

The presence of heavy metals in California water

Abstract

Heavy metals are currently measuring at increasingly high levels in California's drinking water sources. Multiple factors contribute to these surges of metals including wild fires, old plumbing materials, erosion, mining, along with many others. This paper explores these multiple causes of drinking water contamination in the state, as well as the impact that toxic metals have on the human body. Having access to clean drinking water is a basic human right in the state of California. However, multiple communities within the state do not have access to clean water that is free of heavy metals. This paper discusses the socioeconomic correlations between readily available clean drinking water and rural communities. There is also a clear correlation between contaminated drinking water and communities with high percentages of people of color. The human right to have access to clean drinking water is not fully followed in the state of California because multiple communities depend on personal wells for water. In addition, state government officials do not prioritize maintenance of plumbing lines to ensure certain communities are safe from toxic metals contaminants. This paper discusses the importance of clean drinking water to ensure organ failure and diseases such as cancer stop increasing in number. ICP-MS instrumentation offers a way for scientists to test drinking water metal levels and determine which areas in California suffer from toxic water the most.

Keywords: contamination, toxic, ICP-MS instrumentation, arsenic, lead, chromium

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Abbreviations: ICP-OES, inductively coupled plasma- optical emission spectroscopy; ICP-MS, inductively coupled plasma- mass spectrometry; EPA, environmental protection agency; USGS, United States Geological survey; EWG, environmental working group; CRLA, California rural legal assistance

Introduction

The level of heavy metals in water is a rising issue that individual states across the country need to deal with because metals are toxic and can lead to many health issues for those who are exposed to them. Metals are present in both drinking water and in faucet water that is used for bathing and everyday life. Instrumentation, such as ICP-OES and ICP-MS, can be used to assess the level of metal content in water samples. The reason toxicity levels have increased so much throughout the years is because heavy metals can leach into drinking water from household plumbing and service lines, mining operations, petroleum refineries, electronics manufacturers, municipal waste disposal, cement plants, and natural mineral deposits.¹ They also contaminate private wells through groundwater movement and surface water seepage and run-off.¹ The effect of this can be catastrophic on one's health because high levels of metals in the body can lead to issues such as acute and chronic toxicity, liver, kidney, and intestinal damage, anemia, and cancer.¹

Examples of metals in water

Environmental example

Metals can increase in the environment after natural disasters such as wildfires. California suffers from wildfires on a yearly basis with some destroying thousands of acres of land while also demolishing many homes and whole entire communities. After fires burn, vegetation is no longer there and soil composition changes. This means that storms that take place after a wildfire can lead to flooding, erosion, and the spread and ash and pollutants.² It is important to keep in mind that older homes may have asbestos and paint that can be loaded with metals such as lead and arsenic. Once these homes burn down in a fire, these metals are present in debris and can be pushed

into water sources after rainfall. Asbestos can remain airborne for 4 to 80 hours after being disturbed.³ It is extremely dangerous for the human body to be exposed to chemicals and metals present in such materials. It is important to keep in mind that drinking water can get contaminated in the water source itself or the system that delivers it.⁴ This means that if local water treatment plants are damaged in a fire, then contaminated water can flow right into people's homes.

Infrastructure example

Metals contamination in water does not only occur after wildfires. There are many sources of metals contamination. In Fresno California, it was reported that 14% of children had high levels of lead in their systems and 25% of schools had lead present in their drinking fountain water.⁵ Lead can leach into water systems because of corroded old plumbing pipes. This emphasizes the importance of infrastructure being maintained within cities. As seen in Figure 1, a large amount of California's drinking water infrastructure is in desperate need of replacement.⁵ Arsenic is another dangerous metal that has also been measured at high levels in drinking water in certain communities within California. Almost one million people are served by water systems within the state that do not pass requirements for safe and clean drinking water.⁶ Specifically, Latino farm communities are some of the most affected groups of people.⁶ So, it can be concluded that rural and poorer areas seem to be hit with dirtier water at a higher rate. Toxic metal contaminants are present in areas where infrastructure is not treated with the importance that it should be.

