Feature Article

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Status of Backflow Prevention and Cross-Connection Control Programs in the United States

A SURVEY OF US WATER UTILITIES INDICATES A NEED TO DEVELOP AND IMPROVE CROSS-CONNECTION CONTROL PROGRAMS TO HELP ENSURE PUBLIC HEALTH.

Cross connections, defined as actual or potential connections between any part of a potable water system and an environment that would allow substances to enter the potable water supply (AWWA 2015), are prevalent throughout potable water supply systems and individual plumbing systems. According to the US Environmental Protection Agency (USEPA) and the Centers for Disease Control and Prevention, cross connections and backflow incidents to the potable water distribution systems continue to represent a significant public health risk. There are chemical and biological contaminants finding their way into the potable water supply, causing widespread illness and undermining the public's confidence in potable water supplies.

To address these risks in the United States, the USEPA implemented the Revised Total Coliform Rule, which in part requires states to document that each of their public water systems has an approved cross-connection control (CCC) program. But while US federal and state regulations require public water supply systems to implement a containment or premise isolation program for the purpose of protecting the public water supply from accidental contamination (USEPA 2013), little guidance is provided as to what constitutes a compliant program or what elements should be included. And while

Layout imagery by Scott A. McPherson and Shutterstock.com artist: Wisanu_nuu regulations are in place to address public water supply protection, they typically do not address plumbing systems on private property.

State regulations often reference plumbing codes for the appropriate method of backflow prevention. Several plumbing codes address the method of backflow prevention required for internal isolation (i.e., point of use [POU]) protection, installation requirements, and testing requirements, most notably CSA B64.10 (CSA 2017) in Canada and the *International Plumbing Code* (ICC 2015) in the United States. While these plumbing codes are similar in content, the Canadian standard provides specific information about the method of protection required at certain types of facilities for containment protection and, depending on the hazard encountered, any isolation protection methods that may be required.

SURVEY OF BACKFLOW AND CCC PROGRAMS IN THE UNITED STATES

In 2016, AWWA's CCC Committee, a group of water professionals representing municipal, regulatory, research, sales, and consulting interests throughout North America, created and conducted a survey of water systems to estimate the level of compliance with national, state, and local backflow and cross-connection regulations and to explore any correlation between the relative size of a water system and its level of compliance. In addition, the survey was intended to develop a better understanding of the needs and challenges facing CCC programs, such as lack of funding, enforcement, or education.

To avoid bias, AWWA membership was not a factor in survey distribution. Through the study design and distribution, efforts were made to anticipate and minimize errors attributable to coverage, sampling, nonresponse, and measurement. However, despite these efforts, the response rate from states and provinces was not uniform (i.e., more responses were received from certain areas). While the data collected from the respondents does not represent all water systems in North America, it does provide an indication of the levels of compliance for participating systems.

The cross-connection survey was distributed via e-mail to water systems of all sizes throughout the United States, Canada, and Mexico using lists generated by AWWA and the CCC Committee; the results in this article focus exclusively on the 724 US systems that voluntarily responded to the online survey in October 2016. Lack of participation may have resulted from several potential factors, including unawareness, time constraints, and apathy. Duplicate and incomplete responses were not included in the final data set, and the data have not been weighted to reflect any demographic composition. No estimates of error have been calculated because the full population of utilities is not well defined, the amount of self-selection bias from respondents is unknown, and a nonprobability sampling method was used.

SURVEY RESULTS AND DISCUSSION

The following sections summarize the results and analyses of the reporting utilities' practices and implementation progress as collected in 2016. To begin with, Figure 1 shows the distribution of the 724 respondents across the 50 states and territories in which they operate as well as their average potable water system demand. The number of responses per state ranged from one utility (several states) to 133 utilities (California). The potable water plants varied in average system

