Patient Water Qualities
in Healthcare Foodservice

By Dean Jarog M.S. CWS VI CFSP, Phil Rolchigo PhD,
David J. Swiderski CWS-VI

Executive Summary

The purpose of this document is to explain the optimal water quality characteristics for peak equipment performance and delivery of culinary-grade water to prepare the best tasting water-based products possible. Little is currently published with regard to relevant water standards or their effect on equipment and the overall patient experience. The U.S. Environmental Protection Agency (EPA) does define drinking water standards; however, in addition to these standards exists a host of water quality specifications targeted towards ideal equipment function and the preparation of the highest quality water-based products.

This paper will explain Everpure's findings regarding ideal patient water quality attributes, developed from over 75 years of investigation and close collaboration with equipment manufacturers and beverage providers, combined with detailed, in-depth knowledge of both water chemistry and its effect on the production and sale of beverages and ice. The starting point for the information enclosed assumes the following about the foodservice water source: that it is potable and microbiologically safe, and that it conforms to the EPA Primary and Secondary Drinking Water Standards. It also assumes that water quality is closely monitored on-site, with sufficient multi-barrier treatment at the facility level, as water supply quality continually changes at both municipal and facility points of origin. Also, more efficient equipment designs—those that offer greater energy and water savings—are now increasingly common, and these machines require better control of water qualities to function properly.

EVERPURE®

Approach

The ideal patient water quality attributes were developed by Everpure, a global leader in foodservice water treatment by working with leading industry manufacturers, companies, and related associations. During over 75 years of research development, piloting, laboratory testing and collaborative work with equipment machine vendors, foodservice experts, beverage companies, major chains and chemists, Everpure determined the patient water quality specifications included in this paper to be the most acceptable standards for optimal foodservice applications in healthcare. Everpure's ongoing internal laboratory and manufacturing site-based testing has added to its knowledge base over time. Written references also have been denoted and, should the reader choose to learn more, further reading on specific topics are contained in the reference area at the end of this document.

All specifications assume the water is microbiologically safe and complies with the EPA. Each specification for ideal patient water quality standards for Coffee, Ice, Fountain Beverages, Drinking Water, Steam and Warewashing have been derived from that starting point.

Introduction/Scope

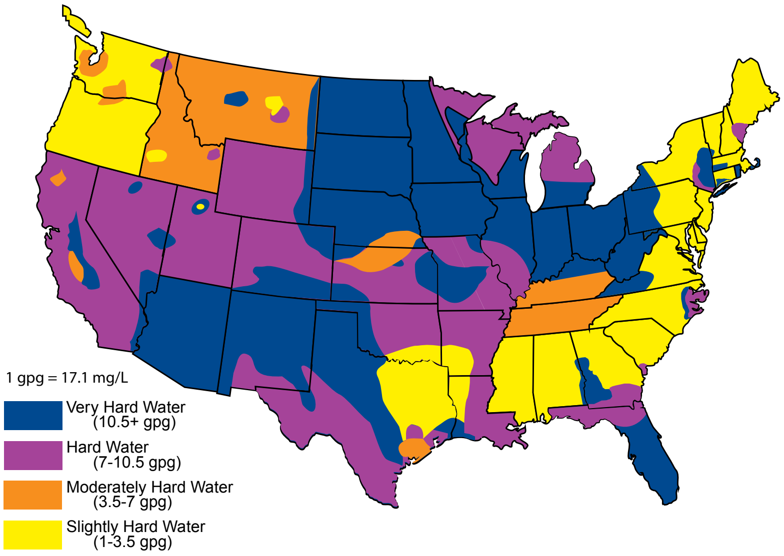
The Importance of Water Qualities in Foodservice
Water is one of the principal ingredients that influences taste, odor, form and aesthetic characteristics of many of the leading foodservice products sold.

