



Hazen

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Do More With Less

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of Drinking Water

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Delivery Options

HORIZONS

water environment solutions

FALL 2017

your path to doing more with less

RESOURCE RECOVERY

For many years now, the water industry has been shifting from a paradigm of wastewater treatment and disposal to one of water resource recovery. Newer technologies enable recovery of resources that can be used to generate products with economic value in the facility and/or secondary markets, while also helping utilities meet stringent discharge limits.

Recovery of Nutrients

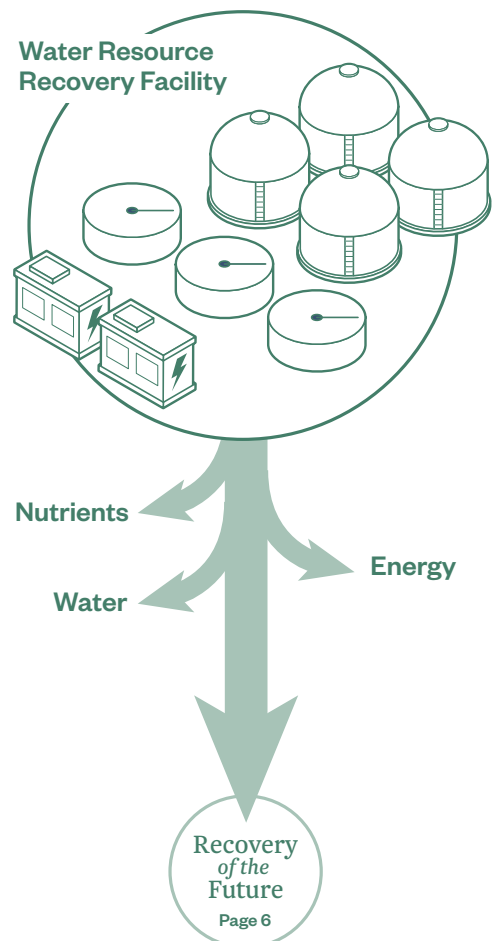
Recovery of Phosphorus and Nitrogen can help address nutrient management goals while alleviating nuisance struvite formation.

Recovery of Digester Gas

Recovery of digester gas can help to offset purchased electricity and fulfill thermal energy demand.

Recovery of Water

Recovery of water for reuse/recharge can alleviate water scarcity, address nutrient management goals, and/or alleviate subsurface issues via aquifer replenishment.



*“The resource recovery paradigm considers that most, if not all, **materials** in wastewater can be **recovered** and commoditized.”*

– WE&RF

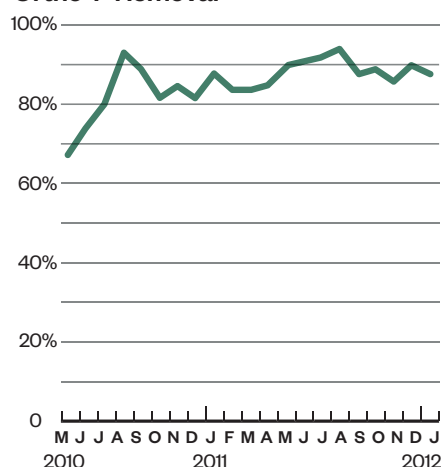


The Nansemond Treatment Plant (NTP) in Suffolk, Va., is a 30-mgd facility operated by the Hampton Roads Sanitation District (HRSD) that has implemented nutrient recovery. The recovery process at the plant consists of patented fluidized bed reactors that recover ammonia and phosphorus from the centrate stream as struvite. The nutrient-rich centrate stream is mixed with appropriate stoichiometric doses of magnesium chloride and caustic to precipitate struvite pellets, which are then harvested from the reactors, dried, and bagged for sale.

Since May 2010, more than 1,000 lbs of struvite have been recovered on a daily basis from the NTP. The recovered struvite is used as a slow-release fertilizer (Crystal Green®) in the agricultural market. In addition to recovering nutrients, implementation of struvite recovery at the NTP has reduced the soluble phosphorus and nitrogen content in the centrate by up to 85% and 25% respectively. This has minimized the need for ferric addition throughout the NTP and reduced the phosphorus content of the biosolids by 10 to 15%. Combined benefits of nutrient recovery at the NTP can translate to annual savings of up to \$450,000 per year.

The combined benefits of nutrient recovery at the facility can translate to as much as \$450,000 each year.

Ortho-P Removal



F. Wayne Hill Water Resources Center



Fats, oils, and grease (FOG) collection at FWHWRC (top photo) provides a robust source of methane gas for the biogas engine generator to convert into electricity (bottom photo), which is used to significantly offset energy costs at the facility.

The F. Wayne Hill Water Resources Center (FWHWRC) is a 60-mgd facility owned and operated by the Gwinnett County Department of Water Resources (GCDWR). Consistent with its values to be wise stewards, GCDWR embarked on a project to maintain full treatment capacity (60-mgd) at the FWHWRC while increasing digester gas production so that it could leverage the capacity of a 2.1-megawatt biogas engine generator. The engine generator is equipped with a natural gas/biogas blending system to enable continuous operation of the engine generator even during periods of low digester biogas production, maximizing both energy production and return on investment, while minimizing the plant's

