COLORADO
Water Quality Control Division
Department of Public Health & Environment

Colorado PFAS drinking water mitigation guidance

Introduction

This document helps drinking water suppliers determine the best path forward for mitigating per- and polyfluoroalkyl substances (PFAS). Navigating PFAS compliance alternatives and identifying their optimal choice involves many site-specific factors. The department recommends suppliers use this document to start conversations about PFAS compliance with their engineers or water treatment professionals.

PFAS compliance alternatives

The department has made both non-treatment and treatment alternatives available to help drinking water suppliers comply with the PFAS Maximum Contaminant Levels (MCLs).

Non-treatment alternatives

Drinking water suppliers should consider non-treatment alternatives since they usually involve lower capital investments and reduced operations, maintenance, and labor costs.

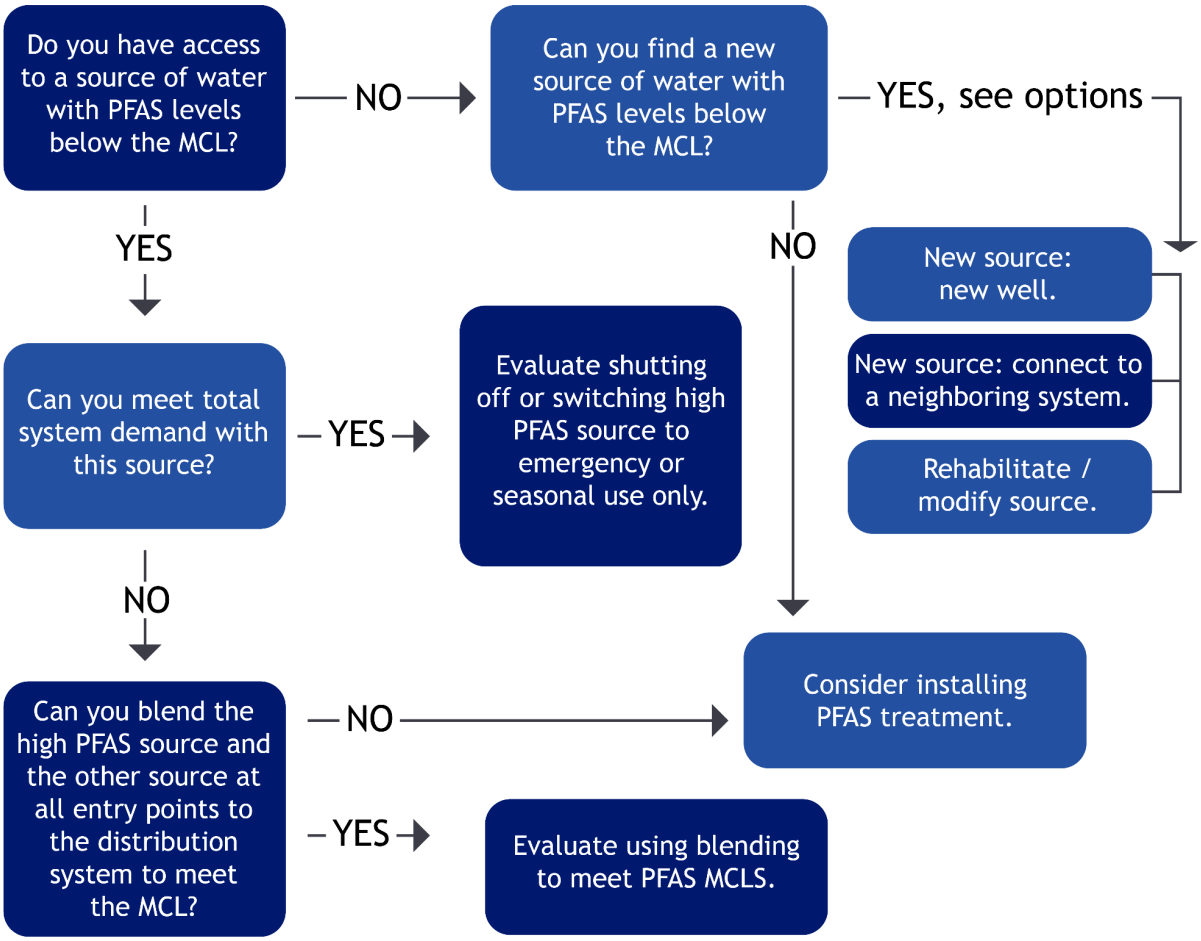
- New source—connection to a neighboring system: This involves connecting to a nearby supplier's system that has PFAS levels below the MCLs. Some small suppliers may be able to use hauled water with PFAS levels below the MCLs.
- New source—new well: Hydrogeologic studies can help identify and isolate the source of contamination and determine whether drilling and developing a new well is an option.
- Rehabilitate or modify well: Rehabilitating, sectional screening of casing, or deepening an existing well to avoid a zone of contaminated water can be an effective way to access water with PFAS levels below the MCLs. This option requires hydrogeologic studies and sampling to identify which zones might have PFAS contamination and which zones do not.
- Seasonal use: Switching the problematic source(s) from full-time use to seasonal or peaking use must include subsequent blending with other sources of water. This

strategy is consistent with alternatives for other chronic contaminants and their running annual average compliance criteria.

- Blending: Combining multiple water sources (including potential new sources) to produce a combined finished water with PFAS levels below the MCLs.

See the flowchart below to evaluate whether a non-treatment alternative may be an option.

Non-treatment flowchart



If non-treatment alternatives aren't an option, a supplier should evaluate the available treatment alternatives.