Foodservice Product	Water Content
Coffee	99%
Tea	99%
Fountain Beverages	83%
Ice	100%
Steam	100%

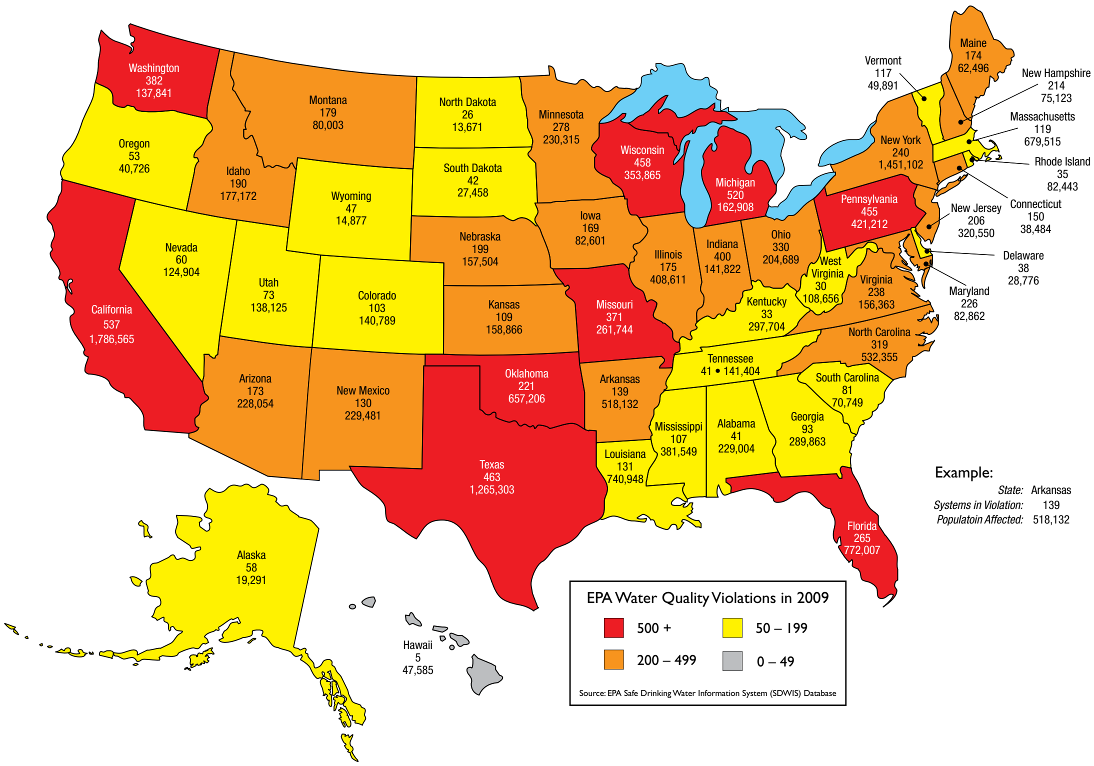
VARIANCES IN MUNICIPAL WATER
Water quality can vary greatly across regions, states and local communities, even in municipal water supplies. Further variation occurs when one takes private groundwater well sources and small municipal operators into consideration, which complicates this issue. While the United States generally has some of the best water quality in the world, as can be seen from the maps included in this document, even uniform EPA standards can vary for individual users across regions and states. Some notable variances may also occur within different localities with regard to compliance with EPA water quality standards.

Chloramine Challenges in the Foodservice Industry
In many U.S. communities, chloramines are now used as a disinfectant in municipal water supplies alongside other chemicals used in the water treatment process or for distribution. In the U.S., approximately 40% of municipalities use chloramines—a mixture of chlorine and ammonia—which poses further challenges to foodservice operators, ingredient water quality and equipment performance. Chloramines affect taste, odor, disinfection contact times and equipment much more than previous methods of disinfection. A municipality may add phosphates or alum, and other contaminants may be added at the local water treatment or facilities level, or occur due to corrosion and leaching from the water distribution network as a whole.

