IWS
INTEGRATED WATER SERVICES

IWS White Paper

A New Standard for Decentralized Wastewater Infrastructure

Next-Level Wastewater Treatment

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Executive Summary

Faced with phased urban expansion and rising regulatory standards, decentralized wastewater facilities now bear a greater share of treatment duties, even as staffing models become increasingly lean.

At the same time, capital planning cycles increasingly favor infrastructure that can perform reliably for decades without repeated capital reinvestment to restore aging infrastructure. To address these shifting conditions, Integrated Water Services (IWS) and CROM collaborated to merge membrane bioreactor (MBR) treatment with long-life watertight tensioned shotcrete containment systems.

The resulting NXT|MBR™ platform converges two technologies to provide rapid delivery, modular expansion in 250,000-gallon increments, and superior effluent quality suitable for high-value reuse applications. Its structural platform is built for permanence and long-term reliability, using engineering technology designed for durability, watertight performance, and resistance to corrosive wastewater environments. The process configuration provides stable solids separation and consistent effluent quality while supporting automation and remote operational oversight.

Historically, these technologies have often been implemented independently. Treatment processes have been designed by one group of specialists, while containment structures were engineered separately using conventional tank construction methods. As decentralized systems take on a more permanent role in infrastructure networks, however, the integration of treatment performance and structural durability is becoming increasingly important.

Figure 1: NXT|MBR Rendering

McKinney Roughs Nature Park

The platform's development was driven by a complex set of project requirements at McKinney Roughs Nature Park in Central Texas. The park's legacy treatment facility faced significant degradation, requiring substantial capital to restore aging infrastructure, increase capacity, and meet stringent discharge limits for the Lower Colorado River. When conventional approaches proved cost-prohibitive, an integrated MBR process housed within a watertight, tensioned shotcrete containment system was deployed. This solution delivered the necessary effluent performance and capacity within a viable budget, while simultaneously simplifying the operational profile. Ultimately, the project demonstrated that a permanent structural platform paired with a modular MBR configuration can meet both immediate expansion needs and long-term service life expectations.

From that foundation, IWS and CROM formally brought these technologies together to meet defined flow ranges intended for repeatable deployment under the product name NXT|MBR.

The guiding premise behind the platform is straightforward: decentralized facilities expected to serve communities for decades should be planned, constructed, and supported as permanent infrastructure assets rather than interim installations.

The convergence of these two technologies supports phased expansion, remote monitoring, and consistent effluent quality while reducing the fragmented delivery structures that often complicate commissioning and long-term performance. Owners and operators gain a facility designed for structural durability, predictable operation, and evolving regulatory pressure.

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The Market Shift Towards *Permanent Assets*

Growth and Decentralization

Population growth patterns and development economics are fundamentally changing the role of decentralized wastewater facilities. In many regions, new development occurs beyond the reach of centralized interceptors, or in areas where extending those systems would require major capital investment and long permitting timelines. Private utilities are expanding portfolios of community systems. Municipal utilities are managing growth in stages, often through satellite facilities or independent treatment sites.

These facilities now carry performance expectations once associated primarily with large regional plants. Effluent limits for nutrients and suspended solids are tightening, and reuse is moving from a secondary consideration to a central planning factor in some regions. Operators are expected to maintain compliance across multiple sites, often with limited staff and increasing reporting requirements. The result is a shift in how decentralized plants must function. They are expected to deliver stable compliance, predictable operation, and minimal disruption over long periods of service.

Traditional approaches often struggle under these conditions. Facilities built as interim solutions may remain in service far longer than originally intended. Structures designed around short life cycles introduce reinvestment pressure sooner than anticipated. A decentralized plant that must be replaced or heavily rehabilitated after fifteen or fewer years can force owners into a second capital cycle well before the surrounding community has matured.

Lifecycle Exposure

Population growth patterns and development economics are fundamentally changing the role of decentralized wastewater facilities. In many regions, new development occurs beyond the reach of centralized interceptors, or in areas where extending those systems would require major capital investment and long permitting timelines. Private utilities are expanding portfolios of community systems. Municipal utilities are managing growth in stages, often through satellite facilities or independent treatment sites.

Facilities expected to serve communities benefit from structural systems intended to maintain integrity over decades rather than years. When the treatment vessel remains stable, operators can focus on process performance instead of maintaining degrading infrastructure and structural remediation. When reinvestment cycles extend beyond typical bond horizons, owners gain flexibility in long-term planning.

