



National Occurrence and Causes of Boil Water Advisories in the United States Report to Congress

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Executive Summary

The *Safe Drinking Water Act* requires the EPA to establish and enforce standards that public water systems (PWSs) must follow. A critical objective of a PWS is to provide safe, affordable drinking water continuously. When a situation occurs during which the water is, or may likely become, contaminated with microbial pathogens (e.g., *Giardia*, *Cryptosporidium*, *E. coli*, and viruses), a PWS may voluntarily issue a boil water advisory (BWA) to better protect public health while the issues are being resolved. Contamination, or the potential for contamination, may be the result of several factors. These factors include source water contamination, lack of adequate treatment or treatment failures and failures of, or damage to, water system infrastructure. BWAs may be needed for a single event or may be needed where identified contamination, or the potential for contamination, and vulnerability persists and remediation, such as capital improvements, are needed. A BWA is a voluntary protective public health measure that the water systems can take until contamination, or the potential for contamination, is corrected. Understanding the prevalence and causes of BWAs across the United States can provide critical information on the health and sustainability of the PWS infrastructure.

The *Infrastructure Investment and Jobs Act* (Public Law 117-58, Section 50115, November 15, 2021) requires the Administrator of the U.S. Environmental Protection Agency to conduct a study on the prevalence of boil water advisories issued in the United States. The legislation requires that the Administrator submit a report to Congress describing the results of the study. The report must include a description of the reasons for which the BWA was issued.

The EPA analyzed information collected on the BWAs issued across the United States to identify the most prevalent cause of BWAs and any trends in PWS type, size, and source. The majority of BWAs were issued because of main breaks, distribution system repairs, or loss of water pressure events (e.g., power outages or tank pressure loss) and most of those BWAs were issued as a precaution while additional sampling was performed to clarify whether fecal contamination, measured as *E. coli* bacteria, was present in the distribution system. The second highest category of an issued BWA was for unknown or unidentified reasons.

The majority of BWAs were at community water systems. Community water systems serve at least 15 connections used by year-round residents or regularly serve at least 25 year-round residents.

PWSs are identified by their source type as either surface water PWSs or ground water PWSs. The majority of BWAs occurred in ground water PWSs. In a small number of cases the source type for the systems could not be identified.

The Safe Drinking Water Act allows states, Tribes, and territories to receive approval from the EPA to have the primary enforcement responsibility (or primacy) for the PWS program if they have established programs that meet the standards set by the EPA to support drinking water systems, ensure that drinking water systems consistently provide a safe and adequate supply of water to consumers, and ultimately protect public health. Where state, Tribe, or territory has an approved PWS primacy program, the EPA provides the national oversight and retains its independent compliance monitoring and enforcement authorities. In this report the term “state” refers to a state, territory, or Tribe that has primacy under the SDWA.

The primary PWS source (i.e., ground water vs. surface water) and the PWS size (i.e., population served) did not have much of an effect on the number of BWAs issued. However, the specific reasons for issuing a BWA varied by PWS size. Very small water systems (serving less than 500) had the highest number of BWAs in categories 1, 2, 3 and 6. This may reflect the continuing challenges faced by very small water systems in maintaining compliance with the National Primary Drinking Water Regulations (NPDWRs) and adequate infrastructure due to the lack of technical, managerial, and financial capacities. This also may be reflected in the number of ground water systems with BWAs compared to the number of surface water systems with BWAs. More than 90 percent of public water systems serving less than 10,000 people use a groundwater source.

The BWA events were assigned to one of six categories. Category 1 advisories include those issued for a microbial violation, where a microbial contamination was identified, where sanitary risks have been found, where there were treatment technique failures, or treatment interruptions. A significant number of BWAs issued in Category 1 were at very small PWSs (population served ≤ 500). This is consistent with the Safe Drinking Water Information System Federal Reporting Services (SDWIS/Fed) violation data for the NPDWRs compliance for small water systems where the lack of technical, managerial, and financial capacity at these systems contributes to ongoing compliance concerns.

Introduction

Public water systems are critical infrastructure that provide services vital to the health, safety, and economies of communities throughout the United States. Although most PWSs typically strive to provide safe, affordable drinking water continuously, situations arise that may temporarily disrupt service or require consumers to take precautionary measures to protect their health (e.g., boiling water before use). Such situations vary in terms of scope, scale, and severity. For example, routine maintenance or a small water main break may impact a handful of consumers for a short period of time, while a hurricane or other natural disaster that causes widespread infrastructure disruption or power outages may impact hundreds of communities throughout a state or region for an extended period. When a situation occurs during which water is or may likely become contaminated with microbial pathogens (e.g., *Giardia*, *Cryptosporidium*, viruses, or bacteria), PWSs may issue consumers an advisory notifying them to boil the water before use (i.e., a “boil water advisory”).

Individual states and local agencies often have different names for drinking water advisories depending on the situation. Boil Water Advisories, for example, may also be called “boil water notices,” “boil water alerts,” and “boil water orders.” For the purposes of this study and report, the term BWA includes all instances in which a boil water statement is issued regardless of the regulatory authority or organization issuing the BWA.

This report presents the results of an analysis conducted by the EPA on the prevalence of BWAs issued in the United States during the 2021 calendar year to satisfy the Congressional mandate directing the EPA Administrator to conduct such a study on an annual basis and submit to Congress a study report with the agency's annual budget request.

The study focuses on PWSs as they are defined in the *Code of Federal Regulations* (40 CFR 141.2). Water suppliers that are not PWSs, including households that maintain a private well, are not considered here. However, people that rely on private wells at their residences may also consume water from PWSs at schools, businesses, and other establishments.

A PWS is defined at 40 CFR 141.2 as a system that provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves at least 25 people for at least 60 days a year.

Boil Water Advisory Background

PWSs use drinking water notifications and advisories to protect public health, meet federal and state regulatory requirements, educate consumers, build trust in and support for services and maintain a positive relationship with their community. Some notifications are solely informational and are not related to a situation that poses a public health risk (e.g., a notice to inform consumers about anticipated seasonal changes in how the water tastes). Other notifications, often referred to as advisories, are used when a PWS or regulatory agency believes that services are or may be disrupted, or that water quality may be compromised. Advisories may alert PWS consumers to be prepared for an anticipated event, such as a hurricane that may disrupt service, or instruct them to take specific measures due to potential contamination (e.g., boil water or use an alternative source of water).

“Boil Water,” “Do Not Drink,” and “Do Not Use” are three types of drinking water advisories that instruct consumers to take immediate action to protect their health. Before issuing such an advisory, PWS, state, and local officials may weigh the potential public health risks against other impacts on customers (e.g., costs for businesses to boil water or use an alternative source such as bottled water). BWAs are the most common advisory, typically issued for the potential of microbial contamination because boiling water kills many disease-causing microbes. “Do Not Drink” and “Do Not Use” notices, which are less common, are often issued due to chemical contamination and are not part of this boil water advisory analysis.

