What People in the United States Are Asking About Per- and Polyfluoroalkyl Substances in Their Drinking Water Based on Online Search Behaviors

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Abstract Per- and polyfluoroalkyl substances (PFAS) are a human health concern associated with increased incidence of specific cancers, reproductive health effects, immune effects, and developmental effects on children, among other issues. One study found that 45% of municipal water in the U.S. contains at least ≥1 PFAS; according to the Centers for Disease Prevention and Control, nearly all people in the U.S. have measurable amounts of PFAS in their blood (U.S. Environmental Protection Agency, 2024a). Many people first turn to the internet for health-related questions. For public health communicators to successfully educate communities about PFAS exposure from water supplies, it is helpful to know what questions people are already asking online about PFAS. For this research, we used a search engine analytics tool called Semrush to identify common questions asked and to inform subsequent outreach messages. Using Semrush, we categorized the type of questions and search terms online that information seekers used related to PFAS in their water and ranked the questions and search terms based on search volume. Overall, the highest search volume was related to how to reduce risk for exposure to PFAS, followed by general questions about PFAS in water. These insights on search terms can help health professionals create informational resources tailored to address what people want to know about PFAS.

Keywords: per- and polyfluoroalkyl substances, PFAS, human health concerns, public health communication, online search behaviors

Introduction

According to the U.S. Environmental Protection Agency (U.S. EPA), there are nearly 15,000 per- and polyfluoroalkyl substances (PFAS), which are the synthetic chemicals that are widely used in many manufactured products and are highly resistant to breakdown in the environment (National Institute of Environmental Health Sciences, 2025; U.S. Environmental Protection Agency [U.S. EPA], 2024a). PFAS have a long half-life, are found ubiquitously in the environment, and have been linked to adverse human health effects (U.S. EPA, 2024b, 2025). Nearly all people in the U.S. have measurable amounts of PFAS in their blood (Agency for Toxic Substances and Disease Registry, 2024), with previous research results finding that 97% to 100% of human blood samples tested contain PFAS (Lewis et al., 2015).

Although there is a growing understanding of the sources of water contamination and how PFAS contaminants can affect the environment and personal health, large research gaps remain. Among the general public, awareness of personal exposure to PFAS remains low (Berthold et al., 2023), and little research has been conducted to identify best practices for communicating PFAS information to the public to improve awareness. Additionally, 85% of people in the U.S. rely on public water, and thus we focus this research on public exposure to PFAS from municipal water supplies (U.S. Geological Survey, 2019). Further, as press coverage and public interest in PFAS increase, people are searching for additional information about PFAS (Google Trends, n.d.). Given that individuals frequently use internet searches as an initial step to seek information about health threats (Powell et al., 2011), it is important to understand what PFAS-related search terms people might use so that outreach messages align with common concerns as indicated by search terms (Kidd et al., 2019). In our study, we used Google search data to explore the use of PFAS-related keywords and questions by individuals conducting internet searches.

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Recently, limited research has begun to explore how public agencies and other organizations are informing the public about PFAS exposure (Ducatman et al., 2022; Harclerode et al., 2021; National Academies of Sciences, Engineering, and Medicine, 2022; PFAS Exchange, 2021). Ducatman et al. (2022) reviewed official health communication messages from federal, state, and local agencies and found that PFAS messaging often fails to adequately inform communities about the potential health risks associated with PFAS exposure by avoiding causal statements about the potential negative health impacts of PFAS and instead focusing on the uncertainty of exposure and the fact that research is ongoing. Further, communication often fails to "provide actionable information" (Ducatman et al., 2022) about what the public can do to reduce exposure.

When communicating water health risks, including risks from PFAS exposure, frequent and transparent communication to consumers is paramount (Ryan, 2021). Effective methods for increasing awareness of current research include issuing press releases, publishing open-access materials as sources of information, and gaining media attention—all of which increases awareness among both scientific and nonscientific audiences (Fuoco et al., 2023). Multiple researchers have called for high-level social science research that equips public health communicators with how to more strategically inform vulnerable populations, especially when the research being communicated is ongoing and when policies and solutions are in the process of being created and implemented (Berthold et al., 2023; Bruton & Blum, 2017; Harclerode et al., 2021). The first step toward developing effective outreach is to understand the audience's current questions about PFAS.

