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Meeting the Water Challenge with Solutions for a Changing World

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The United States is grappling with critical challenges in water infrastructure, resulting in an unprecedented demand for innovative treatment solutions. Many existing systems, constructed between the 1950s and 1970s, are becoming increasingly inadequate to meet the needs of expanding urban areas. This inadequacy is especially pronounced in drought-prone regions such as California, Nevada and Arizona, where water scarcity is a pressing issue.

Several interconnected factors contribute to this growing crisis. The changing climate is altering precipitation patterns and exacerbating drought conditions, placing additional stress on already strained water resources. Simultaneously, population growth in urban areas drives up demand for water, leading to greater competition for this finite resource.

Production increases in industrial markets, like power, food & beverage, mining, pharmaceuticals, semiconductor, data centers, automotive and agriculture also further intensify the need for reliable water supply even as many companies implement strategic initiatives to reuse and/or reduce their water consumption.

In response to these issues, municipalities, companies and developers are increasingly looking for sustainable water management strategies. Advanced technologies and collaborative delivery methods are essential to creating effective solutions.

Advanced Water Treatment (AWT) technologies, particularly membrane filtration, are emerging as vital tools for both wastewater treatment and desalination projects. These technologies enable the efficient purification of water, allowing for the recycling of wastewater and the production of high-quality drinking water from previously unusable sources.

Ultimately, addressing the water infrastructure issues in the United States requires a multifaceted approach that embraces innovation, sustainability and collaboration.

Considering the pressing water challenges confronting our communities, builders must recognize their pivotal role in adopting innovative solutions.

McCarthy Building Companies (McCarthy) has harnessed these developing technologies in partnership with clients and municipalities, paving the way for the future of water.

EPA Regulations and Industry Response

New Environmental Protection Agency (EPA) regulations are significantly reshaping how water infrastructure projects are designed, with a stronger emphasis on water quality and sustainability.

Recent wastewater discharge standards include stricter requirements for the removal of nutrients like nitrogen and phosphorus, which contribute to harmful algal blooms and environmental degradation if left untreated.

These rules are pushing municipalities to adopt advanced biological nutrient removal technologies, which are now essential to meeting water quality goals. Additionally, new standards for per- and polyfluoroalkyl substances (PFAS) require water systems to monitor and reduce these harmful chemicals by 2027.

However, rising material costs and ongoing supply chain disruptions pose obstacles to meeting these standards. The complex nature of water projects, combined with economic pressures, often lead to longer project timelines and increased costs. Early-stage planning and collaboration between municipalities, engineers and contractors are essential to address these hurdles and ensure successful project delivery.

Strategic partnerships and value engineering also help mitigate risks, allowing projects to stay on budget despite fluctuating costs.

Workforce development is another critical factor in the industry's adaptation to these new standards. The growing demand for specialized skills in environmental engineering, particularly in chemical and biological processes, underscores the need for training programs.

Developing a pipeline of talent is essential for implementing these new technologies and meeting regulatory requirements, ensuring long-term sustainability in the water sector.

Emerging Technologies in Water Treatment

Advancements in water treatment technology are helping municipalities address both immediate and long-term water management needs. Several technologies are gaining traction:

- Membrane Processes: Widely used in both desalination and wastewater treatment, membrane technologies remove contaminants at a microscopic level, offering efficient solutions for treating and recycling water.
- Ultraviolet and Ozone Disinfection: These chemical-free disinfection methods are becoming increasingly popular due to their environmental benefits and effectiveness in eliminating harmful pathogens and destruction of harmful organic contaminants like PPCP's, 1,4 dioxane and NDMA.
- Biofiltration and Activated Carbon: These techniques help remove organic contaminants, improving water quality and enabling more effective recycling efforts.
- Indirect Potable Reuse (IPR) and Direct Potable Reuse (DPR): Treating wastewater to a potable standard is an emerging trend, particularly in drought-prone areas where water conservation and reuse are essential.

As these technologies continue to evolve, they offer promising solutions to the growing global challenges of water scarcity and sustainability.

Collaborative Delivery Models in Water Projects

To address the complexities of modern water projects, municipalities are increasingly drawn to the value of collaborative delivery models such as design-build and integrated project delivery (IPD). These approaches foster early-stage collaboration among key stakeholders — including engineers, contractors and municipal leaders — facilitating a unified vision from the outset.

This collaborative environment helps reduce delays and optimizes resource allocation throughout the project life cycle.