Private wells

In 2012, it was announced by the state of California that the right to clean drinking water is a basic human right.⁷ This means that community water systems must regularly be tested for metals and other harmful contaminants. It has been concluded that many systems in the state do not pass the guidelines required for safe drinking water, while rural communities get water from private wells that are rarely ever regulated or tested.⁷ Scientists have been studying levels of arsenic in individual counties in California. The image on the left of Figure 2 shows arsenic levels in drinking water

from ground water contamination while the image on the right shows arsenic contamination in both community water systems and private wells.⁷ Ingesting arsenic is a serious health problem because arsenic

has been proven to pose a risk to cancer.⁸ Lung and urinary bladder cancers show a direct correlation to this metal, highlighting just how dangerous it can be.⁸

XI. LEAD SERVICE LINE REPLACEMENT INVENTORY LIST

Water System ID	Water System Name	Population	Service Connections	Degree of Disadvantaged ¹	Total Service Lines Inventoried	Lead Lines	Lead Goosenecks, Pigtails, or Connectors	Estimated Cost to Replace ²
CA0400070	BUTTE-GLENN COMMUNITY COLLEGE DIST	18,000	37	DAC	37	8	-	\$32,000
CA1910139	CALJAM WATER COMPANY - SAN MARINO	47,626	14,080	Non-DAC	14,080		108	\$432,000
CA4310004	CITY OF GILROY	57,315	15,220	Non-DAC	15,167		393	\$1,572,000
CA5410006	CITY OF LINDSAY	13,445	3,090	DAC	3,040	1	-	\$4,000
CA4810004	CITY OF RIO VISTA	9,416	5,312	DAC	5,187		453	\$1,812,000
CA1910154	CITY OF SOUTH PASADENA	25,619	6,163	Non-DAC	6,163		322	\$1,288,000
CA0110005	EAST BAY MUD	1,300,000	390,779	Non-DAC	379,229		2380	\$9,520,000
CA0310005	PINE GROVE COMM SERV DIST	900	388	DAC	388		605	\$2,420,000
CA3610039	SAN BERNARDINO CITY	204,870	45,413	DAC	45,671		1301	\$5,204,000
CA1910143	SAN FERNANDO CITY, WATER DEPT.	24,565	5,183	Non-DAC	5,183		127	\$508,000
CA4310011	SAN JOSE WATER	1,007,514	222,047	Non-DAC	233,608		6	\$24,000
CA3810011	SFPUC CITY DISTRIBUTION DIVISION	884,363	170,842	Non-DAC	177,274		4297	\$17,188,000
CA4910004	SWEETWATER SPRINGS CWD - GUERNEVILLE	6,000	2,565	Non-DAC	2,726		27	\$108,000
CA3610053	WESTERN HEIGHTS WATER COMPANY	7,521	2,340	Non-DAC	2,083		950	\$3,800,000
Total			11		889,836	9	10,969	\$43,912,000

Figure 1 List of water systems in California in need of plumbing replacements.⁵

The image shows multiple water systems across the state of California that need their plumbing pipes replaced due to corrosion. Corrosion leads to lead contamination in water.