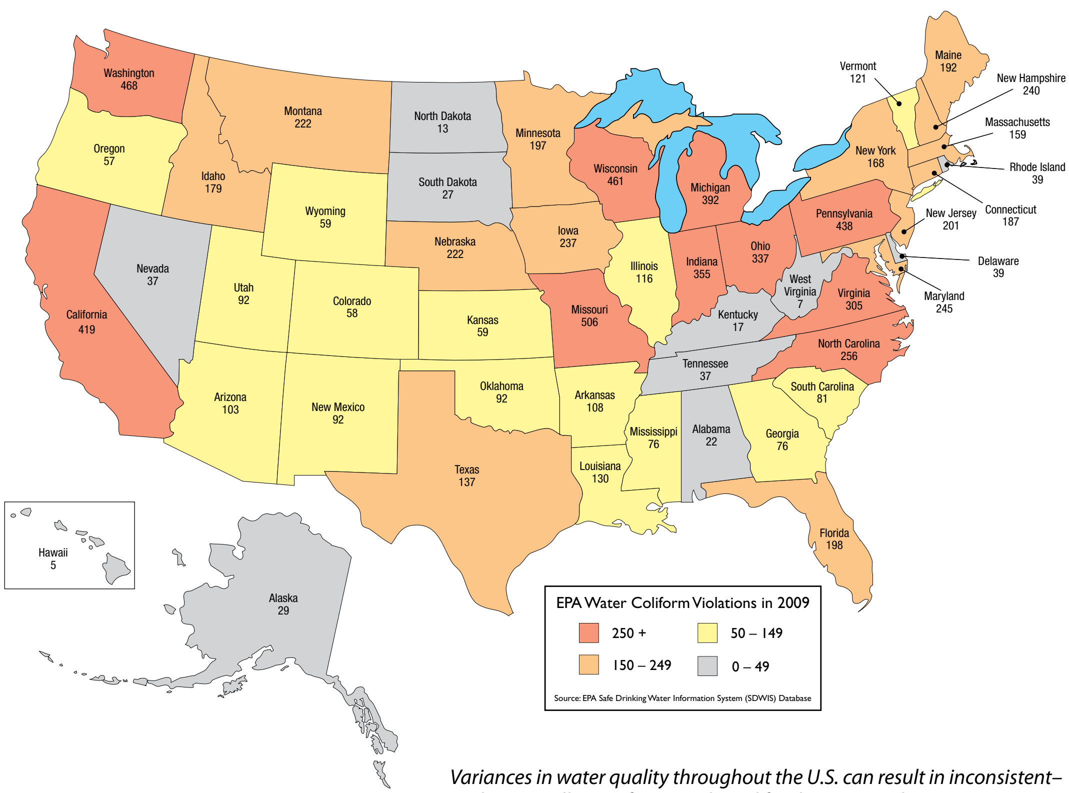
Concentration Of Hardness Expressed As Grains Per Gallon (GPG)



EPA Water Quality Violations in the U.S.



EPA Water Coliform Violations in the U.S.



Variances in water quality throughout the U.S. can result in inconsistent–and potentially unsafe–water-based foodservice products.

WATER ALTERATIONS AT THE FACILITY LEVEL

In foodservice locations that exist as part of a larger organization or facility, departments such as facilities management might be responsible for general water quality throughout the building, including foodservice areas. Facility-wide water treatment solutions might include ion exchange, which completely removes hardness and replaces it with sodium or potassium. Other possible treatments include copper/silver ionization, which adds copper and silver ions into the water, and disinfectant dosing that could add to the chemical composition of the water. Biofilms and corrosion in the municipal distribution system and at the facility level can further add variances in chemical composition and promote flora/fauna growth at individual points of use in a facility. Since water is the principal ingredient of many of available foodservice products, it is important for industry professionals to understand that general water quality characteristics for a building might be deficient versus ideal patient water quality standards for the production and delivery of various foodservice products.

Example: Additional Sodium in Patients' Water/Diets?

Many healthcare foodservice professionals are tasked with accounting for total sodium intake in milligrams on their menus. It is critical that we understand both source water quality and on-site water treatment processes impact sodium levels to properly account for total dietary intake. In a common water softening process, all hardness levels are exchanged with sodium. Therefore, meals might be tightly controlled for sodium, but beverages, ice, sauces and other water-based products could contain additional sodium content.

In water treatment analysis hardness is generally expressed as parts per million (ppm), which is actually the same as milligrams per liter (mg/L). If hardness originally measured 150 ppm and a softener employing sodium chloride was used to regenerate it, the total sodium content would be 150 mg/L of water consumed. And thus, could potentially add 0.375 grams of sodium to the diet of a person drinking 2.5 liters of water per day. Alternatives might include switching to potassium chloride to regenerate the softener (changing the sodium content to 150mg/L of potassium), developing a central reverse osmosis looped treatment system for the foodservice area, or isolating drinking water for foodservice lines only to avoid the softened water circuit altogether. Sodium is merely one example of an added contaminant that routinely appears in local water treatment processes or during additional water treatment at the facility level.

History of Culinary Water Standards

Early Foodservice Water Treatment

Everpure understood early on that certain water contaminants—including disinfection products added to municipal water supplies—had adverse effects on foodservice equipment performance. As a result, it began working collaboratively with premier equipment manufacturers as early as 75 years ago to address related concerns. The effects of these contaminants are the same as often experienced at home, such as coffee pot scaling, pitting of metal components, staining of utensils, leaking seals and gaskets, and stains in sinks. Many of the first solutions Everpure introduced into the foodservice market addressed problems associated with equipment function and maintenance.