To assist drinking water systems and states, the EPA has recommended BWA language (example provided in Appendix B) that may be included in notices for different regulatory situations. State policies specify when BWAs are required or recommended¹. Further, in some cases the EPA may invoke its SDWA authorities to require a system to issue a BWA independent of any state policies. In some circumstances PWSs or the local public health department may issue BWAs at their discretion. Some BWAs are issued to all consumers served by the water system, while others may impact a sub-group of consumers who are served by certain sections of the PWS. BWAs may last days, months, or years, depending on the threat and how the water system is operated. Once the concern that triggered a BWA

¹ Although the NPDWRs do not require PWSs to issue BWAs, there are situations for which federal policies recommend BWAs. Several states use certain provisions in the NPDWRs as triggers for requiring BWAs. BWA policies vary by state. States are not required to report information regarding BWAs to the EPA.

has been addressed, the advisory is “lifted” or “rescinded,” and consumers are notified that they no longer need to boil the water prior to consumption.

Safe Drinking Water Act

The *Safe Drinking Water Act* is the federal statute that protects public health by regulating PWSs. It authorizes the EPA to set standards for drinking water quality in the National Primary Drinking Water Regulations; and gives states, territories, and Tribes the opportunity to assume primary enforcement authority of those standards (i.e., primacy). States, territories, and Tribes can also set and enforce their own drinking water standards, provided their requirements are at least as stringent as the EPA’s national standards. Direct oversight of PWSs for compliance with NPDWRs is largely conducted by primacy agencies through the Public Water System Supervisory Program (PWSS Program). However, even in primacy states, the EPA continues to maintain oversight authorities to ensure compliance with NPDWRs. The NPDWRs, as they relate to BWAs, the PWSS Programs and primacy agencies are described in more detail below.

Public Water System Types

The EPA classifies PWSs into three categories based on the number of people served by the water system and whether the same consumers are served year-round or on an occasional basis. The three categories of PWSs are:

- **Community water systems (CWSs)** serve at least 15 connections used by year-round residents or regularly serve at least 25 year-round residents.
- **Non-transient non-community water systems (NTNCWSs)** serve 25 or more of the same people at least six months per year. Examples include daycares, schools, factories, hospitals and office buildings that have their own water system.
- **Transient non-community water systems (TNCWSs)** serve 25 or more people per day at least 60 days per year. The people served the water do not need to be the same people. Examples include gas stations, hotels, campgrounds and restaurants.

There are about 144,000 PWSs in the United States that serve an estimated 330 million people per day (Figure 1).

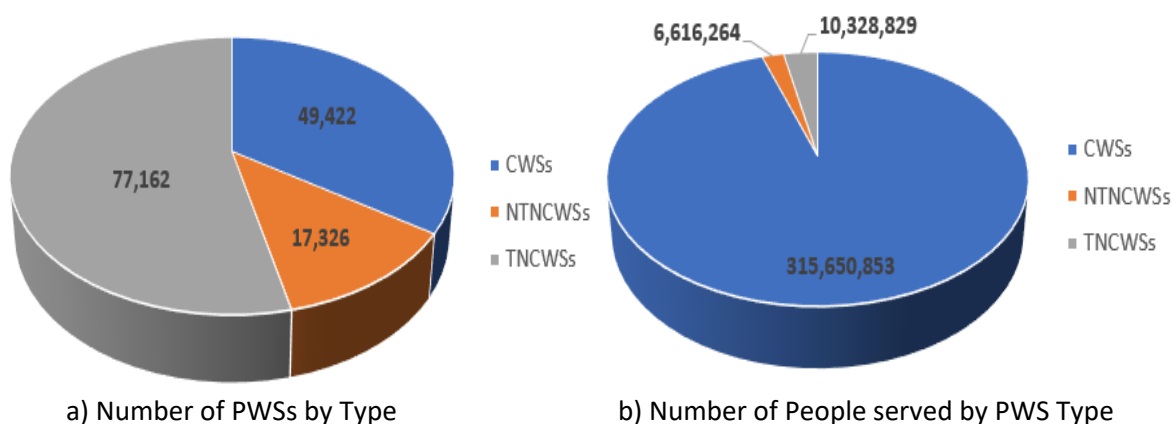


Figure 1: PWS Breakdown [Source: Safe Drinking Water Information System Federal Reporting Services (SDWIS/Fed) (Submission year 2022 Quarter 1)]

National Primary Drinking Water Regulations Overview

The NPDWRs are legally enforceable primary standards and treatment technique requirements that apply to PWSs and protect public health by limiting the levels of contaminants in drinking water. The NPDWRs for microbial contaminants reflect a risk-based, multi-barrier approach to control microbial pathogens as well as public communication requirements. Although the requirements of NPDWRs can vary based on a PWS's type classification and its water sources, all PWSs are required to:

- Protect water sources by identifying and limiting potential sources of contamination (e.g., loss of pressure and cross-connections and backflow events).
- Monitor for disinfectant residual (if applicable) in the distribution system to protect against microbial regrowth and issues in the distribution system that may lead to microbial contamination.
- Monitor water quality for indicators of microbial contamination.
- Take corrective actions to address potential vulnerabilities and deficiencies that may lead to microbial contamination; and
- Notify the public of potential health risks.

Drinking water treatment requirements regarding inactivation or removal of microbes are based upon the PWS's source water and are included in the suite of Surface Water Treatment Rules² and the Ground Water Rule. (40 CFR 141 Subpart S). These NPDWRs establish the performance criteria for filtration and/or disinfection treatment before water enters the drinking water distribution system.

The Public Notification Rule (40 CFR Subpart Q) requires all PWSs to notify their consumers about significant events related to the water system, including violations of NPDWRs or other situations where a violation has not occurred when these events pose a public health risk due to microbial contamination. Each notice must describe the violation or other situation, including the contaminant(s) of concern and any potential adverse health effects, the population at risk, actions consumers should take to reduce risks (e.g., boil water or use an alternative water supply), what the system is doing to correct the violation or other situation and when they expect it to be resolved.

Each violation or other situation requiring a notice is assigned to one of three tiers based on the risk of adverse health effects. Tier 1 notices,³ which are the most time-sensitive, are for violations and situations with significant potential to have serious adverse human health effects from short-term exposure, including effects from microbial pathogens. PWSs must notify people that may use the water about Tier 1 situations within 24 hours. The EPA recommends⁴ that PWSs include BWA language when a Tier 1 notice related to microbial contamination is required, including for the following situations:

- *E. coli* maximum contaminant level (MCL) violations under the Revised Total Coliform Rule (40 CFR 141, Subpart Y).
- Detection of *E. coli*, enterococci, or coliphage in a ground water source sample.

² The suite of Surface Water Treatment Rules includes the Surface Water Treatment Rule (40 CFR 141 Subpart H), Interim Enhanced Surface Water Treatment Rule (40 CFR 141 Subpart P), Long-term 1 Enhanced Surface Water Treatment Rule (40 CFR 141 Subpart P), and the Long-term 2 Enhanced Surface Water Treatment Rule (40 CFR 141 Subpart W).

