BEST PRACTICES IN BACKFLOW PREVENTION & PROTECTION

CHAPTER 1:

PROTECTING OUR MOST PRECIOUS RESOURCE: WATER

The United States is home to one of the safest drinking water systems in the world. Nonetheless, the Centers for Disease Control and Prevention reports as many as 32 million gastrointestinal illness cases every year due to contaminated public drinking water.[1] These cases often result when water systems are not adequately equipped to prevent instances of backflow.

Backflow is a hydraulic phenomenon in which contaminated water can reverse flow into piping that contains potable drinking water. Backflow preventers are mechanical valve assemblies that prevent reverse flow in a water system and ensure public drinking water safety in city water mains, commercial buildings, and at the point of use. **Despite the inherent risks, more than 60% of public water systems are designed without proper backflow preventers.[2]**

Purveyors are keen to follow the strict Statement of Policy on Public Water established by the American Water Works Association (AWWA), which reads: *"The return of any water to the public water system after the water has been used for any purpose on the customer's premises or within the customer's piping system is unacceptable and opposed by the AWWA."*

American Water Works Association

To that end, all commercial and industrial buildings must have backflow prevention on the supply side of the system to protect public drinking water from contamination. However, standards vary between state and local water jurisdictions regarding where and how backflow preventer assemblies are installed. If guidelines do exist, they are often outdated or are not reflective of current best practices. Without the availability of quick and accurate standard details, engineers defer to whatever was done in prior projects, unattuned to the potentially devastating consequences of installing backflow preventers inside a mechanical room or underground in a utility vault. From millions of dollars of destruction to injury and death, Murphy's Law prevails. What can happen does happen, and all-too-often, the costs are incalculable.

THE DIRE NEED FOR CROSS-CONNECTION CONTROL PROGRAMS

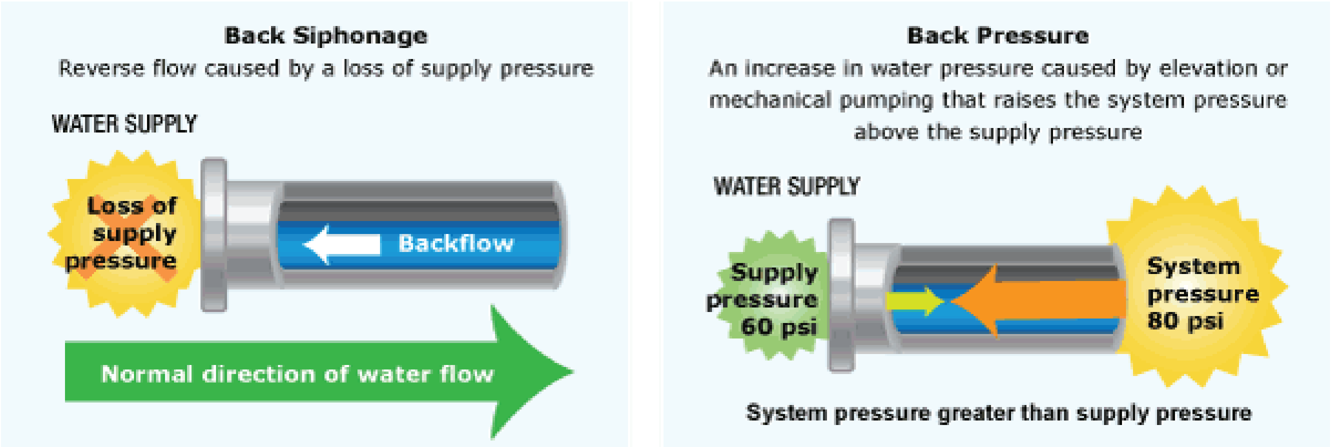
While there is no easy fix for this problem, the AWWA believes that the collaborative efforts of municipalities, health officials, and building owners to develop and administer clear, comprehensive, up-to-date specifications would vastly improve the cost, safety, and liability of designing and installing backflow preventer assemblies.

"AWWA encourages the partnering of utilities, property owners and other stakeholders to jointly develop measures to maintain water quality within premise plumbing systems. Operations should include at a minimum a cross-connection program, routine monitoring, and response training to prevent, detect, control, and resolve water quality issues."[3]

CHAPTER 2:
TYPES OF BACKFLOW

WHAT CAUSES BACKFLOW TO HAPPEN IN THE FIRST PLACE?

