EPA United States Environmental Protection Agency

Distribution System Water Quality

Protecting Water Quality with Online Water Quality Monitoring

Many public water systems (PWSs), including some small and medium systems, implement online water quality monitoring (OWQM) in their distribution systems for regulatory compliance and operational surveillance. While grab samples are most often used for compliance monitoring in their distribution systems, online analyzers are typically used for continuous disinfectant residual monitoring at entry points and storage facility outlets, and for detecting water quality changes (e.g., red water incidents, nitrification) to provide system personnel information for them to optimize operations. This fact sheet is part of EPA's Distribution System Toolbox developed to summarize best management practices that PWSs, particularly small systems, can use to maintain distribution system water quality and protect public health.

Examples of Utility Actions

A PWS serving 8,600 customers in the mid-Atlantic had difficulty maintaining a chloramine residual throughout the distribution system. In response, the PWS conducted continuous disinfectant residual monitoring at tank outlets, collected grab samples to measure disinfectant residual at other locations, and worked with the state to evaluate water age in finished water storage tanks and the distribution system. As a result, the PWS modified tank operations, expanded flushing operations, and improved disinfection practices, and the chloramine residual increased to 1.0 mg/L at all locations and tank water age decreased by 50 percent.

A PWS serving approximately 130,000 people in the northeast found that water quality monitoring with the use of grab samples was not able to detect distribution system contamination in a timely manner. The PWS installed 15 OWQM stations in the distribution system, including at entry points, storage tanks, and booster stations, to monitor free chlorine, pH, specific conductance, temperature, turbidity, and UV-254. By integrating OWQM data with the supervisory control and data acquisition (SCADA) system and establishing water quality alert levels, the PWS improved abnormal water quality event identification and reduced the corrective action response time.

What Types of Water Quality Monitoring are used in a Distribution System?

- *Grab samples* are single volume samples collected at one time from one place. Grab samples are collected for compliance with SDWA regulations such as the Revised Total Coliform Rule and the Disinfectants and Disinfection Byproducts Rules. Systems serving <3,300 people may collect grab samples for disinfectant residual measurements at entry points to meet Surface Water Treatment Rule requirements.
- *Composite samples* are a mixture of several grab samples collected from different locations at the same time, or samples collected from the same location at different times. Composite samples are allowed in regulatory frameworks, typically for select chemical groups (e.g., volatile organic compounds) when a PWS has multiple entry points. This can help the PWS reduce analytical laboratory costs. Under the SDWA, composite samples are not allowed for bacteriological analytes or DBPs.
- *Continuous sampling* with online analyzers (i.e., OWQM) generates real-time data that can be used for regulatory compliance monitoring of disinfectant residual at entry points and for operational monitoring throughout the distribution system. Online analyzers are commercially available for parameters such as turbidity, pH, alkalinity, orthophosphate, ammonia, nitrate, nitrite, chlorine, monochloramine, oxidation reduction potential (ORP), total organic carbon (TOC), temperature, disinfection byproducts, and specific conductance.

Design and Operational Considerations for an OWQM Station in the Distribution System

- Setting up monitoring objectives ensures that an OWQM system will provide useful information to a utility; possible monitoring locations and parameters should be selected based on established monitoring objectives.
- Compiling and assessing distribution system informational resources prior to designing the OWQM system can be helpful.
- Including all individuals that will be involved with OWQM system operation and maintenance (equipment technicians, IT specialists, water quality managers) from the beginning of system design will help the system meet its objectives.
- Installing monitoring systems at distribution system entry points, finished water storage facility outlets, booster pump stations and meter or valve vaults, or in other protected areas, such as fire or police stations, town halls and parks can give a broad sense of water quality throughout the distribution system.

- Developing an information management and analysis system (e.g., SCADA) helps a utility to achieve the selected monitoring objectives. This system provides users with useful data and information to monitor real-time system conditions and generate notifications when anomalies are detected. Standard operating procedures for alarms and triggers based on OWQM data can help detect potential anomalies; such procedures can be configured based on utility objectives.
- Routine instrument maintenance and calibration needs to be implemented to ensure data quality and equipment performance.

Online water quality monitoring station at a distribution system booster pumping station

Applications where OWQM May Be Helpful in the Distribution System

- Improve operations by using OWQM data when corrective actions are needed such as changing the disinfectant dosage rate, flushing water mains, or cleaning storage tanks.
- Manage water age by monitoring disinfectant residual at entry points, dead-end locations, and tank outlets and triggering corrective actions such as optimizing tank operating levels or opening valves to improve water circulation.
- Identify the onset of nitrification by monitoring pH, monochloramine, free and total chlorine, temperature, ammonia, nitrate, and nitrite.
- Assist in diagnosing causative factors for increased risks of waterborne disease by monitoring disinfectant residual and temperature.
- Evaluate the effectiveness of booster disinfection or flushing operations by continuously monitoring disinfectant residual.
- Identify areas where the system may have trouble maintaining disinfectant residuals by continuously monitoring disinfectant residual.
- Detect contamination incidents or unusual water quality conditions by establishing a historical record of OWQM data and using the data to establish setpoints for alerts and alarms.
- Planning and justifying capital improvement projects such as tank mixers, piping projects that eliminate dead-end water mains, and replacement of unlined cast iron water mains.

Table 1. Resources and Guidelines for Online Water Quality Monitoring

Resource Title and URL	Relevance to Online Water Quality Monitoring
USEPA. 2021. Online Water Quality Monitoring Resources. https://www.epa.gov/waterqualitysurveillance/online-water-quality-monitoring-resources	Provides resources and guidance documents to help PWSs select online water quality analyzers.
Umberg and Rogers. 2017. Take a Cost-Effective Approach to Online Water Quality Monitoring. *Opflow*. www.awwa.org Note: There may be a fee associated with obtaining this resource.	Presents applications for online water quality monitoring and describes how to develop a monitoring program and design a monitoring station.
AWWA. 2017. M68 Manual of Water Supply Practices. Water Quality in Distribution Systems. https://www.awwa.org/ Note: There may be a fee associated with obtaining this resource.	Describes monitoring programs for various water quality applications in distribution systems. Summarizes regulatory monitoring requirements. Includes an example nitrification monitoring plan and case study examples.
National Academy of Sciences. 2006. *Drinking Water Distribution Systems. Assessing and Reducing Risks*. www.nap.edu	Explains how monitoring can be used to maintain the water quality integrity of a distribution system. Lists important parameters and describes available online sensors. Describes how to use customer complaint data.

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