³ Tier 2 and 3 notices are for violations and other situations that do not pose adverse health risks from short-term exposure.

⁴ Source: U.S. EPA (2010) [Revised Public Notification Handbook](#), EPA 816-R-09-013, March 2010.

- Certain treatment technique violations under the suite of Surface Water Treatment Rules and Ground Water Rule; or
- Occurrence of a waterborne disease outbreak or other waterborne emergency.

Although BWA policies vary by primacy agency, most follow these recommendations from the EPA. In addition, primacy agencies' policies may also identify other situations that trigger BWAs.

As mentioned earlier, direct oversight of PWSs for compliance with NPDWRs is conducted through the PWSS Program. Section 1413 of the SDWA gives states, territories and Tribes the opportunity to obtain primacy for implementing the PWSS Program within their jurisdiction. To obtain and maintain primacy, states, territories and Tribes must adopt and enforce drinking water standards that are at least as stringent as the EPA's national standards (or the NPDWRs).

Primacy agencies' responsibilities related to drinking water standards include requiring that PWSs monitor for contaminants, reviewing plans and specifications for PWS improvements, conducting on-site inspections and sanitary surveys, issuing violations, providing training and technical assistance and ensuring that PWSs inform their consumers about violations the PWS has incurred and the quality of the water they are providing. Using annual Congressional appropriations under SDWA section 1413, the EPA provides grants to eligible primacy agencies to develop and implement the PWSS Program. This funding helps ensure the SDWA requirements are enforced and PWSs comply with the NPDWRs.

With the exceptions of Wyoming and the District of Columbia, all states, the Navajo Nation, and five U.S. territories (i.e., Puerto Rico, the U.S. Virgin Islands, American Samoa, Guam, and the Commonwealth of Northern Mariana Islands) currently have primacy for the NPDWRs. In cases where states, territories or federally recognized Tribes do not assume primacy, the EPA serves as the primacy agency and implements the PWSS Program directly. The EPA plays an important oversight role and retains its independent compliance monitoring and enforcement authorities, even if a state, territory or Tribe has primacy.

The EPA's authorities include Section 1414 of the SDWA, which provides the agency with the authority to enforce violations of "any applicable requirement" of a state or federal program. Congress defined "any applicable requirement" expansively to include, among other things, more stringent requirements of a state primacy program. Section 1445 of the Act also provides the EPA with authority to request information from a PWS or to conduct an onsite inspection of the system in order to determine compliance or identify potential health risks. Finally, SDWA Section 1431 confers the EPA with emergency authority to address contamination that "may present an imminent and substantial endangerment to the health of persons." As noted above, the EPA may require a PWS to issue BWAs and to take other related corrective measures, such as flushing the distribution of the system.

Data and Information Sources

The EPA used data available from a variety of sources to develop its analysis, each of which is described below.

ASDWA and State Websites

The Association of State Drinking Water Administrators worked with the state drinking water programs on their practices for tracking BWAs. Twenty (20) states responded with information. Some states

responded that they planned to organize or begin tracking while other states indicated they do not have plans to track BWA information.

The EPA also conducted searches on the state agencies websites using common terms such as “Boil water,” “Boil Water Order (BWO)/BWA list,” and “Public Notice Boil Water.” Some BWA data were obtained using targeted internet searches for state-specific datasets. The extent of information varied from updated BWA databases with extensive information, including information for current BWAs and lifted BWAs, to only current and on-going BWAs. In some cases, the BWAs are removed from the public sites after the BWA has been lifted to avoid confusion for the public.

A few states had a section on their website dedicated to providing links to BWA notices, published by local news outlets. Occasionally, links were inactive and inaccessible, or there was no indication of when the BWA was lifted.

Online Searches

The Center for Accountability in Science (CAS)⁵ compiled a list of BWAs for calendar year 2021 that were reported by news outlet articles. The CAS dataset includes information on the date reported, the location affected, the number of people affected, the cause, the duration and the data source (news article), if known. This list was developed by CAS through targeted internet searches; therefore, additional searches for specific news articles reporting on BWAs were not conducted. The EPA conducted further online research to verify that online database sources were captured to the extent possible. The EPA also conducted general Google searches using common terms such as “Boil water,” “Boil Water Order (BWO)/BWA list,” and “Public Notice Boil Water” and a specific state, in the event the state health and environmental agency site did not have an available BWA database.

SDWIS/Fed Data

The Safe Drinking Water Information System Federal Reporting Services is the EPA’s national database that manages and collects PWS information from primacy agencies, including reports of drinking water standard violations, reporting and monitoring violations, and other basic information, such as water system location, type and population served. In addition to using available information in SDWIS/Fed on BWAs, the EPA also used the database to identify additional information about the BWAs identified through the state information and online searches discussed above. For example, if a BWA included the PWS name and/or PWS identification number (PWSID), that information was used to identify additional information such as the primary water source (i.e., ground water vs. surface water) and PWS type (i.e., CWS, NTNCWS, TNCWS) for the BWA. For those BWAs that had limited information, including no official PWS name or the PWSID, the water source and PWS type would be recorded as unknown.

Data Limitations to Identifying BWAs

The information compiled in this report was limited due to a variety of factors, including availability of BWA data from primacy agencies, various data collection methodologies used by primacy agencies and the different level of content provided in the BWAs.

⁵ Source: <https://accountablesience.com/about-us/>

In most circumstances, primacy agencies are typically responsible for oversight of the issuance of BWAs. While primacy agencies may require BWAs and BWA reporting, not all primacy agencies maintain databases that track BWA occurrence and causes, and if they do, this tracking information is not always publicly available. BWA information is managed using a variety of primacy agency-specific databases; therefore, information regarding the issuance and causes of BWAs is also inconsistent in scope and completeness. Primacy agencies' BWA tracking databases may have limited data fields and descriptions. Some databases provided limited information on the BWAs, such as the name of the PWS, the general reason for the BWA (e.g., microbial), and the start and end dates. Other datasets provided information on whether the BWA event was caused by a specific natural disaster event, or attributed to scheduled repairs in precautionary situations, as compared to a response to unpredictable events such as a main break.

Some primacy agency databases for tracking BWAs indicate whether a violation also occurred during the BWA event but may not fully describe the violation.

In general, the primacy agency BWA databases contained more BWA event information than was often available in press releases to consumers. In a few instances, BWAs obtained for this study from press releases did not contain details about the situations or causes prompting the BWAs. In some situations, press releases contained geographic descriptions such as town names without including the PWS name; therefore, the PWS type, size, and source were left as unknown [7.5 percent (302) of issued BWAs].

The EPA found other discrepancies in the data provided regarding the length of the BWAs. Numerous BWAs appear to remain unresolved (i.e., no end date was provided), and it is unclear whether the end date was simply not included in the dataset or if the situation remains unresolved. Out of all the BWAs identified, 29.5 percent (1,190) appear to be open at the end of 2021 with six percent (241) remaining open because the event was not documented as resolved. The status of the remaining 22.3 percent (899) of the BWAs could not be determined.