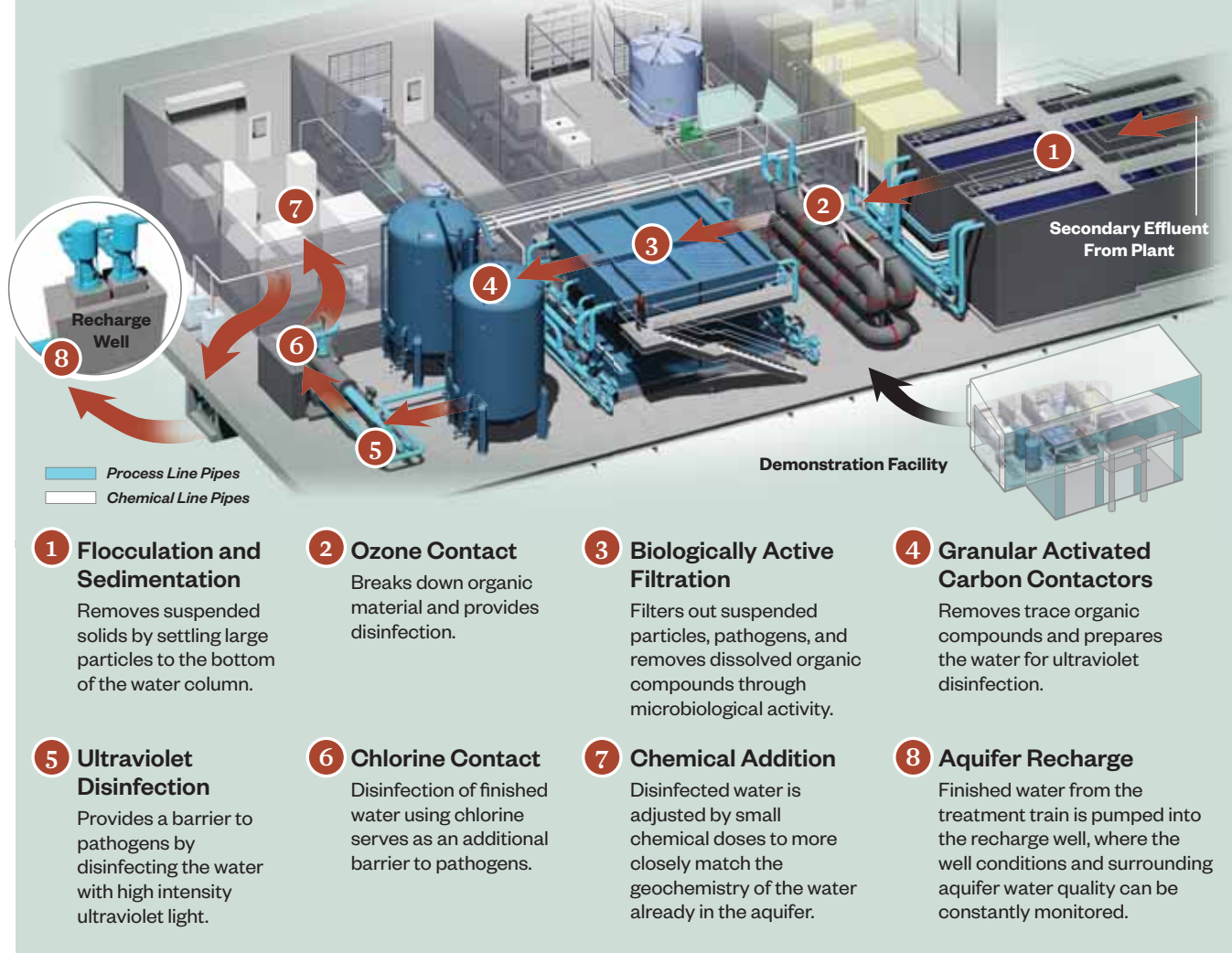
carbon footprint. The project also included a gas conditioning and handling system, as well as a waste heat recovery system that produces hot water to heat the anaerobic digesters.

Since installation of the engine generator, GCDWR has also implemented a co-digestion program, whereby high strength organic wastes from the region are received and processed at the FWHWRC prior to injection into anaerobic digesters to boost gas production. Leveraging the benefits of co-digestion with the engine generator and conversion to a real-time power rate structure has allowed FWHWRC to lower its average power cost, resulting in a savings of over \$1 million (USD) per year.

Sustainable Water Initiative For Tomorrow (SWIFT) Research Center

Advanced Water Treatment Process

Highly treated water from the Nansemond Treatment Plant is pumped to the Research Center's advanced treatment facility where it undergoes an 8-step process to prepare the water for recharge of the aquifer.



Hampton Roads Sanitation District (HRSD) arrived at an innovative single solution to solve several challenges – using reclaimed water to recharge the Potomac Aquifer. The SWIFT Research Center, currently under construction in Suffolk, VA, is an advanced treatment demonstration facility that incorporates an 8-step process to facilitate water reclamation for recharging the Potomac Aquifer.

Recharging the Potomac Aquifer with reclaimed water will replenish eastern Virginia's dwindling groundwater supply, increasing the region's water supply stability; reduce the rate of land subsidence, mitigating some of the impact of sea level rise on the coastal communities

area; and support Chesapeake Bay restoration by diverting water from disposal to beneficial reuse.

The demonstration facility is expected to begin operations in April 2018 and will be able to recover one million gallons of water per day. It will also be used as a research and learning facility for training HRSD staff and providing public education. The information collected during different loading rates at the research center will enable HRSD to improve the efficiency of both design and operation of future full-scale facilities, which are expected to encompass seven of the utility's nine treatment plants and over 100 million gallons of water per day of managed aquifer recharge.



Beyond Nutrients, Energy, and Water

Throughout the past century, our efforts in the water industry have shifted from mastering the basics of biological wastewater treatment to focusing on reclaiming water for reuse and recovering energy from biomass. During the transition into the 21st century, we developed and implemented full-scale nutrient recovery applications. We now sit at the crossroads where recovery of cellulose, high value carbon, bioelectrochemical products, rare earth elements and plasmids represent the next generation of resource recovery.

- Cellulose is an end product of microsieving of raw influent wastewater. Recovered cellulosic material can be processed into paper or used as a feedstock for energy and/or high value carbon recovery.

- High value carbon products include volatile fatty acids (VFAs), polyhydroxyalkanoates (PHAs), and various alcohols.

- o VFAs are an end product of fermentation and represent a building block for creating polymers used within the manufacturing industry.

- o PHAs are a biopolymer produced by micro-

organisms that can be used as a bioplastic precursor.

- o Alcohols like methanol and/or ethanol are end products of fermentation and can be used in industrial and transportation applications.

- Bioelectrochemical products like hydrogen peroxide and caustic can be used within industrial applications for scaling and pH control.

- Rare earth elements are redox-stable metals with unique electrochemical properties that have extensive use in electronics, energy systems, and transportation technologies.

- Plasmids are mobile genetic elements that can be coded for novel enzymes which can be exploited by the biotechnology industry.

