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EDITOR'S LETTER

By Kevin Westerling
Chief Editor, editor@wateronline.com

POWERING UP: Perspective On America's Infrastructure Plan

Envisioning an America where every community has access to clean water and resources to live a quality life is pretty powerful — and it is enough inspiration to power a transformation that could make America's future much stronger.

The recent federal stimulus initiative passed by the U.S. Senate will fund major improvements to the nation's aging infrastructure, including $55 billion aimed at improving access to clean drinking water.

Aging water systems threaten public health in thousands of communities nationwide, and modernization of our country's water systems is imperative to ensuring every American has access to clean water. To learn more about what it will take to help water districts and utilities improve system uptime, increase safety, and improve energy efficiency, I spoke with Kerry Tingley, the vice president and general manager of Eaton's Industrial Controls Division.

What do you think about the water-centric investments included in the bipartisan infrastructure bill?

When it comes to water, the goal is to improve access to clean and safe drinking water. In my view, this is a powerful goal that envisions an America where every community has access to clean water and resources to live a higher quality life while reducing our environmental footprint. At Eaton, we see the federal stimulus initiative as support for both the nation's aging infrastructure and its impact on the environment, and we stand ready to help through the use of power management technologies.

How can power management technologies help this work be successful?

Whether you need to power a new plant, expand operations, or modernize systems, electricity is critical to day-to-day operations that provide clean water. Experts at designing, installing, maintaining, and modernizing electrical equipment stand ready to help water districts and utilities advance sustainability and energy efficiency, improve system uptime, support remote monitoring and control, and enhance safety with modern and digital power distribution, quality, and control solutions.

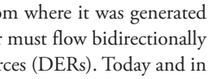
In short, we are helping our customers prepare for and continue to operate with reliable, resilient power — even during a pandemic, a major storm, or both.

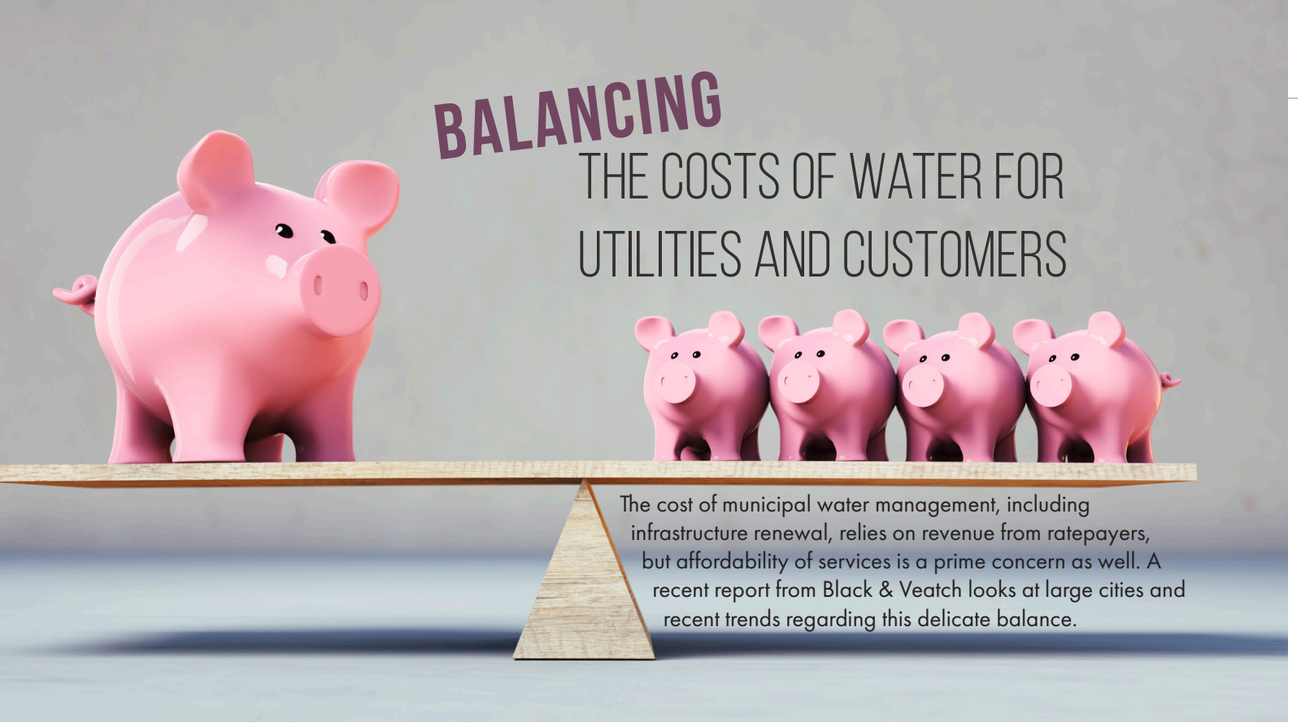
Why is it important to make these investments today?

From my perspective, investments in infrastructure will help keep water and wastewater treatment plants operating far into the future and optimize how they work — keeping equipment in service longer, reducing energy and maintenance costs, and advancing resilience and sustainability. Here's why I know these investments are critical:

1. Modernizing water systems is imperative to ensuring every American has access to clean water. It's important to recognize that aging water systems threaten public health in thousands of communities nationwide. Many water and wastewater treatment plants are using equipment that may be unsafe and/or beyond its anticipated useful life. This equipment is more likely to fail and needs to be updated, upgraded, reconditioned, or retrofitted to continue to work more effectively and efficiently every day.
2. Energy delivery systems and sources are changing. The energy transition created a new power paradigm. Power used to flow in one direction, from where it was generated to where it was used. Now, power must flow bidirectionally between distributed energy resources (DERs). Today and in the future, electrical infrastructure needs to do much more than receive power from the grid for distribution to plant loads and equipment. For water and wastewater treatment plants, the proliferation of DERs such as renewables and energy storage provides new ways to meet energy goals and power operations.
3. Energy efficiency improvements will create dramatic cost savings. I've seen figures from the U.S. EPA that indicate as much as 40 percent of operating costs for drinking water systems can be for energy, and incorporating energy efficiency practices into water and wastewater treatment plants can yield significant savings for municipalities and utilities.
4. Resilient operations are a must. Water and wastewater treatment plants have to operate around the clock, every day of the year — so keeping the power on for critical operations is essential. Resilience requires preparation and an approach that prioritizes cybersecurity and keeping the power flowing during utility outage events.
5. Safety is a critical consideration. Protecting the personnel working at water and wastewater plants is essential and electrical safety considerations (and codes) are constantly evolving. It's important that the water and wastewater industry adopts new technologies and approaches to help reduce risk.

Here's the bottom line as I see it [and this editor concurs] — there's a dramatic opportunity right now to optimize systems through smart investments that will continue to provide financial, health, safety, and other benefits for years to come. ■





BALANCING THE COSTS OF WATER FOR UTILITIES AND CUSTOMERS

The cost of municipal water management, including infrastructure renewal, relies on revenue from ratepayers, but affordability of services is a prime concern as well. A recent report from Black & Veatch looks at large cities and recent trends regarding this delicate balance.

By Pete Antoniewicz

Water scarcity, aging infrastructure, and workforce turnover are all key challenges to water-sector service and reliability that also conflict with a competing variable — affordability. A recently released report from Black & Veatch shows how far water service providers have come and how far they still have to go to make affordable water and wastewater services equitably accessible across the full spectrum of consumers.

That document, *2021 50 Largest Cities Water and Wastewater Report,*[1] from Black & Veatch Management Consulting, quantifies and addresses the rise in water and sewer rates as an outgrowth of multiple factors. These include aging infrastructure, operational costs, capital funding issues, regulatory requirements, and the impacts of the COVID-19 pandemic. It shows that in many of the cities, actual water rates are still well below the U.S. EPA's Affordability Index, despite ongoing needs for new infrastructure investment. Yet when viewed through the lens of affordability — as a fraction of income or as minimum-wage hours required to pay the average water bill — regional disparities can be tremendous, especially for economically challenged areas.