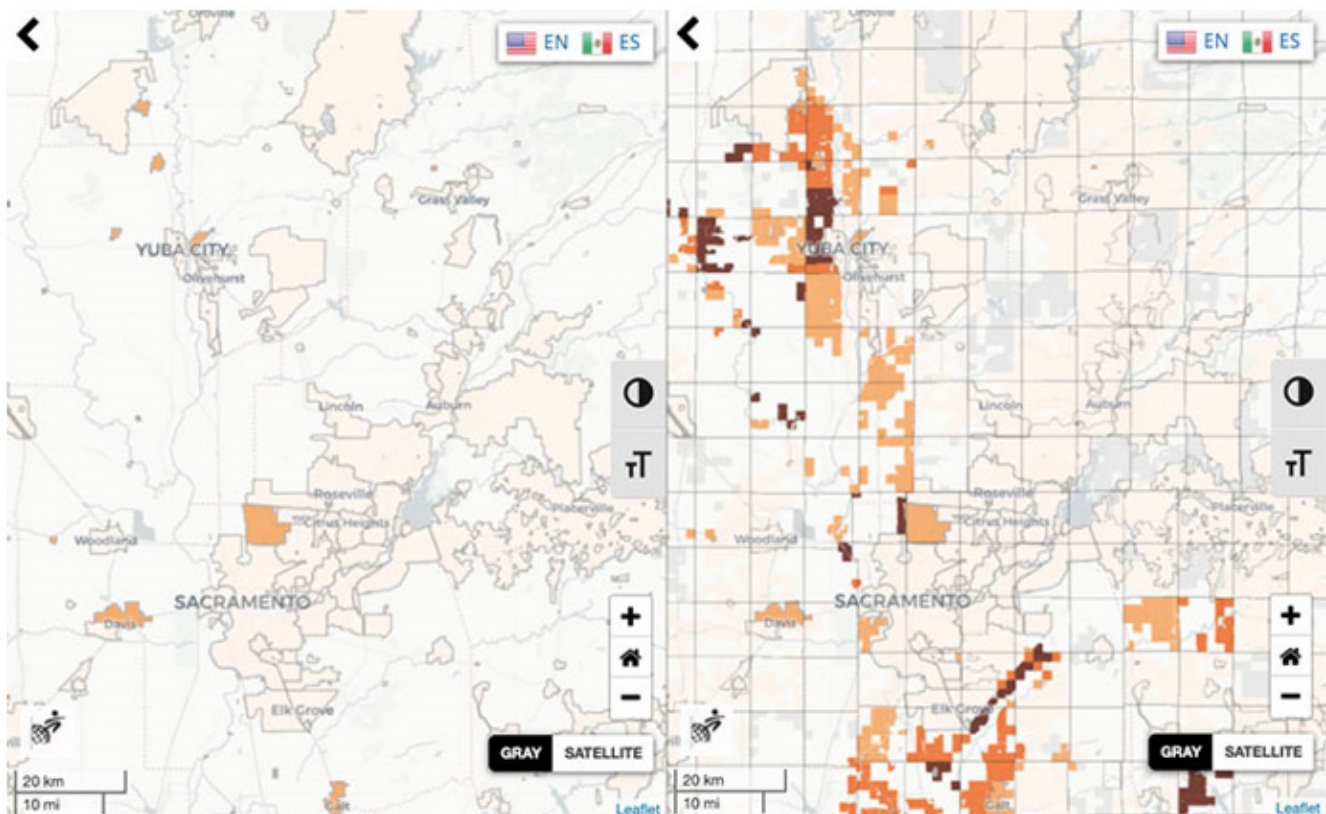


Figure 2 Arsenic levels in ground water & community water systems and wells.⁷

The image shows a map marking areas with high levels of arsenic. Ground water arsenic contamination is seen on the left while community water systems and private wells suffering from arsenic contamination is seen on the right.

Effectuated states

The Environmental Working Group uses data collected from across the country to see what areas test high for contaminants such as arsenic and chromium. California, Arizona and Texas are hot spots as some of the worst areas in the country for such dangerous metals.⁹

Figure 3 shows these three states as testing positive for chromium and arsenic metals as well as nitrate. The EWG wants it to be known that the implementation of reverse osmosis systems or ion exchange could easily solve this contaminant issue.⁹ It can be inferred that there are many other dangerous metals also present in these areas, outside of the ones that were tested for.

