



Case Study: Philadelphia Tracks Customer Perceptions to Confirm Its Taste-and-Odor Practices – 01/06/2006

The Issue

Over the past three decades, the Philadelphia Water Department has devoted considerable attention to the aesthetics of its tap water. In the 1970s the utility switched from a chlorine residual to chloramine, in part to alleviate customer complaints about taste-and-odor issues that developed as finished water traveled to the tap through its extensive distribution system.

During the 1980s the utility adopted Flavor Profile Analysis to assess and document the baseline qualities of its tap water. This helped the utility understand cause and effect when altering its water treatment strategy to address aesthetic issues. The utility had learned how to provide a consistent, less noticeable residual (predominantly monochloramine), measured as "total chlorine." Though customer complaints no longer focused on chlorine-related matters, geosmin concentrations from the source water occasionally spiked, leading to episodic taste-and-odor problems.

In practical terms, achieving total removal of geosmin is not feasible, but lowering its concentration to a level where its flavor is masked by a chlorine or chloramine residual has proved an effective strategy. In addressing the issue, the utility revised its treatment goals and adjusted its use of powdered activated carbon (PAC). Water Research Foundation research reports were useful in this regard; Philadelphia Water consulted *Advances in Taste and Odor Treatment and Control* (order # 90610), published in 1995, and its companion volume, *Identification and Treatment of Tastes and Odors in Drinking Water* (order # 90518), published in 1987. And the utility participated in the Foundation study *Optimization of Powdered Activated Carbon Application for Geosmin and MIB Removal* (order # 90782), published in 2000, in order to learn how to select the best PAC for its situation.

On its own, Philadelphia Water had determined the efficacy of switching to chloramine and fine-tuned its practices to provide a consistent, daily residual throughout its distribution system. It had developed a baseline for its water's aesthetic qualities. It was able to analyze complaints, and respond confidently to local or episodic taste-and-odor problems through well-tested protocols.

In this scenario of self-assessment and corrective action, one variable remained elusive: Philadelphia Water did not have a full understanding of the public's perception of the chloramine residual. In the 1980s the utility's Flavor Profile Analysis work had showed: a) it took more chloramine than chlorine to produce a noticeable flavor in the water, and b) typical fluctuations in the chloramine residual should not be detected by most customers.

For the utility to continue to evolve in its approach to self-assessment and corrective action, however, it needed to better understand specific issues relating to chloramine use, as well as the more general context of consumer perceptions of tastes and odors relevant to the drinking water industry.

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The Solution

To better understand consumer perceptions and the factors affecting them, Philadelphia Water participated in two Foundation studies, one on customer perceptions of tap water, bottled water, and filtration devices and the other on public sensitivity to, and perceptions of, tap water chlorinous flavor. The utility would use the results to ensure it understood the nature of its public's sensitivity to and perception of its chloramine residual and, therefore, hone its understanding of customer perceptions and attitudes on aesthetic issues. These insights could aid the utility's ongoing review of its own practices and, conceivably, might inspire changes in the utility's treatment approach.

The two Foundation studies have both been published:

- *Customer Perceptions of Tap Water, Bottled Water, and Filtration Devices* (order # 90944F) 2003
- *Public Perception of Tap Water Chlorinous Flavor* (order # 90980F) 2004

Customer Perceptions of Tap Water, Bottled Water, and Filtration Devices (order # 90944F), published in 2003, found that most consumers were satisfied with their tap water, although the perception of an "off" flavor (chlorinous or otherwise) significantly decreased consumer satisfaction. Decreased satisfaction was often associated with a perception of tap water unhealthiness and lack of safety. ("Chlorinous" was the most commonly cited "off" flavor, though the term was likely erroneously applied to other off flavors.)

Public Perception of Tap Water Chlorinous Flavor (order # 90980F), published in 2004, also included Philadelphia Water in its surveys of U.S. consumers' sensitivity to chloramine. The threshold of average U.S. consumer sensitivity to monochloramine was determined to be 3.7 milligrams per liter (mg/L) – seven times the threshold previously reported in the scientific literature. Only 15 percent of the tasting group had a threshold sensitivity below 2.5 mg/L. Because Philadelphia Water maintains a chloramine residual at about 2.0 mg/L, it could conclude that most of its consumers were insensitive to monochloramine in their tap water under the conditions typical of tap water consumption in their homes. This is important to customer satisfaction in the Philadelphia market because, in this study, only one-third to one-half of respondents (depending on the market) thought it safe to drink water that has a chlorinous flavor.