About The Report

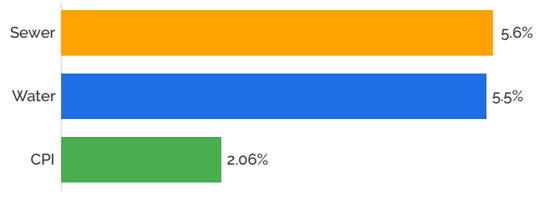
The 2021 report is the latest in a series of water/sewer-rate reports generated by Black & Veatch since 2001. The analysis methodology for the report utilized input from representatives among the top 50 U.S. cities providing water and sewer services (cities were ranked by population size). Using the applicable water/sewer rates for those cities as of December 1, 2020, the analysts calculated typical bills for various commercial, industrial, and residential account profiles.

How We Got To Where We Are

The Black & Veatch report addresses today's state of residential and commercial/industrial water and sewer rates from a historical perspective as well as from a geographical perspective of affordability. Its findings include:

- Quality Of Service. The report notes that, in general, the American public has access to quality water and sewer services. But it also notes the disparity in financial impacts for different locations and income levels, some of the roadblocks of customer-assistance programs, and some potential approaches for achieving a more equitable sharing of the burden.

Compound Average Rate of Change in Surveyed Typical Bills (2001-2020)



Inset A. Both water and sewer cost increases have outstripped the rise in the Consumer Price Index (CPI) over the 20-year period addressed in the report, indicating incrementally increasing pressures on the water/sewer budgets of lower-income households.

- Rate Growth. The analysis found that the compound average rate of change for surveyed sewer bills (5.6 percent) and water bills (5.5 percent) outstripped the compound rate of increase in the Consumer Price Index (2.06 percent) over the surveyed period from 2001 through 2020 (Inset A). This ultimately makes water utility charges an increasingly larger portion of customer cost-of-living expenses — a particular concern for historically lower-income households and those impacted by the COVID-19 pandemic.
- The Value Of Water. Despite increasing rates, the revenues generated by water and wastewater utilities do not generally reflect the true value of water relative to the costs of treating it and transporting it (Inset B). This can leave utilities at a disadvantage when it comes to maintaining infrastructure and keeping up with regulatory requirements necessary to sustain acceptable levels of service and resiliency.
- Affordability. Despite the generally increasing billing rates for water and sewer services, not all cities reflect the same impacts of water and sewer bills relative to earning power (Inset C).
  - The eight cities with the highest volume of minimum-wage hours needed to cover the cost of the average water/sewer bills each month ranged between 8 and 12 hours.
  - The seven cities with the lowest volume of minimum-wage hours needed to cover the cost of the average water/sewer bills each month ranged between 2 and 4 hours.
  - The remaining 35 cities ranged between 4 and 8 hours of minimum-wage earnings needed to cover the cost of the average water/sewer bill.

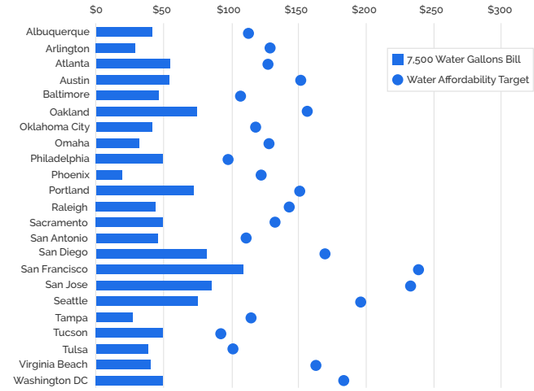
In addition to identifying those economic discrepancies, the report also goes into detail on some alternate measures of affordability for lower-income customers.

Potential Paths Forward

From the report, it is obvious that even many large water and sewer service providers have a tough row to hoe in order to make water bills equitable to all customers while still meeting their aging infrastructure challenges. Fortunately, there is hope on the horizon in the form of the Low-Income Water Customer Assistance Programs Act of 2021 (HR 3293)[2], which was incorporated into the INVEST In America Act (HR 3684) passed by the House of Representatives July 1, 2021, and forwarded to the U.S. Senate for consideration. The Low-Income Household Water Assistance Program (LIHWAP) would function as a permanent, federally funded, low-income water-assistance program, similar to how the existing Low-Income Home Energy Assistance Program (LIHEAP) works.

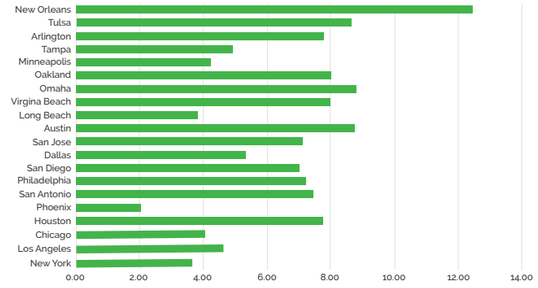
There is also new infrastructure funding relief available specifically to rural communities with populations of 10,000 or less. That comes in the form of a $307 million program[3] announced by the U.S. Department of Agriculture (USDA) on July 7, 2021, as part of that department's Water & Waste Disposal Loan & Grant Program.[4] It makes long-term low-interest loans and grants available to qualified state and local governmental entities, private nonprofits, and federally recognized tribes for water, wastewater, and stormwater infrastructure investments. ■

Typical Residential Water Bill for 7,500 Gallons Versus USEPA Affordability Target



Inset B. For most of the water utilities serving the top 50 U.S. cities, actual billing rates are below the affordability levels established by USEPA guidelines, as represented in this abridged version of the report's full chart. Residential sewer bills are typically a bit closer to EPA affordability targets, but only exceed those guidelines in eight of the 50 cities, according to the report.

Hours of Minimum Wage



Graphic courtesy of Black & Veatch

Inset C. As shown in this abridged version of the report's full chart, what a typical household pays for water and sewer services can vary widely — from more than 12 hours at the prevailing minimum wage in New Orleans to as little as 2 hours at the prevailing minimum wage in Phoenix. Fortunately, new legislation is being proposed to relieve some of the resulting pressure on lower-income households.