We draw on the model of communication accommodation theory (CAT) to answer this call. CAT states that audience reception of messages is more positive when the messaging aligns with the audience's understanding of an issue and their linguistic preferences (Giles, 2016). In the context of PFAS communication, this model suggests that outreach professionals would benefit from understanding the terminology used and questions asked by search engine users because the internet is often the first stop for information-seeking. Given that the internet produces a tremendous amount of data daily and that 95% of adults in the U.S. have access to the internet (Pew Research Center, 2024), assessing the content of common searches could help health communicators apply the CAT model strategy of communication alignment when developing outreach materials and thereby increase audience receptivity. Insights gained from knowing what types of information people seek can then be coupled with strategic communications plans to develop and test public health messaging and inform outreach professionals, with the goal of increasing the effectiveness of PFAS messaging. Tailoring informational needs via audience-centered communications strategies can increase message relevance, effectiveness, and retention (Hawkins et al., 2008; Kidd et al., 2019). To better serve their constituencies, public health communicators can benefit from knowing the type and volume of questions being asked about PFAS in drinking water. With this knowledge, outreach professionals can focus the content of their messages on what is most relevant to their audience by answering the questions their constituents are likely searching for.

Search engine optimization (SEO) research has shown that one of the two factors that best predict if an internet user will visit a website from their search is how closely the website's information relates to the user's question (Lewandowski & Kammerer, 2021). Furthermore, PFAS are commonly referred to by different words: scientific terms for groups of chemicals (e.g., PFAS), specific chemical terms (e.g., PFOS [perfluorooctanesulfonic acid]), and colloquial terms (e.g., forever chemicals) (Cao & Ng, 2021). If users exclusively use colloquial terms in their searches, their search results might exclude credible websites that instead use more scientific terms.

Therefore, our first research question (RQ1) identified the use volume associated with PFAS-related keywords and determined which keywords are used most frequently by U.S. Google users. Google has a search engine market share of 87.8% in North America (StatCounter, 2025), making its data largely descriptive of what types of information people are searching for online. After identifying which terms are used the most by Google users, our study then determined the types of questions Google users are asking regarding the most used keyword categories. Therefore, the second research question (RQ2) analyzed the types of questions U.S. Google users are asking related to PFAS in their water supplies.

Methods

To answer RQ1, a list of keywords associated with PFAS was gathered from a consortium of water researchers to ensure our study captured a comprehensive list of related keywords. This list was referenced with and complemented by the related keywords provided via Semrush, an analytical service that creates usable information from Google search and Web analytics data. The term used with the highest monthly volume within Google searches was used for the analysis of RQ2.

To answer RQ2, Semrush was used to obtain a list of the most frequently asked questions for specific keywords of interest for U.S. users on Google's search engine. Semrush's SEO tool was used to review the volume of questions asked about PFAS and water-related keywords. Keyword research is an SEO tool that provides insights into what keywords Google users search for and what information they access based on their search behaviors. Semrush provides available information about keywords of interest by using third-party data providers to collect Google search engine data (Semrush, 2025). The volumes of searches within our study are the monthly average searches over a recent 1-year period. Data were captured on July 3, 2024, and included the previous 12 months of search queries related to PFAS in drinking water for U.S. Google users. Because this study focuses on PFAS in drinking water, "PFAS and water" was used as a combined keyword to ensure the context of PFAS questions were related to drinking water.

The keyword combination of "PFAS and water" was reviewed to answer RQ2: What are people asking about PFAS in their drinking water in the United States? After collecting the top 100 questions related to PFAS and water, the first author analyzed the types of questions present within the Semrush list and developed five thematic question categories:

1. What is/are (keyword/s)
2. How to filter or avoid (keyword/s)
3. How to test for (keyword/s)
4. What water products contain (keyword/s)
5. What geographic locations contain (keyword/s)

The first and third authors then independently coded each question and placed each question into one of the five categories. The independent coding of each of the questions resulted in the following Krippendorff's alpha: PFAS and water = 0.965 (Marzi et al., 2024). These results show high internal consistency and agreement among coders. As only 15% of people in the U.S. rely on private water sources (U.S. Geological Survey, 2019), most questions pertaining to private water and PFAS contamination did not rise to our attention because of the lower question volume. Any remaining questions related to private water supplies from wells were removed from the list. This filtering of questions resulted in a final list of 97 questions related to PFAS and water.