The convergence of IWS and CROM technologies was developed with this lifecycle perspective in mind, pairing a membrane bioreactor process with a watertight structural system intended to serve as a permanent asset. The NXT|MBR platform addresses this lifecycle exposure by pairing a stable process configuration with a durable structural vessel. When the treatment vessel remains stable and watertight over several decades, operators can focus on process performance. This shift in strategy allows owners to treat decentralized plants as long-term infrastructure assets rather than temporary or short term installations.

Figure 2: NXT|MBR Features and Benefits

Feature	Benefit
Prestressed Shotcrete	Provides a watertight, corrosion-resistant environment with a 50+ year service life.
Integrated Delivery	Merges process engineering (IWS) with structural engineering (CROM) to eliminate fragmented commissioning.
Capital Efficiency	Modularity allows alignment of infrastructure investment directly with project growth.
Effluent Quality	Produces high-clarity discharge suitable for stringent regulatory standards (e.g., Lower Colorado River discharge limits).

Delivery Structure and Operational Reality

Decentralized wastewater projects often involve multiple design and construction entities. Process engineers, structural designers, contractors, controls integrators, and startup teams may operate under separate scopes. While this model can deliver successful projects, it can also create gaps in accountability when systems move from construction into operation. In smaller facilities, those gaps can translate into longer troubleshooting timelines and greater operational burden.

The NXT|MBR integrated delivery platform provides a different framework. When process design, structural delivery, and commissioning support are aligned within a single platform, design decisions can reflect operational realities from the outset. Responsibilities remain clear from initial design through long-term support. IWS and CROM designed this integrated model to provide owners and operators with a consistent path from concept to operation.

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Capital Constraints are Shaping Project Outcomes

Across municipal and private utility markets, capital—not process selection—is increasingly the limiting factor in wastewater infrastructure decisions. Projects are often defined less by what is technically achievable and more by what can be funded within a given cycle. This reality is especially pronounced in decentralized systems, where smaller rate bases and phased development patterns constrain available capital.

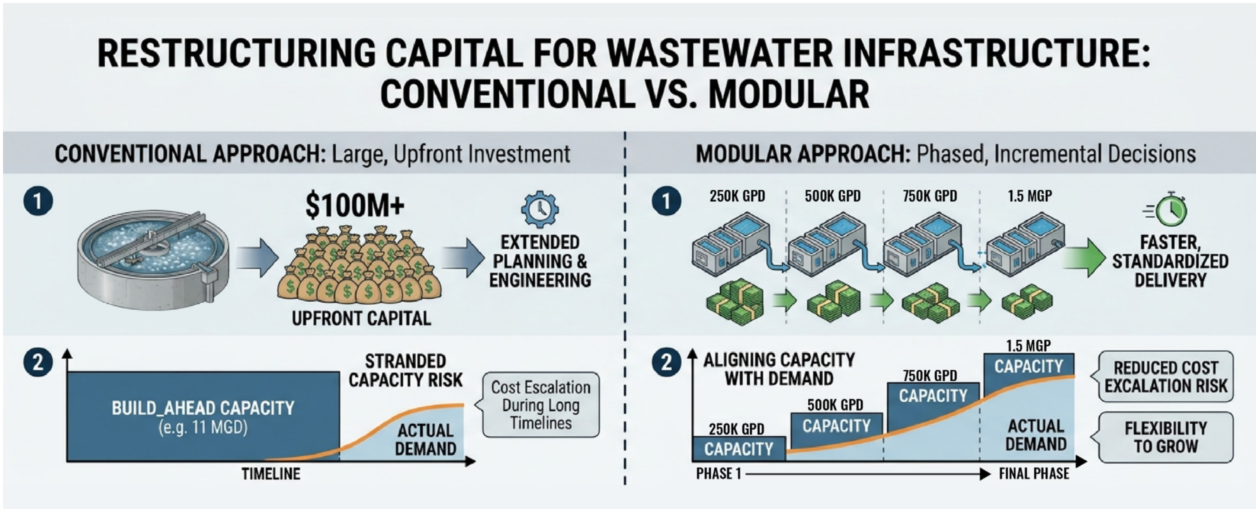
In this environment, conventional delivery approaches can introduce friction early in the project lifecycle. Large, site-specific designs require extended engineering timelines, and cost estimates can escalate as projects move from concept to bid. For growing communities or private developments, this often results in delayed construction, reduced scope, or interim solutions that remain in place longer than intended.