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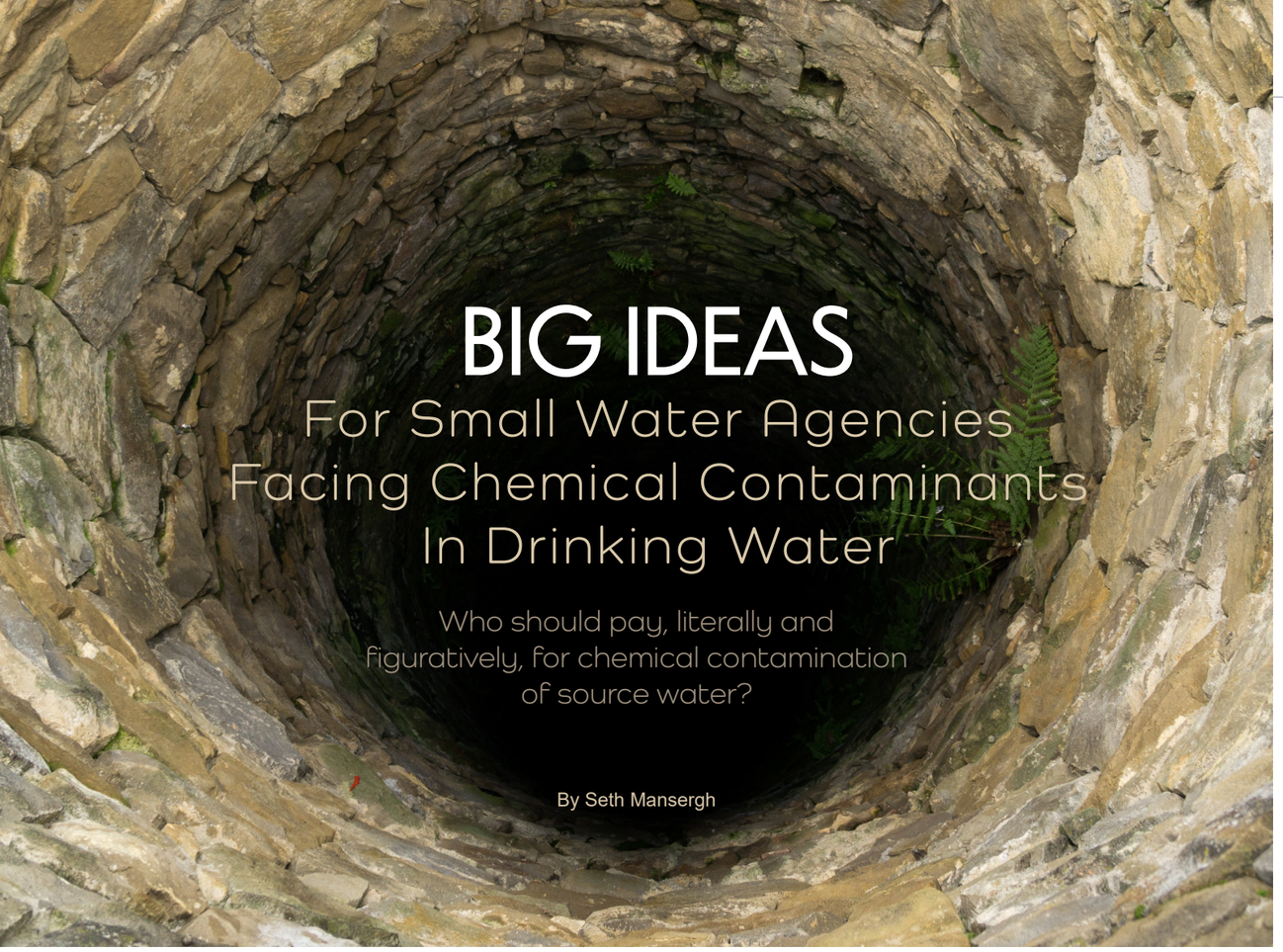


BIG IDEAS

For Small Water Agencies Facing Chemical Contaminants In Drinking Water

Who should pay, literally and figuratively, for chemical contamination of source water?

By Seth Mansergh

Small water utilities are facing existential challenges as they struggle to meet new state and federal drinking water standards. For example, in California more than 200 small water systems have groundwater contaminated with the chemical 1,2,3-trichloropropane (TCP), a toxic legacy from pesticides used for decades in agricultural areas. Smaller systems — some serving as few as 15 people — struggle to earn enough revenue to finance expensive water treatment facilities or import alternative water supplies. They are forced to consider shutting down wells in violation of TCP health standards. Others are looking to consolidate with large neighboring systems. Some, however, are looking at product liability law to play a major role in finding funds to clean up their water supplies. Understanding why requires a little bit of background.

The law is clear in most states that the designer, manufacturer, or seller of a defective product is responsible for harm caused by that product.

A History Of Contamination

Starting in the 1940s and continuing for decades, chemical companies like Shell Oil and Dow Chemical Company sold agricultural pesticides, known as soil fumigants, to farmers working up and down California. These fumigants had different names, the most common being Shell's D-D and Dow's Telone. But they had one thing in common: They all contained TCP — not as an active ingredient that helped to kill pests, but as an impurity, a byproduct left over from the manufacturing process that the companies chose not to remove. Unlike other chemicals in the soil fumigants, TCP does not bind to soil or break down easily. Instead, it leaches into groundwater. Evidence shows that Shell and Dow knew the TCP would enter groundwater supplies and contaminate them, but the manufacturers never shared this information with the farmers. They continued to sell the product for years until the companies ceased making soil fumigants that included TCP in the 1980s. What was left was a legacy of TCP-contaminated groundwater throughout California.

Regulations And Funding

Both California and the International Agency for Research on Cancer have added TCP to their lists of chemicals known to cause cancer. Because of TCP's extreme toxicity, even at low levels, California's Office of Environmental Health Hazard Assessment in 2009 adopted one of the most stringent public health goals for TCP in drinking water ever established in the state at the time. Since 2018, California water agencies have complied with quarterly testing mandates and a maximum contamination level (MCL) of five parts per trillion. Meeting this very strict standard has been difficult for water systems, especially the small and underfunded systems in California's agricultural areas.

Over the past few years, California's focus on helping small systems that routinely violate state and federal health guidelines has brought several new tools to the fight to improve water quality. In 2015, California became the first state in the U.S. to legally declare that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. A few years later, the law known as Senate Bill 88 gave substance to the largely symbolic declaration by authorizing the state to order cities to consolidate their water systems with smaller, unincorporated neighbors when public health is at issue. But funding has always been an issue with these consolidations.

In response, the state legislature in 2019 established the Safe and Affordable Drinking Water Fund, which set aside over $1 billion over a decade to help struggling public water systems and private wells meet health standards. These funds can be used to improve treatment and delivery systems or to hire experts to help address problems. They can also be used to fund mergers between small systems, a priority for the state. The success of these consolidations depends on many factors: the willingness of the utilities to merge and the ability of ratepayers to afford water system improvements, among others. Even with this fund, getting the appropriate amount of funding can be difficult. Product liability law can help with this complex water-quality challenge for small water systems.

Suing the parties responsible for the pollution helps water providers pay for critical water infrastructure facilities without passing on the heavy burden to ratepayers.

Seeking Justice Via The Courts

The law is clear in most states that the designer, manufacturer, or seller of a defective product is responsible for harm caused by that product. Product liability laws are in place to protect consumers from dangers, defects, or malfunctions that could harm people. Cities and water systems are fighting back against the chemical companies abusing these laws. Their argument is simple: Polluters should pay for cleaning up the messes they made. Since 2005, dozens of water providers of all sizes have brought lawsuits against Shell and Dow to recover the costs of removing TCP from their drinking water.

Recently, Shell and Dow have paid to settle multiple lawsuits for TCP contamination, and Shell has been found liable for TCP contamination in multiple jury trials. In 2019, a jury awarded a verdict against Shell for $54 million. In 2016, a jury awarded the city of Clovis $22 million in its suit against Shell Oil. In both lawsuits, the jury found that the cities were harmed by the design of the fumigant, that the benefits of its product with TCP did not outweigh the risks, and that those risks were knowable at the time it was sold. But these were results with larger cities. How would that process work for small community water systems? How long would it take? How much would it cost?

Starting The Legal Process

The pathways to taking legal action can vary. Most water systems, municipalities, and organizations start by looking for attorneys who specialize in complex environmental law. Environmental law is a vast field but, in general, has to do with how people treat the natural world. The "polluter pays" principle has been a key concept within this field for decades as a means for demanding that polluters, not innocent community members, bear the costs of their pollution.

The good news for these cash-strapped small systems is that some environmental law firms take on cases like these on a contingency basis. No money for attorney fees is required up front. Instead, the attorneys take their fee and related costs from a pre-negotiated percentage of the settlement or judgment. This means that attorneys typically take cases that they believe have good merit with clear liability by an organization or person with the ability to pay a judgment or settlement.

For very small water systems, there are also some other options. For example, one community water system might have to shut down a well because of contamination with TCP. In the same groundwater basin, a vineyard or a school might also face the same problem with its well. These water users could band together to sue the chemical manufacturers responsible for contaminating the groundwater for the costs of cleaning it up.