Results

Keyword Identification

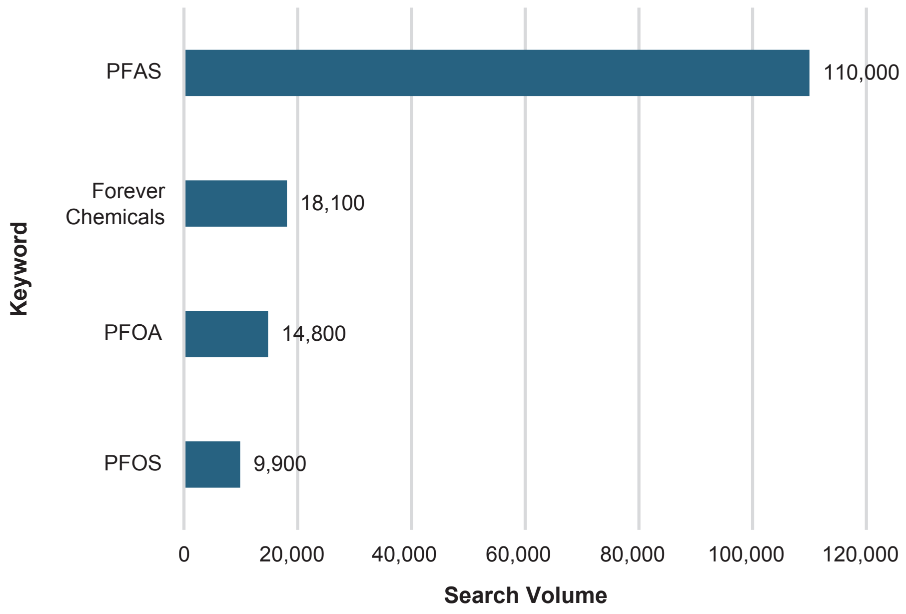
Figure 1 shows the list of the analyzed keywords. Semrush showed that the highest volume of questions was centered around the keyword PFAS, followed by the colloquial term forever chemicals. More technical PFAS names (e.g., PFOS, PFNA, PFHxS) were not found in high-volume searches. The volume of searches for PFAS was 6-times higher than searches for forever chemicals and 7-times higher than the third-highest volume keyword PFOA [perfluorooctanoic acid]. PFAS was chosen for our analysis to answer RQ2 based on its much higher search volume compared with alternative terms (Figure 1).

Analysis of Search Questions

In July 2024, the average monthly U.S. Google search volume over the previous 12 months for PFAS and water combined was 8,840. Within those searches, almost one half (48.9%) of questions were inquiries to understand how to filter/remove PFAS from water. This category included questions such as: how to filter PFAS from water, if specific brands of filters remove PFAS, and does boiling water remove PFAS? The next highest category of questions was general questioning about PFAS in water, at 26.8% of questions. Examples of questions in this category included: what are PFAS in water and how does PFAS get into water? The third-highest category, with 16.7% of questions, was about which water contains PFAS; these questions centered on commercially available

FIGURE **1**

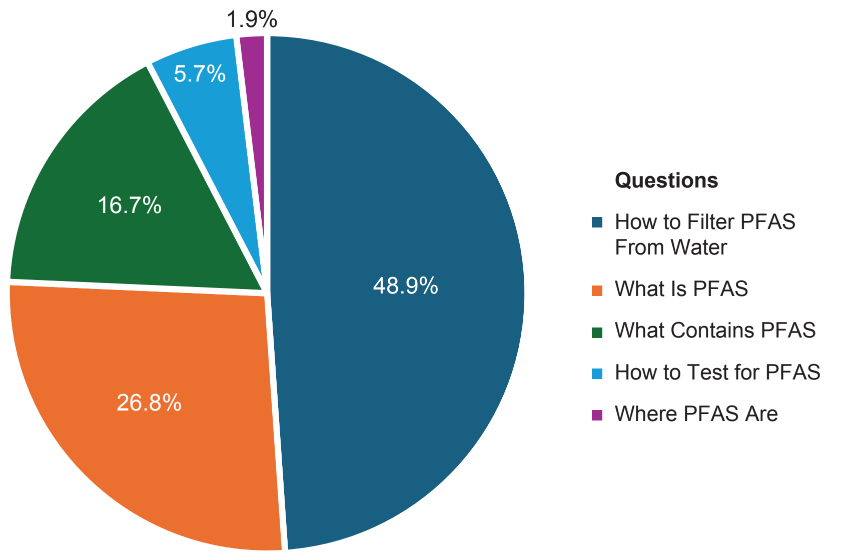
Search Terms Related to Per- and Polyfluoroalkyl Substances and Average Monthly Search Volumes, July 2024