The ability to bring projects within a viable capital range at the outset is therefore not a secondary consideration. It determines whether infrastructure is built on schedule, deferred, or fundamentally restructured.

At larger scales, conventional treatment facilities routinely reach capital costs on the order of $100 million for an 11 MGD plant, or approximately $9 to $10 per gallon of installed capacity. These costs reflect not only treatment infrastructure, but also extensive civil work, site development, and the need to build capacity well ahead of actual demand.

This model assumes that scale will ultimately reduce cost per gallon. In practice, however, it often requires significant upfront investment and long-term growth assumptions that may not align with actual development patterns.

Figure 3: Capital for Wastewater Infrastructure



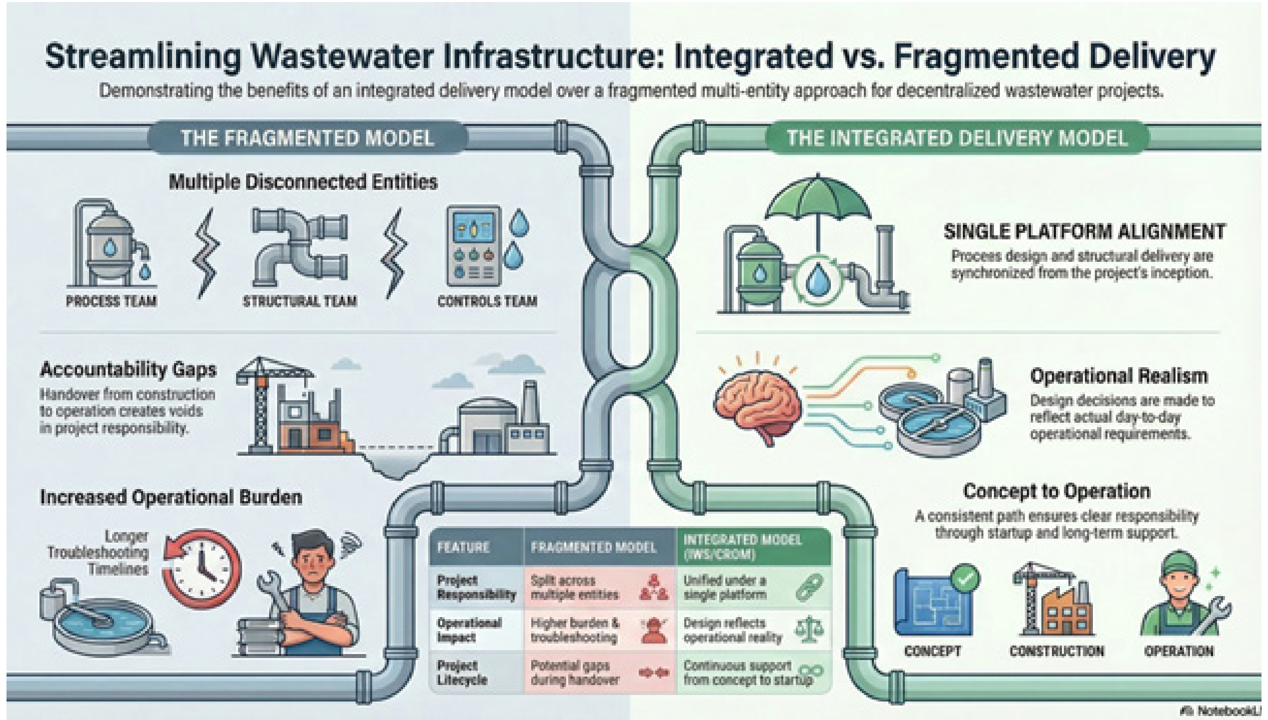
A modular approach introduces a different capital profile. Capacity can be deployed in defined increments, beginning at 250,000 gallons per day and scaling through 3 MGD facilities and beyond. Instead of committing to full buildout at the beginning of a project lifecycle, owners can align capital deployment with real demand. This reduces the risk of stranded capacity and allows infrastructure to grow alongside the community it serves.

When combined with standardized design and integrated delivery, this approach allows smaller facilities to remain competitive on a cost-per-gallon basis, rather than carrying the premium historically associated with decentralized systems. Rather than viewing wastewater infrastructure as a single, large investment, owners can approach it as a series of controlled, incremental decisions.