These study results helped confirm that Philadelphia Water had a solid grasp of its customers' perceptions of local tap water, and that the utility's practices were in line with known parameters affecting their customers' satisfaction with local tap water.

Today, Philadelphia Water's goal is to maintain about 2.0 mg/L chloramine residual where the finished water enters the distribution system. The utility's three water treatment plants try to keep the residual from dropping below 1.5 mg/L or exceeding 2.7 mg/L. Within the distribution system itself, the goal is to maintain the residual at or above 1.0 mg/L and to take corrective action when it drops below 0.5 mg/L. Reasons for minimizing the goal include long-term control of disinfection by-products, the concerns of sensitive customers (such as dialysis patients), and cost savings in treatment chemicals. The strongest reason for maintaining the goal at 2.0 mg/L is to prevent the die-off of chloramine residual in the distribution system in the summer and the occurrence of biological nitrification.

Under the U.S. Environmental Protection Agency's Surface Water Treatment Rule (SWTR) the residual must be detectable and should not exceed 4.0 mg/L over a period of time. The chloramine residual has helped Philadelphia

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Water meet the USEPA's Stage 1 Disinfectant/Disinfectant By-Products Rule (D/DBPR) "80/60" requirements. The "80/60" requirement means that, based on running annual averages, utilities should not exceed maximum contaminant levels (MCLs) of 80 micrograms per liter ($\mu\text{g/L}$) for total trihalomethanes (TTHMs) and 60 $\mu\text{g/L}$ for five haloacetic acids (HAA 5).

Yet there are good reasons to maximize the residual as well, because the loss of an effective chloramine residual (concentrations below 0.5 mg/L) can lead to nitrification (the formation of nitrate and nitrite from ammonia) in the distribution system, particularly in summer when temperatures are warmer. Philadelphia Water has relied on Foundation reports for insights on chloramine and nitrification: *Guidance Manual for Monitoring Distribution System Water Quality* (order # 90882), published in 2002, and *Maintaining Water Quality in Finished Water Storage Facilities* (order # 90763), published in 1999.

Philadelphia Water's history of work in this area enabled the utility to participate in a third study, *Water Utility Self-Assessment for the Management of Aesthetic Issues* (order # 90978F), published in 2004. The project assembled state-of-science and practical guidance from utilities that had solved taste-and-odor problems and from previous Foundation studies on aesthetics. The report's self-assessment guide helps utilities understand how well they're doing. The second component, a CD-ROM, is a diagnostic tool that uses a decision-tree format to help managers diagnose the probable causes of aesthetic problems and lead them to answers and further resources.

Lessons Learned

Consumers can provide useful, real-time data on drinking water-related concerns, especially when the utility has a system for handling customer complaints with several key elements: system supervision, single point of contact, customer education efforts encouraging them to report problems, procedures for handling complaints, and a database for this information. Such a system can help track and analyze taste-and-odor problems, among other issues. Understanding how your customers perceive the aesthetic qualities of their tap water can aid in solving taste-and-odor problems.

Educating stakeholders about your utility's practices and the rationale behind them, Philadelphia Water officials say, provides an advantage when defending your practices or proposing new ones, particularly if you can establish that you're delivering better water quality than in the past.

When Philadelphia Water conducted its in-house Flavor Profile Analysis, it invited local media to observe – sending the message that the utility took its customers' preferences and perceptions seriously.

The results also convinced Philadelphia Water that it could benefit from direct communication with the public about the benefits of a chloramine residual in tap water so that when it was detected, it would be associated with healthy, safe water.

One surprise result of the Foundation survey projects: Philadelphia 's customers are not making a pronounced shift to bottled water, an issue that affects a significant number of other U.S. markets, particularly in coastal markets and among younger consumers.

Finally, the evolving view that distribution systems and the water that passes through them create a dynamic system with complex chemical and biological interactions underscores the need for constant vigilance. Therefore, Philadelphia Water keeps abreast of Water Research Foundation research on distribution systems in four areas: nitrification, biofilm control, corrosion control, and the occurrence of *Legionella*.

Utility Profile

Utility name: Philadelphia Water Department

Service area: Serves the City of Philadelphia and provides some water to adjacent townships. Over 3,300 miles of pipe and about 475,000 service connections in a city of about 1.5 million people.

Size of utility: 270 million gallons per day (mgd) from three treatment plants

Source water: surface water from the Delaware and Schuylkill rivers

Basic treatment scheme: presedimentation, coagulation, flocculation and sedimentation, rapid dual-media filtration (conventional dual media treatment)

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