The occurrence of unprotected cross-connections was not tracked in any BWA database. For this reason, the occurrence of potential backflow contamination events could not be quantified.

Data Analysis

Reasons for Issuing BWAs

There are a variety of ways that water can be contaminated with microbial pathogens. The EPA analyzed information collected on the BWAs issued across the United States to identify the most prevalent cause of BWAs and any trends in PWS type, size, and source. The BWA events found in the data reviewed were assigned to one of six categories. These categories are based on the highest level of known public risk in decreasing order in terms of an identified or attributed public health risk. The six categories were:

- Category 1 – Microbial violation, microbial contamination identified, sanitary risks found, treatment technique failures, and treatment interruptions.
- Category 2 – Long-term/extended deficiencies (vulnerable or improperly constructed source, required treatment not provided).
- Category 3 – Natural or other disasters.
- Category 4 – Backflow events.
- Category 5 – Main breaks, distribution system repairs, and loss of water pressure events.

- Category 6 – Unknown/not identified.

A detailed description of each category follows.

Figure 2 in the following section provides information on the number BWAs issued as a result of the reason.

Category 1. Microbial violation, microbial contamination identified, sanitary risks found, treatment technique failures, and treatment interruptions.

When a PWS incurs a microbially related health-based violation, or fecal contamination is identified at a PWS, a BWA is typically issued in conjunction with required regulatory notices under 40 CFR 141 Subpart Q to the public about the violation or fecal contamination. Records for health-based violations of this nature are maintained by the primacy agency and include compliance schedules and enforcement actions. These BWAs are usually directed by the primacy agency, or in some instances by the EPA in its oversight role and are not precautionary in nature. They represent known situations when a PWS has failed to meet microbial standards of the NPDWRs, has identified fecal contamination, or has failed to provide required treatment. A few examples of these types of situations include:

- Fecal contamination or *E. coli* identified in the distribution system (microbial violation and/or fecal contamination identified); and
- Failure to operate disinfection or filtration treatment as required (treatment technique failure).

In situations where coliform bacteria are found in the distribution system pipes of a water system, but no NPDWR violation has occurred or fecal contamination is suspected but has not yet been confirmed, there may still be the possibility of fecal contamination in the water system. This situation typically involves issuing a precautionary BWA while additional sampling is performed to clarify whether fecal contamination, measured as *E. coli* bacteria, is present. Additional situations in this category include:

- Interruptions in treatment where no violation was incurred; and
- The primacy agency has identified sanitary risks and the water system is in the process of completing timely corrective action; however, there was no confirmed fecal contamination of the water system.

Category 2. Long-/extended (vulnerable or improperly constructed source, required treatment not provided)

This category of BWAs is associated with the quality of water sources and appropriate treatment of those sources. If there is a change in water quality that indicates new microbial contamination at the source, or if the source is ground water that is newly designated as being groundwater under the direct influence of surface water (i.e., GWUDI) and as a result, vulnerable to microbial contamination and additional treatment requirements may become necessary and an interim BWA may be issued. In situations like these, the duration of BWAs may typically be longer than other BWAs where the cause can be resolved without capital improvements due to the time needed to design the treatment system, obtain related plan approvals and install the new treatment.

Similarly, structural changes may need to be made at the water system if the primacy agency finds improperly constructed wells or intakes. These changes would also need time for design, permit approval, and equipment modifications or installation.

Category 3. Natural or other disasters

Natural or other disasters such as floods, ice storms, droughts, lightning storms and fires can cause disruptions in water services. These include water main breaks, power outages, treatment or storage failures and changes in source water availability. Although many PWSs assess vulnerabilities to improve their resilience and capability to respond to adverse events, natural disasters can still damage PWSs when infrastructure is overwhelmed by severe events. Quick restoration of service following a natural or other disaster is important for providing quality water to consumers. The BWAs are often issued after the storm when it becomes known that the PWS is adversely affected by the storm; however, a primacy agency may require the PWS to issue a precautionary BWA in advance of an impending natural disaster (e.g., hurricane).

Category 4. Backflow events

Normally, the operating pressure of a PWS drinking water distribution system prevents water in a building's plumbing system from re-entering the PWS distribution system (i.e., backflow event). During a backflow event, a loss of pressure in the distribution system or a higher pressure in the building plumbing system can reverse the flow of water. If there is a connection between the PWS distribution system and a building's plumbing system where a potential contaminant may be present that is not protected by the appropriate method or backflow prevention device, this reversal of flow could cause contamination of the drinking water supply.

Primacy agencies perform sanitary surveys to ensure water systems implement a cross-connection oversight program. The EPA, either in a direct implementation role or an oversight role in a primacy state, may conduct onsite evaluations by doing sanitary surveys or inspections and observe potential cross connections. When an unprotected cross-connection is identified at a PWS, the PWS may be required to issue a BWA until the cross-connection is protected or eliminated. For the issued BWAs of this reporting period, there was no identified occurrence of an actual backflow contamination event that resulted in a BWA being issued.

Category 5. Main breaks, distribution system repairs, and loss of water pressure events

Main breaks, distribution systems repairs, and loss of water pressure events can compromise the protection provided in a public water supplier's distribution system and can result in microbial contamination of the water supply. The water supply or pipes can be exposed to the soil or flooding of streets while losses of system pressure can result in infiltration, reversed flows or siphon conditions that can introduce water of unknown quality from customer's connections.

Main breaks can occur due to deteriorated infrastructure that is used beyond its expected service life, seasonal freeze-thaw thermal expansion, localized pipe corrosion, or accidental rupturing of a water main when other work is performed in the area, among other reasons. Deterioration of a water system's distribution system infrastructure is a function of both material age and the cumulative effect of hydraulic and operating forces acting on it. Main breaks and distribution system repairs can include water main or valve leaks and service connection piping leaks.

Pressure management is an important element of water quality management for PWSs because it helps to sustain high water quality and reduce water losses and main breaks. To maintain optimal water pressure throughout the distribution system, the water system needs to address varying terrain elevation and consumer water demand. System design or inadequate operating practices can contribute to ineffective low and high pressures.

The federal drinking water regulations consider maintaining continued positive water pressure in all parts of the distribution system to be an operational practice that can achieve compliance with the MCLs for *E. coli*

[40 CFR 141.631(3)]. Water systems must also meet any state water pressure requirements or local plumbing codes.⁶

Loss of system pressure at a ground water source can commonly be attributed to well pump malfunctions due to lack of power or insufficient source water quantity to meet system supply demands. Other losses of system pressure in the distribution system that are not attributed to a main break can be from power outages or from the storage facility, which may be impacted by leaks or planned activities such as storage facility cleaning or inspection. 16.6 percent of the total BWA occurrences (668) were attributed to power outages or other loss of system pressure unrelated to natural disaster events. Power or pressure issues at the water source, unrelated to natural disaster events, were less than one percent (33) of the total BWAs occurrences. Other losses of water pressure unrelated to natural disaster events that were not attributable to source issues or main breaks were found to be 5.5 percent (222) of the total BWA occurrences. 2.2 percent (88) of the total BWA occurrences were attributed to power outages unrelated to weather events.