Phased deployment allows capacity to be added as needed, reduces exposure to future cost escalation, and aligns infrastructure investment with actual system demand. In an environment defined by growth variability, regulatory pressure, and capital constraints, this approach provides a more flexible and defensible path forward.

The result is a restructuring of how capital is applied, moving from large, upfront commitments toward a model defined by scalability, timing, and long-term asset value.

Figure 4: Wastewater Delivery Model



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Project Origin: *The McKinney Roughs Case Study*

The NXT|MBR platform originated from practical demands of a specific expansion project rather than from theoretical modeling.

Located near Austin, Texas, the McKinney Roughs Nature Park wastewater treatment facility required a substantial capacity increase to support regional development. Because the plant discharges into the Lower Colorado River, expansion necessitated adherence to stringent effluent standards designed for environmental preservation and downstream protection. Consequently, the project's primary challenge was to scale capacity and maintain rigorous compliance within a fixed capital budget.

Initial planning centered on a conventional activated sludge approach. As cost projections were refined, the project moved beyond the available capital range. At that stage, IWS and CROM evaluated an alternative configuration that paired an MBR process housed within a watertight tensioned shotcrete containment system. The revised concept reduced footprint requirements, simplified solids separation, and aligned the structural platform with long-term operational expectations. The integrated approach allowed the project to move forward within budget while delivering the required capacity and effluent quality.

The facility successfully validated the synergy between a stable process configuration and a durable structural vessel. By utilizing standardized flow-band configurations, the project demonstrated a significant reduction in engineering variability while facilitating seamless phased expansion. This success served as the blueprint for the NXT|MBR platform, formalizing it into standardized capacity ranges that offer site-specific adaptability within a consistent structural and process framework.

The financial impact of an integrated approach was immediate and decisive. Early planning for a conventional treatment expansion produced cost estimates approaching $14 million, placing the project outside a viable funding range. By shifting to an integrated MBR system housed within an engineered concrete structure, the project was delivered for approximately $7.6 million, a reduction of roughly 45 to 50 percent while still meeting the required capacity and effluent standards tied to discharge into the Lower Colorado River.

The result was not a marginal cost improvement, but a fundamental change in project feasibility, demonstrating how integrated design and delivery can bring capital-intensive wastewater projects back within reach.

PROJECT TYPES: Construction Management; Water Reuse & Reclamation; Permanent, Fixed Systems
TECHNOLOGIES: CROM² Tank, Membrane Bioreactor (MBR)
INDUSTRIES: Private Utilities; Parks & Recreation
SERVICES: Construction, Design-Build, Engineering, Permitting, and Start-up

McKinney Roughs WWTP

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Integrating Structural Infrastructure *& Advanced Biological Treatment*

The previous discussion raises a practical question: how can these technologies be integrated within a functioning decentralized treatment facility?

One approach is to treat the treatment process, containment structure, and operational framework as components of a single facility architecture rather than independent design elements. When biological treatment performance, structural durability, and operational strategy are planned together, decentralized plants can be delivered more predictably and expanded more easily over time.

Developed through a strategic collaboration between IWS and CROM, the platform serves as a benchmark for integrated wastewater design. The system harmonizes advanced MBR technology with watertight, tensioned shotcrete containment, delivering a standardized yet decentralized configuration optimized for long-term performance.

At the process level, the system uses a membrane bioreactor configuration to provide stable biological treatment and solids separation within a compact footprint. The biological treatment zones and membrane separation components are housed within the hydrostatically independent and watertight chambers engineered specifically for water and wastewater applications. This structural system provides long-term watertight performance.

Rather than designing each facility as a one-off installation, the platform is structured as repeatable plant architecture. NXT|MBR systems are developed in defined capacity increments beginning at approximately 250,000 gallons per day and scalable to millions of gallons per day. These increments allow owners to align capital deployment with actual growth while preserving a coherent long-term site plan.

Standardization and in-house engineering reduce variability and shortens delivery times. Core structural and process components remain consistent across installations, while site-specific adjustments focus primarily on influent characteristics, discharge requirements, and local site conditions. This approach improves predictability in budgeting, procurement, construction durations, and guaranteed long-term performance.

The platform is delivered through a vertically integrated design/build team that coordinates process engineering, structural tank construction, mechanical and electrical integration, startup, and operational support. Aligning these responsibilities within a single delivery framework reduces the fragmentation and division of responsibility that often complicates decentralized wastewater projects.