Through the years, more industry focus on and data regarding the importance of water quality in foodservice emerged, concentrating on aesthetic differences that affected tastes and delivery of final products. Some of the major developments that drove this consciousness was the emergence of large-scale foodservice chains and bottlers with point-of-use dispensing equipment, who were looking for beverage uniformity and consistency across multiple regions within the U.S. and Canada. These remain major chain priorities today, and the recent rise of large coffee chains and specialty beverage offerings has resulted in increasing expectations among consumers for the highest quality and consistent taste in their beverages and the ice that often accompanies them.

Early to Late 1990s

Another notable development that increased public water quality awareness the 1993 outbreak of Cryptosporidium in Milwaukee, where approximately 403,000 people were contaminated and over 100 people died. In response, a host of water treatment options with NSF Standard 53 certification for cysts reduction were deployed to address the need for cyst protection in the foodservice market. This incident also brought about a deeper understanding of the impact of potential infection-related contaminants in municipal water on water-based products. A series of research studies have since been conducted across different geographical regions to investigate this issue further. One such study found that, in general community populations, evidence showed up to a 35% reduction in gastrointestinal (GI) symptoms among individuals using bacteria-reducing water treatment devices compared to people drinking municipal water treated to current quality standards. (14)

A growing amount of research and investigation regarding the role biofilms play in water distribution networks and facility water supplies has also emerged. This research explains that opportunistic pathogens and antibiotic-resistant or disinfectant-resistant bacteria are to be found in biofilms. (20)

While normal populations may experience fewer GI issues and health effects, there are segments of the population that greatly benefit from further protection from water contamination, such as pregnant women, the elderly, immunocompromised and the temporarily immunocompromised (due to procedures in healthcare)—segments that could be dramatically affected by even low levels of possible infection. These population segments are more highly concentrated in healthcare facilities than the general public, making water monitoring in such operations even more critical.

Another study, conducted in 1998, researched the timeliness of public boil alerts. It identifed that 56% of the canvassed population drank unboiled water after contamination occurred to the water supply, *before* a boil water notice was given. (21) Many water tests commonly take up to 72 hours to positively confirm potential water problems, and municipalities must weigh a complex amount of information to determine when alerts might be warranted/issued. (22)

Late 1990s to Present

From the late 1990s until present day, a growing consciousness around water quality and energy conservation has driven industry equipment makers to require more stringent control of water chemistries to ensure proper equipment function. Boilerless equipment, as well as low-flow equipment with finer nozzles and less waste generation, have driven the need for better water quality. In addressing those new equipment specifications, the market has reaped significant energy savings and improved water usage (less waste).

Backlash against bottled water and its environmental impact is another significant cultural development that's led more facilities to attempt replicating bottled water quality "on tap" with dispensers, refillable non-BPA containers, and increased point-of-use filtration. This practice is also highlighted in the *President's Cancer Panel Report of 2008-2009*. (12)

Another dynamic that has emerged within the past few years is the increasing public awareness of pesticides, weed killer (herbicides), endocrine disruptors and pharmaceuticals presence in water supplies, as well as the problems created by existing and changing disinfection byproducts in most water sources. The aforementioned were recently highlighted in the P*resident's Cancer Panel Report,* released in April 2010, where point-of-use NSF listed filtration is recommended to address these contaminants. Such contaminants are of growing concern to the public and likely to affect the development of future water quality standards. (12)

In addition, a growing amount of literature and research studies are starting to accumulate around the role of biofilms in distribution networks and hospital buildings, along with studies showing lower GI issues among general populations and the elderly when water treatment devices are used to address bacteria. (17)

Today, more public attention is also now paid to various dissolved contaminants, disinfection products and waterborne diseases. In a press release dated July 14, 2010, the Centers for Disease Control (CDC) reported that "Hospitalizations for three waterborne diseases cost the healthcare systems as much as $539 million annually." The best way to address these concerns is by applying multi-barrier approaches to water circuits, coupled with routine monitoring. This can be accomplished using point-of-use filtration products, which have been shown to help as a key piece of a larger total solution of multi-barrier water treatment systems. (18)

The role of water qualities in healthcare foodservice, and the available water treatment options for controlling water supplies to meet exacting patient water quality standards, have increased dramatically in the past 75 years. And, over that time, Everpure has designed and released a host of solutions to address most concerns. Everpure continues to improve upon existing and develop newly-refined solutions to control the quality of patient water, a key ingredient for foodservice professionals in the healthcare industry.