The backflow of water occurs when a hydraulic event creates more or less pressure inside a water distribution system's piping. Hydraulic events can trigger two types of backflow:



1. BACK PRESSURE

Back pressure occurs when the downstream (private side) water pressure becomes higher than the water pressure being delivered to a property through the public distribution lines. Events that can trigger back pressure include:

- Pump systems with head pressures not set properly
- Draining down a building to make plumbing repairs

2. BACK SIPHONAGE

Back siphonage occurs when negative pressure is created in the public distribution lines. The consequential vacuum effect draws water to wherever the negative pressure was created. Events that can trigger back-siphonage include:

- Broken water main or distribution pipe
- Sudden use of mass quantities of water (e.g., firefighter hose)

Now more than ever, jurisdictions acknowledge that without proper prevention for both types of backflow, they cannot effectively comply with the Clean Water Act (CWA), The Cross-Connection Control Manual (CCCM), or the AWWA.

In lieu of this, water utilities nationwide have increasingly mobilized efforts to approve and standardize requirements in accordance with the American Society of Sanitary Engineers (ASSE) and the Foundation of Cross-Connection Control and Hydraulic Research (FCCCHR) at the University of Southern California (USC) for backflow isolation on the private side, in addition to backflow containment on the public side.

CHAPTER 3:
TYPES OF BACKFLOW PREVENTION

A backflow preventer is a one-way assembly of check valves or vacuum breakers that only allow water to flow in an intended direction while mechanically impeding reverse flow. The end-goal is the same for all types of backflow preventers, but mechanical functionality varies.

The two most popular assemblies include:

1. DOUBLE-CHECK VALVE ASSEMBLY (DC):

A DC valve assembly works for back pressure and back siphonage events and is commonly found in fire protection systems. These assemblies consist of two independently-operating spring-loaded check valves. When downstream pressure exceeds the public side pressure, the first check valve closes to stop the backward flow of water. Should that valve malfunction due to debris or mechanical issues, the second check valve closes to stop the backward flow of water. DC valve assemblies can be installed above-grade or below-grade in subterranean vaults. However, it’s important to note that with DC assemblies, there is no way to tell if the check valves malfunction without conducting a full-scale test. For this reason, DCs are not recommended for high-hazard applications or installations that could put property and people at risk. We’ll get into the specifics of those risks in the next chapter.

APPROVED FOR:

- Operation Under Continuous Pressure
- Back Pressure
- Back Siphonage
- Above Grade & below-grade
- **Low-Hazard Applications Only**

KEY CONSIDERATIONS:

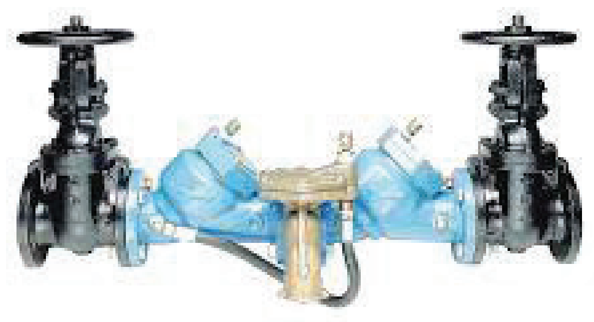
- Safe access to equipment for inspections and testing
- Ample space around equipment to conduct maintenanc
- Cannot insure proper operation without a test
- The risk of valve malfunction leading to cross-connection
- **Not Recommended for Installation Below Grade**[4]

2. REDUCED PRESSURE ZONE ASSEMBLY (RPZ):

A reduced pressure zone assembly is similar to a DC valve assembly but features a fail-safe design that makes them best-suited for every cross-connection situation, including high-hazard applications. In addition to two independently operating spring-loaded valves, RPZ valve assemblies have a hydraulic differential relief valve located between the two check valves. Should a backflow event occur and one or both of the check valves fail, the relief valve opens and disposes of the backward-flowing water. Unlike DC assemblies, an RPZ assembly's design inherently draws attention to malfunction. If a lot of water is dumping out of the relief valve, something is wrong with the primary check valves (hence the relief valve disposing of water). If no water is dumping out of the relief valve, then the entire RPZ assembly is working properly.