Category 6. Unknown/not identified.

Some of the primacy agency tracking methods do not specify the cause of the BWA event. This category represents those BWAs for which information was not available to properly describe the BWA event.

BWAs by category

Figure 2 provides a breakdown of the various reasons for issuing a BWA with each reason described earlier corresponding to a category. The largest reason identified for a PWS to issue a BWA is Category 5, main breaks and distribution system repairs and loss of water pressure events. Eighty percent of BWAs (3,221) occurred due to main breaks, distribution system repairs and loss of water pressure events. In the majority of water main break and repair situations, 63.2 percent of BWA events (2,550), the primacy agency did not identify whether there was pressure loss impact. For those situations where pressure loss was attributed to main breaks and distribution system repair situations, 12.5 percent of BWA events (504) were reported to have resulted in uncontrolled loss of pressure, while 4.1 percent of BWA events (167) were identified to have partial loss of pressure. Some distribution system repairs were planned or scheduled distribution work and performed under a precautionary BWA. This analysis found that 6.2 percent (252) of BWA events in all categories were attributed to planned or scheduled source, treatment, or distribution system repairs.

The second highest category of an issued BWA was for unknown or unidentified reasons (Category 6) at 11.2 percent (454). Identified microbial contamination or events with the potential for fecal contamination (Category 1) were a cause for 6.3 percent of the BWAs found (256). Natural or other disasters (Category 3) were identified as a cause for 1.4 percent of BWAs found (57). There were no backflows events found as a cause for BWAs.

⁶ Source: ASDWA (2020) [State Drinking Water Distribution System Survey](#).

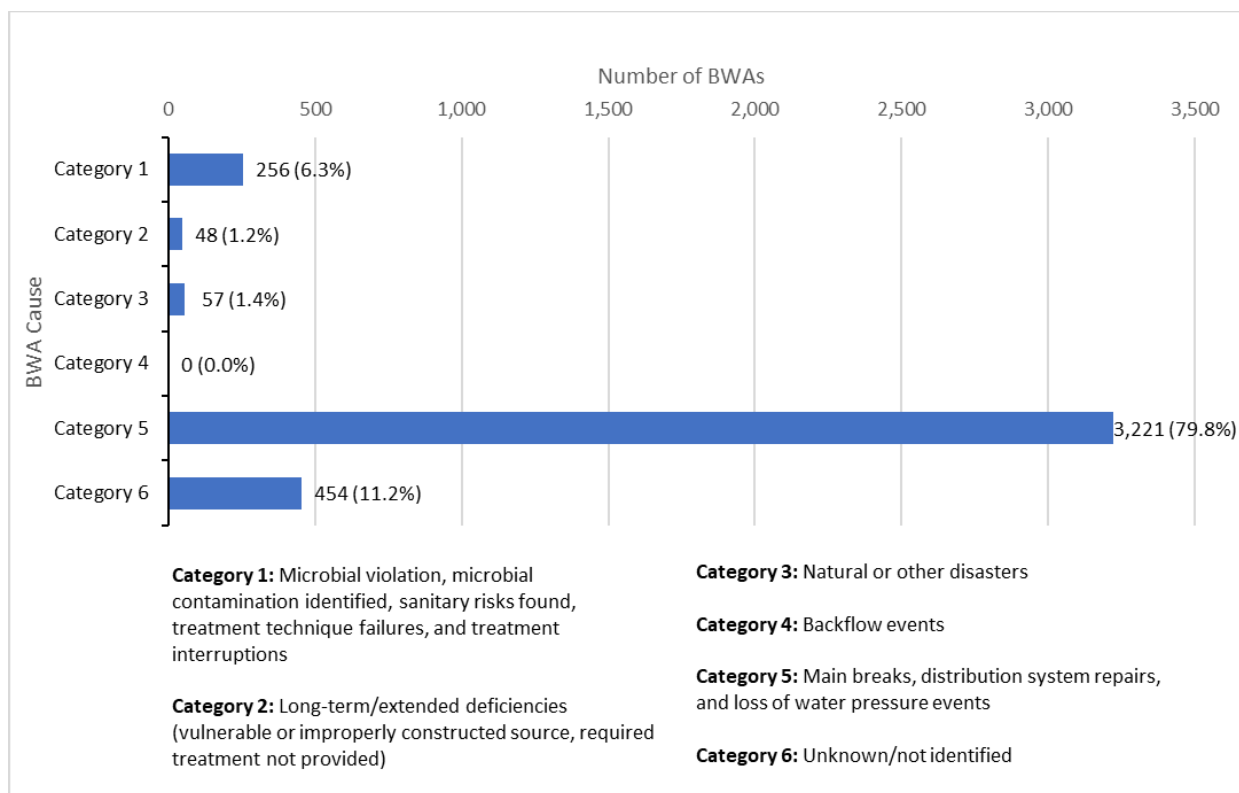


Figure 2: Reasons for Issuing BWAs in 2021

BWAs by system size

PWSs are often categorized by the number of people served (population served) by the PWS due to the differences in available resources, capital, personnel, and other unique challenges. PWSs serving 10,000 or fewer customers represent more than 92 percent of all CWSs, and nearly all the NCWSs.⁷

For the purposes of this report, PWSs were divided into five size categories:

- Very small: ≤500
- Small: 501 – 3,300
- Medium: 3,301 – 10,000
- Large: 10,001 – 100,000
- Very large: >100,000

As seen in Figure 3, 23.8 percent (961) of the BWAs were issued by large PWSs, while 22 percent (889) were issued by small PWSs, and 19.9 percent (803) were issued by very small PWSs. When focusing on PWSs serving less than 10,000 people, the BWAs for these size systems account for 58.1 percent (2,345) of all issued BWAs in 2021. The system size could not be determined from the data collected for 10.5 percent (425) occurrences and are categorized and included as “unknown” in Figure 3.

⁷ Source: U.S. EPA (2011) [National Characteristics of Drinking Water Systems Serving Populations Under 10,000](#). EPA 816-R-10-022, July 2011.