Coffee and Espresso

EVERPURE

Attribute	Specification ©2011
Turbidity	Must not exceed 0.5 nephelometric turbidity units
Taste/Odor	Free from tastes and odors
Total Chlorine or Chloramines	Less than 0.05 ppm (mg/L)
Iron/Copper	Must not exceed 0.25 ppm (mg/L)
Total Alkalinity	Must not exceed 100 ppm (mg/L)
Total Hardness	17-85 ppm (mg/L)
Sodium Potassium	Less than 50 ppm (mg/L)
Total Dissolved Solids	70-200 ppm (mg/L)
pH	6.8-7.4

Everpure **www.everpure.com**

Water Attributes and Effects:

- **Turbidity** – Dirt, Microbes, Silt, Sand, Metals, etc.
  a) Causes abrasion and clogging of brewing equipment
  b) Adds to scale formation, decreasing efficiency
- **Taste**
  a) Chlorine – Medicinal taste
  b) Iron – Metallic taste
- **Odor**
  a) Chlorine – Medicinal odor
  b) Hydrogen sulfide – Rotten egg odor
  c) Chloramines/Ammonia – Ammonia odor
  d) Tannins (decaying plant vegetation) – Sewer-like odor
- **Chlorine or Chloramines** – Less than 0.05 ppm
  a) Oxidizes coffee aromatics, flavor compounds and oils, negatively affecting flavor
  b) Alters pH balance, affecting flavor
  c) Adds chemical off-taste
  d) Swells equipment gaskets
  e) Corrosive to metals – Adds color/stain
- **Iron/Copper** – Must not exceed 0.25 ppm
  a) Reacts with coffee phenolics to form green coloration
    - Creamer addition increases green coloration
  b) High levels can produce a metallic taste
- **Total Alkalinity** – Must not exceed 100 ppm
  a) Slows flow through coffee grounds
  b) Adds bitterness and/or astringency
- **Total Hardness** – 17-85 ppm
  a) Combines with carbonates, sulfates, and silicates to indirectly affect flavor – Causes bitter/sour taste
  b) Causes scaling
    - Scale serves as an insulator and prevents efficient heating of water
    - Scale blocks inlet and outlet ports, reducing flow and energy efficiency
  c) Thermostatic
    - Leads to equipment relay failure
  d) Changes contact times
  e) Changes extraction rate
- **Sodium/Potassium** – Less than 50 ppm
  a) High concentrations
    - Sodium – Sour taste
    - Potassium – Bitter taste
  b) Low concentrations
    - Sweet taste
- **Total Dissolved Solids** – 70-200 ppm
  a) High levels
    - Increases acidity
    - Heavy brew
    - Off-odors
  b) Low levels
    - Light brew
    - Tart taste
- **pH** – 6.8-7.4
  a) High levels – Bitter taste
  b) Low levels – Sour taste

IDEAL PATIENT QUALITY WATER ATTRIBUTES:

Fountain Beverages and Drinking Water

EVERPURE

Attribute	Specification ©2011
Turbidity	Must not exceed 0.5 nephelometric turbidity units
Cysts/Bacteria	≤ 0.15 micron filtration or NSF P231 protocol recommended
Taste/Odor	Free from tastes and odors
Total Chlorine or Chloramines	Less than 0.05 ppm (mg/L)
Iron	Must not exceed 0.3 ppm (mg/L)
Sodium/Potassium	Less than 50 ppm (mg/L)
Total Alkalinity	Must not exceed 150 ppm (mg/L)
Total Hardness	Must not exceed 100 ppm (mg/L)
Total Dissolved Solids	Must not exceed 500 ppm (mg/L)
Sulfates	Must not exceed 250 ppm (mg/L)
Chlorides	Must not exceed 250 ppm (mg/L)
pH	6.5-8.5

Everpure **www.everpure.com**

Water Attributes and Effects:

- **Turbidity** – Dirt, Microbes, Silt, Sand, Metals, etc.
  a) Causes abrasion and clogging of fountain equipment
  b) Reduces effectiveness of disinfectants
  c) Adds to decarbonating soft drinks
  d) Cysts/bacteria in product create health and liability issues
- **Taste**
  a) Chlorine/Chloramines – Medicinal taste
  b) Manganese – Metallic taste
  c) Hydrogen sulfide – Sour taste
- **Odor**
  a) Chlorine – Medicinal odor
  b) Hydrogen sulfide – Rotten egg odor
  c) Ammonia – Ammonia odor
  d) Tannins (decaying plant vegetation) – Sewer-type odor
- **Chlorine or Chloramines** – Less than 0.05 ppm
  a) Added chemical off-taste
  b) Equipment gaskets and seals swell
  c) Corrosive to metals – Adds color/stains
- **Iron** – Must not exceed 0.3 ppm
  a) Metallic taste
  b) Adds off-color to non-carbonate drinks
- **Total Hardness** – Must not exceed 100 ppm / **Alkalinity** – Must not exceed 150 ppm
  a) High levels
    - Reduces carbonation, producing flat and foamy drinks
    - Produces off-tasting drinks
    - Causes scale buildup on fountain equipment
  b) Low Hardness/Alkalinity
    - Carbonation inefficiencies
- **Total Dissolved Solids** – Must not exceed 500 ppm
  a) High levels
    - Reduces carbonation
  b) Low levels
    - Corrodes equipment
    - Adds metals to drinks, yielding metallic taste
- **Sulfates** – Must not exceed 250 ppm
  a) High levels
    - Medicinal/bitter taste
    - Laxative effect
    - Foaming drinks
  b) Low levels
    - No issues, unless related to low TDS
- **Chlorides** – Must not exceed 250 ppm
  a) High levels
    - Creates salty drinks
    - Corrodes equipment
  b) Low levels
    - No issues, unless related to low TDS
- **Sodium**
  a) High levels
    - Salty and/or bitter drinks
    - Corrodes equipment
    - Causes foaming of drinks
  b) Low levels
    - No issues, unless related to low TDS
- **pH** – 6.5-8.5
  a) High or low levels
    - Corrodes equipment
    - Releases metals that add metallic taste and cause health concerns

Ice*

EVERPURE

Attribute	Specification ©2011
Turbidity	Must not exceed 0.5 nephelometric turbidity units
Cysts/bacteria	≤ 0.15 micron filtration or NSF P231 protocol recommended
Taste/Odor	Free from tastes and odors
Total Chlorine or Chloramines	Less than 0.05 ppm (mg/L)
Iron	Must not exceed 0.25 ppm (mg/L)
Sodium/Potassium	Less than 50 ppm (mg/L)
Chloride	Less than 100 ppm (mg/L)
Total Alkalinity	Less than 150 ppm (mg/L)
Total Hardness	17-85 ppm (mg/L)
Total Dissolved Solids	70-200 ppm (mg/L)
pH	6.8-7.4

Everpure **www.everpure.com**

** Properties may apply to flake ice machines (F), cube ice machines (C) or both (B).*

Water Attributes and Effects:

- **Turbidity** – Dirt, Microbes, Silt, Sand, Metals, etc.
  - a) Large particles are abrasive, causing scratching or scoring metal inside ice machine (B)
  - b) Particles clog small orifices in float, solenoid assembly (B) and distribution tubes (C)
  - c) Cloudy, dirty ice due to particulate matter (F)
  - d) Mineral scale volume is increased by small particulate matter (B)
- **Cysts/Bacteria**
  - a) Water distribution biofilms or municipal supplies may contain cysts/bacteria that will be introduced into product, creating health and liability issues (B)
- **Taste**
  - a) Chlorine and chloramines – Medicinal taste (B)
  - b) Manganese – Metallic taste (B)
  - c) Hydrogen sulfide – Sour taste (B)
- **Odor**
  - a) Chlorine – Medicinal odor (B)
  - b) Hydrogen sulfide – Rotten egg odor (B)
  - c) Ammonia – Ammonia odor (B)
  - d) Tannins (decaying plant vegetation) – Sewer-type odor (B)
- **Chlorine and Chloramines** – Less than 0.05 ppm
  - a) Adds chemical off-taste (B)
  - b) Swells equipment gaskets and seals, causing leaks and equipment malfunctions (B)
  - c) Corrosive to metals
    - Forms mild acid vapors inside ice machine (B)
    - Adds color/stains (B)
- **Iron** – Must not exceed 0.25 ppm
  - a) Adds metallic taste (B)
  - b) Discoloration of ice (B)
- **Chloride** – Less than100 ppm
  - a) High levels
    - Salty and/or soft ice
    - Corrodes equipment
  - b) Low levels
    - No issues, unless related to low TDS
- **Sodium** – Less than 50 ppm
  - a) High levels
    - Salty and/or soft ice
    - Corrodes equipment
  - b) Low levels
    - No issues, unless related to low TDS
- **Total Hardness** – 17-85 ppm/ **Alkalinity** – Less than 150 ppm
  - a) High levels
    - Reduces efficiency of unit (B)
    - Reduces flow through float, solenoid, pump and distribution tubes (C)
    - Scale deposits on evaporator can score metal surfaces (B)
    - Continued scaling requires too-frequent acid cleaning (C)
    - Scale buildup can cause auger damage (F)
    - Continued scale buildup causes auger misalignment and bearing stresses, leading to premature failure (F)
  - b) Low levels
    - Corrodes equipment
    - Adds metallic taste
- **Total Dissolved Solids** – 70-200 ppm
  - a) High levels
    - Soft ice
    - See: Hardness, High levels; Sodium, High levels; Chloride, High levels
  - b) Low levels
    - Corrodes equipment
    - Adds metallic taste
    - Hardens ice, making it non-chewable
- **pH** – 6.8-7.4
  - a) High or low levels
    - Corrodes equipment
    - Releases metals that add metallic taste, as well as cause health concerns

