chloride, low temporary hardness, alkalinity, and pH. Chloramines do not contribute to dezincification. Avoiding and mitigating dezincification failures is best accomplished by use of dezincification resistant (DZR) brass alloys (Edwards 2011).

In 2012, plumbing code standards were updated to require all brass used in potable plastic plumbing (e.g., PEX) to meet NSF-14 standards for dezincification resistance.

What is aggressive water?
Aggressive water is water that is more likely to corrode a material. However, different materials are sensitive to different water chemistry parameters. For example, the water chemistry that contributes to lead corrosion is different than the water chemistry that contributes to dezincification.

A high chloride to temporary hardness ratio is particularly aggressive with respect to brass dezincification. Temporary hardness refers to the ions that contribute to both alkalinity and hardness. Temporary hardness is removed by boiling the water, which encourages the formation of carbonate solids that precipitate out of solution leaving softer water behind. Early research did not differentiate between the role of alkalinity and hardness in dezincification potential. More recent research found that alkalinity contributes more to the aggressiveness of water with respect to dezincification potential than hardness.

Ranges of water parameters

- Chloride

High chloride is correlated with higher zinc release and higher dezincification. OWASA water has a low level of chloride, 14 mg L^{-1} (indicated by the red dot on the graph below). OWASA does not use any chloride based salts, such as ferric chloride, in our water treatment process.

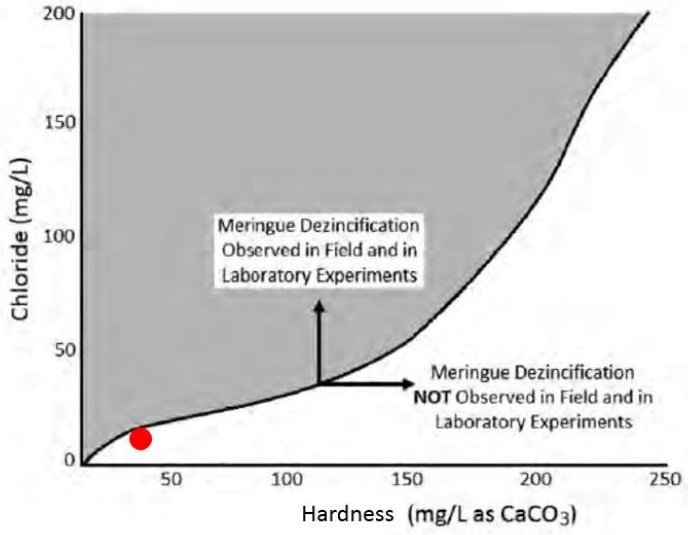


Figure from: Water Research Foundation. 2011. Copper Pitting and Brass Dezincification: Chemical and Physical Effects. Web Report 4289.

- Hardness
  Higher hardness is correlated with a very small decrease in dezincification. OWASA water has a hardness of 28 mg L^{-1} as $CaCO_3$. Water with a range of 0 to 60 mg L^{-1} as $CaCO_3$ is soft, 61 to 120 mg L^{-1} as $CaCO_3$ is moderately hard, 121 to 180 mg L^{-1} as $CaCO_3$ is hard, and greater than 181 mg L^{-1} as $CaCO_3$ is very hard.

- Alkalinity
  Higher alkalinity is correlated with lower zinc leaching and lower dezincification. OWASA water has alkalinity of 34 mg L^{-1} as $CaCO_3$ (indicated by the red circle on the graph below).

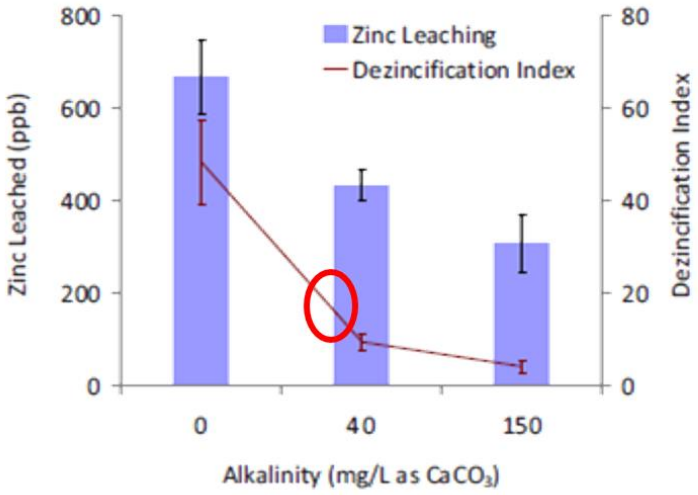


Figure from: Water Research Foundation. 2011. Copper Pitting and Brass Dezincification: Chemical and Physical Effects. Web Report 4289.