FIGURE 1 Distribution of US survey respondents by state and average water demand

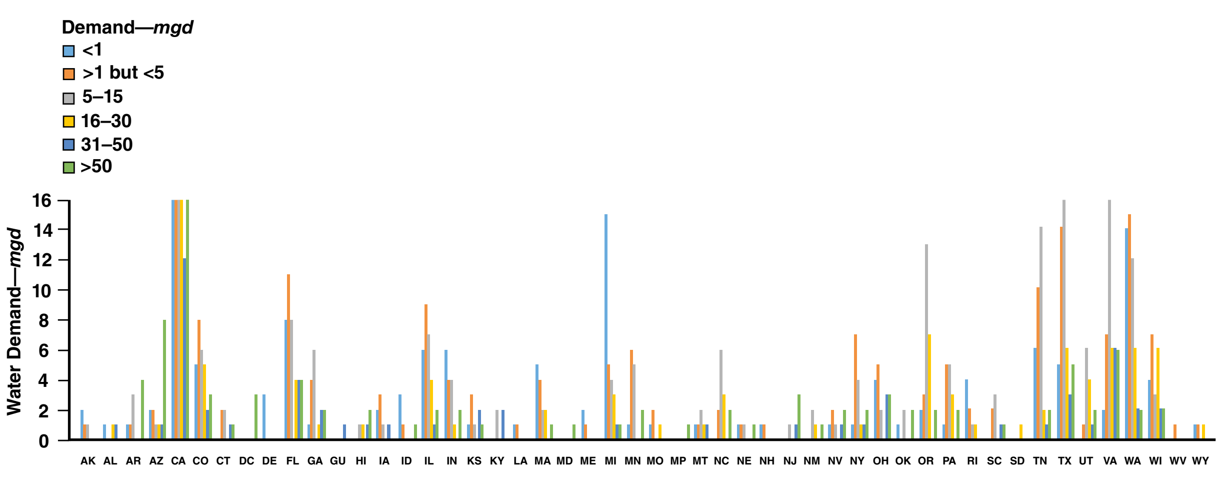
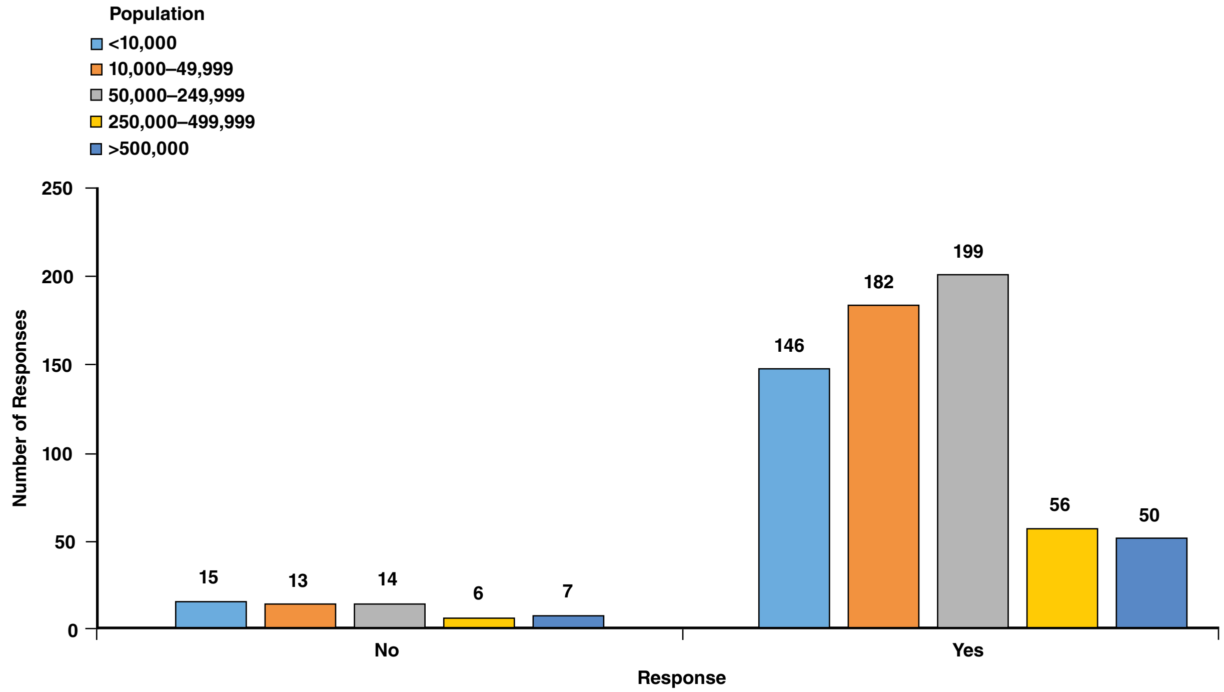


FIGURE 2 Responses from utility personnel regarding the number of testable backflow prevention assemblies in their service area for those with and without CCC programs in place



CCC—cross-connection control

demand from less than 1 mgd to over 50 mgd. The population served ranged from less than 10,000 to more than 500,000. The population range with the most respondents was mid-size utilities serving 50,000–249,999 people (222 of 724 respondents).