Treatment alternatives

Suppliers may be able to optimize their existing treatment process, use EPA "Best Available Technologies" (BATs), or potentially use newly developed technology for PFAS compliance.

Modification to existing treatment

For those with low levels of PFAS, suppliers may be able to optimize or modify some existing treatment processes to achieve compliance without a large capital project, such as:

- Powdered activated carbon (PAC)—Suppliers already adding PAC to remove organics and taste and odor compounds may be able to remove some PFAS with higher PAC doses. If PAC treatment is not currently in place, it may be added to an existing treatment process, but the department would require pilot or demonstration testing.

BAT strategies

BATs are the most reliable treatment alternatives because they have already demonstrated PFAS removal to achieve compliance in existing water treatment plants. EPA has identified four BATs for meeting the PFAS MCLs: Granular activated carbon (GAC), ion exchange (IX), reverse osmosis (RO), and nanofiltration (NF). These technologies are summarized below. Please see the EPA's BAT technical support document for more information on these technologies.

- GAC: Contaminated water passes through a pressure vessel or filter box containing GAC; PFAS then "sticks" to the activated carbon. The supplier must replace the GAC when there is not enough space left for PFAS to stick to it. Understanding the breakthrough curve for PFAS chemicals through GAC media is essential in evaluating this technology.
- IX and PFAS-selective media: Ion exchange and PFAS-selective media both work like tiny magnets that attract and hold the contaminated materials (in this case, PFAS) and prevent them from passing through the media and entering the treated drinking water. Negatively charged ions of PFAS are attracted to the positively charged anion exchange media. The supplier must replace the media when the exchange anions become exhausted.
- RO/NF: RO and NF are high-pressure membrane processes that split water into two streams: clean water (also known as permeate) and a contaminated stream (known as reject, concentrate, or brine).

The table below summarizes the advantages and considerations of the BATs.

BAT table

Treatment	Advantages	Considerations
GAC	• Reliable PFAS removal. • Additional contaminant removal includes removing taste and odor and trace organics like pharmaceuticals. • Highly proven.	• Other organics in water compete with PFAS for available GAC sites to stick to. • O&M costs can be high as carbon may require frequent replacement. • Media disposal challenges. • Media may require flushing after change-outs; requires a flushing water source and disposal of flushed water.
IX	• PFAS-selective media are available. • Smaller footprint than GAC (typically 50-75% of the size of GAC). • Media life is generally longer than GAC.	• Fewer secondary water quality benefits than other methods. • Media is more expensive than GAC on a pound-for-pound basis. • Media disposal challenges. • Potential corrosion concerns. • Media may require flushing after change-outs; requires a flushing water source and disposal of flushed water.
RO/NF	• Highly effective removal of all PFAS tested. • Additional contaminant removal.	• Produces a concentrated waste stream that requires disposal with limited permitting options or treatment. • Requires extensive pretreatment. • High capital and O&M costs from energy-intensive high-pressure membranes. • Treated water corrosivity impacts.

Most suppliers installing PFAS treatment choose between GAC and IX due to RO/NF concentrated waste stream disposal and cost considerations.

Newly developed technologies

As technology advances, more newly developed PFAS treatment strategies, such as specialized removal media, may become available. While the department encourages the development of new PFAS treatment technologies, technologies that have not yet demonstrated reliable PFAS

removal at existing treatment plants will require pilot or demonstration testing to demonstrate performance.

Design and Approval

Before construction, most projects must undergo the department's review and approval process based on the State of Colorado Design Criteria for Potable Water Systems. Information on the design approval process and criteria is available on our design website.

Regulation 11 requires a Colorado professional engineer to design community water systems. Non-community systems do not require a Colorado professional engineer, but the department encourages suppliers to coordinate with someone experienced with water system design.

In 2024, the team updated the design criteria to include parameters for PFAS treatment. The design criteria have conservative minimum design parameters for new GAC and IX PFAS treatment processes. Suppliers can also choose to conduct pilot testing for site-specific criteria.

Pilot testing

Suppliers may elect to do small-scale testing on their water to either a) verify PFAS removal at higher flow rates and/or lower the time the water is in contact with the treatment media or b) test out newly developed technologies. Researchers typically conduct testing using Rapid Small Scale Column Tests (RSSCTs) or field piloting. RSSCTs utilize miniature scale columns (1-centimeter diameter columns) and smaller-size media to evaluate media performance over a short period (typically less than 3 weeks). Field pilots use small-scale columns (3-6 inch diameter columns) and various media to model full-scale performance. Field pilots provide the most accurate estimations of PFAS treatment performance; however, pilot studies can be costly and time-consuming, often requiring over a year of operation to produce meaningful results for contaminant breakthrough.

Getting started

Figuring out compliance with your PFAS mitigation alternatives can be challenging or overwhelming. We encourage you to start at our PFAS project homepage. Feel free to contact the department at cdphe_pfas@state.co.us to discuss any available funding for design and/or

construction projects, possible non-treatment alternatives, possible treatment alternatives, and the design approval process. You should also contact water treatment professionals who can help you select and design a PFAS compliance alternative.

For more information:

- Arizona Department of Water Quality Decision Trees For PFAS Mitigation.
- EPA Fact Sheet. April 2024. Treatment Options for Removing PFAS from Drinking Water.
- EPA Technical Support Document. March 2024. Best Available Technologies and Small System Compliance Technologies for Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water.
- EPA Science in Action. Technologies for reducing PFAS in drinking water.