APPROVED FOR:

- Operation Under Continuous Pressure
- Back Pressure
- Back Siphonage
- All Hazard Levels
- **Above-Grade Only**



KEY CONSIDERATIONS:

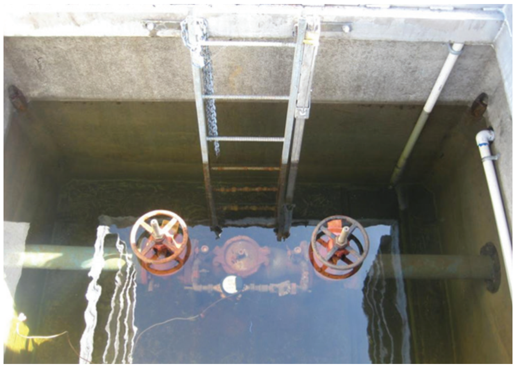
- Safe access to equipment for inspections and testing
- Ample space around equipment to conduct maintenance
- Proper drainage capacity that accommodates for massive discharge of water
- **Placement inside a commercial building is not recommended**

***FOR THE MOST UP-TO-DATE LIST** of approved backflow prevention assemblies by the FCCCHR (published in August of 2020), click here.*

USC University of Southern California

CHAPTER 4:
COMMON INSTALLATIONS

One of the most important design considerations for backflow prevention is placement. As mentioned at the beginning of this guide, the consequences of choosing an unsafe location can be catastrophic. For this reason, careful consideration is advised.



UNDERGROUND UTILITY VAULTS

Despite the numerous risks of sending technicians underground, subterranean utility vaults are still the most common location for backflow preventer installations. However, this trend is gradually beginning to change. Their subterranean location follows the generational practice of "out of sight out of mind." However, OSHA considers all subterranean vaults as Confined Space, and numerous requirements and precautions must be followed to enter and maintain the vaults. For this reason, the FCCCHR at USC updated its stance in 2016, urging water utilities to avoid installing assemblies in subterranean vaults. USC Crosstalk Winter 2016

ACCORDING TO THE BUREAU OF LABOR STATISTICS, over 1,000 workers died between 2011-2018 due to confined spaces.[5]

OSHA® Occupational Safety and Health Administration

ADDITIONAL DRAWBACKS:

- More expensive compared to other installation methods
- Safety concerns related to air quality, slips and falls, wild animals, and other hazards
- Poor accessibility due to location and limited internal space
- Flooding, which can damage equipment and create additional safety hazards
- Flooded vaults CREATE cross connections, which can contaminate drinking water
- Regulatory limitations, which prohibit the use of RPZ assemblies below-grade
- Deterioration, which can warrant costly and time-consuming rehabs

IMPORTANT INSTALLATION FACTORS:

- Vaults must comply with additional standards enforced by the OSHA for confined space work environments
- Vaults must comply with protective measures for falls, ventilation, and gas detection

SUMMARY: ***Vault installations create dangerous confined spaces and dangerous cross connections.***

INSIDE BUILDINGS

Another common housing option for BPAs is inside commercial buildings, such as a mechanical room or basement. Indoor installation provides the same weather protection and climate control as the building's internal environment, and prevents vandalism by cutting off public access to the equipment. However, if the system requires the use of an RPZ assembly, building owners are at serious risk for catastrophic flooding.

> Depending on the assembly and pressure combination, an RPZ assembly malfunction can dump over **375 GALLONS OF WATER PER MINUTE**, resulting in millions of dollars in damages.[6]

ADDITIONAL DRAWBACKS:

- BPAs require lots of indoor space, creating spatial constraints and wasting valuable square footage
- The need for greater liability coverage due to the elevated risk of flooding
- Access to water supply is controlled by the building owner, requiring municipalities and testers to coordinate with tenants, even in emergencies.

IMPORTANT INSTALLATION FACTORS:

- The presence of an adequate drainage system is rarely sized with the capacity to prevent catastrophic flooding.
- Compliance with building codes to ensure proper clearance around assemblies for maintenance, testing, and repair.
- It is never advisable to install an RPZ valve assembly with a pipe size of 21/2" or larger indoors.
- [See an RPZ Relief Valve in Full Operation]

***SUMMARY:* Indoor installations are usually poorly designed and can cause catastrophic water damage.**

CHAPTER 5:
ABOVE-GROUND ENCLOSURES

Without question, the safest, most cost-effective housing option for backflow preventer assemblies is an outdoor above-ground utility enclosure. Above-ground utility enclosures come in stock sizes or can be customized to fit around equipment for adequate clearance. Compared to the installation of an underground vault, above-ground enclosures get approved two times faster on average and can be ordered and installed in less than half the time of a below-ground utility vault. More importantly, they remove the threat of confined space injury, flooding, property damage, and unnecessary liability while protecting equipment from vandalism, extreme temperatures, harsh weather conditions, and of course cross-connection with contaminated water.