Organizations should review qualifications and experience before selecting and entering into a contract with a law firm. Some factors to consider include:

- Specific knowledge of water utilities and water contamination law
- Track record of success in similar cases
- Licensed to practice law in your state
- A fee schedule that works within your budget

With these factors in mind, water systems, cities, and other organizations can often find a legal partner willing to help them

recoup groundwater treatment costs and restore safe and reliable water supplies to the communities they serve.

Time Is Ticking

For many communities coping with contaminated groundwater, the damage to their water supplies happened over many years, often decades. The solutions to these problems take time to put into place as well, whether it means applying for state grants, merging with another water agency, recovering costs through the courts, or some combination of all three.

But taking time to see how grant applications play out may not be the best option before pursuing legal action. In some instances, water systems may be subject to a three-year statute of limitations on product liability cases. This means that cases brought three years after a water provider has taken steps to remediate TCP may risk dismissal by the court. It certainly is a deadline to be aware of when thinking about taking legal action. It may be best to move quickly and make a claim for some organizations.

An All-Of-The-Above Approach

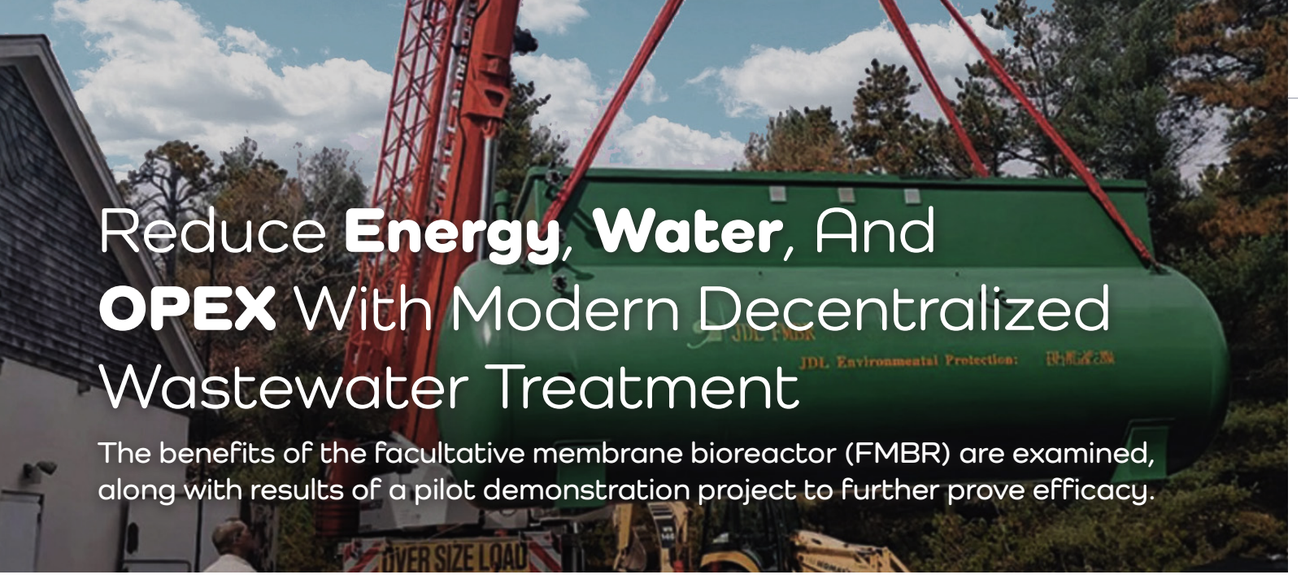
Litigation can be time-consuming, with resolution (and dollars) coming years after filing suit. But for many communities dealing with a toxic legacy in groundwater, it is a good option, especially when combined with other strategies such as consolidation with other water systems and the pursuit of state funding for water-quality issues.

Suing the parties responsible for the pollution helps water providers pay for critical water infrastructure facilities without passing on the heavy burden to ratepayers. The chemical companies that caused the contamination should bear the costs of bringing water supplies into compliance with state regulations. The law holds those companies liable for the problem.

With the emergence of PFAS in more water systems across the country, there is a lot to be learned from TCP litigation in California that can help utilities to make better and faster decisions. In many ways, they have set a precedence for other communities to seek rightful compensation from chemical polluters to complement their typical funding mechanisms. When the health of future generations is at stake, using every tool to tackle the challenge just makes sense. ■

About The Author

Seth Mansergh is an attorney at SL Environmental Law Group San Francisco, where he exclusively represents drinking water suppliers, including cities, water districts, mutual water companies, and other utilities in identifying and holding groundwater polluters accountable. He can be reached at SMansergh@slenvironment.com.



Reduce **Energy**, **Water**, And **OPEX** With Modern Decentralized Wastewater Treatment

The benefits of the facultative membrane bioreactor (FMBR) are examined, along with results of a pilot demonstration project to further prove efficacy.

By John Tillotson

According to Frost & Sullivan, the decentralized containerized/packaged water and wastewater treatment (W&WWT) systems market is estimated to garner $7.92 billion in revenue by 2026 from $5.22 billion in 2020, an uptick at a 7.2 percent compound annual growth rate.[1] Rising water stress worldwide is compelling authorities in charge of water and sanitation globally to explore decentralized solutions, pushing the demand for decentralized containerized/packaged W&WWT systems and ensuring water sustainability and circular economy.

For most mid-market community, education, commercial, and food facilities, it is commonly assumed that the wastewater generated by the operation will be handled by the local municipal wastewater treatment plant (WWTP). It's rather simple: Discharge wastewater generated by the operation down the drain, which is transported down septic lines, sometimes for miles and miles, until received by the WWTP, where it is treated. Pay a sewer bill and let someone else deal with the waste.

In the past, discharging wastewater to a municipal WWTP may have been the only practical solution for managing and disposing of wastewater. Today, mid-market and even large facilities may want to consider opportunities to reduce costs, energy, and water consumption and improve the sustainability of their operation with decentralized wastewater treatment systems (DEWATS) installed onsite.

Improve Sustainability By Reducing Water And Energy Consumption

DEWATS are installed and operated onsite, at the source of wastewater, and eliminate the need to discharge wastewater offsite and pay a sewer discharge bill. Eliminating the sewer bill, by itself, can correlate to a significant savings. A mid-market food processor in the Midwest discharging 500,000 GPD of food cleaning wastewater may pay an annual sewer bill over $1 million.

The composition of wastewater is 99.9 percent water and the remaining 0.1 percent is what is removed. A DEWATS installed onsite at the above food processor could recover that water as clean water used for cooling tower makeup and cleaning food processing equipment, saving 180 million gallons of water annually.

Let's say a mid-market commercial development project involves an office building (750,000 sq. ft.), hotel (400 rooms), retail space (350,000 sq. ft.), and two restaurants netting a daily wastewater flow of 240,000 GPD. At a sewer discharge rate of $5 per thousand gallons, and a potable water supply cost of $5 per thousand gallons, the annual cost of wastewater treatment services plus the corresponding water supply cost would be $876,000. Total annual water consumption would be 87.6 million gallons. If the wastewater were treated onsite, it would produce clean, National Pollutant Discharge Elimination System (NPDES)-permittable effluent — over 80 million gallons per year — that could be reused onsite for cooling tower makeup, irrigation, and a variety of other non-potable graywater uses.