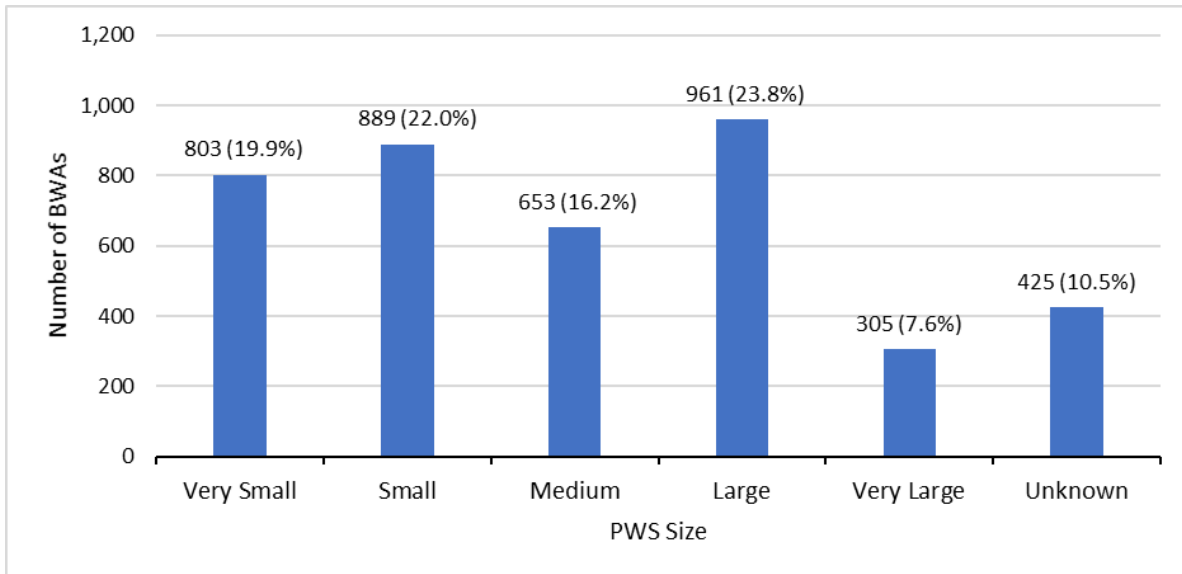


Figure 3: BWAs by PWS Size in 2021

For BWAs issued for Category 5 – main breaks, distribution system repairs, and loss of water pressure events by PWS size – Figure 4 shows that 28.6 percent (921) of these issued BWAs were at large PWSs, compared to the 24 percent for all issued BWAs (961), as shown in Figure 3. Meanwhile, the number of very small PWSs that issued BWAs for main breaks, distribution system repairs and loss of water pressure events is only 10.6 percent (341), compared to 20 percent for all issued BWAs (803).

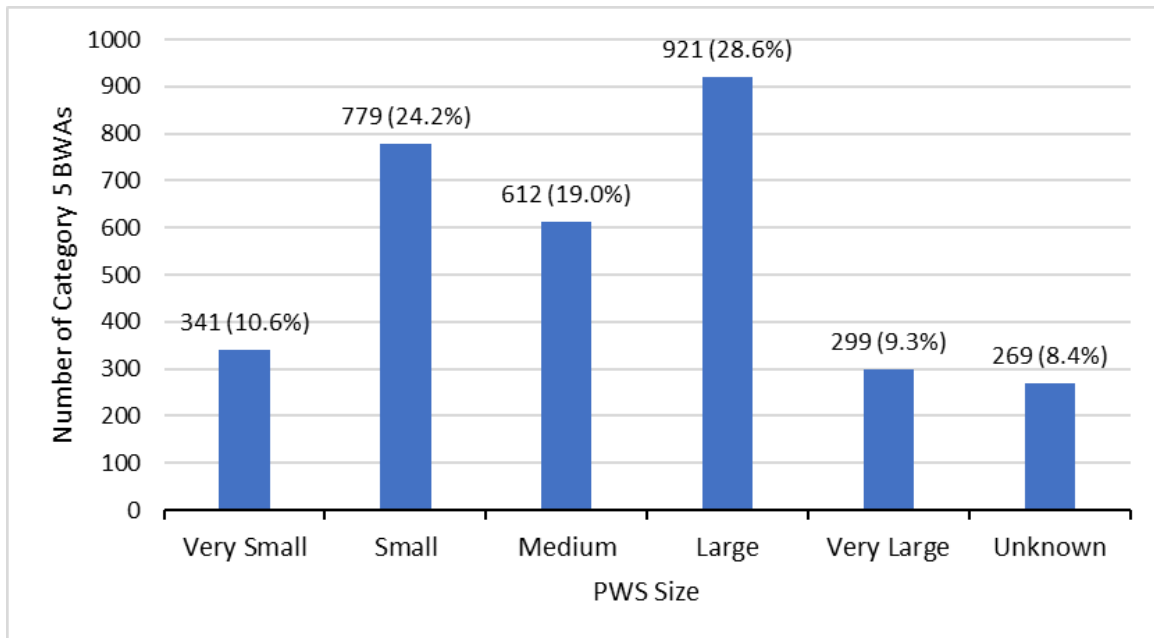


Figure 4: BWAs under Category 5 – Main Breaks and Distribution System Repair by PWS Size in 2021

Figure 5 shows the variability in the PWS size and the reasons for issuing a BWA for the remaining categories, excluding Category 4 – backflow events – since there were no BWAs issued for that category. For example, 43.4 percent of BWAs (111) issued for Category 1 BWAs – microbial violation, fecal contamination identified, sanitary risks found, treatment technique failures, and treatment

interruptions – were at very small PWSs. Similarly, 63.4 percent (288) of the Category 6 BWAs – unknown/not identified – were at very small PWSs.