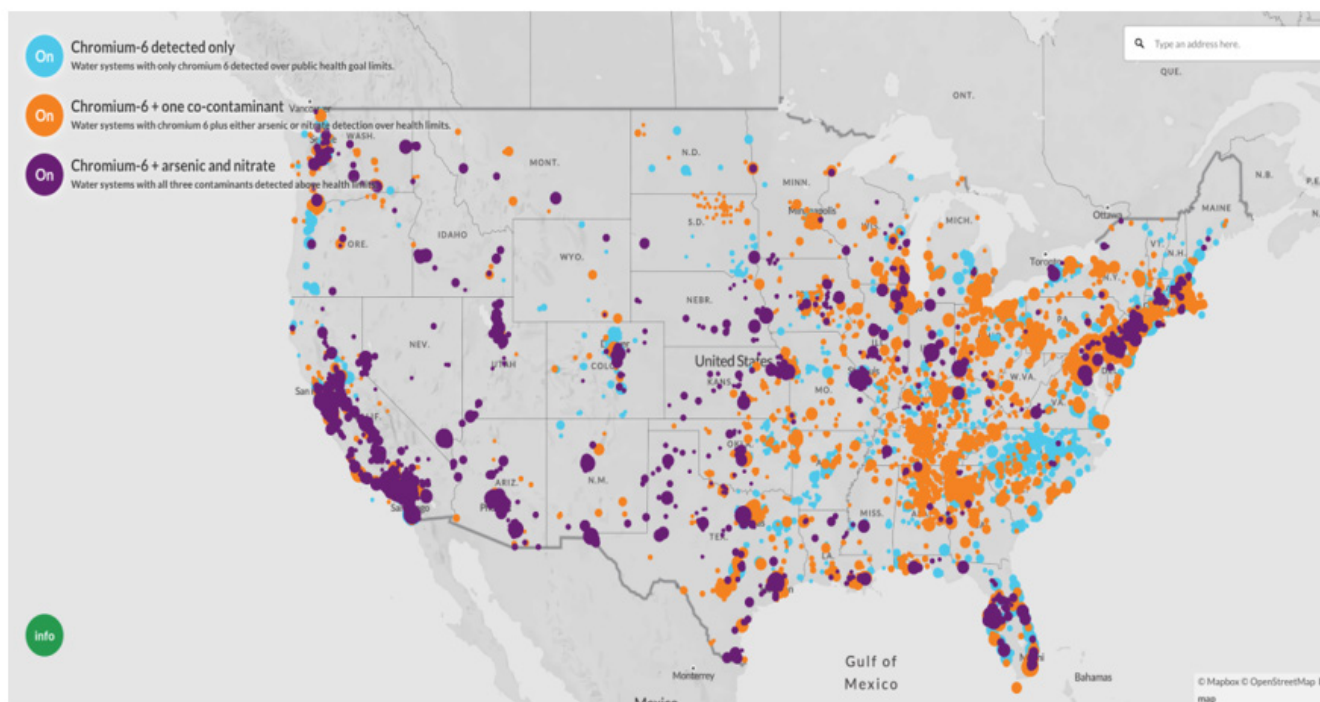


Figure 3 CA, NV and TX water contamination levels.⁹

The image shows a map of the United States while demonstrating how California, Nevada, and Texas have the highest levels of chromium 6, arsenic and nitrates (seen in purple).

Socioeconomic correlation

Agricultural communities and people of color

Certain areas seem to be more susceptible to dirty water compared to others. Poor quality water- specifically waters with high levels of arsenic and chromium- impact communities of color in California.¹⁰ In major agricultural regions within the state, one in ten Californians pay large amounts of money for well water that is actually contaminated with pollutants such as metals.¹¹ Many people in these agricultural communities are Spanish Speaking Latinos who are not being treated properly. They have the right to clean water under California law, but the wells their water is coming from are not regulated or being properly tested/purified to ensure the water is safe. In addition, as stated above, old and non-maintained infrastructure also leads to metals leaching into residential water supplies.⁵ Many households do not have the resources or funds to do full renovations and replace their whole plumbing pipeline systems.

It is not only Latinos that are disproportionately affected by dirty drinking water within the state of California. African American communities, in cities such as Allensworth, are also facing difficulties

regarding the cleanliness of their drinking water.¹² There is only one spigot in this whole town that provides clean water to community members.¹² Figure 4 shows a resident of the town filling up her water from the one clean source that is free of metals.

Latino population

The central coast of California has a large Latino population. The fact that many members of this community are isolated because of language barriers, poverty and high numbers of nonwhite community members means that they are not able to advocate for themselves and fight for the basic human right of access to clean water.¹³ It is important to note that nitrates are just as dangerous as toxic metals in water. Figure 5 is a map that clearly displays the levels of nitrate ground water contamination in the central coast of California.¹³ Clean water is a basic human right and it should be a number one priority of legislators and government officials to work on the implementation of water systems within communities with high numbers of people of color. Everyone should have the right to access safe and clean water sources within the state of California. Rural farming communities and low income areas are disproportionately affected by dirty water and it is time that these areas gain access to proper filtration systems.



Figure 4 Denise Kadara of Allentown using the only clean water source spigot in town.¹²

The image shows a California resident filling up her water bottle at the one clean water source spigot in her town.