TABLE 1 Responses from utility personnel regarding whether their utility has its own CCC program

Yes, with at least one dedicated staff person	342
Yes, the program responsibilities are shared among staff	288
Not currently; however, we are developing a program	33
Not at this time; currently relying on plumbing codes	23

CCC—cross-connection control

TABLE 2 Responses from utility personnel regarding what authority their utility uses to implement and enforce its CCC program if their utility has one[a]

Plumbing code, ordinance, and/or regulations (three choices combined)	742
Locally adopted code of ordinance	502
State/federal regulations	129
Other	35

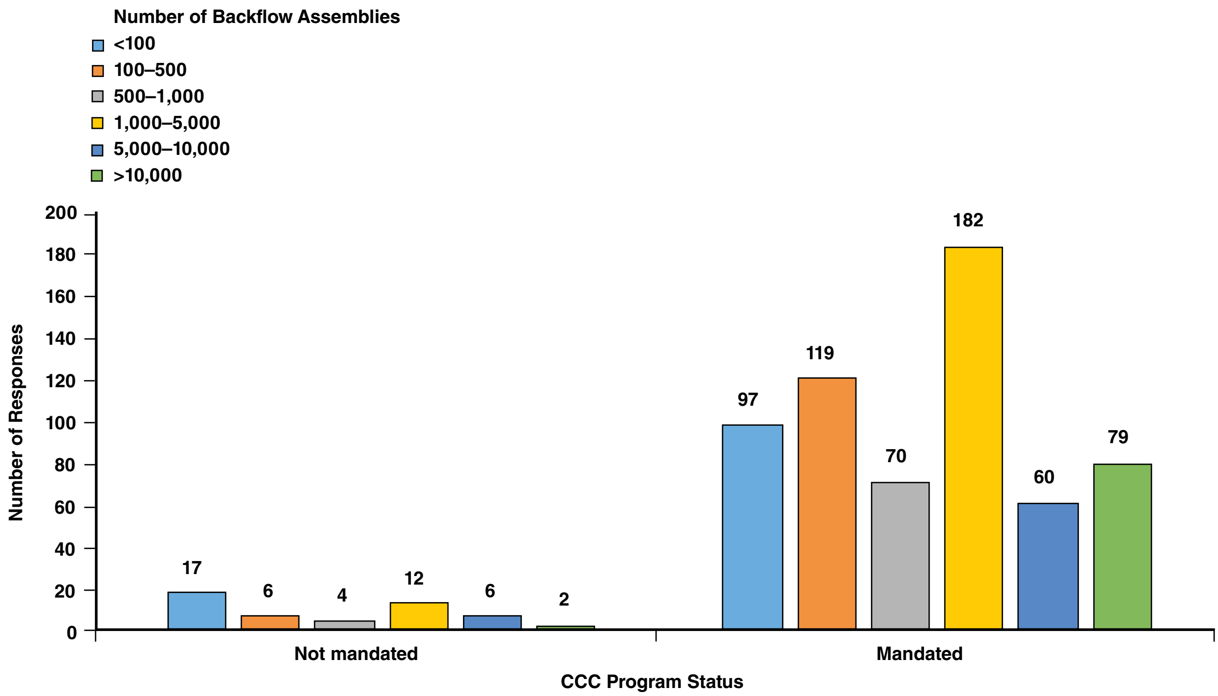
CCC—cross-connection control

[a]Respondents could select all of the options their utility uses

Figure 2 shows the distribution of utilities separated into ranges by service population, which are also further distinguished by whether the utility has a CCC program. Focusing on the utilities without CCC programs, it is somewhat startling that so many utilities don't have a CCC program in place. However, this seems to occur even for those serving larger populations, indicating that a lack of CCC attention is not just an issue for small systems.

Table 1 reveals that most of the respondents' utilities have a CCC program, where half have at least one dedicated staff person and 42% share program responsibilities among staff. More than 8% of responding utilities have no program. Just under 5% of respondents reported that they are developing a program, and just over 3% rely on plumbing codes only.

FIGURE 3 Responses from utility personnel regarding the number of testable backflow prevention assemblies in their service area for those with and without CCC programs in place



CCC—cross-connection control

Responses from utility personnel regarding what authority their utility uses to implement and enforce its CCC program are shown in Table 2. Either alone or in some combination, the majority of responses indicate that the utility's authority is based on plumbing codes, ordinances, or regulations (53% of total responses). The next most popular basis for authority was a reliance on a locally adopted code of ordinance (36% of total responses). Just 9% of responses indicated using state/federal regulations as a basis. Of the "other" responses, some respondents reported using a utility-specific guidance or other industry documentation (e.g., USC Foundation's manual).