***NOTE:** To ensure maximum protection and value, only select above-ground enclosures that are ASSE 1060-certified. The ASSE 1060 is a multi-level standard that will ensure that your enclosure comes equipped with the necessary exterior protection, interior temperature control, locking mechanism, and drainage for the environment.*

ADDITIONAL ADVANTAGES:

- Enclosures can be completely customized to meet the exact needs of an application
- The costs associated with an above-ground enclosure are significantly less than a utility vault due to the absence of heightened compliance, liability risks and installation costs
- Easier access to equipment, which allows technicians to maintain the operation of the equipment and the surrounding environment and extend the backflow installations's life span

IMPORTANT INSTALLATION FACTORS:

- The enclosure must meet ASSE 1060 certification requirements
- The enclosure must be of sufficient size to house all required piping and meet the required clearances for maintenance
- Designs must include a tamper-resistant locking mechanism for protection against vandalism
- Heaters required to provide proper freeze protection

THE ASSE 1060 STANDARD

The ASSE 1060 Standard was created in 1996 to regulate the backflow enclosure industry. It has been updated over the years, most recently in 2017, to include more details and account for changes over time.

Here are the primary specifications.

THE PRIMARY SPECIFICATIONS OF THE ASSE 1060 STANDARD:

1.0 CLASSIFICATIONS

CLASS I – Freeze Protection Enclosures *Heated*
Enclosures designed and constructed to maintain a minimum internal temperature of 40°F with the external temperature of -30°F with a minimum Thermal Resistance (R) Value of eight (8.0).

CLASS I-V – Freeze protection enclosures for pressure and atmospheric vacuum breakers.

CLASS II – Freeze Retardant Enclosures *may or may not have a Heater*
Enclosures designed and constructed to maintain a minimum internal temperature of 40°F for a 24-hour period with a minimum Thermal Resistance (R) Value of eight (8.0).

CLASS II-V – Freeze protection enclosures for pressure and atmospheric vacuum breakers.

CLASS III – Non-Freeze Protection Enclosures No Heat
Enclosures designed and constructed with NO freeze protection and NO minimum Thermal Resistance (R) value.

CLASS III-V – Non-Freeze enclosures for pressure and atmospheric vacuum breakers.

2.0 STRUCTURAL STRENGTH

- All classification enclosures must be designed to support a minimum vertical load of 100 pounds per square foot (100 psf).

3.0 DRAINAGE CAPABILITY

- All classification enclosures must be designed to discharge water from within the enclosure to prevent submerging the equipment. The depth of water rise within the enclosure shall not exceed 8 inches during full discharge of a Reduced Pressure Zone backflow preventer and according to the following diameter requirements:

DIAMETER	BACKFLOW PREVENTER ENCLOSURE DRAIN CAPABILITY (GPM)
¼" to ½"	27 GPM
¾" to 1"	45 GPM
1 ¼" to 2"	155 GPM
2 ½" to 3"	260 GPM
4" and above	710 GPM

4.0 ACCESS FOR TESTING AND MAINTENANCE

- Equipment components such as test cocks and valve handles or hand wheels must be within 24 inches of the access opening.
- Hinged access panels must be restrained in the open and closed position.
- All unrestrained panels and horizontal hinged panels must weigh 70 lbs. or less.

5.0 SECURITY AND VANDALISM

Access to the internal equipment shall be lockable. Access shall be by keyed devices or have the ability to affix padlocks

6.0 MATERIALS OF CONSTRUCTION

EXPOSED EXTERIOR WALL PANEL MATERIALS

Aluminum

Galvannealed steel

Prepainted galvanized steel

Stainless steel

Natural Stone

Fiberglass reinforced plastic & gelcoat 25% glass fiber by weight with 18- 20 mil Gelcoat on outer surface

EXPOSED INTERNAL WALL PANEL MATERIALS

Cedar

Redwood

Closed cell foam insulation *1% maximum water absorption*

Glass fiber reinforced facers

Approved External materials

CHAPTER 6: MUNICIPAL EXAMPLES

ARLINGTON, TEXAS

The city of Arlington, located in north-central Texas, manages about 3,000 high-hazard backflow assembly sites. After a two-year survey conducted by EnviroDesign and Safe-T-Cover, city officials realized that local plumbing authorities and civil engineers were not following best practices outlined by governing organizations such as the (AWWA) and the American Society of Plumbing Engineers (ASPE).[7]

THE SURVEY FINDINGS

The survey sought input from 1,200 DFW civil and plumbing engineers to better understand the city's standards. Results revealed a critical gap in understanding and opinion among civil and mechanical engineers regarding proper backflow preventer installation.[8]

3 IN 4 RESPONDENTS AGREED, "Local water guidelines for commercial and industrial construction lack needed standard details for above-ground backflow preventer installations."