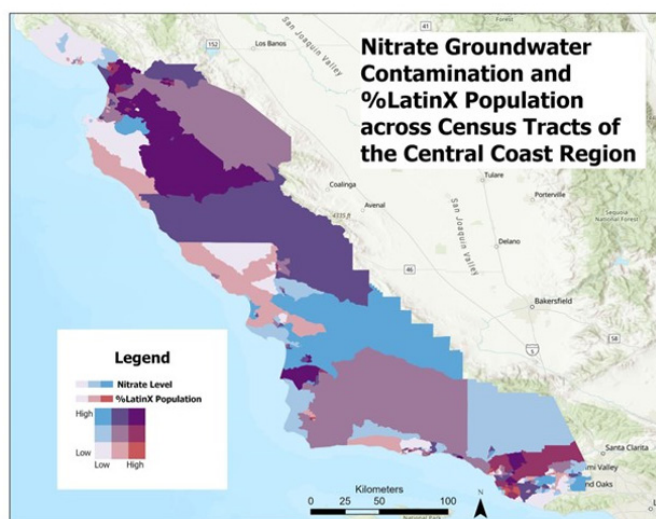


Figure 5 Nitrate Contamination in Latino Communities.¹³

The image shows how certain communities along the central coast of California test for high levels of nitrates in their groundwater. Many communities in this central coast area are made up of rural Latino residents.

Health implications on the human body

Organ damage

Heavy metals are highly toxic and it is important to not consume them because they have adverse effects on the body. When metals enter the system (through drinking water for example) they attach to our cells and prevent the cells from carrying out their normal functions.¹⁴ Exposure to metals, such as lead and arsenic in water, can ultimately damage one’s organs because they will stop carrying out their regular tasks. This can lead to issues such as brain damage, kidney damage, liver damage and so on.¹⁴ Organ damage can be irreversible and cause long term issues for one’s body. Therefore, if someone is exposed to contaminated water and drinks from it for an extended amount of time, their chances of developing health issues from organ failure increases at a much higher rate than someone with access to clean water.

Cancer

Cancer has a strong correlation to heavy metals exposure.¹⁵ Specifically, long term exposure to metals in drinking water has a

correlation to cancers of the skin, lungs, and kidneys.¹⁵ Dangerous metals such as arsenic, cadmium, chromium and nickel are considered category one metals according to the International Agency for Research on Cancer. This is because they have a direct correlation to disruptions of tumor suppression genes and damage repair processes.¹⁶ The body has a natural genetic response to fight against tumors and genetic disruptions. Metals in the biological system take away this natural response, and the chance of cancer development therefore increases drastically.

Ongoing research

The EWG (environmental working group) has done research to show just how much cancer rates could decrease if contaminants in water were properly filtered out/extracted from water systems. The map in Figure 6 above is a prediction of the amount of cancer cases that could be reduced in the country if chromium and arsenic were no longer present in drinking water sources.¹⁷ Researchers are now realizing that metals should be studied in groups, not just individually.¹⁸ In California, more metals than just lead, arsenic and chromium are

being discovered in water sources. Radioactive elements such as uranium and radium are also being discovered.¹⁸ Radioactive elements like these can settle into body tissues and over time will effect organ function (specifically for the kidney).¹⁹ Also, prolonged exposure to radioactive elements through water consumption can have long

term effects on the body. Radium specifically can settle into bones and cause an increased risk of osteosarcomas.²⁰ Toxic metals pose a dangerous threat to everyone. Consumption of metals has a proven correlation with organ failure and certain cancers.

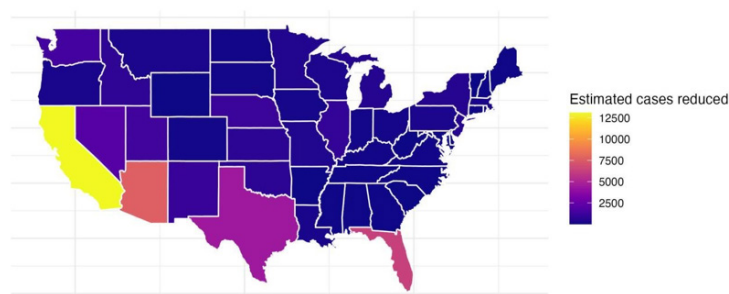


Figure 6 Prediction of cancer reduction with arsenic and chromium removal from water sources.¹⁷

The image shows how many cancer cases would decrease across the United States if arsenic and chromium were no longer present in water sources. California alone has the potential to see over 10,000 decreased cancer cases.