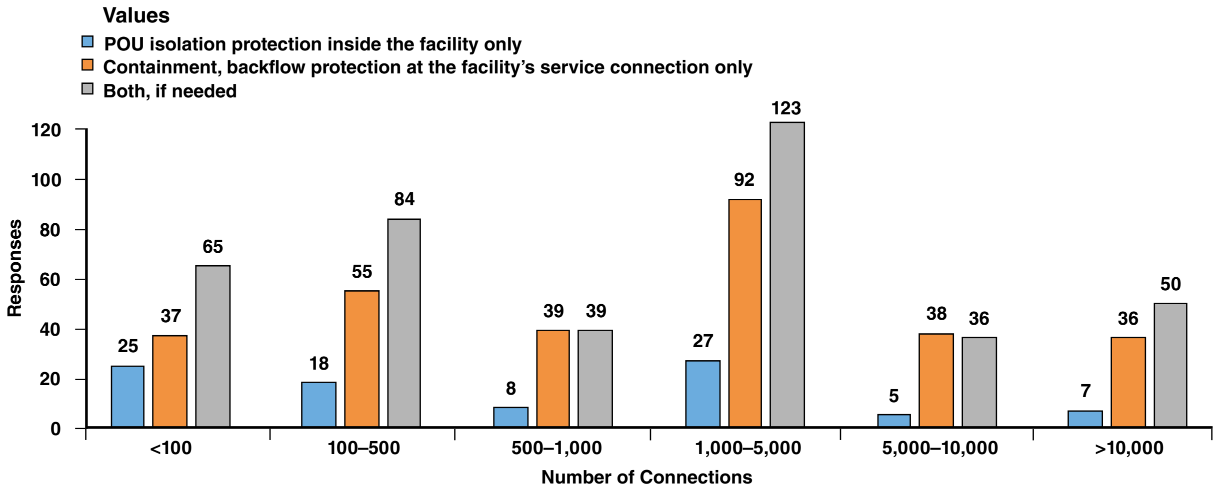
Similar to Figure 2, Figure 3 shows the distribution of utilities separated into ranges by the number of backflow prevention assemblies in their service area; these are further distinguished by whether the utility has a mandated CCC program in place. Again focusing on the utilities without CCC programs, the survey responses show that there are utilities with thousands of backflow prevention assemblies in their service areas that do not have a CCC program in place. Although they are beyond the scope of this survey, these results lead to several questions about how best to protect public health and how much a CCC program could help in these efforts.

Preventing backflow incidents from entering the public water supply is a necessary step to protect the public health of a community. However, preventing backflow incidents within a facility is equally important to all workers and customers within that facility. Backflow prevention assembly testing may be performed within a facility (also known as POU), at the service connection point (sometimes referred to as "at the meter"), or both, as necessary. POU containment supports public health protection, but for industrial purposes it may be targeted at preventing contamination of goods and services.

On the basis of the number of backflow prevention assemblies in respondents' service areas, Figure 4 shows the breakdown of whether utilities require backflow prevention assembly testing inside the facility only, at the service connection only, or both. Testing that requires both is generally considered more protective of public health than either approach separately, and this was the most popular option across all categories. Figure 4 also shows that POU testing was the least used option and was much less used compared with testing at the meter or both POU and testing at the meter across all categories.

Field testing of backflow prevention assemblies is performed by certified or licensed testers who are typically private contractors or utility staff. Although the data are not shown, of the 642 responses to this question, the survey found that 47%

FIGURE 4 Responses from utility personnel regarding whether their utilities require backflow prevention assembly testing inside the facility only (POU), at the service connection only, or both of these



POU—point of use

of utilities used private contractors, 10% used utility staff, and 44% used a combination. Private testers are certified or licensed by either a state, county, water system, or a third party. The fact that private testers are used to such a great extent might point to the value of establishing minimum regional or national standards for tester certification or licensing programs.

A containment CCC program includes the installation of the appropriate backflow prevention method at the water meter, while an isolation program addresses hazards at the POU internal to the meter. Containment responsibility is that of the water purveyor, and isolation protection is generally the responsibility of the local building or plumbing official. Results indicate that approximately half of the systems are testing both containment and isolation backflow preventers. This is an indication of program conflict between local regulatory agencies; consequently, CCC isolation and containment program deficiencies exist.