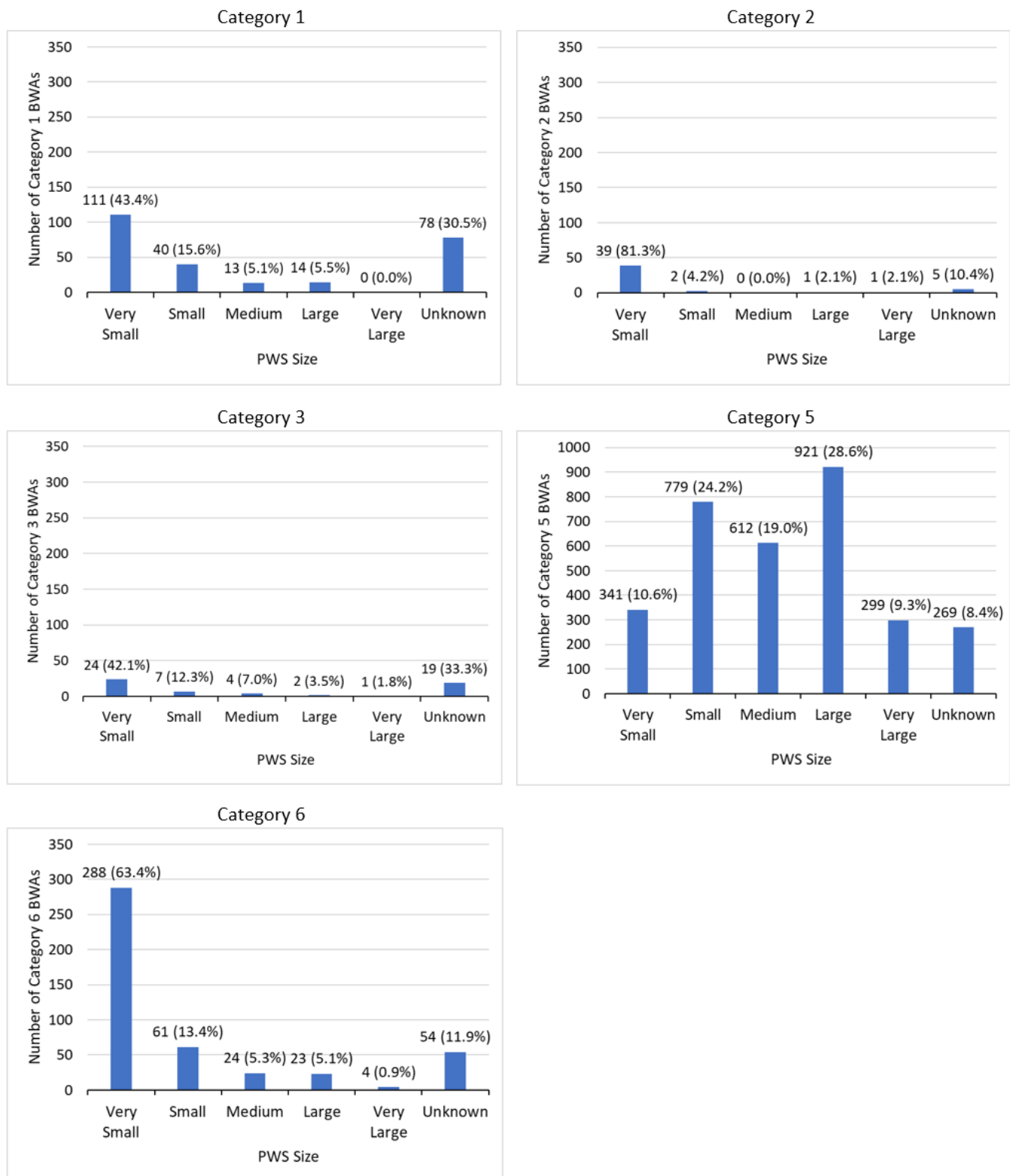


Figure 5: Reasons for Issuing BWAs by PWS Size in 2021

BWAs by system type

Figure 6 shows a breakdown of the different PWS types (i.e., CWSs, NTNCWSs, and TNCWSs) and the number of BWAs issued by each PWS type. The data shows that 80 percent of the BWAs issued (3,228) were issued by CWSs while 7.1 percent (288) were issued by TNCWSs, three percent (122) were issued by NTNCWSs, and 9.9 percent (398) of the BWAs were for unknown types of PWSs.

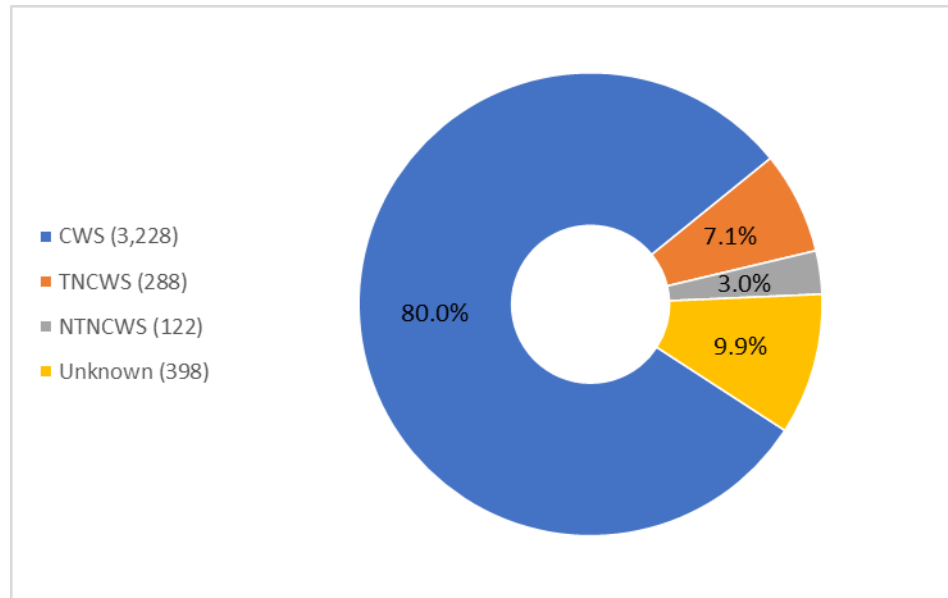


Figure 6: BWAs by PWS Type in 2021

For BWAs issued for Category 5 BWAs – main breaks and distribution system repairs by PWS type, Figure 7 shows that 88.9 percent of these issued BWAs (2,862) were at CWSs. NTNCWSs and TNCWSs each only comprised approximately 1.9 percent (62) and 0.9 percent (28) of these BWAs, respectively, while 8.4 percent (269) of the PWS type was unknown.

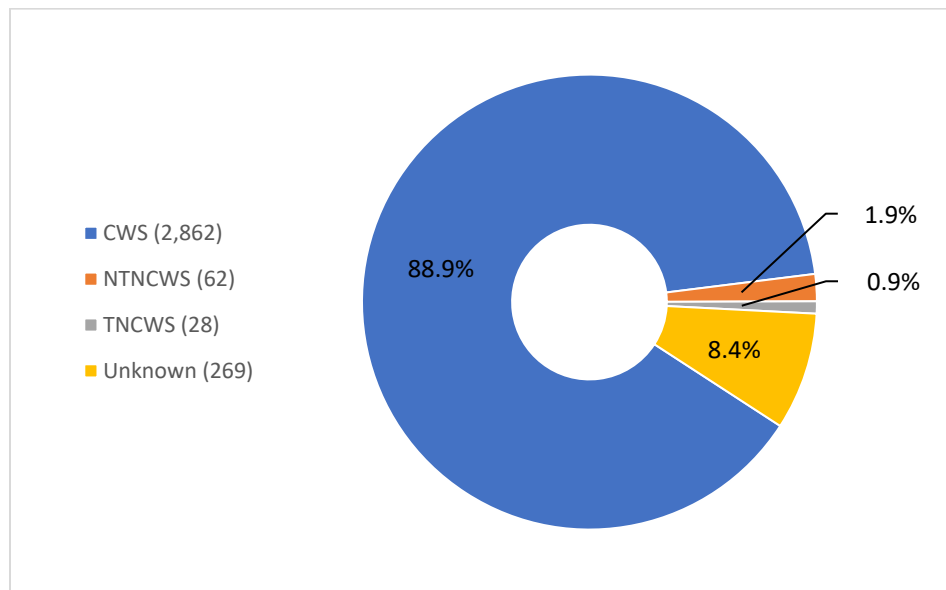


Figure 7: BWAs under Category 5 – Main Breaks and Distribution System Repair – by PWS Type in 2021

BWA by source type

PWSs are identified by their source type as either surface water PWSs or ground water PWSs. If a PWS uses any surface water, it is identified as a surface water PWS even if they also use ground water. For the BWA occurrences reviewed for this report, 31.8 percent (1,284) were by surface water source PWSs while 57.7 percent (2,327) were PWSs served by a ground water source (Figure 8). The source water type was unknown for 10.5 percent of the PWSs (425). When only looking at the BWAs issued for Category 5 – main breaks, distribution system repairs, and loss of water pressure events – by PWS source type, the percentages are about equal to all BWAs (i.e., 35.4 percent for systems served by a surface water source (1,139), 56.3 percent for systems served by a ground water source (1,813), and 8.3 percent (269) for which the source type was unknown).