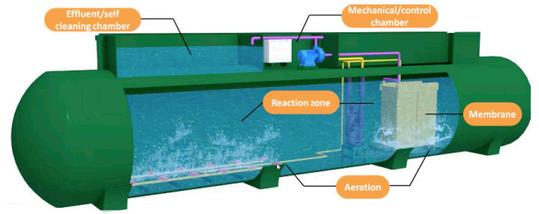
Some modern membrane bioreactors (MBRs) significantly reduce energy consumption for wastewater treatment by operating at a low dissolved-oxygen (DO) set point, thereby minimizing aeration energy, which is the largest energy-consuming activity in wastewater treatment. In the facultative membrane bioreactor (FMBR) pilot demonstration summarized below, the FMBR reduced electric energy consumption by 77 percent for wastewater treatment processes.

Reduce Infrastructure Costs And Bottlenecks

When DEWATS is installed upstream at the source of wastewater, eliminating discharge to the municipal wastewater treatment plant, the WWTP gains the corresponding flow of wastewater as increased capacity. In the above development example, 87 million gallons of wastewater per year would not be discharged to the municipal wastewater treatment plant. The WWTP gains the equivalent in additional treatment capacity to support economic development and new customers, eliminating or at least delaying expensive plant upgrades and expansions. This helps keep rates down for wastewater treatment services provided by the local municipal WWTP. This also may enable economic development to move more quickly when facing capacity limitations of the local municipal WWTP.

The Facultative Membrane Bioreactor

FMBR is a modern, low-energy, small-footprint MBR wastewater treatment technology that provides a single-tank solution for onsite wastewater collection and treatment. The FMBR produces clean water effluent that can be reused onsite, while generating a minimum volume of sludge requiring further processing or offsite disposal. It is suitable for handling the wastewater treatment needs of commercial, retail, hospitality, educational, healthcare, and community facilities and activities, and wastewater treatment plant upgrades and expansions.



The FMBR was invented by Jiangxi JDL Environmental Protection Co., Ltd. (JDL) of Nanchang, China, in 2008. JDL claims 47 invention patents across the USA, UK, France, Japan, China, and other countries, and over 3,000 systems installed and commissioned across 19 countries.

The FMBR Pilot Demonstration Project

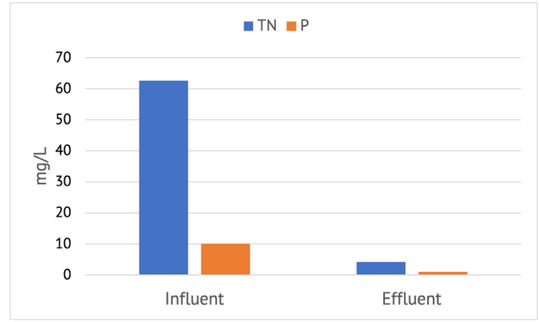
The first FMBR pilot demonstration project installed in the U.S. was in November 2019 at the Plymouth, MA, Municipal Airport. This was made possible by winning a global competition hosted by the Massachusetts Clean Energy Center (MASSCEC) for wastewater treatment innovations that minimize energy consumption. It was granted the highest available funding of $150,000. The final report summarizing the results of the pilot can be found here.

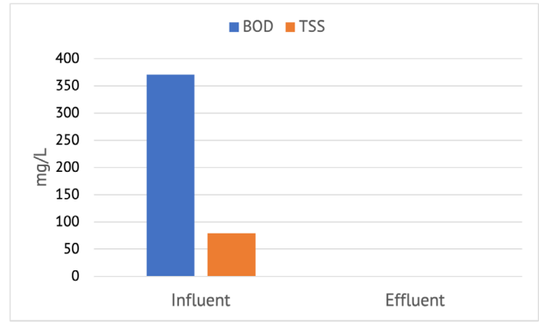
Requirements

- Replace a sequencing batch reactor (SBR) wastewater treatment process due to high energy costs.
- Treat 5,000 GPD of wastewater generated by the airport and surrounding restaurants.
- Meet effluent discharge permit requirements:
  - Biological oxygen demand (BOD) < 30 mg/L
  - Total nitrogen (TN) < 10 mgN/L
  - Total suspended solids (TSS) < 30 mg/L

Carbon, Nitrogen, And Phosphorus Removal

Daily testing of influent and effluent for TN, phosphorus (P), BOD, and TSS showed strong performance of carbon (C), TN, and P removal. Over one year of operation, the FMBR pilot observed average daily P removal of 10.0 mgP/L to <1.0 mgP/L; TN removal of 62.7 mgN/L to 4.1 mgN/L; BOD removal of 371 mg/L to non-detect; and TSS removal of 79 mg/L to non-detect.





Key Benefits Observed

~77% energy savings

Electric energy savings averaged 77 percent from February to December, 2020, and a 73 percent reduction in energy cost.

~65% less biosolids volume requiring offsite disposal

The volume of residual biosolids requiring offsite disposal was reduced 65 percent, from 20,000 to 6,500 gallons per year.

~75%+ reduction in footprint

The footprint of the wastewater treatment system was reduced by more than 75 percent. The SBR was installed in 2003 with a design flow capacity of 25,000 GPD. The footprint is 2,303 sq. ft. The actual flow of wastewater requiring treatment at the airport is 5,000 GPD. Therefore, the FMBR pilot design flow capacity is 5,000 GPD. The footprint is 224 sq. ft. This correlates to a 90 percent smaller footprint than the SBR system that it replaced. If the FMBR had a design flow capacity of 25,000 GPD, the footprint would be approximately 500 sq. ft. This correlates to a 75 percent reduction in footprint as compared to the legacy SBR.

30-day installation

The FMBR equipment arrived at the site on Oct. 25, 2019. The installation was completed on Nov. 7. The operation started on Nov. 12. The effluent began meeting the discharge permit stably on Nov. 25.

FMBR — How Does It Work?

Removal of nitrogen

The FMBR completes nitrification/denitrification in one step, simultaneously, in a low-dissolved-oxygen condition (<0.5 mg/L). The nitrification/denitrification process is enhanced by encouraging a facultative environment and maintaining a high activated sludge concentration. A facultative environment is encouraged by carefully controlling DO, the gradient of DO distribution, and the liquid flow regime in specialized control schemes that are designed to optimize nitrogen removal.

Removal of organic matter

The FMBR is designed to decompose organic matter to a greater degree than traditional MBR or SBR wastewater treatment processes. This is accomplished by facilitating a higher-than-normal concentration of facultative heterotrophic bacteria that decompose organic matter. A higher concentration of this bacteria is achieved by maintaining a higher-than-normal activated sludge concentration in the FMBR reactor.

Removal of phosphorus

By decomposing organic matter to a greater degree than normal, the FMBR is designed to generate a greater amount of volatile fatty acids (VFAs). This means more food for polyphosphate-accumulating organisms (PAOs). The unique operating characteristics of the FMBR are designed to enable biological phosphorus removal in the same single reactor where simultaneous nitrification/denitrification (SND) occurs, when the proportion of each component in the influent is appropriate.

Reduction of organic residual sludge (biosolids)

The FMBR is designed to significantly reduce residual biosolids mainly on two aspects. First, many anaerobic or facultative anaerobic bacteria with low productive rate coefficients are enriched in the facultative environment. This results in a low sludge productive rate, while meeting the requirement of carbon, nitrogen, and phosphorus degradation. Second, the sludge loading of the FMBR system is low and the sludge age is long. As a result, biological nutrient removal (BNR) microbes are basically in the endogenous respiration period, and the sludge growth rate and decomposition rate are basically balanced. The benefits are a very small production of biosolids requiring offsite disposal and a much longer amount of time between offsite disposal occurrences than traditional processes.

FMBR — How Is It Different?

Traditional SBRs perform nitrification/denitrification in two steps with a DO concentration commonly >1.0 mg/L and remove phosphorus in a separate biological process. Some modern MBR systems complete nitrification/denitrification simultaneously, in a low DO condition, saving energy and footprint. Normally, however, phosphorus is removed in a different process. With the FMBR, phosphorus is removed biologically in the same reactor and ecological system where simultaneous nitrification/denitrification occurs, further reducing footprint and cost.