ALMOST 97% OF RESPONDENTS felt that the survey enhanced their knowledge and understanding of backflow prevention, representing clear evidence of a serious lack of understanding. [survey results images]

THE SOLUTION:

Arlington officials knew they needed to update and approve a set of standards to bridge gaps in understanding between the city, recognized best practices, and civil and plumbing engineers. However, the feat would not be easy. Utility providers and government workers did not prioritize the same management benchmarks and, therefore, did not share the same improvement objectives. To standardize one installation method over another would be tedious.

THE RESULTS:

Arlington was successful in its endeavor and became the first city in north-central Texas to publish containment and isolation backflow preventer guidelines for non-residential projects. The approved set of guidelines were published in 2016 to include backflow preventer assemblies immediately following the water meter.

Arlington Standard Specifications for Water & Sanitary Sewer Construction

Today, engineers have exact installation details that can easily be copied into plans to eliminate guesswork and expedite the design process while enhancing the health and safety of the city's water supply.

The city believes that promoting the new guidelines, especially the inherent risks associated with high-hazard properties, may help deter building owners from making unknown changes to on-site plumbing systems without proper approval for a building permit and plumbing review. The new guidelines also aim to reduce subrogation risks, which entitle insurers to a claim for damages on behalf of the insured if a third-party (such as a contractor) is responsible for losses—for example, due to flooding caused by the indoor installation of an RPZ valve assembly.

LAS VEGAS, NEVADA

The effects of Nevada's harsh climate and environment on underground utility vaults became a constant cause of concern for Doa Meade, the director of infrastructure management for the Las Vegas Valley Water District. The concrete walls wore down over time, the rebar inside the walls lost structural stability, and rehab projects were increasingly required to bring vaults up to code.

Rehabbing a concrete vault is expensive and can be dangerous, requiring construction crews to remove the vault deck (roof), climb into the unstable environment, and reinforce the walls. The process is also time- and labor-intensive, involving multiple phases to allow concrete to set before pouring another section.

"Even if we go out and find the vault is in good condition, it's still a confined-space entry," said Meade. "You need two people minimum for the job; sometimes you need fall protection depending on how deep the vault is, and sometimes you have to drop a sump pump in there to clean the vault out first. And that's not to mention the 'creepy-crawlies' that find their way in there."

VAULTS CAN COST UP TO $5,000 annually to cover the maintenance and update the necessary safety precautions.

THE FULL VAULT REHAB PROCESS takes at least a month to complete and may only yield another ten years or less.

THE SOLUTION:

The Las Vegas Valley Water District decided that standardizing the use of above-ground backflow prevention assemblies made the most practical and financial sense. Rather than incur the cost of constructing and rehabilitating concrete underground vaults, above-ground enclosures need only a concrete pad, which drastically lowers the cost of construction and the time required for installation.

> Installing backflow preventers in an aluminum above-ground enclosure can be completed and ready for use **IN AS LITTLE AS ONE WEEK.**

THE RESULTS:

"The truly unique part of what we're doing is that we are pulling the meter out of the vault and putting it into the same enclosure as the above-ground-backflow preventer. It's a move that's not only safer and cost-effective, but it's also not taking up any additional space on the property."

After a detailed cost analysis, Meade discovered that as much as $60,000 could be saved when installing backflow prevention assemblies and meters in the same outdoor, above-ground enclosure.

"We're able to do this in the same footprint as the vault," Meade said. "We don't have to take up any more real estate."

NEW JERSEY

New Jersey water systems complete 200,000 or more mark-outs each year as part of their “811,” “Call Before You Dig,” or “Know What’s Below” program. These programs are funded by the Federal Pipeline Safety Act and exist in every state to ensure that utility service lines, including gas, water, and electric are marked by an 811 representative from the tap to the meter. If meters are installed inside a building, representatives from the Public Water System (PWS) are forced to knock on doors, request access, and depend on building occupants to allow them inside. Unfortunately, the ratepayers shoulder the cost burden of these inefficiencies.