The next generation of resource recovery is promising, and new directions in resource recovery will undoubtedly occur in the next few decades. Translating these concepts into practice will require concerted effort by all water industry stakeholders to understand how these emerging technologies, recovery products, and markets can be best leveraged to achieve multiple benefits at utilities.

WRRF | TODAY

*Biosolids
In-Plant Carbon*

Phosphorus

Nitrogen

*High-Value
Carbon*

WRRF | TOMORROW

*Rare Earth
Elements*

Plasmids

Reducing Lead Levels in Drinking Water

The latest findings from tragic lead exposure events and continuing research have highlighted that corrosion control is a critical consideration when implementing significant modifications to treatment and finished water quality entering the distribution system.

Recent events centered on lead in drinking water have eroded public trust in drinking water safety. In response, the United States Environmental Protection Agency (USEPA) is working on upcoming Lead and Copper Rule Long-Term Revisions (LCR LTR). The proposed revisions have the potential to cause significant impacts to community water systems (CWS) throughout the United States, requiring additional actions associated with optimal corrosion control treatment, lead service line replacement, public education, and localized household-level responses (USEPA and NDWAC, 2016).

Action Levels and Sampling Requirements

The current Lead and Copper Rule lead action limit (AL) of 15 µg/L, which serves as a benchmark for effective corrosion control treatment, is not a health-based standard. Research is currently underway to determine a health-based benchmark based on infant and child blood levels. New household health-based action levels proposed for the upcoming LCR LTR will likely decrease current lead level



requirements, possibly forcing CWSs to turn to more aggressive corrosion control treatment options, increasing costs of compliance. While the exact Federal action level requirements of the LCR LTR have not been established, some State and local policymakers are already setting standards more stringent than EPA's current AL. For example, the City of Buffalo, NY has recently lowered its AL to match the FDA's requirement for lead levels in bottled water (5 µg/L).

Recent research has shown that the current standard of first-draw sampling only captures stagnant water in building fixtures and associated piping, while lead levels are often sig-

nificantly higher in samples derived directly from lead service lines. Revised sampling protocols proposed for the LCR LTR require CWSs to obtain compliance samples from lead service lines, which will likely increase lead levels in compliance samples, triggering more systems to optimize their corrosion control. Lead tap sampling campaigns and optimization studies will need to be conducted and experts will need to help connect corrosion theory with the practical complexities of tap sampling.

Optimizing Corrosion Control

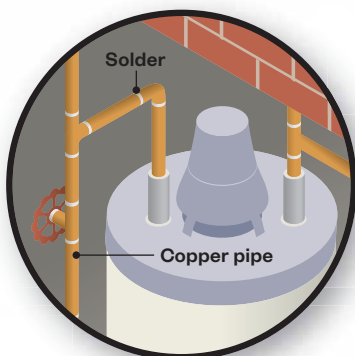
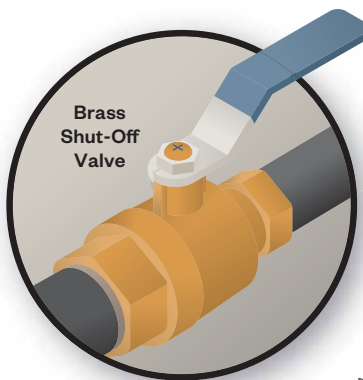
Optimized corrosion control is notoriously complicated and utility-specific, depending on factors such as source water quality, treatment, and interactions between finished water and pipe materials throughout the distribution system. To protect customers from exposure to lead and copper, utilities must have a complete understanding of where sources of lead may exist in a system, mechanisms by which lead may be leaching into drinking water, and possible treatment and operational changes to sustain water quality throughout the system. In short, a holistic "source to tap" (page 10)

Look for Potential Lead Sources at Home

Lead service lines, often found in homes built before the 1950s, are a major source of lead in drinking water. Corrosion in other common plumbing materials may also increase lead levels. Full **lead service line replacement** provides long-term reductions in lead levels.

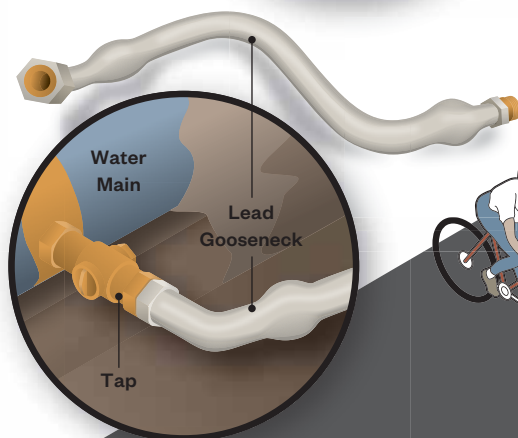
Brass Fixtures

Prior to 2014, “lead-free” fixtures and valves could contain as much as 8% lead by weight. In 2014 the standard was lowered to 0.25% lead by weight.



Solder

Buildings constructed prior to 1987 may contain lead solder.



Service Line and Water Meter

Scales within lead service lines may contain a significant amount of lead. Older water meters can also contain high levels of lead in the brass alloy. Ownership of service lines, between utility and customer, varies across water systems.

Water Meter

Property Line

Service Line

See Sample Size detail at right.