Conclusion and ICP-MS testing

Heavy metals are extremely dangerous for the human body. In present day society, an estimated 900,000 United States citizens in California alone lack access to clean drinking water.²¹ Exposure to metals is catastrophic for one's health due to the correlation between toxic metals and health issues such as cancer. Scientists must continue to work on testing water sources to ensure the cleanliness of drinking water. It is up to government officials to work on the implementation of filtration systems to strip drinking water of contaminants. Figure 7 shows ICP-MS instrumentation that can be used to run trace metal

elemental analysis and accurately detect the levels of metals in drinking water samples.²² It is important that scientists learn how to properly operate such instrumentation because it can be used as tool to ensure that drinking water is safe to consume within the state. Some metals occur naturally within the environment. But, their levels can become dangerously high due to wildfire run off, drought, rusty pipes and much more. Ensuring every person in California has access to clean water is an issue that should be treated with great care. Metals contamination will happen no matter what. It is our job to figure out how to ensure systems are put in place to keep water clean while actively testing toxicity levels.



Figure 7 Agilent ICP-MS used for drinking water metals testing.²³

The image shows an Agilent 7800 ICP-MS instrument which can be used to test drinking water for metals contaminants.

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References

1. Potential well water contaminants and their impacts. *EPA*, Environmental Protection 2025.
2. California Water Science Center. Water quality after a wildfire. *USGS*, 2018.
3. Rodgers Travis. Raging California wildfires may spread toxic asbestos. *Mesothelioma Center - Vital Services for Cancer Patients & Families*. 2025.
4. Huang Pien. Amid the fires, La Is warning some residents the tap water isn't safe. Here's Why. *NPR*. 2025,
5. Lee Ellen. Does California have a lead in drinking water problem? *Does California Have a Lead in Drinking Water Problem?* 2023.
6. Becker Rachel. Drinking water of almost a Million Californians failed to meet state requirements. *CalMatters*. 2024.
7. Manke Kara. Study: Safe drinking water remains out of reach for many Californians. *Study: Safe Drinking Water Remains Out of Reach for Many Californians | Research UC Berkeley*; 2022.
8. California State Water Quality Control Board. Arsenic in drinking water. 2025.
9. Shoaib Alia. Map shows states where drinking water has multiple contaminants. *Newsweek*. 2025.
10. Clare Pace, Carolina Balazs, Komal Bangia, et al. Inequities in drinking water quality among domestic well communities and Community Water Systems, California, 2011–2019. *American Journal of Public Health*. 2021;112(1):88–97.
11. Gross Liza. Environmental Health News. Pollution, poverty and people of color: don't drink the water. *Scientific American*. 2024.
12. Cotsirilos Teresa. Racism robbed this historically black California town of its water. Now, they're developing water of their own. *KQED*. 2024.
13. Racial discrimination complaint names CA state water board as partly to blame for fertilizer contamination in central coast drinking wells. *California Rural Legal Assistance, Inc*. 2024.
14. Heavy metal poisoning (Heavy metal toxicity): symptoms, causes & treatment. *Cleveland Clinic*. 2022.
15. Majid Radfard, Hassan Hashemi, Mohammad Ali Baghapour, et al. Prediction of human health risk and disability-adjusted life years induced by heavy metals exposure through drinking water in fars province, Iran. *Nature News*, Nature Publishing Group. 2023.
16. Hyun Soo Kim, Yeo Jin Kim, Young Rok Seo, et al. An overview of carcinogenic heavy metal: Molecular toxicity mechanism and prevention. *Journal of Cancer Prevention*. 2015;20(3):232–240.
17. Lacey Anthony, Tasha Stoiber. *EWG Map supports 'co-contaminant' tap water rules for preventing up to 50,000 Cancer cases*. 2025.
18. Kounang Nadia. Study estimates 15,000 cancer cases could stem from chemicals in California tap water. *CNN*, Cable News Network. 2019.
19. Radium and Uranium in public drinking water systems. *Environmental Protection Division*. 2025.
20. Radiation. *Vermont Department of Health*. 2025.
21. Caitrin Chappelle, Joy Collins, Ellen Hanak, et al. Access to safe drinking water in California. *Public Policy Institute of California*. 2021.
22. Derrick Quarles C, Andrew D Toms, Ronald Smith, et al. Automated ICP-MS method to measure bromine, chlorine, and iodine species and total metals content in drinking water. *Talanta Open*. 2020;1:100002.
23. Home. *Agilent*. 2025.