- pH
  Dezincification is greatest at a pH of 8.0. OWASA treated drinking water leaves the plant at pH 8.3 – 8.6 and pH rises in the distribution system with detention time. The average pH in our distribution system is 8.75. The pH range of water in our distribution system is indicated by the blue box in the graph below.

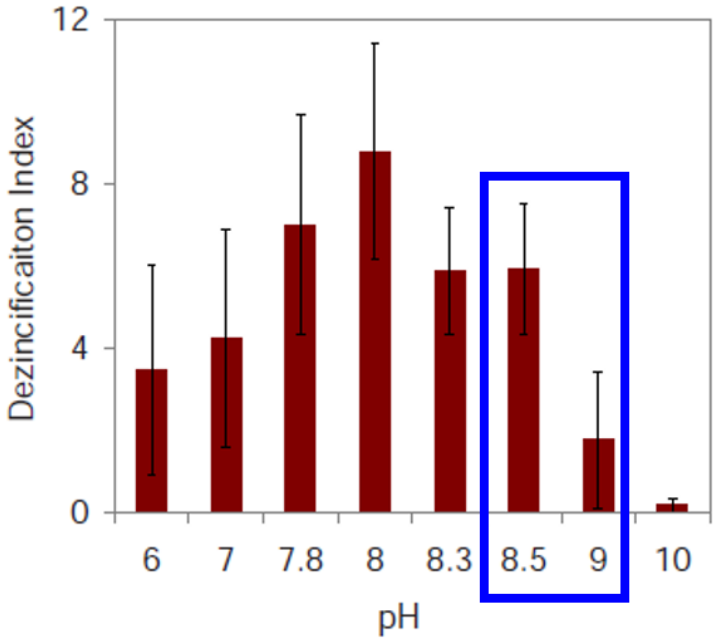


Figure from: Water Research Foundation. 2011. Copper Pitting and Brass Dezincification: Chemical and Physical Effects. Web Report 4289.

- Zinc
  There is no relationship between zinc concentration and dezincification.

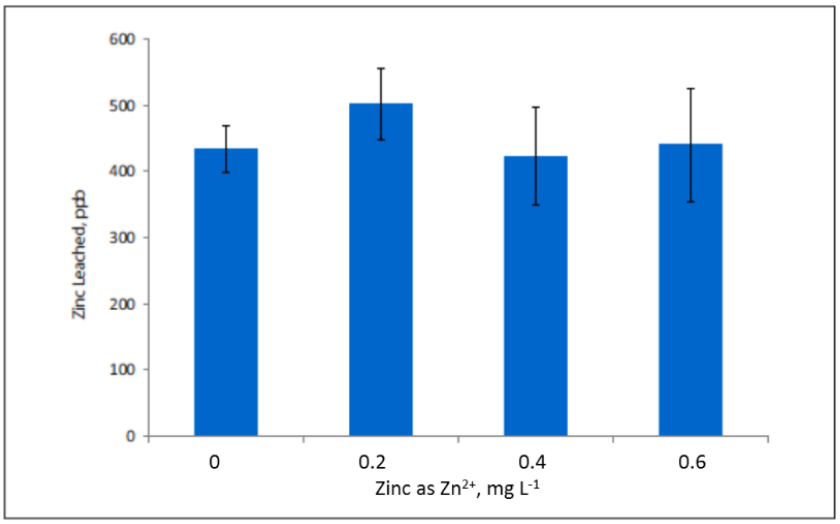


Figure from: Water Research Foundation. 2011. Copper Pitting and Brass Dezincification: Chemical and Physical Effects. Web Report 4289.

Recirculating Hot Water Heaters

Factors that contribute to dezincification

The majority of inquiries OWASA has received from our customers about dezincification have been from customers with recirculating hot water heaters. There are several physical factors that make hot water heaters, especially recirculating hot water heaters, more prone to dezincification. Heated water accelerates buildup of meringue (zinc oxide). Direct connection of different types of metal (e.g., steel or copper) to brass increases the potential for dezincification and these

connections are common in hot water heaters. Pipes containing stagnant or non-moving water connected to pipes containing circulating water are more prone to dezincification. When not in use, recirculating hot water heaters have incoming cold water and outgoing hot water pipes in which there is no flow connected to the circulating pipes.