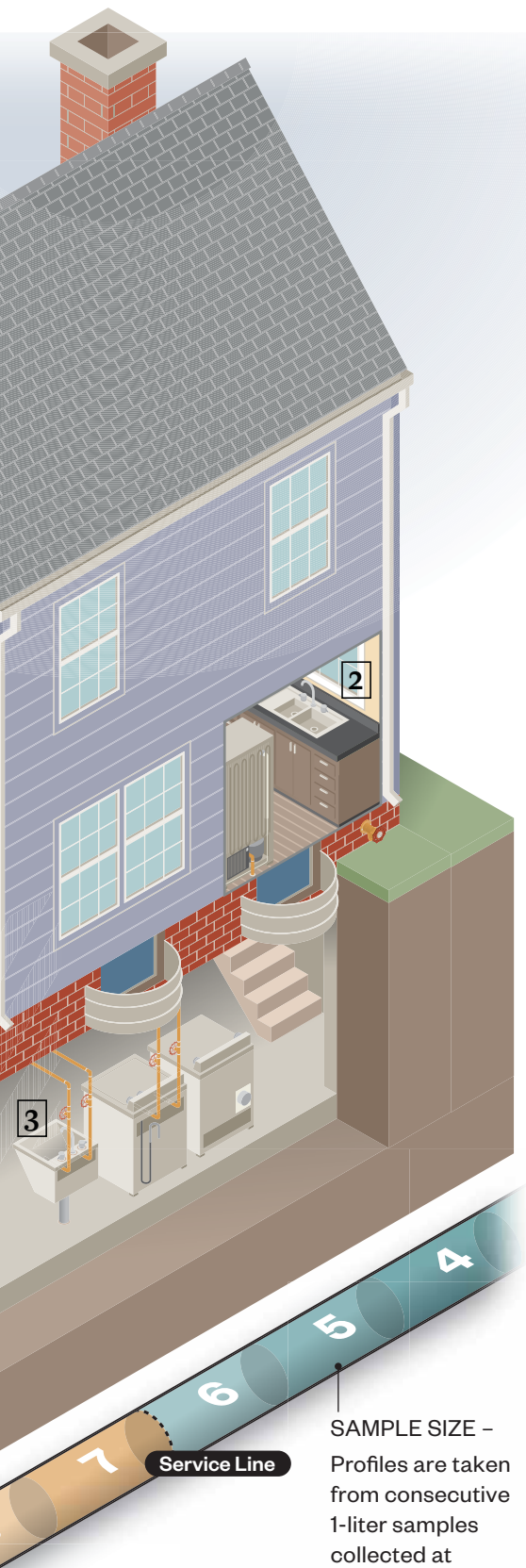
Water Main

Lead Gooseneck

LEAD PIPES are gray and coated in chalky, white film; and are easily scratched with a coin.

CUSTOMER SIDE

UTILITY SIDE

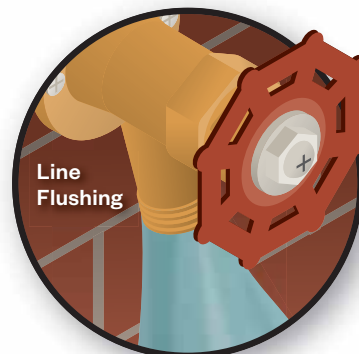


SAMPLE SIZE –
Profiles are taken from consecutive 1-liter samples collected at the tap.

Flushing Protocols

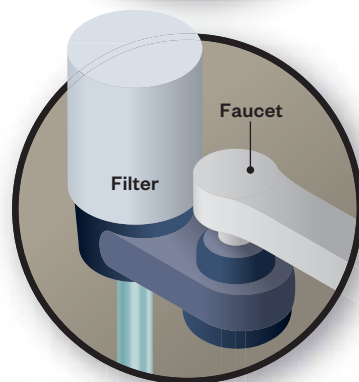
Flushing taps after lead service line replacement can reduce the potential for spikes in lead release due to physical disturbance.

- 1** BASELINE FLUSHING – 10 minutes of flushing at an outdoor tap.
- 2** HIGH VELOCITY FLUSHING – outdoor flushing for 30 minutes followed by 30 minutes of flushing at all indoor taps.
- 3** SEQUENTIAL FLUSHING – After outdoor flushing, flush each interior tap a minimum of 5 minutes working from the lowest level to the highest level in the house.



Point-of-Use Filters

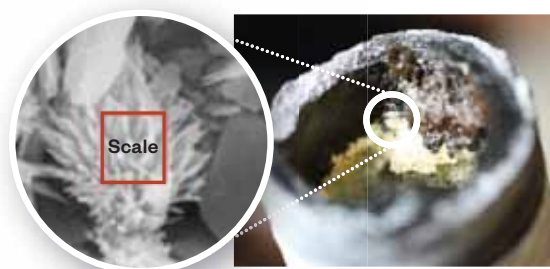
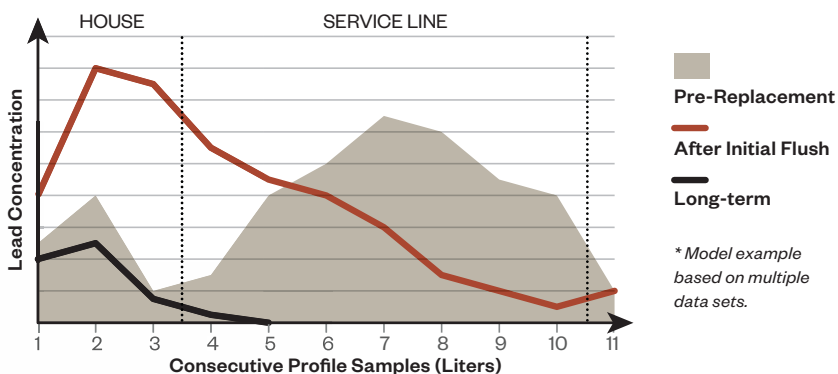
Certified filters are often provided to each lead service replacement line site to mitigate potential lead exposure. Filters can be analyzed to characterize cumulative lead release.



Profile Sampling

Profile sampling can be completed to identify the range of lead levels and sources of lead. Dissolved and total lead analysis is critical to determine the fraction of particulate lead.