THE SOLUTION:

The state decided to update its guidelines to require above-ground installation for all new non-residential meters and containment backflow preventers. The guidelines further stated that the above-ground enclosures used to house equipment must be close to the curb, where mark-outs could be done quickly and easily.

THE RESULTS:

Outdoor above-ground enclosures were easier to access for testing and maintenance, reduced annual maintenance expenses, and eliminated the need for representatives to depend on building occupants for access to meters. More importantly, moving meters and containment backflow preventers above-ground saved lives. According to the New Jersey Board of Public Utilities:

“Board staff has investigated incidents in which it has concluded that unmarked water underground facilities contributed to the loss of life, property damage, and injuries to the public.”

The state knows that providing safe, easy access to backflow preventers and meters in above-ground enclosures reduce instances of damage and injury while lowering costs and supporting greater efficiency.

CHAPTER 7:
THE AESTHETICS OF ABOVE-GROUND ENCLOSURES

There are a lot of misconceptions about the drawbacks of installing above-ground utility enclosures. In this chapter, we debunk the three most common fallacies:

MISCONCEPTION #1: ABOVE-GROUND ENCLOSURES ARE BIG & BULKY

The existence of this misconception isn't entirely unfounded. Traditional utility enclosures tended to be long and oversized. Today, however, enclosures offer more compact installation options.

As the director of infrastructure management in Las Vegas pointed out, many plan designs also incorporate backflow preventers and water meters in the same above-ground enclosure to effectively reduce the footprint of the equipment.

MISCONCEPTION #2: ABOVE-GROUND ENCLOSURES ARE AESTHETICALLY DISPLEASING

To be frank, injury and destruction related to indoor or underground installation can produce far uglier outcomes than an above-ground utility enclosure. Furthermore, while there is no way to make utility boxes invisible, contractors have more practical options to help enclosures blend in with building facades or landscaping, such as:

- **COLOR:** Enclosures are available in a full spectrum of colors, which are applied using a pre-finished sheet metal coating rather than paint to prevent chipping, discoloration, and weathering over long-term exposure to the elements. From every color of the rainbow to patina metals and wood grains, virtually any type of non-weathering finish can be achieved to help camouflage utility enclosures with surroundings. [See the full selection of finishes]
- **WRAPS:** Instead of hiding above-ground utility enclosures, some building owners prefer to draw attention to them with high-resolution vinyl graphic wraps. Wraps are a creative way to showcase the company logo, advertise a product or idea, feature art, and more. Wraps also protect enclosures and graphics from the effects of long-term exposure to UV and precipitation.
- **LANDSCAPING:** In addition to colored finishes, the creative placement of trees, shrubs, and bushes can effectively conceal above-ground utility enclosures of any size. Certain species of Privet grow up to 12 feet tall and can be hedged to hide enclosures large and small with year-round foliage.
- **LOCATION:** Civil planning can locate the installation strategically on site.

MISCONCEPTION #3: ABOVE-GROUND INSTALLATION EXPOSES EQUIPMENT TO VANDALISM

Backflow *cages* can result in theft and vandalism, but ASSE 1060-certified enclosures are designed to protect and secure equipment. These enclosures are constructed of marine-grade aluminum and include a tamper-resistant locking mechanism on the access panel that has been tested and approved for the utmost safety and security.

DESIGN FOR THE WORST.
HOPE FOR THE BEST.

ABOVE ALL ELSE, REMEMBER MURPHY'S LAW OF PROBABILITY.

There is no penalty for over-protecting water, and there is no penalty for over-protecting the employees maintaining the water systems. Incorporate these best practices into your next design project and work with local water jurisdictions, property owners, and contractors to document standardized guidelines for backflow prevention. As more and more jurisdictions move to outlaw underground vaults, these best practices will ensure that your new standards are well ahead of the curve. From better cost control and lead times to great accessibility and maintenance efficiency, the benefits of above-ground enclosures are significant, but nothing compares to the unrivaled safety they represent for people, buildings, and assets.

Ready to raise the standards in your area?

CONTACT US

[1] Magnitude & Burden of Waterborne Disease in the US | Healthy Water
[2] Safe-T Cover: How To Build a Successful Cross Connection Control Program
[3] Distribution System Water Quality
[4] USC Crosstalk Winter 2016
[5] Fact Sheet | Fatal occupational injuries involving confined spaces
[6] Part 3: Why You Should Keep Backflow Preventers Out of Basements
[7] Arlington, Texas Updates Waterworks Standard Details
[8] Backflow Preventer Installation Survey Results From 1,200 Engineers

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