How Does The FMBR Save Energy, Residual Biosolids, And Footprint?

16S DNA sequencing confirmed the FMBR pilot system was mainly relying on SND bacteria to remove nitrogen.[2] SND requires 20 to 30 percent less oxygen and 40 percent less carbon than most other nitrogen bacteria. This translated into a 77 percent energy savings. A high abundance of denitrifying phosphate accumulating organisms (DPAOs) was also observed, specifically *Tetrasphaera*.[3,4] The high abundance of SND and DPAO bacteria, which have stronger endogenous respiration, reduced sludge production by 50 percent.[5] Combined with other factors, annual biosolids volume requiring offsite disposal was reduced by 65 percent. In the end, the DNA and operational data confirmed the results — simultaneous removal of C, N, and P, in a single tank, with a surprisingly small amount of energy, footprint, and biosolids waste.

Takeaway

Treating the wastewater generated by your facilities or the facilities that you service, onsite at the source, may not have been even a consideration in the past. If you are seeking new ways to conserve and reuse water at mid-market community, education, commercial, and food facilities or evaluating wastewater treatment and water reuse options for a new facility, expansion, or development, modern DEWATS like the facultative membrane bioreactor may be worth looking into. You may not only improve the financial performance of the operation but also inspire the people who work and live in the area by setting the example with action toward a more sustainable future. ■

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About The Author

John Tillotson, MSCE, is the managing partner at Microbe Detectives (MD) and its environmental consulting practice, WaterTrust. Over the past five years, John has been developing MD's DNA sequencing services with a specialization in water reclamation, biological nutrient removal, and anaerobic digestion in municipal and industrial systems. Prior to MD, he had over 25 years' experience in water/environment, data, and IoT. He holds an MS in civil engineering from Tufts University, a BS in geochemistry from West Chester University, and a toxics use reduction planner certification from the Massachusetts Toxics Use Reduction Institute.

FROM INSIGHT TO OUTPUT:
How Digital Solutions Can Advance Industrial Water Management

SMART WATER MANAGEMENT IS NOT JUST A MORAL RESPONSIBILITY; IT'S ALSO A BUSINESS IMPERATIVE.

By Pedro Sancha

Whether in the clouds above us or the digital cloud, water is a crucial component of our lives. From powering and cleaning facilities that manufacture our phones to rinsing the wafers that make up semiconductors, water is fundamental for the continuation of innovation and technology. And we can, in turn, harness digital insights to help ensure that businesses across all industries use water efficiently.

Today we face increased urgency to change the way we use water, as rising industrial water use continues to contribute to the world's growing water stress and scarcity challenges. According to the World Resources Institute (WRI),[1] if nothing changes, the world will experience a 56 percent freshwater shortfall by 2030, an increase from the 40 percent shortfall projected by the UN in 2015.[2]

While many companies are aware of the need to change the way they use water to future-proof their operations, they often have trouble embedding it into their business planning and operations. According to an Ecolab and GreenBiz February 2021 survey of 93 companies with revenues of at least $1 billion,[3] only 38 percent of respondents stated that water is a strategic corporate initiative that is proactively managed across their operations. This is due, in part, to the fact that the current prices of water often do not reflect its true cost, which incorporates the operational, reputational, and regulatory risks associated with water in the facilities' regions in addition to the dollar amount.

It is almost impossible for companies to create a plan when they don't understand their current performance and how it could be improved. In fact, in that same survey, only half of the respondents were currently using measurement tools to track water progress.

Understanding Water Performance Can Advance Sustainability Goals And Cost Savings

Without insights and analytics that empower organizations to act quickly to reach optimal water performance, enterprises stand to lose billions of dollars in asset, water, energy, and operating efficiency.

Greater visibility into water use across operations allows companies to identify inefficiencies and change behavior to help optimize operations, which leads to real progress on water-related sustainability goals, from the enterprise level to individual facilities. By understanding the quality and usage of the water throughout a process on a global scale, organizations can then reduce the amount of water used in total and increase the amount they reuse and recycle. This, in turn, reduces net consumption and helps lower carbon emissions, since so much energy is used to heat, cool, treat, and move water. And the best part is that the resulting optimization also delivers cost savings, which more than offset the investments in water technologies. Using digital technologies can enable companies to advance sustainability, profitability, and performance at the same time.

Measurement Can Be Time-Consuming And Complicated

Water treatment systems are dynamic and complex, and companies may not track water performance and progress because the manual data collection and analysis process is often tedious, resource-intensive, and difficult to execute consistently across sites. And that's why digital analytic tools are game changers.

Intelligent digital services enable real-time insights and response, providing visibility into water usages at the enterprise, site, and asset levels. Businesses can efficiently use these insights to pinpoint where water is being consumed across connected assets and processes within their facilities, set enterprise-wide benchmarks, and strategically target improvement efforts to help maximize water savings.

> **Intelligent digital services enable real-time insights and response, providing visibility into water usages at the enterprise, site, and asset levels.**

Let's take an example from the brewing industry. Say you run a global network of 100 breweries, and across your sites, you use an average of 3 hectoliters of water per hectoliter of beer. But at one site, you use only 2 hectoliters of water per hectoliter of beer. You'd want to be able to use that plant as an internal benchmark. And you might see that a competitor needs to use only 1.8 hectoliters. Capturing performance at the enterprise- and site-level and working with a third-party evaluator can help businesses understand how to drive those results using best-in-class insights, practices, and solutions.

A Customized, Local Approach Can Drive Enterprise Performance

This ability to pinpoint performance at the site level also can help an organization make scalable progress on its water-use goals. Individual facilities play a key role in an overarching water management strategy: While water targets and goals are typically set by sustainability and corporate responsibility teams, 95 percent of respondents in the Ecolab-GreenBiz survey said that facility-level teams are responsible for achieving these targets.

A common pitfall for many organizations with multiple sites is not looking at individual site performance and setting one-size-fits-all water reduction targets for all locations. Because sites operate within unique watersheds and weather conditions or may manufacture products that use differing amounts of water, this could lead to targets that are too high for some locations and too low for others. Unlike greenhouse gas emissions targets, which can be set at the global enterprise level, water use needs to be solved within the context of a local watershed. Understanding site-level performance and surrounding factors can help businesses set localized targets for unique facilities, which allows them to make efficient progress on targets without sacrificing performance.

Optimized Water Management Helps Protect Your Business

Smart water management is not just a moral responsibility; it's also a business imperative. Optimizing water use is key to building resilient and efficient operations, and it protects business assets. For instance, predictive insights and real-time alerts can help protect facilities against operational disruption due to water quality and quantity risks. Features such as real-time monitoring, advanced alarm notifications, and 24/7 oversight enable alerts to users as out-of-spec conditions occur, enabling faster responses to address leaks and other issues.

And optimizing water use can help organizations operate as responsible members of their communities, ensuring that they are not taking more than their fair share of water and resources within a watershed. Rather than using and dumping water, we need to invest in solutions that mirror the natural water cycle, focusing on reducing, reusing, and recycling. With water scarcity putting more people and communities at risk, businesses are wise to be at the table, building trust in their commitments and supporting their local environments and communities. Future water allocations, and even permission to operate, could depend on it.

Supporting businesses to gauge the effectiveness of their water management plans and improve their water footprints with insights and analytics is more important than ever as we face a widening gap between freshwater availability and increasing demand from industry. Understanding the role of water in operations and opportunities to reduce use is critical as companies progress on their sustainability commitments and operations resiliency in the face of climate change and water stress. ■

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About The Author

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Telling Water's Story; Selling Your Story

Why good storytelling is important for improving the state of municipal water service.