One of the primary advantages of these delivery models is the integration of process engineering and design during the planning phase. By involving engineers and designers in the early stages, projects can achieve better regulatory compliance.

This proactive approach allows for a thorough understanding of local, state and federal regulations, ensuring that all necessary permits and approvals are obtained efficiently. It also minimizes the likelihood of costly redesigns or adjustments later in the process, which can arise from unforeseen regulatory challenges.

Additionally, early collaboration can enhance the project's overall sustainability.

By considering environmental impact from the beginning, teams can design water treatment facilities that are not only compliant with regulations but also environmentally friendly. This can include selecting energy-efficient technologies, optimizing land use and integrating green infrastructure solutions that protect local ecosystems.

The use of collaborative delivery models also enables municipalities to leverage the diverse expertise of various stakeholders. This interdisciplinary approach fosters innovation and allows for the sharing of best practices, resulting in more effective and efficient solutions to water management problems.

With a shared commitment to project goals, stakeholders can better anticipate and address potential risks, leading to improved project outcomes.

Preparing for the Future of Water Management

Looking ahead, sustainability and resilience will be the cornerstones of future water infrastructure projects. With climate change accelerating water scarcity and increasing the frequency of extreme weather events, it is essential to design systems that are both adaptable and sustainable. This means prioritizing technologies like water recycling, energy-efficient treatment systems and resilient infrastructure capable of withstanding environmental stresses.

The focus on Advanced Water Treatment technologies, such as membrane filtration and bionutrient removal, will continue to grow as municipalities and developers seek to meet evolving regulatory requirements and address long-term water management hurdles.

By investing in innovative solutions today, the U.S. water infrastructure can be better prepared to meet the challenges and demands of a changing world.

Case Studies

McCarthy has completed several water infrastructure projects across the U.S. that set benchmarks for advanced water treatment, including the Oxnard Water Treatment Facility in Oxnard, Calif.

The Oxnard Advanced Water Purification Facility (OAWPF), located in Southern California, was developed to provide the city with an alternative to imported water from northern California.

This innovative facility employs a newly installed microfiltration system combined with reverse osmosis and ultraviolet (UV) disinfection, allowing it to produce locally controlled recycled water that is independent of external factors like climate and governmental regulations.

The 60,000-square-foot facility spans five acres and has a process that requires less energy than traditional water importation methods. The recycled water generated will serve various applications, including industrial processes, irrigation, and indirect potable reuse through groundwater injection.

By prioritizing local resources and reducing reliance on outside influences, the AWPF exemplifies a forward-thinking approach to sustainable water management.

Orange County Water District Ground Water Replenishment System (Fountain Valley, Calif.)

The Orange County Water District (OCWD) Ground Water Replenishment System is the largest advanced water purification facility in the world and produces up to 130 million gallons of purified water daily. Originally built as a 70-million-gallon-per-day (MGD) facility, it underwent significant expansion and modernization to enhance its capacity and energy efficiency.

As part of the 30 MGD expansion, McCarthy added eight new concrete underground basins which contain the hollow fiber membrane modules for the microfiltration system. A new, 32,000-square-foot reverse osmosis building was constructed by the team of builders, along with two large 7.5-million-gallon water tanks.

The foundations of these tanks were designed with fewer joints, allowing for more efficient concrete pouring.

Throughout the expansion, the plant remained fully operational. McCarthy coordinated closely with the water district to minimize downtime, a critical effort given California's ongoing drought.

Chandler Airport Water Reclamation Facility (AWRF) (Chandler, Ariz.)

The 90-acre Airport Water Reclamation Facility (AWRF), operated by the City of Chandler, Calif., provides recycled water for irrigation, benefiting over 248,000 residents in the growing area.

To address the community's increasing water demands, the facility underwent an upgrade and expansion, increasing its processing capacity from 10 to 15 MGD. This project involved implementing advanced treatment processes, installing new equipment and enhanced reclaimed water capabilities.

The expansion included the installation of new equipment and reservoirs for the distribution system, along with upgrades to treat 15 MGD of equivalent solids.

Improvements comprised a pre-stage basin, aeration basins, secondary clarifiers, solids storage tanks and a reclaimed water reservoir, in addition to necessary piping, electrical systems and controls.

To ensure adherence to the project's schedule, quality and safety standards, all concrete work and process piping installation were carefully managed. Virtual design technology, including 3D modeling, was utilized to enhance quality and expedite procurement.

Throughout the construction process, the facility remained operational, consistently producing Class A+ reclaimed water that meets Arizona's highest standards.