Tracking cross-connection inspections (CCI) and backflow prevention assembly testing (BPAT) is an important part of a CCC program. Table 3 reveals the distribution of utilities that are not tracking CCI and BPAT as a function of the utility's estimated number of residential and commercial service connections. These results show that communities with fewer service connections are more prone to inadequately tracking CCI and BPAT. For example, 19% of systems with fewer than 3,000 connections and 12% of systems with 3,000–9,999 connections were not tracking CCI and BPAT. In comparison, the percentage of larger systems that were not tracking CCI and BPAT averaged between 2 and 5%, or much less than the smaller systems. Of the systems not tracking CCI and BPAT, 45% served populations of fewer than 10,000 (26 total), while 7% served populations greater than 500,000, demonstrating a need for more and better CCC programs across communities of all sizes.

TABLE 3 Distribution of utilities by number of residential and commercial service connections that do not track CCI and BPAT

Estimated Number of Utility Service Connections	Respondents in Each Category	Total not Tracking CCI and BPAT
<3,000	145	27
3,000–9,999	162	19
10,000–24,999	149	4
25,000–49,999	99	3
50,000–149,999	100	2
≥150,000	63	3

BPAT—backflow prevention assembly testing, CCI—cross connection inspections

RECOMMENDATIONS AND CONCLUSION

Minimizing public health risks caused by cross-connections and backflow incidents remains an ongoing challenge that all public and private water systems face. Many of the issues facing utility CCC programs have been confirmed from the results of the 2016 CCC survey. On the basis of these findings, it seems that more efforts could be made to identify and correct cross-connection incidents that could contaminate potable water distribution systems of all sizes. Other recommendations from this research include the following:

- Develop a central repository to track cross-connection incidents at the local, state, and federal levels. A requirement to report backflow incidents is important for detection and correction of cross-connections.
- Establish funding approaches for developing and supporting CCC programs to address staffing, public education, enforcement, data tracking, and related administrative requirements.
- Continue to improve public education programs by developing innovative communication strategies, including educational materials and programs that explain CCC programs and the vital role they play in protecting a community's drinking water.

In addition, proper placement and ownership of CCC programs remains an ongoing issue at the state and local levels. The results from this survey show that respondents' CCC programs most commonly reside with the following operational areas: health agencies, plumbing boards and departments, and water utilities. However, there remains no clear process for establishing responsibility for developing a CCC program, and there are still issues with interagency or departmental communication and cooperation for CCC programs.

Lack of enforcement strategies also continues to be an issue. Within the United States, USEPA is aware that many state officials have adopted a regulation prohibiting cross-connections and requiring that local water suppliers establish a program with the responsibility to administer and enforce the program at the local level. However, there is often little or no follow-up or enforcement at the state level. Furthermore, there are states that do not require systems to develop programs to implement or enforce the requirements through additional drinking water regulations, plumbing codes, or health codes.

Federal regulatory changes requiring public and private water operations to implement cross-connection backflow prevention programs are necessary. It is recommended that authority for CCC programs include clearly defined enforcement procedures such as provisions to shut off water service if devices are not installed or tested, entry to property is not allowed, devices and assemblies are not installed properly, devices are not tested, or testing payments are not received.

Finally, a critical component that is still absent is effective communication with public and elected officials about the importance of protecting potable water distribution and internal potable plumbing conveyance systems. Improving communications can only help with ongoing efforts to establish effective CCC programs.

Even with the best-laid plans, it is certain that cross-connections will continue to occur, so it is vital that federal, state, and local government authorities work with public water suppliers to support their efforts to develop and improve their CCC programs. Controlling cross-connections protects public health and benefits all water system customers, and from the utility perspective, effective CCC can avoid the disaster of a contaminated water system.

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AWWA RESOURCES

- Backflow Prevention Resource Community. AWWA webpage. www.awwa.org/resources-tools/water-knowledge/backflow-prevention-cross-connection-control.aspx.
- Getting Optimized—Ensure Cross-Connection Control and Backflow Prevention With a Multipoint Approach. Martin, B. & Ries, T., 2015. *Opflow,* 41:7:8. Product No. OPF_0082156.
- *Backflow Prevention and Cross-Connection Control* [Video]. AWWA, 2015. AWWA Catalog No. 64398.

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