IDEAL PATIENT QUALITY WATER ATTRIBUTES:

Steam and Warewashing

EVERPURE

Attribute	Specification ©2011
Turbidity	Must not exceed 0.5 nephelometric turbidity units
Total Chlorine or Chloramines	Less than 0 ppm (mg/L)
Chloride	Less than 30 ppm (mg/L)*
Sulfates	Less than 40 ppm (mg/L)*
Iron/Copper	Less than 0.1 ppm (mg/L)
Total Alkalinity	Less than 80 ppm (mg/L)*
Total Hardness	Less than 35 ppm (mg/L)*
Total Dissolved Solids	Less than 150 ppm (mg/L)*
pH	6.5-7.8

Everpure **www.everpure.com**

** NOTE: Boilerless, combi-type steamers require these values or less to protect the cooking compartment.*

Water Attributes and Effects:

- **Turbidity** – Dirt, Microbes, Silt, Sand, Metals, etc.
  - a) Particles serve as seed crystals and accelerate scaling
  - b) Forms scale that contains a high percentage of particulate matter
  - c) High levels lead to foaming
- **Chlorine or Chloramines** – 0 ppm
  - a) Corrosive to metals – Adds color/stains
  - b) Forms hydrochloric acid upon heating
    - Vaporization then leads to corrosion
- **Iron/Copper** – Less than 0.1 ppm
  - a) High levels
    - Causes sludge buildup in boiler-based units
    - Stains interiors of boilerless steamers
- **Total Hardness** – Less than 35 ppm*/**Alkalinity** – Less than 80 ppm*
  - a) High levels
    - Scale buildup in and on equipment
    - Scale buildup insulates heat exchangers, reducing efficiency
  - b) Low levels
    - Foaming
  - c) Extremely low levels
    - Corrodes equipment
- **Total Dissolved Solids** – Less than 150 ppm*
  - a) High levels
    - See: Hardness - High levels
  - b) Extremely low levels
    - See: Hardness - Low levels
- **Chloride (Boilerless Steamers)** – Less than 30 ppm
  - a) High levels
    - Corrodes equipment
    - Accelerates stainless steel corrosion and pitting
  - b) Low levels
    - No issues
- **Sulfates** – Less than 40 ppm*
  - a) High levels
    - See: Hardness - High levels
  - b) Low levels
    - No issues, unless related to low TDS
- **pH** – 6.5-7.8
  - a) High levels
    - Leads to excessive foaming in boiler-based units
    - Caustic, attacking metal surfaces
  - b) Low levels
    - Corrodes metal surfaces

SUMMARY

While a tremendous amount of research and insight about water quality has been published in the water treatment industry, much of this information not easily accessible. Therefore, it is still quite common for most healthcare foodservice professionals to have concerns and questions related to patient-quality water and the making of water-based products. Patient-quality water is one of the main ingredients affecting products on foodservice professionals' menus and the performance of their capital equipment. The purpose of this whitepaper is to provide foodservice professionals with a practical means of evaluating their patient water and to inform them about ideal patient water qualities, the goal being to enable them to offer the highest quality products on their menus and maximize capital equipment life and performance. The information presented in this whitepaper not only highlights how patient-quality water is critically important to ensuring the best customer experience possible, but also demonstrates how proper water quality management can help protect equipment investments and reduce related operating costs.

