IDENTIFYING CONTAMINANTS OF CONCERN

Abstract

In America today there are millions of people who lack access to safe water. In most cases, these water sources have been contaminated by years—often decades—of mismanagement of industrial chemicals, where the people at large are left to deal with health consequences. At AqueoUS Vets, our mission is to provide Americans with sustainable access to clean water and reverse the cycle of pollution.

We are proud to offer solutions for the contaminants most prevalent in the U.S. today, including PFAS, 1,2,3-TCP, Arsenic, Perchlorate, Hexavalent Chromium, Volatile Organic Compounds (VOCs), and Disinfection By Products (DBPs). In this article, we outline the sources, occurrence, known health issues, and mitigation options for each contaminant.

PFAS

PFAS (per- and polyfluoroalkyl substances) are a group of organoflourine compounds that have a wide range of consumer and industrial uses. After their discovery in 1939, PFAS found nearly endless use cases from dental floss to firefighting foams; yoga pants, to micro-electronics. Of all the contaminants we will discuss, PFAS is truly unique in its ubiquity.

The ubiquity of PFAS has led to its discovery in surface and groundwater on every continent including the Arctic and Antarctica—two regions with no anthropologic sources. So ingrained in society is PFAS that 98% of Americans' have it in their blood. In the U.S., the EPA is still discovering the extent of PFAS exposure. Data available to-date shows exposure near all population centers, with exposure frequency most frequent near historic manufacturing sites, commercial airports, fire-fighting training areas, or landfills.

While there are more than 7 million different PFAS compounds, the two that occur most commonly are PFOA (per-fluorooctanoic acid) and PFOS (perfluorooctancesulfonic acid). Despite being largely phased out from most consumer products in the early 2000's, exposure to PFOA and PFOS has persisted through historically polluted groundwater.

PFAS compounds are linked to adverse health effects including decreased fertility, developmental effects in children, and increased risk of certain cancers. In April of 2024, the EPA established regulations for PFOA and

PFOS, along with PFHxS (perfluorohexanesulfonic acid), PFNA (Perfluorononanoic acid), and HFPO-DA ("GenX compounds").

The best available technologies for PFAS removal are Granular Activated Carbon (GAC), Ion Exchange (IX), and Reverse Osmosis (RO). Of the three options, GAC and IX are the gold standard because of reliability and cost effectiveness.

Learn more in this Project Profile: Yorba Linda Ion Exchange Treatment Plant for PFAS

1,2,3-Trichloropropane

1,2,3-Trichloropropane (1,2,3-TCP) is an organic compound primarily used as a solvent. It is also an ingredient in the synthesis of chemicals that are critical to aerospace, automotive, electronic, and pharmaceutical applications. 1,2,3-TCP was an important ingredient in agricultural pesticides until the 1980's, and, despite having been phased out, persists today in regions where it was used. California's agricultural central valley is one of the most seriously impacted regions in the U.S., though other states with agricultural activity have also been impacted.

Classified as a likely human carcinogen, 1,2,3-TCP exposure is associated with an increased risk of cancers, particularly of the liver, kidneys, and gastrointestinal tract. Today, only California, New Jersey, and Hawaii have established maximum contaminant levels for 1,2,3-TCP, though it is on the EPA's Contaminant Candidate List and may be subject to federal regulations in the future.

1,2,3-TCP is readily treatable using GAC.

Learn more in this Project Profile: 1,2,3-Trichloropropane (TCP) Mitigation Project

Hexavalent Chromium

Hexavalent chromium (CrVI) is a toxic form of the heavy metal chromium. While some Cr(VI) occurs naturally in serpentine-containing or chromium-containing geological formations, major sources of Cr(VI) are from industrial uses, including steel and pulp mills, metal plating operations, and boiler corrosion control.

Pollution of groundwater with Cr(VI) is commonly associated with these industrial activities, particularly where waste is not properly managed. For example, in Hinkley, CA, the owners of a natural gas fired power plant, using Cr(VI) for corrosion control, dumped 370 million gallons of wastewater into unlined ponds that leached into local groundwater. This pollution led to the lawsuits that became famous in the 2000 film, “Erin Brockovich”.

Exposure of Cr(VI) in drinking water is associated with increased risk of stomach cancer and reproductive harm. The EPA has an MCL of 100 ppb for total chromium, which includes both Cr(VI) and Cr(III); however, many have argued that this MCL is not sufficient. In 2024, California established an MCL of 10 ppb for Cr(VI) alone—the only state with such levels.

Reduction of Cr(VI) to Cr(III), coagulation, and filtration (RCF), is commonly used to treat Cr(VI); however, IX may be preferred in regions where sludge disposal is not a readily available option.

Learn more in this Project Profile: [Dunnigan WTP Using Ion-Exchange for Chrome VI]

Perchlorate

Perchlorate is an inorganic compound used in rocket propellants, fireworks, munitions, and explosives. Contamination is linked to military and aerospace activities, manufacturing sites, and improper storage or disposal of materials containing perchlorate. States with a history of military testing, namely California, Nevada, and Texas, have been found to have high occurrences of perchlorate in drinking water.