Prevalence of use in OWASA service area

Unknown. The majority of inquiries OWASA has received about dezincification have been from customers who have recirculating hot water heaters.

Brass Fixture Pricing and Availability

A direct comparison of prices of dezincification resistant (DZR) brass to non-DZR brass is difficult because the plumbing code standard only specifies DZR requirements for brass fittings used in plastic plumbing (e.g., PEX). However, presented here are the range of prices for brass fittings used with PEX plumbing vs brass fittings not used with PEX plumbing. The price per item of PEX brass fittings, which should be DZR, is less than $10 and the majority cost less than $2 each, with some fittings costing $5 each. The price per item of brass fittings not intended for use with PEX plumbing, which do not have to be DZR, is in the range of $5-10 each.

Other Water Utilities

Lawsuits against manufacturers of brass fittings indicate that this is a widespread problem and not a regional issue.

In 1985, other countries were experiencing dezincification and the majority of the countries experiencing dezincification were using yellow brass (Jester, 1985). At the time, dezincification was generally not a problem in the US due to the use of red brass. Other countries have addressed dezincification issue through updated plumbing standards (see Sarver, 2010).

Survey Results

OWASA surveyed other utilities about their experience with dezincification in 2015. Eight utilities responded (Birmingham, AL; Columbia, SC; High Point, NC; Southern Nevada Water Authority, NV; Savannah, GA; Wilmington, NC; and Winston Salem, NC). Many utilities do not respond to or advise on internal plumbing issues and indicated they were unaware if this is an issue in their area. Only one utility, Southern Nevada Water Authority (SNWA), responded that they are aware of customers experiencing dezincification issues. There was a successful lawsuit against Kitec (a brass fitting manufacturer) in Clark County, NV. SNWA uses free chlorine as their secondary disinfectant, not chloramines.

Sources (listed oldest to newest):

Turner, M.E. 1961. The Influence of Water Composition on the Dezincification of Duplex Brass Fittings. In *Proceedings of the Society of Water Treatment and Examination.* pp.162-179.

Jester, Thomas C. 1985. Dezincification Update. *Journal AWWA*, 77(10):67-69.

Lytle, Darren A.; M Schock. 1996. Stagnation time, composition, pH, and orthophosphate effects on metal leaching from brass. *National Risk Management Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.*

Zhang, Y. 2009. Dezincification and Brass Lead Leaching in Premise Plumbing Systems: Effects of Alloy, Physical Conditions and Water Chemistry. *Virginia Polytechnic Institute and State University.*

Sarver, E.; Y Zhang; M. Edwards. 2010. Review of Brass Dezincification Corrosion in Potable Water Systems. *Corrosion Reviews*, 28(3-4):155-196.

Zhang, Y; M Edwards. 2011. Effects of pH, chloride, bicarbonate, and phosphate on brass dezincification. *Journal AWWA*, 103(4):90-102.

Zhang, Y; M Edwards. 2011. Zinc content in brass and its influence on lead leaching. *Journal AWWA*, 103(7):76-83.

McNaught, H; R Sarver, E; M Edwards. 2011. Controlling non-uniform copper and brass corrosion in building plumbing. *Materials Selection & Design*, 50(8):60-5.

Sarver, E; M Edwards; Y Zhang. 2011. Revisiting dezincification performance testing for brass plumbing devices. *Materials Selection & Design*, 50(8):70-5.

Sarver, E; Y Zhang; M Edwards. 2011. Copper Pitting and Brass Dezincification: Chemical and Physical Effects. *Water Research Foundation*, Web Report 4289.

Trenholm; D Claassen; C Scott; G Kodweis; BJ Vanderford; D Rexing; EC Wert. 2015. No-lead brass service valve performance in Colorado River water. *Journal AWWA*, 107(8): E416-E424.

Staff Recommendations

Our current water treatment practices are very effective in ensuring our customers have safe, high quality drinking water and we do not recommend making any changes at this time.

We will be taking additional measures to more fully inform and engage our customers and stakeholders about the safety and disinfection of our drinking water to include typical private plumbing system issues and remedies. These measures will include: developing a webpage, brochures, news releases, The Blue Thumb customer newsletter, and messages on bills. We will also engage directly with customers and other stakeholders (plumbers, realtors, town inspectors, and home inspectors) to fully understand their issues and to provide useful information and assistance.