REFERENCES:

1. Steen, David P. *Carbonated Soft Drinks: Formulation and Manufacture*. 2006.
2. Chapter Ice Makers. *The ASHRAE Refrigeration Handbook*. 2010.
3. Lingle, Ted R. *The Coffee Brewing Handbook, First Edition*. 1996.
4. Beeman, David. *Specialty Coffee Association of America Handbook Series Water Quality*. 2010.
5. *NEWS for Air-conditioning, Heating and Refrigeration*.
6. Leach, David. *The Water Factor in Ice Machines*. 2001.
7. Fayne, Colin. *Boiler Water Treatment, Principles and Practices, Vol. 1 and Vol. 2*.
8. Flynn, Daniel. *The Nalco Water Handbook, Third Edition*. 2009.
9. Centers for Disease Control (CDC). *A Guide to Water Filters*. http://www.cdc.gov/crypto/gen_info/filters.html#filter_table
10. Environmental Protection Agency (EPA). *National Primary Drinking Water Regulations*. http://water.epa.gov/drink/contaminants/upload/mcl-2.pdf
11. Centers for Disease Control. *Waterborne Diseases Could Cost over $500 Million Annually in U.S.* July 14, 2010.
12. U.S. Department of Health and Human Services. *President's Cancer Panel Report 2008-2009*. April 2010.
13. Hall, J., Hodgson, G. and Kerr, K. "Provision of Safe Potable Water for Immunocompromised Patients in Hospital." *Journal of Hospital Infection*. Volume 58, Issue 2. 155-158.
14. Payment, Pierre; Richardson, Lesley; Siemiatycki, Jack; Dewar, Ron; Edwardes, Michael; and Franco, Eduardo. "A Randomized Trial to Evaluate the Risk of Gastrointestinal Disease Due to Consumption of Drinking Water Meeting Current Microbiological Standards." *American Journal of Public Health*. 1991. 81: 703-708.
15. Angelbeck, Judy A., Ortolano, Girolamo A., Canonica, Francis P. and Cervia, Joseph S. "Hospital Water: A Source of Concern for Infections." *Managing Infection Control*. 2006. 6 (1): 44-54.
16. Reynolds, Kelly A. "Increased Risks in the Elderly from Tap Water Consumption." *Water Conditioning & Purification*. December 2009.
17. Colford Jr., John M.; Hilton, Joan F.; Wright, Catherine C.; Arnold, Benjamin F.; Saha, Sona; Wade, Timothy J.; Scott, James; and Eisenberg, Joseph N.S. "The Sonoma Water Evaluation Trial: A Randomized Drinking Water Intervention Trial to Reduce Gastrointestinal Illness in Older Adults." *American Journal of Public Health*. November 2009. Vol. 99, No. 11.
18. Sheffer, P.J. et al. "Efficacy of New Point-of-Use Water Filter for Preventing Exposure of Legionella and Waterborne Bacteria." *American Journal of Infection Control*, 2005. 33 (5) S20-S25.
19. Anderson, Roger L.; Bland, Lee A.; Favero, Martin S.; McNeil, Michael M.; Davis, Barry J.; Mackel, Donald C.; and Gravelle, Clifton R. "Factors Associated with Pseudomonas Picketti Intrinsic Contamination of Commercial Respiratory Therapy Solutions Marketed as Sterile." *Applied and Environmental Microbiology*. December 1985. 1343-1348.
20. Environmental Protection Agency. *Seminar Publication: Control of Biofilm Growing in Drinking Water Distribution Systems*. EPA/625/R-92/001. June 1992.
21. O'Donnell, M.; Platt, C.; and Aston, R. "Effect of a Boil Water Notice on Behavior in the Management of a Water Contamination Incident." *Communicable Disease and Public Health*. March 2000. Volume 3, Issue 1. 56-58.
22. Wagner, Michael M.; Wallstrom, Garrick L.; and Onisko, Agnieska. *Issue a Boil-Water Advisory or Wait for Definitive Information? A Decision Analysis*. AMIA 2005 Symposium Proceedings. RODS Laboratory, Center for Biomedical Informatics, University of Pittsburgh.

EVERPURE®

Pentair Filtration Solutions, LLC • 1040 Muirfield Drive • Hanover Park, Illinois 60133-5468
Phone: 630-307-3000 • Fax: 630-307-3030 • Toll Free: 800-942-1153 • Email: CSeverpure@pentair.com • www.everpure.com