As part of a multi-barrier regulatory framework to control microbial contamination, public water systems (PWSs) supplied by or under the direct influence of surface water must maintain a disinfectant residual for water that is delivered to customers through a distribution system. Disinfectant residuals in the distribution systems serve three main purposes: to protect against microbial contaminants, to act as an indicator of distribution system upset, and to limit growth of heterotrophic bacteria and Legionella within the distribution system. 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.

Understand Disinfectant Demand and Effects of Water Age

Conditions that exert a demand on disinfectants limit the system’s ability to maintain a disinfectant residual. For example: biofilms and sediments in piping and tank surfaces can harbor microorganisms that consume the disinfectant. Corrosion products and other compounds present in finished water can also react with disinfectants. Breaks or leaks in a distribution system can lead to contaminant intrusion that further consumes disinfectants.

The length of time water spends in the distribution system is called “water age.” The higher the water age, the more reaction time for the disinfectant residual, leading to reduced concentration of disinfectant residual, increased potential for microbial growth, and detriments to water quality. Causes of high water age in the distribution system can include:

- Oversized pipes and tanks,
- Decreased water demand due to conservation efforts,
- System configuration (e.g., dead end mains), and
- Incorrect valve position (e.g., when a valve that is not reopened after maintenance, preventing water circulation).

What follows is some practical advice for maintaining disinfectant residuals.

Diagnose Issues with Maintaining Disinfectant Residuals

- Compile historical water quality data. Identify specific locations and times (e.g., times of year, like during warmer months) where residuals are below state regulatory thresholds.
- Review system configuration and operational records to identify locations with potentially slow water turnover and high water age. Monitor disinfectant residual at those locations.
- Review sanitary survey reports and related corrective actions to identify known sanitary defects (e.g., cracks and leaks) that need to be addressed.
- Review maintenance records to assess whether infrastructure issues (e.g., pipe materials, pipe condition, or presence of sediment and/or biofilm) could be contributing to excessive disinfectant demand.
- For systems using chloramination, conduct monitoring to determine if nitrification occurs in the distribution system.
- Review the quality of water provided to consecutive systems.

Disclaimer: To the extent this document mentions or discusses statutory or regulatory authority, it does so for information purposes only. It does not substitute for those statutes or regulations, and readers should consult the statutes or regulations themselves to learn what they require. The mention of trade names for commercial products does not represent or imply the approval of EPA.
Keep the Distribution System Clean and Add Booster Disinfection if Needed

- Reducing the amount of organic matter and nutrients in the water entering the distribution system can help limit the growth of biofilms on pipe and tank surfaces.
- Flushing and pigging can remove sediments and biofilms.
- Replacing or rehabilitating older pipes, such as unlined cast iron water mains, can remove corrosion tubercles; lining mains also can reduce disinfectant demand from pipe materials.
- Finished water storage facility cleaning can remove sediments and corrosion deposits from tank floors as well as biofilms and other deposits from tank wall surfaces.
- Booster disinfection facilities can be added at selected locations in the distribution system to increase the disinfectant residual.

Reduce Water Age with Design and Operational Changes

- Hydraulic models such as EPANET can be used to design distribution systems and optimize their operation.
- Dead-end piping can be eliminated (e.g., as part of capital projects).
- Pumping and storage facility filling/draining operations can be optimized to increase water turnover.
- Mixing devices can be added to storage facilities to improve water circulation.
- Spot flushing programs for dead-end piping or low water use areas can be implemented to remove stagnant water and restore disinfectant residual.

Table 1. Resources and Guidelines for Disinfectant Residual Maintenance

<table>
<thead>
<tr>
<th>Resource Title and URL</th>
<th>Relevance to Maintenance of Disinfectant Residual</th>
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<tbody>
<tr>
<td>ASDWA. 2020. Distribution System Survey White Paper. <a href="https://www.asdwa.org/">https://www.asdwa.org/</a></td>
<td>Summarizes state responses to a survey on distribution system issues; topics include minimum disinfectant residual requirements in the distribution system.</td>
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<tr>
<td>Hill et al. 2018. WRF 4653 Flushing Guidance. <a href="https://www.waterrf.org/">https://www.waterrf.org/</a></td>
<td>Reports research findings and guidance on flushing as a technique to restore water quality in the distribution system.</td>
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