By Jim Lauria and Adam Tank

If long sales cycles give you nightmares, the water industry will ensure you never sleep.

Long utility planning discussions make 12- to 24-month sales cycles. Regulated rate structures and budgets can delay a deal by years as the utility and manufacturer wait for funds to become available. And communications behind the transactions can be challenging as understaffed utilities get frustrated by a parade of new salespeople whose companies and their quarterly focused executives don't have the patience for.

But there are great opportunities for successful selling in the municipal/utilities market. At the heart of those opportunities is telling water's story. Good water storytelling helps manufacturers position their product, sell the benefits, and serve the customer. But it goes much further. Good water storytelling in the sales process helps the utility explain to regulators and ratepayers why your product — and theirs, water itself — is so important. It could help shake loose funding from government and build support within the regulatory chain. And good storytelling can generate enthusiasm among the public about technologies a utility is adopting (as long as the story is easy for a layperson to understand).

The bottom line is that telling water's story helps build the public's perception of the value of water. If people don't value water, they don't support budget allocations and rate increases to pay for better technology.

"Water plays in this weird space in our lives where it's a right," says Reese Tisdale, CEO of Bluefield Research, who was a guest on the *Water We Talking About?* podcast on June 28, 2021. "I think people expect it, but also people think that distribution and supply are free, and the infrastructure is free, which it is not."

Adding to the challenge, says Tisdale, is that the water industry tends to be invisible to most of the public.

"It's 'out of sight, out of mind' for most people, so the water industry as a whole kind of operates in the shadows," he notes.

Our job in the water industry is to bring the process out of the shadows and explain what's behind the water in the tap — to increase the perception of the value of water and to provide the products, services, and support that help utilities source, treat, and deliver that water.

Through our *Water We Talking About?* podcast hosted by *Water Online*, we have a unique opportunity to talk with some of the best storytellers in the water industry and share their insights with listeners. In conversations with three leaders in the business, we distilled several key lessons that can be applied to selling in the municipal/utilities market.

Tisdale's perspective, informed by his analysis of the water industry, on the challenges of telling a highly technical story is the first major lesson.

Jeff Hobbs, former vice president of technology for San Jose Water and our *Water We Talking About?* guest on May 26, 2021, points out that utility staffs tend to be extremely small and extremely busy. His department had 25 employees handling the technical needs of a utility that serves about 235,000 customers.

"That's a pretty small department for what we're trying to handle," Hobbs told us. "I wanted to be able to trust my contractors, my vendors."

Hobbs points out that building that trust could be difficult, especially when forced to continually tell his own story to new salespeople — and that was doubly problematic when those salespeople didn't do their homework before calling on him.

"We think it's a public agency, but in many cases it's a public company that's very heavily regulated," Hobbs explains (as he had to do countless times to green salespeople calling on him). "Just a hint: Oftentimes an investor-owned utility will have the word 'company' in its name. And a company almost always means that it's not an agency in the public sense.

"Go online. Just look at the website," he urges. "Do an 'About the Company' type of thing. If someone's just, 'Hey, I know you're on the NYSE,' that's like, 'Alrighty, you've done at least some research. That's already a step up on more than 95 percent of the people I've talked to.'"

How Your Customer Makes Money

Use some of that research time to determine how your client makes its money. With utilities, it may not be as simple as just taking a margin on sales.

"The vast majority of the business model from a private water utility is capital dollars — the utility is granted an authorized rate of return — every three years, at least in California; you can earn this much on this amount of capital dollars," Hobbs explains.

So where does your story fit into that? Investing in your technology or service could be part of your customer's profit picture — but only if you time your pitch and transaction right.

You've got to know what your customer's budgeting and rate case cycle is. If you miss it today, you may be on the bench for the next several years. That's years of trying to keep on your customer's radar (and keeping your sales manager at bay).

"So you may have a great discount offer for a signature this year, but you may be two years too early," Hobbs notes.

Another Key Audience: Government

While you're working your way through your municipal or utility customer's budget cycle, you could be doing him or her a favor by telling water's story to public officials. The more elected officials and agency staffers understand the importance of your solutions, the more support your customer is likely to get when it comes to allocating grants and support.

Mae Stevens, vice president and chair of water practice for Signal Goup in Washington, DC, is a go-to lobbyist for the water industry and was our podcast guest on June 14, 2021. She pointed out that we're fortunate to have some officials — like U.S. EPA Principal Deputy Assistant Administrator for Water Radhika Fox, former CEO of the Water Alliance, who understands water and the water industry. But there are many others who, like the rest of the public, just haven't heard our story yet.

"People in Washington don't understand what you need — anybody, whether it's water or any other sector of the economy — unless you tell them," Stevens says. "They don't know what you want unless you ask for it."

Just as important, we need to understand their story, too, just as we need to understand our customers' stories.

Clockwise from left: Jim Lauria, Adam Tank, and Reese Tisdale

Jeff Hobbs (left) confers with Adam Tank and Jim Lauria.

Jim Lauria and Adam Tank talk with Mae Stevens.

"If you are in the water sector, you need to understand what's going on in Washington because it has a really significant impact on what you do back home, wherever you are," Stevens says.

Stevens emphasized that telling your story in Washington (and we can make the parallel at the state level) is a process, too. Your first call is going to end up at the desk of a young intern, who can pass your message to a legislative aide, who can ultimately deliver your perspective to the representative or senator. Over time, a pressing story can evolve from a message to an issue to a policy to a piece of legislation — and you can build a relationship with your elected representatives and their staffs as a valuable resource for understanding what's happening at ground level.

When change happens, when allocations are made, when a new system is installed to benefit ratepayers, it's time to tell the public what happened. Make sure the public knows how its water system just improved, and be sure to thank the officials who helped make it possible, notes Stevens.

Thanking the public fuels the careers of elected officials. If they do you a solid, make sure you return the favor.

Allies Provide Consistency

Telling your story over time — and through different levels of government or a customer's organization — can be a challenge, especially when sales teams are often training grounds for rising stars who get shifted frequently to new roles.

Look for representatives who can be your allies. Trade associations are an outstanding place to unite with others in the industry to zero in on messages and deliver your story from multiple angles to government and prospective customers. On a more company-focused level, team up with manufacturers' reps for equipment or value-added resellers for software. Those organizations tend to have salespeople who stay in their positions for years, building trusted relationships with their customers — your customers. They see all aspects of the utility's operation, so they can present your product or service in context and at the right time in the procurement cycle. And they have expertise not just in your technology but also the technologies around it. In all, it's a perfect setup to tell a great story.

Tell Your Story — Loud

When it comes to selling to municipalities and utility companies, start with your story. Distill your messaging and keep it consistent. Learn your customer's needs not just in terms of technology, but in terms of timing, too. Use your story to help your customer gain the support of government and the public, celebrate the wins, and ally yourself with others who can help tell water's story.

"I think ... for significant change to happen … it takes leadership, and it takes a sponsor within the organization to do it," says Tisdale.

Be that leader. Be that sponsor. And turn the water story into the story of your sales success. ■

About The Authors

Jim Lauria is vice president of sales and marketing for Mazzei Injector Co. LLC, a fluid design company that manufactures mixing and contacting systems. He has been a water technology executive for over 20 years, with global experience in the agricultural, municipal, industrial, and commercial markets. Lauria holds a Bachelor of Chemical Engineering degree from Manhattan College. He and Adam Tank co-host *Water We Talking About?*, a podcast sponsored by *Water Online*. You can contact him at jlauria@mazzei.net.

Adam Tank has over 10 years of experience in the water industry with a focus on business development, software, and innovation. As the director of software solutions at Transcend Water, he has responsibility for client success related to Transcend Design Generator Software, a tool that helps water OEM's and engineering firms streamline their conceptual design practices. Tank received his undergraduate degree from Kansas State University and his MBA from the University of Arizona. You can reach him at atank@transcendh2o.com or on his personal site, www.adamtank.com.