EVOLUTION OF LEAD RELEASE – After full lead service line replacement*

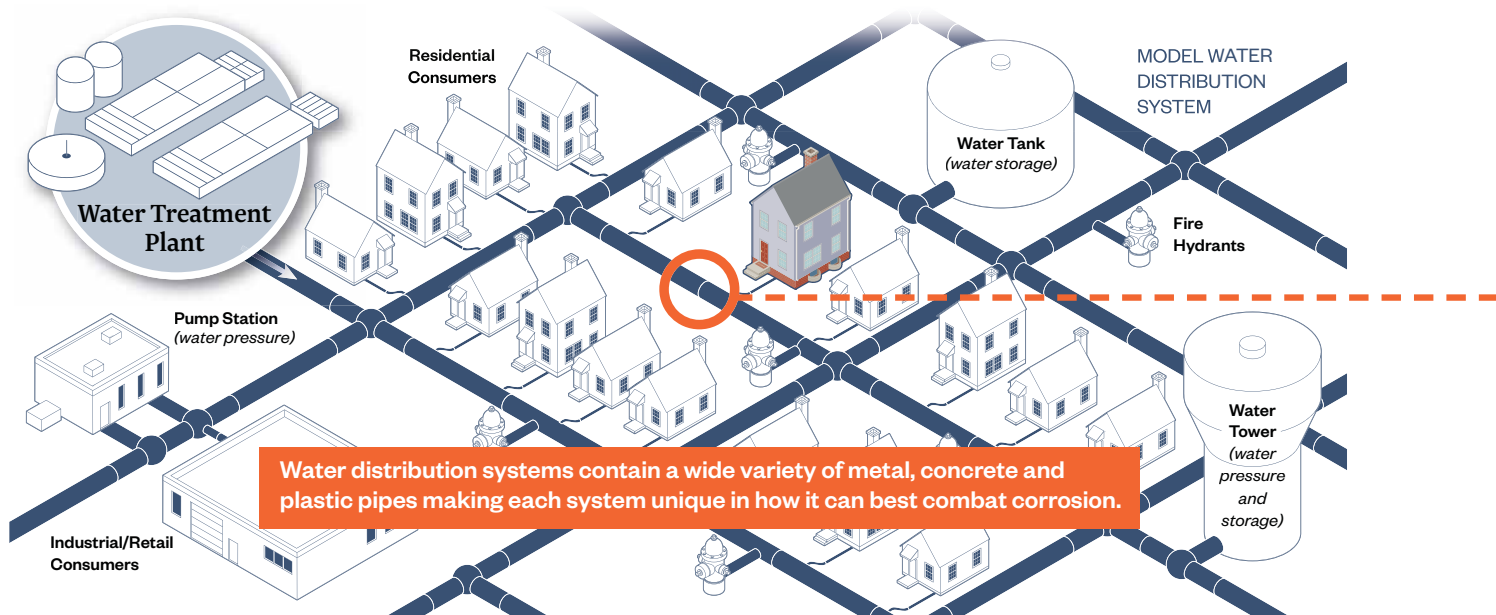


SCALE ANALYSIS –

Using x-ray diffraction or scanning electron microscopy provides insight on the contents and stability of scale formations in lead service lines.

Selecting a Lead-Lowering Strategy

Interconnecting pipes, tanks, and towers in water distribution systems can form a reactor that breeds corrosion. The two competing strategies for attacking corrosion at the water treatment plant are: balancing pH/Alkalinity levels or adding orthophosphates.



(Continued from page 7) approach must be taken when selecting a corrosion control treatment strategy.

There are only two currently available USEPA approved corrosion control methods (USEPA OCCT Guidance Manual, 2016):

1. pH/Alkalinity/DIC Adjustment
2. Corrosion Inhibitors (Phosphate or Silicate based)

When choosing optimal corrosion control treatment, there are a number of variables and questions within these recommended control strategies that are left unanswered. For instance, the optimal pH and DIC levels and appropriate type of chemicals to make these water quality adjustments must be determined for each individual utility. There is also an array of phosphate and silicate-based inhibi-

tor blends available, each performing differently under various water quality conditions. Simultaneous compliance is also a challenge in choosing optimal corrosion control, as treatment and operational adjustments made to optimize corrosion control can also impact other requirements of the National Primary Drinking Water Regulations.

Desktop Optimization Studies

Desktop optimization studies are a simple and effective way to gain a full understanding of what sources of lead are in a system, what types of corrosion may be occurring, how water quality and corrosion reactions interact, and identify changes to better optimize corrosion control.

The most important, and oftentimes overlooked, step in conducting a lead

sampling or corrosion control optimization study is a desktop evaluation to identify possible sources of lead in a system while also developing a holistic understanding of the system.

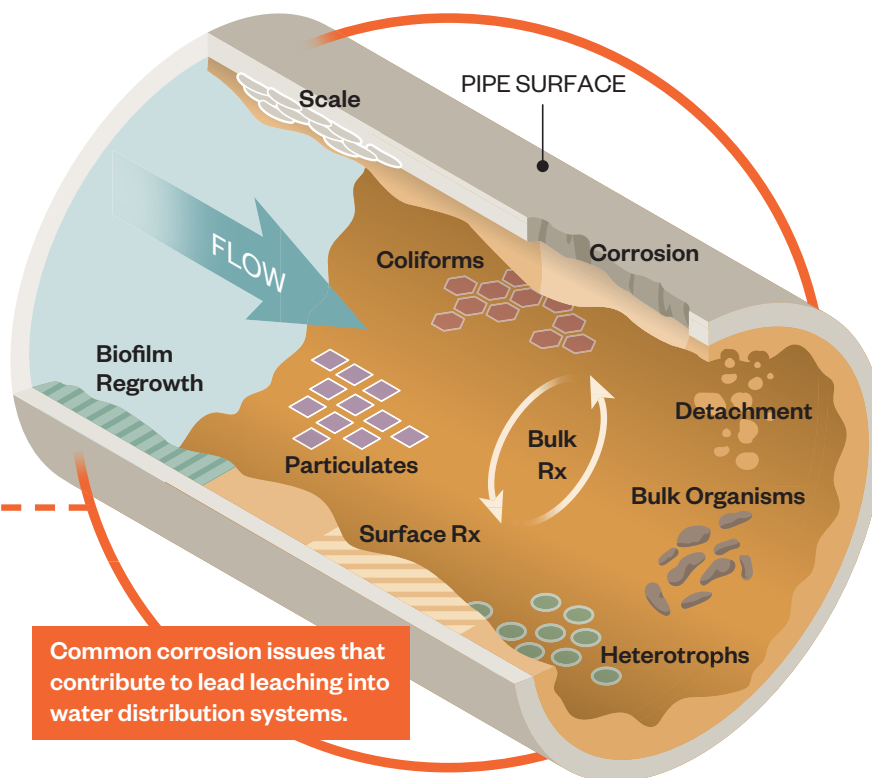
Historical lead and copper compliance results should be evaluated compared to historical water quality to identify any related trends between lead/copper levels and changes in water quality. Key water quality parameters to evaluate include:

- pH
- Chlorine
- Chloride
- Conductivity
- Alkalinity/DIC
- Inhibitor residuals
- Sulfate
- Temperature

Current and Future Lead Service Line Replacement Requirements

Lead service lines (LSL) can be a significant source of lead in drinking

Water Distribution System as Reactor

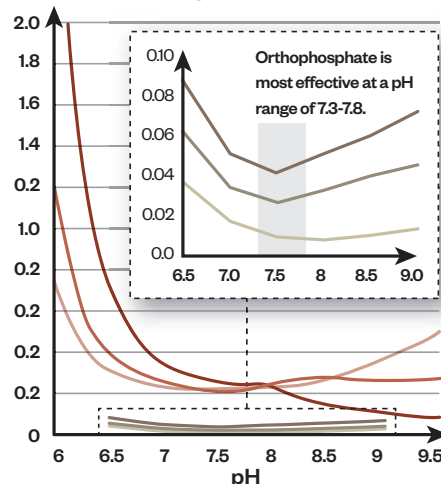


Theoretical Lead Solubility

The presence of orthophosphate in a water distribution system significantly lowers theoretical lead solubility.

- DIC=10 mg/L as C — 1 mg/L PO₄, 5 mg/L DIC
- DIC=10 mg/L as C — 1 mg/L PO₄, 30 mg/L DIC
- DIC=10 mg/L as C — 1 mg/L PO₄, 50 mg/L DIC

Lead Solubility (mg/L)



NOTE: At a DIC level below 50 mg/L as C and pH above 9, the benefits of orthophosphate are considerably less given that lead solubility is significantly lower under these water quality conditions.

water. The current LCR requires LSL replacement only after a lead action level exceedance and allows for partial lead service line replacement of only utility-owned portions of the LSL. Partial lead service line replacement has not been shown to reliably reduce lead levels in drinking water systems and has actually been associated with both temporary and long-term elevated lead levels. Under the proposed LCR LTR revisions, all drinking water systems would be required to establish a full LSLR program and perform a targeted outreach to consumers with LSLs. In order to protect consumer health, new regulations may also require the installation of point-of-use filters at lead service line replacement sites, as well as sites with elevated lead levels.

After investigating the sources of

lead in a system, historical lead and copper levels, and historical water quality conditions, possible corrosion processes and mechanisms that may be contributing to lead and copper leaching in the system can be identified. Theoretical solubility curves may also be used to predict how water quality changes may impact lead leaching in the system. This knowledge allows utilities to fine-tune their existing treatment for optimized corrosion control and to understand how changing their control strategy would impact lead leaching in their system.

When to Act

Both recent and historic utility experiences have shown the severity of impacts that can occur when systems fail to recognize the need to re-evaluate corrosion control treatment.

Utilities should consider re-evaluating corrosion control if there is a change in source water, treatment process, an action level exceedance, or an increase in lead/copper levels.

Extensive water quality monitoring should be performed both before and after a lead service line replacement or a change in treatment. Monitoring before will help establish baseline water quality conditions; monitoring after will help early identification of any unintended consequences and ensure that optimal corrosion control and stable water quality conditions are being maintained.

PROJECT DELIVERY OPTIONS

Infrastructure alternatives to more easily meet your goals

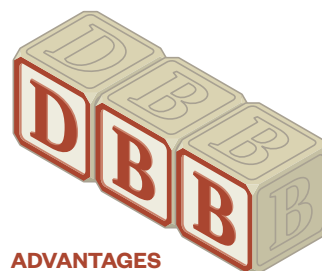
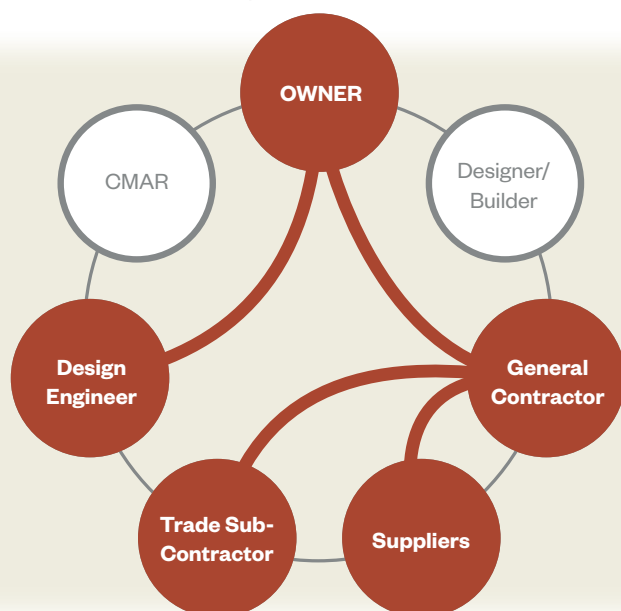
Owners approach every major infrastructure project with specific goals regarding quality, schedule, and budget. Most owners, over time, have become familiar with the challenges of consistently achieving those goals within the traditional Design-Bid-Build project delivery structure.

Recent years have given rise to a set of alternative project delivery processes, each intended to address those challenges. The two most popular in the water industry – Design-Build and Construction Manager at Risk – can provide beneficial structures that influence the ability to meet certain goals, largely by distributing risks in different ways. Having worked successfully within

each of these project delivery structures, as well as others, Hazen and Sawyer advises owners to discard generalities and analyze the pros and cons of each delivery method for each specific project. Performing that detailed analysis will pay for itself many times over.

OPTION 1

Design-Bid-Build, or DBB, is a traditional method that involves separate contracts for design and construction of the project. In DBB delivery, the construction is most often awarded to the lowest bidder. Professional services during construction are either provided by the design consultant or a third-party construction manager reporting directly to the Owner. DBB is the simplest and most universally understood project delivery structure and is the basis for public contracts in all states.