The presence of perchlorate in drinking water disrupts thyroid function by interfering with iodine uptake, which is essential for hormone production. This can lead to developmental issues in children and metabolic problems in adults. California and Massachusetts are the only states with established drinking water MCLs at 6 and 2 ppb, respectively; however, the EPA has committed to issue a proposed MCL by 2025, and a final MCL by 2027.

IX is the most effective method for perchlorate removal.

Arsenic

Arsenic is a naturally occurring metalloid that enters drinking water through natural geological processes, and some industrial activities, namely mining and pesticide application. Arsenic is most prevalent in the western U.S., the Great Lakes region, and New England, generally associated with the local geology. For example, the Fox River Valley region in eastern Wisconsin has Arsenic concentrations >100 ppb, some of the highest in the nation, associated with the oxidation of pyrite and marcasite veins in local sandstone and dolomite.

Long-term arsenic exposure is linked to skin, lung, and bladder cancers. It can also cause cardiovascular issues, neurological damage, and developmental delays in children. In 1975, the EPA established the first MCL for Arsenic at 50 ppb. In 2001, the EPA re-set the MCL to 10 ppb, in line with the latest science.

Oxidation, coagulation-filtration, and adsorption using iron-based media are effective for arsenic removal.

Volatile Organic Compounds (VOCs)

VOCs are a category of organic compounds that have a high vapor pressure and low water solubility. VOCs have been a critical component for many everyday items since the 1940's, including gasoline, carpets, paints, cleaners, and fumigants. There are 54 different VOCs with established MCLs regulated by the EPA. The most common VOCs are industrial solvents and fuel oxygenates. Common solvents include tetrachloroethylene (PCE), trichloroethylene (TCE), and tetrachloroethane (TCA). Methyl Tertiary Butyl Ether (MTBE) is the most common fuel oxygenate, although no federal MCL has been established.

Exposure to VOCs may cause issues with liver, kidney, thyroid, or immune system function, and some may put consumers at an increased risk of cancer. Communities impacted most frequently by VOCs are in southern California, Nevada, Florida, and the New England and Mid-Atlantic states. VOCs are most frequently detected near urban areas, septic systems, RCRA facilities, or near underground hydrocarbon storage tanks ("USTs").

GAC is well suited to treat solvents, but less well suited for MTBE removal, where bioremediation (i.e., fluidized bed reactors) may be a better option.

Learn more in this Project Profile: Comprehensive Solution for PFAS and VOC Compound Removal

Disinfection By Products

Disinfection by-products (DBPs) are compounds formed when disinfectants used for drinking water treatment react with natural organic matter, bromide, or other substances. DBPs can cause anemia, liver, kidney, or nervous system problems, and can put consumers at an increased risk of cancer.

Warm / sunny climates tend to have greater issues with DBPs associated with accelerated interactions between disinfectants and natural organic matter. Proximity to agricultural or urban areas where the groundwater may have greater natural organic matter are also susceptible to greater DBP formation. Large drinking water facilities with large distribution areas may also face greater DBP formation associated with higher doses of disinfectant. There are four DBPs with established federal MCLs; bromate, chlorite, haloacetic acids (HAA5), and trihalomethanes (THMs). The ubiquity of chlorine-based disinfection has made THMs one of the most commonly occurring VOCs present in groundwater.

GAC is best suited for THMs and HAA5, but is not generally effective at removing bromate, or chlorite.

Learn more in this Project Profile: [Critical Total Organic Carbon (TOC) Treatment System]

Taste & Odor Control

Taste / odor contaminants are those which negatively impact the aesthetics of the water supplied by a public drinking water system. Although no serious health effects are associated with these contaminants, utilities will remove them prior to distribution to ensure customers are satisfied with the product they are receiving. These contaminants are typically naturally occurring, but may be influenced by human-caused factors, such as eutrophication.

Compounds that cause poor taste or odor include hydrogen sulfide (H2S), caused by geological conditions or the presence of decomposing organic matter, and geosmin or 2-methylisoborneol (MIB), both caused by the presence of cynobacteria or filamentous bacteria. Groundwater from wells with sulfate-rich rocks or coastal areas with brackish water tend to experience elevated H2S levels. The gulf coast, Appalachian Mountains, and the Colorado, Wyoming, Nevada region of the west all have conditions suitable for elevated H2S levels. Geosmin and MIB are commonly associated with warm, nutrient-rich waters.

GAC is best suited for taste and odor control.

Proven. Experienced. Reliable.

If you have any questions regarding the implementation of a treatment technology for these contaminants, an AqueoUS Vets representative would be happy to support you.

About the Author

Conrad Hopp is the Manager of Strategic Initiatives at AqueoUS Vets, where he focuses on planning and alignment, strategic partnerships and corporate development, and strategic projects. Conrad brings a deep understanding of the emerging contaminants, with a proven track record of success leading the Advisory Services team at BlueTech Research, a global provider of water technology market intelligence.