Note. PFAS = per- and polyfluoroalkyl substances; PFOA = perfluorooctanoic acid; PFOS = perfluorooctanesulfonic acid.

FIGURE **2**

Percentage of Search Volume for Per- and Polyfluoroalkyl Substances (PFAS) and Water Question Categories



Note. The total search volume was 8,840/month. The volume represents the average number of monthly searches in the U.S. based on data collected from the prior 12 months in July 2024.

TABLE **1**

Search Volume for Questions Related to Per- and Polyfluoroalkyl Substances (PFAS) and Water

Question	Search Volume
What is PFAS in water	1,600
How to remove PFAS from water	590
What are PFAS in water	480
Do water filters remove PFAS	320
How to remove PFAS from water at home	320
Which bottled water does not have PFAS	260
Does boiling water remove PFAS	210
Does zero water filter remove PFAS	210
How to remove PFAS from water at-home	210
Can PFAS be filtered out of water	170
How to filter PFAS from water	170
Does bottled water have PFAS	170
What sparkling water does not have PFAS	170
How do PFAS get into water	140
Does zero water remove PFAS	140
What water filters remove PFAS	140
How to test for PFAS in water	140
How to test for PFAS in water at home	110
How to test water for PFAS	110
Are PFAS in bottled water	110
What is PFAS in drinking water	90
What water filter will remove PFAS	90
Does Fiji Water have PFAS	90
Does Waterloo Sparkling Water have PFAS	90
Can you filter PFAS out of water	70
How to get PFAS out of water	70
How to get rid of PFAS in water	70
Are there PFAS in bottled water	70
Does bottled water contain PFAS	70
Can PFAS be removed from water	50
Do refrigerator water filters remove PFAS	50
Does boiling water get rid of PFAS	50
Does distilling water remove PFAS	50
How to remove PFAS in drinking water	50
What water filter removes PFAS	50
Does Kirkland Sparkling Water have PFAS	50
What states have PFAS in water	50
Can water filters remove PFAS	40

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water products. Examples of questions in this category included: are PFAS in bottled water and questions about specific brands of bottled and sparkling water. The fourth category, with 5.7% of questions, was how to test water for PFAS. The fifth category, with 1.9% of questions, was about where PFAS are, with questions such as are there PFAS in my water and what states have PFAS in their water? See Figure 2 for percentages of all categories and Table 1 for a full list of the analyzed questions.

Discussion

This study focuses on internet search behavior by reviewing terms most commonly used when people search for information about PFAS in water supplies. Our study's aim is to support public health messaging to inform public and commercial water consumers (rather than private well water consumers, who may ask different types of questions). In the context of drinking water, the more frequent search categories showed more focused questioning, revealing that people are especially interested in receiving information about risk mitigation and how to avoid exposure (e.g., as in specifically how to filter water to remove PFAS).

Based on descriptive inferences from these large data sets, public health communicators can develop their communication strategies with higher confidence in their decisions about what people want to know about a particular topic, such as PFAS, and thereby develop content that is perceived positively by their audience, in alignment with the CAT central tenet of communication alignment (Giles, 2016). Once communicators understand what their audience is interested in knowing and the words that the audience use, communicators can emphasize high-volume words to increase the relevance of their educational resources and to promote traffic to their websites.

Search results show that when people ask questions about PFAS and water, the most common concern is how to filter PFAS from their water. The variation in high-volume questions shows that there is considerable uncertainty among individuals regarding best practices for filtering PFAS from water, including questions about if boiling water removes PFAS from water and the effectiveness of common commercial filters. Our study recommends that public outreach focuses on communicating the current scientific uncertainty about the health risks of long-term exposure and the magnitude of risk, as well as focuses on applied self-efficacy information that households can easily incorporate into their everyday routines, such as specific knowledge on which filtration systems do and do not remove PFAS (Frewer, 2004; Lee & You, 2020).