ADVANTAGES

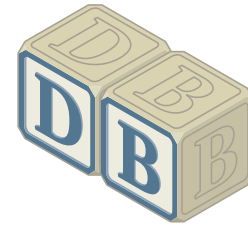
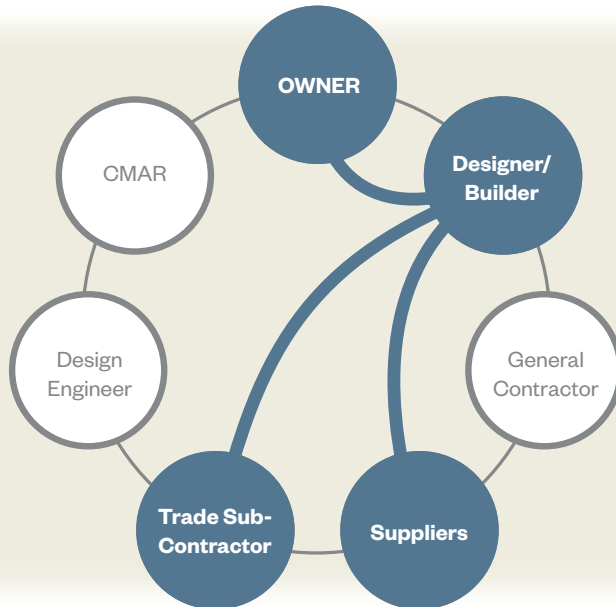
- Owner controls design/construction quality
- Design changes easily accommodated prior to start of construction
- Design precedes construction award
- Fixed cost at construction award, low bid, maximum competition
- Relative ease of implementation

DISADVANTAGES

- Requires significant owner expertise and resources
- Shared responsibility for project delivery
- No contractor input in design, owner at risk for design errors
- Sequential design and construction often results in longer schedules
- Construction cost unknown until contract award

OPTION 2

Design-Build, or DB, consolidates the design and construction functions into one contract, which can either be fixed-price or progressive. Fixed-price results in selection of a DB team based on a competitive fixed price and adequate qualifications for design and construction. Progressive results in selection of a DB team primarily on qualifications, and a guaranteed maximum price (GMP) for construction phase services is negotiated later. This approach offers owners a true “off-ramp” to revert to DBB if a GMP cannot be negotiated.



ADVANTAGES

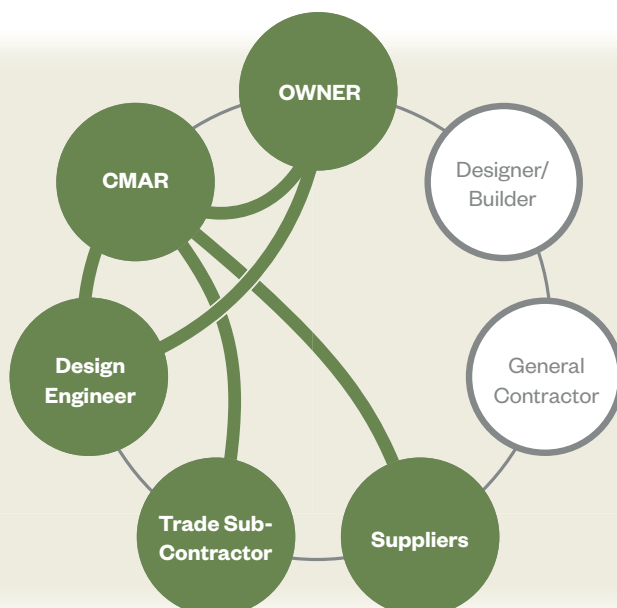
- Single entity responsible for design and construction
- Construction often starts before design completion reducing project schedule
- Construction cost known and fixed during design
- Transfer of risk from owner to the DB
- Emphasis on cost control
- Requires less owner expertise and resources

DISADVANTAGES

- Minimal owner control of both design and construction quality
- Requires a comprehensive and thoughtful performance specification
- Design changes after construction begins are costly
- Potentially conflicting interests as both designer and contractor
- No party represents owner's interests
- High bid costs/fewer bidders

OPTION 3

Construction Manager At Risk, or CMAR, is a method in which the Construction Manager acts as a consultant to the owner in the design phase, but assumes the risk for construction performance as the equivalent of a general contractor during the construction phase. An owner selects the design engineer and construction manager based on qualifications, and a guaranteed maximum price (GMP) for construction phase services is negotiated during the design phase. Because the construction manager guarantees the price, the CM is “at risk” to complete all work at or below that price. Subcontracts are competitively bid under the guaranteed contract ceiling.



ADVANTAGES

- Owner maintains contractual relationship with Engineer
- CM has total control of construction and all subcontractors
- Transfer of some risk from owner to CM
- Construction cost known and fixed during design
- Construction may start before design completion, reducing project schedule

DISADVANTAGES

- Reduced owner control of construction
- Design changes after construction begins are costly
- Potentially conflicting interests as both CM and contractor
- Owner holds separate contract with Engineer and Contractor



Choosing CMAR facilitates Plum Island WPCP collaboration

Work at the Plum Island WPCP comes with a unique set of challenges. Located on a 22-acre island in Charleston Harbor, the 36-mgd facility required improvements after 50 years of operation. For Phase 3 of the Capital Improvements Project at the facility, we helped Charleston Water Systems evaluate several potential delivery methods. They selected the CMAR approach based on the opportunities it offered to optimize the design related to construction sequencing, stay on schedule, and secure available funding.

The CMAR approach enabled CWS to choose both a design engineer and a contractor who were each familiar with the site, streamlining the design process and construc-

tion. This allowed CWS, Hazen, and the contractor to collaboratively schedule work around another large capital project going on at the same site, keeping the Phase 3 project on schedule and on budget despite significant constraints.

We worked directly with the selected CMAR contractor and CWS to complete the preconstruction phase of the project and develop an intermediate design package based upon value engineering, sequencing coordination, and progress of design of the original package. Because of this approach, CWS knew the true project cost throughout the design process. Final negotiations resulted in a \$60M project that maximized facility improvements within the available budget.

PHASE 3 IMPROVEMENTS INCLUDE:

- 150 mgd preliminary treatment facility
- Two 110-foot primary clarifiers
- Anoxic selector with mixed liquor distribution improvements
- One final settling tank
- Site-wide non-potable water improvements
- New electrical distribution and emergency power generation facility



Design, permitting, construction, and startup of the LEED-certified Hidden Lake WTF took just 17 months.