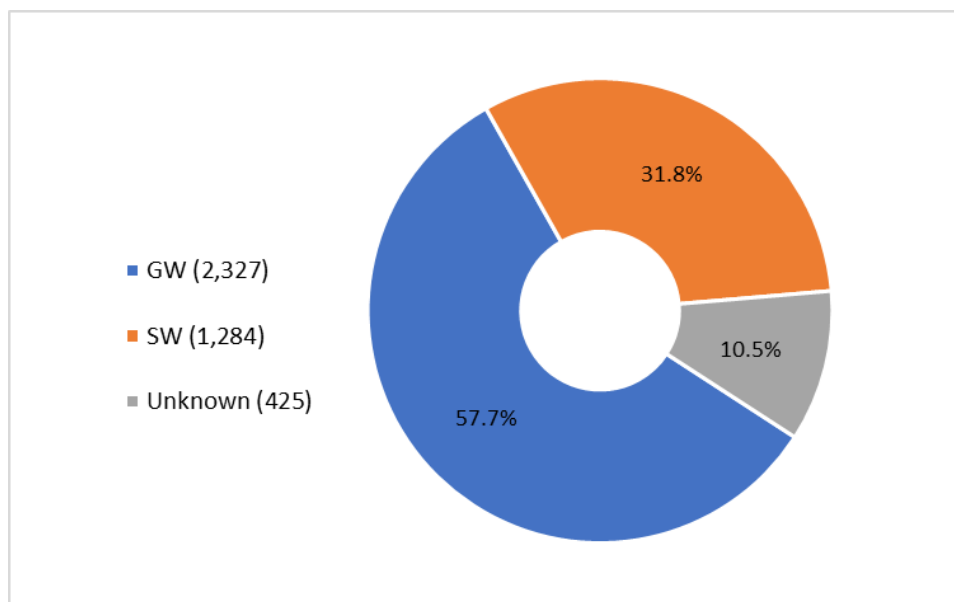


Figure 8: BWAs by PWS Source in 2021

Conclusion

PWSs are vital to the health, safety and economies of communities. Although consumers expect continuous drinking water, a PWS may temporarily disrupt service or require consumers to take precautionary measures to protect their health (e.g., boiling water before use). Such situations vary in terms of scope, scale, severity, and cause.

SDWA primacy agencies or the EPA, either in its direct implementation role or in its oversight role, may require BWAs and BWA reporting. BWA information is managed using a variety of primacy agency-specific requirements and databases and is varied in scope and completeness across the country. The EPA reviewed voluntary state submittal information on BWAs and publicly available data to understand the occurrence and reasons for issuing a BWA across the United States.

Eighty percent (3,221) of the BWAs found for this report occurred due to main breaks, distribution system repairs, and loss of water pressure events (Category 5 BWAs) and not necessarily associated with violations of SDWA or the National Primary Drinking Water Regulations. Other contributing causes were evidence of microbial contamination or treatment failure and natural disasters. The primary PWS source (i.e., ground water vs. surface water) and the PWS size (i.e., population served) did not have much of an

effect on the number of BWAs issued. However, the specific reasons for issuing a BWA varied by PWS size. Very small water systems (serving less than 500) had the highest number of BWAs in categories 1,2, 3 and 6. This may reflect the continuing challenges faced by very small water systems in maintaining compliance with the NPDWRs and adequate infrastructure due to the lack of technical, managerial and financial capacities. This also may be reflected in the number of ground water systems with BWAs compared to the number of surface water systems with BWAs. More than 90 percent of public water systems serving less than 10,000 people use a groundwater source. More data on the BWAs and information on why the BWAs were issued would support a more comprehensive and more nationally representative analysis to fully capture and understand the prevalence and occurrence of BWAs.

Appendices

Appendix A. Acronym List

ASDWA	Association of State Drinking Water Administrators
BWA	Boil Water Advisory
BWO	Boil Water Order
CAS	Center for Accountability in Science
CWS	Community Water System
EPA	U.S. Environmental Protection Agency
GW	Ground Water
MCL	Maximum Contaminant Level
NCWS	Non-Community Water System
NPDWR	National Primary Drinking Water Regulation
NTNCWS	Non-Transient Non-Community Water System
PWS	Public Water System
PWSID	Public Water System Identification Number
PWSS	Public Water System Supervision
SDWA	Safe Drinking Water Act
SDWIS/Fed	Safe Drinking Water Information System Federal Reporting Services
SW	Surface Water
SWTR	Surface Water Treatment Rule
TNCWS	Transient Non-Community Water System

Appendix B. Example Boil Water Advisory

Below is an example of the EPA's BWA for an *E. coli* maximum contaminant level (MCL) violation.

Revised Total Coliform Rule (RTCR) <i>E. coli</i> MCL Violation Notice – Template 1-2 DRINKING WATER WARNING <i>E. coli</i> is present in [Water System Name]'s water BOIL YOUR WATER BEFORE USING [Briefly describe the situation, such as: "<i>E. coli</i> bacteria were found in the water supply on [give date]" or "We did not perform required testing of the water system and must assume that <i>E. coli</i> bacteria are in the water as of [give date]]. These bacteria can make you sick, and are especially a concern for people with weakened immune systems. Bacterial contamination can occur when increased run-off enters the drinking water source (for example, following heavy rains). It can also happen due to a break in the distribution system (pipes) or a failure in the water treatment process. What should I do? What does this mean? • DO NOT DRINK THE WATER WITHOUT BOILING IT FIRST. Bring all water to a boil, let it boil for one minute and let it cool before using, or use bottled water. Boiled or bottled water should be used for drinking, making ice, brushing teeth, washing dishes, and food preparation until further notice. Boiling kills bacteria and other organisms in the water. • <i>*E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Human pathogens in these wastes can cause short-term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a greater health risk for infants, young children, the elderly, and people with severely compromised immune systems.*</i> • The symptoms above are not caused only by organisms in drinking water. If you experience any of these symptoms and they persist, you may want to seek medical advice. People at increased risk should seek advice from their healthcare providers about drinking this water. What is being done? [Describe corrective action]. We will inform you when tests show no bacteria are present and you no longer need to boil your water. We anticipate resolving the problem within [estimated timeframe]. For more information, please contact [name of contact] at [phone number] or [mailing address]. General guidelines on ways to lessen the risk of infection by bacteria and other disease-causing organisms are available from the EPA Safe Drinking Water Hotline at 1-800-426-4791. <i>*Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.*</i> This notice is being sent to you by [water system name]. State Water System ID#: _____. Date distributed: _____.
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