As we did not assess the degree to which existing PFAS messaging provides such information, future research should explore these questions. For example, researchers could assess if public health communicators are spending more time explaining what PFAS are and little time giving advice on how to remove PFAS; if this situation is found to be true, then this communication strategy would reflect a misalignment between what internet users want and what the highest traffic websites offer featuring information about PFAS in drinking water in the U.S, according to our results.

Reverse osmosis filtration systems have been found to be the most effective, while other commercially available filters vary greatly in their ability to filter PFAS (Herkert, 2020). Yet reverse osmosis filters are expensive, which could lead internet users to think about other strategies for avoiding PFAS, such as using cheaper pitcher filters or buying bottled water. Based on interest and search volume, a significant portion of questions involve what types of water products contain PFAS, including questions about common brands of sparkling and bottled water. Thus, if families cannot obtain expensive filtration systems or change less-expensive filters on a regular basis, then it is useful to get information about types of commercially available water that are safe to consume. This statement is particularly true for communities that are highly affected by PFAS contamination, and thus are most likely to seek information about PFAS (Berthold et al., 2023) but least likely to be served by existing PFAS messaging (Ducatman et al., 2022). Additionally, Chow et al. (2021) found that 39% of tested bottled water contained some form of PFAS, demonstrating that information about best purchasing practices would be helpful to immediately reduce PFAS exposure.

This study presents a novel use of Google data using Semrush analytical software to gain insights about the types of questions internet information seekers are actively searching for regarding PFAS in their drinking water supply.

TABLE **1** continued

Search Volume for Questions Related to Per- and Polyfluoroalkyl Substances (PFAS) and Water

Question	Search Volume
Can you boil PFAS out of water	40
Do Berkey water filters remove PFAS	40
Do Brita water filters remove PFAS	40
Do filters remove PFAS from water	40
Does Pur water filter remove PFAS	40
Does water filtration remove PFAS	40
How do you remove PFAS from drinking water	40
How to avoid PFAS in water	40
How to reduce PFAS in water	40
How to remove PFAS from drinking water	40
What removes PFAS from water	40
Which water filters remove PFAS	40
How to test PFAS in water	40
How to test your water for PFAS	40
Is PFAS in bottled water	40
How does PFAS get into water	30
What are PFAS in drinking water	30
Can boiling water remove PFAS	30
Can you filter out PFAS from water	30
Can you filter out PFAS out of water	30
Can you filter PFAS out of your water	30
Can you remove PFAS from water	30
Do any water filters remove PFAS	30
Do fridge water filters remove PFAS	30
Do home water filters remove PFAS	30
Do water filters filter out PFAS	30
Do water filters filter PFAS	30
Do water filters get rid of PFAS	30
Do whole house water filters remove PFAS	30
Does a water filter remove PFAS	30
Does boiling water kill PFAS	30
Does boiling water remove PFAS chemicals	30
Does Brita water filter remove PFAS	30
Does Culligan water filter remove PFAS	30
Does my water filter remove PFAS	30
Does reverse osmosis remove PFAS from drinking water	30
How are PFAS removed from water	30
How to filter out PFAS from water	30
How to filter out PFAS in water	30

continued ▸

TABLE 1 continued

Search Volume for Questions Related to Per- and Polyfluoroalkyl Substances (PFAS) and Water

Question	Search Volume
How to filter PFAS from tap water	30
How to remove PFAS from tap water	30
Can I test my water for PFAS	30
How to measure PFAS in water	30
Does Dasani Water have PFAS	30
Does distilled water have PFAS	30
Does Mountain Valley Water have PFAS	30
Does Poland Spring Water have PFAS	30
Does purified water have PFAS	30
Does Smartwater have PFAS	30
Does sparkling water have PFAS	30
Does spring water have PFAS	30
Does zero water filter PFAS	30
Is bottled water free of PFAS	30
Is there PFAS in bottled water	30
What are PFAS in sparkling water	30
Are there PFAS in my water	30
Does my water have PFAS	30
Does NYC [New York City] water have PFAS	30
Is there PFAS in my water	30

Google users already are interested in topics when they use Google to seek answers to their questions. They are, by definition, already deliberating about PFAS and, as active information seekers, they are looking for answers. Exposure to new information has been found to increase information-seeking behaviors; searchers may conclude they need more information to inform their decisions (Hovick et al., 2020). Using results from this study, public health communicators can better address online information seekers' questions about PFAS in drinking water by ensuring they can find the information they are looking for, especially information regarding efficacy of filtering water or buying PFAS-free water. Furthermore, even if a public health communicator wants to cover other information about PFAS they deem more important on the websites, our results show that web-based outreach must contain content that people are searching for, or those websites will not appear on organic Google searches.