Design-Build choice keeps Hidden Lake WTF on track

With an extremely tight schedule to meet, Indiana-American Water (IAW) chose design-build delivery of its 6-mgd Hidden Lake WTF. Throughout the design-build process, River City Construction and Hazen and Sawyer value engineered many different aspects to minimize construction cost while maintaining the highest performance standards.

The total time for design, permitting, construction, and startup for this project was just 17 months. The project was broken into early bid packages to meet the project completion date, which allowed IAW more time to make decisions and the design team more time to work while construction activities began.

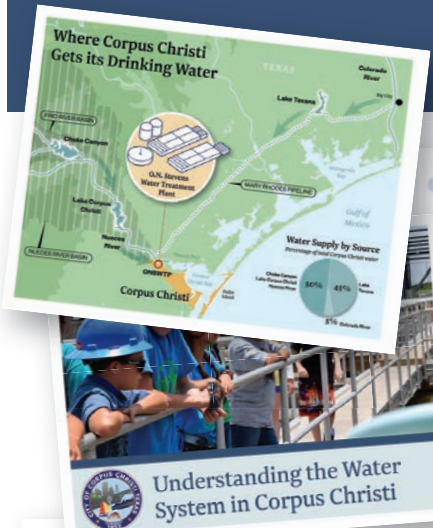
For certain procurement packages, the shop drawing was received and reviewed prior to the 60 percent milestone of the project. This allowed the design to be structured around the equipment, eliminating potential field changes stemming from differences between manufacturers' equipment, and contributed significantly to the project remaining on schedule and budget.

Throughout the design and construction of the facility, the DB team conducted thorough cost evaluations and vendor selections before and after setting a target cost. The DB team also helped IAW enlist in the local electric utility's incentive rebate program, resulting in a \$10,000 refund to IAW.

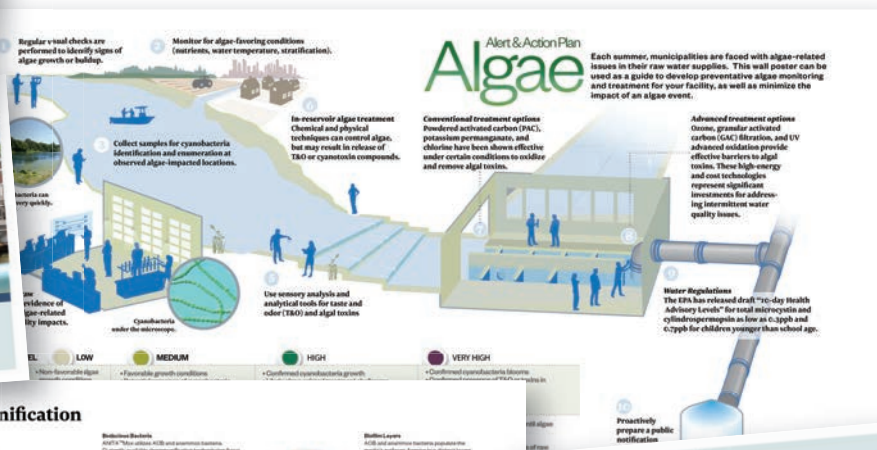
The Hidden Lake water treatment facility is part of a \$25 million project that enhanced water quality, improved system reliability, and increased capacity over the previously used treatment facility. The project included construction of a 6-mgd water treatment plant, including two aerators, a 1-million gallon finished water reservoir, four pressure filters, four distribution pumps, two backwash pumps and all related appurtenances. The project also included the construction of a 12,000-square-foot administrative and laboratory area and separate maintenance facility.

The facility was awarded LEED certification in May 2014.

If you need to better communicate technical information to your customers, staff, or stakeholders—we can help.



Understanding the Water System in Corpus Christi



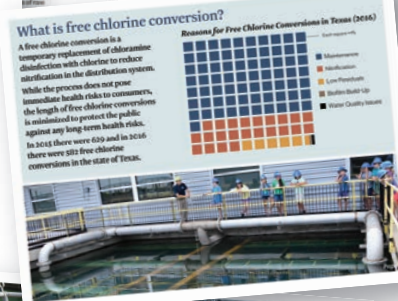
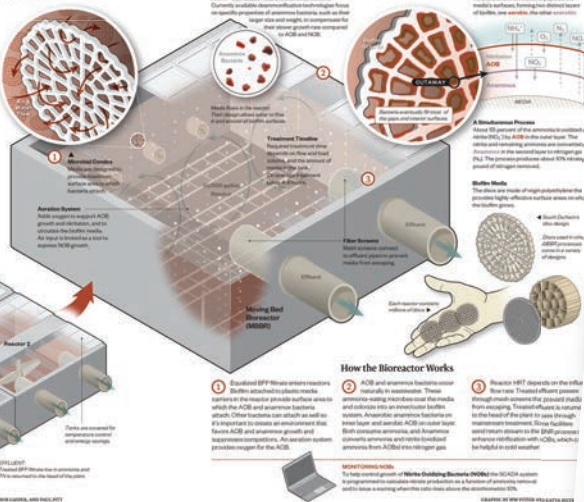
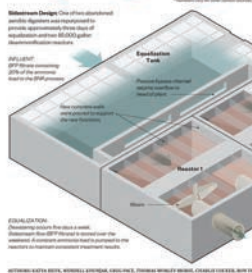
Lessons Learned About Microbial Deammonification

From Design, Startup and Operation of an ANITA™ Mix System

The one-stage ANITA™ Mix process is an energy-efficient deammonification process for removing nitrogen from effluents. In addition to applications, such as that deployed at the South Durham Water Reclamation Facility (SDWR), this process has been running about 10 years of the influent ammonia and 70 percent of the influent total nitrogen (TN). The process utilizes ammonia-oxidizing bacteria (AOB) and anammox bacteria grown on plastic media with no supplemental carbon required.

A "Natural" Shortcut Advantage

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Email: communications@hazenandsawyer.com or visit hazenandsawyer.com/communications