Cost Management In Valve Selection:

Balancing Price With Suitability

Because so many options exist, it's possible to get safe and reliable performance from your valves without overspending. Matching valve specs to your application is the key.

By Gilbert Welsford Jr.

Considering the multiplicity of valve types available on the market and the diversity of applications any one type can serve, proper valve selection can be a tricky proposition.

Even within a specific category of valve, differing styles, specific features, and manufacturers' idiosyncrasies can all serve to complicate the matter.

Cost versus suitability represents an inarguably crucial factor that you can't afford to overlook when choosing valves. After all, selecting a $1,000 ball valve for a certain application where a $500 alternative valve can perform equally well is hardly a prudent choice. Similarly, employing a cheaper valve with poor suitability for a high-risk application in the name of cost management proves equally unwise.

Additional caution is necessary while choosing valves for food processing units because some valves are manufactured with material that contains elements injurious to human health. There can be many direct and indirect consequences of poor valve selection, such as:

- Safety incidents
- Undue maintenance cost
- Capacity loss
- Energy loss
- Cost increment
- Product loss.

Valve Selection Basics

Process requirements

Specifying the correct valve type is a function of understanding your process requirements. Physical and chemical characteristics of the fluid being regulated play a key role in valve selection. The base material of the valve will depend on its compatibility with and suitability for the medium.

Carbon steel valves are often considered for most noncorrosive applications. Stainless steel valves are widely used in high-temperature and high-pressure corrosive applications. If you are choosing a valve for a corrosive application with a moderate temperature, plastic can be a great choice for you, as well.

Ball, plug, and globe-type valves are often considered when frequent adjustments in the process flow are required. On the other hand, gate-type valves are typically employed in binary on-off applications or for isolation purposes.

Operating conditions

Start with determining the temperature and pressure requirements. Find out about the pressure and temperature ranges where the valve will be deployed. Correct information about operating temperature, pressure, and other parameters will help you pick the right-sized valve. Installing an oversized or undersized valve can lead to operational troubles.

Valve manufacturers provide complete information about the maximum operating pressure and temperature of their products. Ensure that the valve you have chosen can withstand maximum operating conditions that may occur during process upsets and abnormalities. In the case of a check valve, it must be ensured that you have chosen a valve with a suitable cracking pressure rating.

Valve Materials — A Brief Summary

- *Cast iron:* Usually used for low-temperature and low-pressure applications.
- *Ductile cast iron*: Commonly used in oil, gas, steam, and water pipeline systems because of its broad range of operating pressures and temperatures.
- *Stainless steel:* Known for its remarkable durability and corrosion resistance, stainless steel is used in plenty of applications, ranging from general plant systems to the petrochemical industry.
- *Bronze:* Bronze is an alloy of zinc, tin, lead, and copper. Bronze offers great resistance against corrosion and wear. Its good machinability makes it a viable choice for complicated castings. Bronze valves are widely used in low- to medium-pressure services.
- *Brass:* Brass is an alloy of zinc and copper. It offers excellent machinability and forgeability and is cheaper than bronze.
- *Cast Steel:* Cast steel is commonly used in refineries, petrochemical, and oil fields because it tolerates a broad range of working pressures and temperatures.

Optimization Possibilities

Avoid expensive material when not required

You can secure tremendous savings by avoiding an expensive metal valve when it is not required for your process requirements and operating conditions. Plastic valves are often an ideal economical alternative, performing well in low-pressure and

mildly corrosive applications. Valves made from stainless steel, brass, bronze, and other metals frequently cost more than plastic valves. However, they are not as durable and/or repairable as their metallic counterparts.

Coated vs. noncoated valves
A broad range of surface treatments and coatings is available for valves, and many vendors are offering valves with coated seats and other internal parts, such as polytetrafluorethylene (PTFE)-lined valves. However, lined and coated valves come at a higher cost, and these devices must only be chosen in cases where uncoated or unlined valves cannot withstand harsh process conditions.

Go with less expensive alternatives where possible
The availability of different valve types in different configurations and with different optional features has made it easy to cope with tight budgetary requirements in valve selection, while not compromising process safety. For example, consider nonrising stem gate valves, which come at a cheaper price than the rising ones. Both ball and butterfly type valves can be used in throttling applications, but the former one comes at a higher price. However, a ball valve is one of the most versatile types of valves, and researchers are continuously working on enhancing its optimization[1] further.

Understand Valves As You Select

Valves are offered in a variety of types, and each type comes with a unique set of characteristics. Understanding different valve designs enables you to find the best type of valve for a process or project. The common types of valves include:

- *Ball valve:* These valves incorporate a ball to regulate flow. Ball valves come equipped with fast-acting quarter-turn handles and are known to be easier and faster to operate than gate valves.
- *Butterfly valve:* The wafer-type design and construction of the butterfly valve makes it an ultimate choice for tight spaces. You can find butterfly valve bodies in various configurations.
- *Gate valve:* In gate valves, linear motion is utilized to start or stop fluid flow. Generally speaking, these valves are not preferred for flow regulation and are used in fully closed or open positions.
- *Globe valve:* Globe valves are well-suited for applications where fluid modulation is required. T-body, angle body, and Y-pattern are the three available types of globe valves.
- *Plug valve:* Plug valves regulate flow through cylindrical or tapered plugs. These valves come with a 90-degree turn valve handle. Plug valves are good for high-temperature and high-pressure environments where tight shutoff is needed.
- *Check valve:* Check valves are self-activated valves used to prevent backflow in a line. Multiple types of check valves are available on the market, such as spring check valves, swing check valves, ball check valves, etc.

Function-based classification of valves
Valves can also be classified by function instead of design. The following are the most common functional designations used for valves:

- *Isolation valves:* Gate, pinch, butterfly, ball, plug, pinch, and piston valves
- *Regulation valves:* Globe, butterfly, ball, needle, plug, pinch, and diaphragm valves
- *Safety relief valves:* Pressure safety (PSV), pressure relief (PRV), and pressure/vacuum relief (PVRV) valves
- *Non-return valves:* Lift and swing check valves.

Clarity on optional features
Commonly, many vendors offer "optional features" for which they charge separately. While buying budget valves, you must avoid wasting money on unnecessary optional features. As an example, consider "stainless steel handles," which are often offered on an optional basis with ball valves. Yes, stainless steel handles are great, but any ordinary handle can do the job for you.

Valve repair vs. replacement
If you are seeking a replacement for a bad valve, you should explore valve repair opportunities around you first. Today, we have a very vibrant valve service industry available. There isn't any generalized rule to determine whether a valve should be replaced with a newer one or be repaired. In some cases, you might be able to incur significant savings by getting a faulty valve refurbished by a reputable vendor.

Conclusion

The availability of valves in various materials and types allows us to make cost-effective choices. After choosing an appropriate type of valve (ball, butterfly, plug, etc.) according to the system's requirement, you must establish which material will be the most suitable in cost and performance. Corrosiveness of atmosphere and process fluid must be kept in mind while choosing the material of construction, e.g., steel, cast iron, carbon steel, etc.

Expensive "optional valve features" should be avoided when not required. Ensure that the products being considered are designed and manufactured in compliance with the relevant industrial standards, e.g., FM, UL, API, OSHA, etc. ■

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About The Author

Gilbert Welsford Jr. is the founder of ValveMan.com and a third-generation valve entrepreneur. He has learned valves since a young age and has brought his entrepreneurial ingenuity to the family business in 2011 by creating the online valve store — ValveMan.com. Gilbert's focus is building on the legacy his grandfather started, his father grew, and he has amplified.