Our review of the questions internet users ask about PFAS in their water suggests that the information-seeking public seems to understand that consuming PFAS should be avoided because searchers' questions are negatively framed and focus on avoidance. In our preliminary discussions for this article, we anticipated a greater focus on inquiries pertaining to specific adverse health outcomes from PFAS exposure. Our findings show, however, that most Google searchers do not ask about the specifics of health effects, but rather searchers inquire about avoiding or removing PFAS from items they want to consume. While toxicologists identify new forms of PFAS and the government works to establish solutions to reduce and remove PFAS, the public must know best practices to reduce their exposure (Dauchy, 2019).

Environmental toxicology outreach information can get technical very quickly; by conducting keyword research, health communicators can identify the words most people use when searching for environmental pollutants. PFAS go by many names because the acronym refers to a group of chemical compounds. By understanding what terms people use, health communicators can infuse their content with keywords and specific information to ensure their content is relevant to their intended audience.

Strategic implementation of keyword research can enable health communicators to streamline their informational output, and the intentional use of these data (including findings from our study) for content development about PFAS in drinking water can help increase the accessibility and reach of educational health content as well as its perceived usefulness. Communicators can create information for any communication platform and use the insights from keyword research to answer the questions they know are being asked most frequently as obtained from statistics generated from Google, the dominant search engine in the U.S. and the world.

Limitations

The Semrush data used in our study focuses on nationally collected data and thus the data do not capture local, regional, or global differences between areas of varying degrees of PFAS exposure. This study was intended to provide a snapshot view of what questions people in the U.S. are asking about PFAS in their drinking water. Semrush can provide more locally or regionally focused results for greater site-specific insights; however, the results will be influenced by local and regional events and media coverage. Search engines other than Google were not examined in our study. Our study also did not account for underserved populations that include individuals who might have limited or no internet access. Additionally, our study did not account for people who prefer to seek information in ways other than internet searches. We also did not examine inquiries related to PFAS in well water or exposure from sources outside of drinking water.

Conclusion

Our results suggest that people already perceive PFAS as something to avoid and are inquiring about how to reduce exposure rather than further investigating more detailed information about these substances and their health impacts. Future research could explore how Google data could be effective in identifying which stage of behavior change users are in based on how the questions they ask map onto the stages of change model in behavioral psychology. The stages of change, or the transtheoretical model of change, is a theoretical framework that helps describe behavior change in a series of 6 stages (Prochaska & DiClemente, 1983).

Based on the categorical search volumes and referencing of the stages of change model (Prochaska & DiClemente, 1983), it might be shown that definitional questions about PFAS or forever chemicals (e.g., What are PFAS?) are asked by online information seekers in the precontemplation stage. Users quickly discover that PFAS harm human health and might begin asking how to avoid or filter PFAS from their water, which would be an indication that they have entered the contemplation stage. This stage is where public health communicators can provide information to help communities enter the action stage with the best available knowledge to reduce PFAS exposure from drinking water supplies. Additional research could investigate how the content of PFAS education can be framed using high-volume keywords to increase personal relevance and elaboration (Sanner & Evans, 2019). Emphasis frames can manipulate the message content visually and/or contextually to emphasize the intended audience's interests (Cacciatore et al., 2015).

With a distinct understanding of the target audience and descriptive data collected strategically, health communicators can emphasize related information to address their intended audience's interests, thereby further increasing the message's effectiveness through alignment with the audience. Future research will develop deeper insights based on more specific audience groups that can be examined to increase the effectiveness of strategic communication campaigns and the influence of desired behavior change.

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Did You Know?

The Private Water Network is a virtual platform and community of professionals working to protect the public's health from contaminants in private drinking water sources. It is the only network specifically for professionals who serve communities with private drinking water and septic systems. Learn more and join this network at www.neha.org/private-water-network.