Automation and monitoring capabilities are embedded within the facility architecture. Instrumentation provides continuous visibility into flow conditions, biological process performance, and membrane operation, while control systems support stable operation under variable loading conditions. Remote access capabilities allow operators to oversee facilities efficiently across multiple sites.

The result is a decentralized treatment facility designed for phased expansion, predictable commissioning, and long-term structural and operational stability.

Figure 5a: NXT|MBR Top View

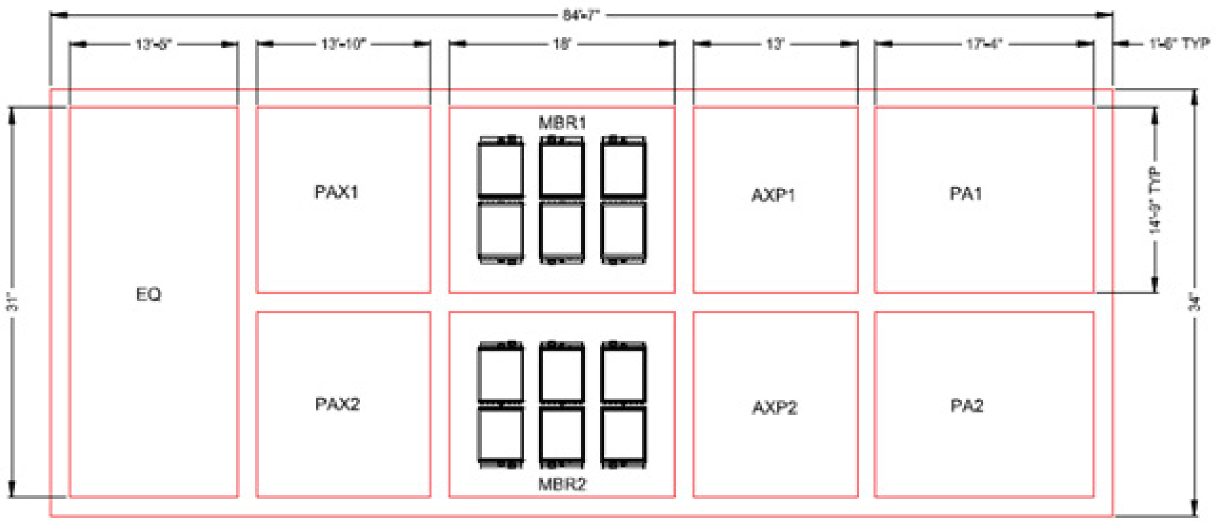
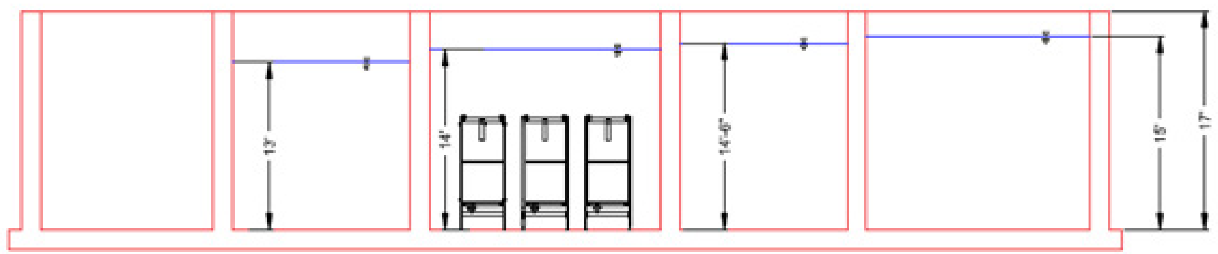


Figure 5b: NXT|MBR Side View



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Structural Platform: *Engineered for Longevity*

Structural integrity defines lifecycle cost. Degrading steel and corrosion from leakage can introduce recurring repair cycles that persist for decades. For decentralized facilities with limited staffing and tight operating margins, structural reliability is a foundational requirement.

This new structural platform utilizes CROM's straight-wall watertight, tensioned environmental engineering concrete system, which employs a shotcrete wall with an embedded steel diaphragm and tension enhancement. This design focuses on watertightness, elimination of allowable cracks, and long-term durability under corrosive wastewater conditions, with ACI-350 water-retaining structure standards.

Figure 6: ACI-350 Concrete Walls

A rich cement mixture is applied strategically where exposure conditions require enhanced resistance. This targeted approach improves durability where needed while managing material costs. In conventional systems, enhanced mixes are often applied uniformly, increasing expense without corresponding benefit.

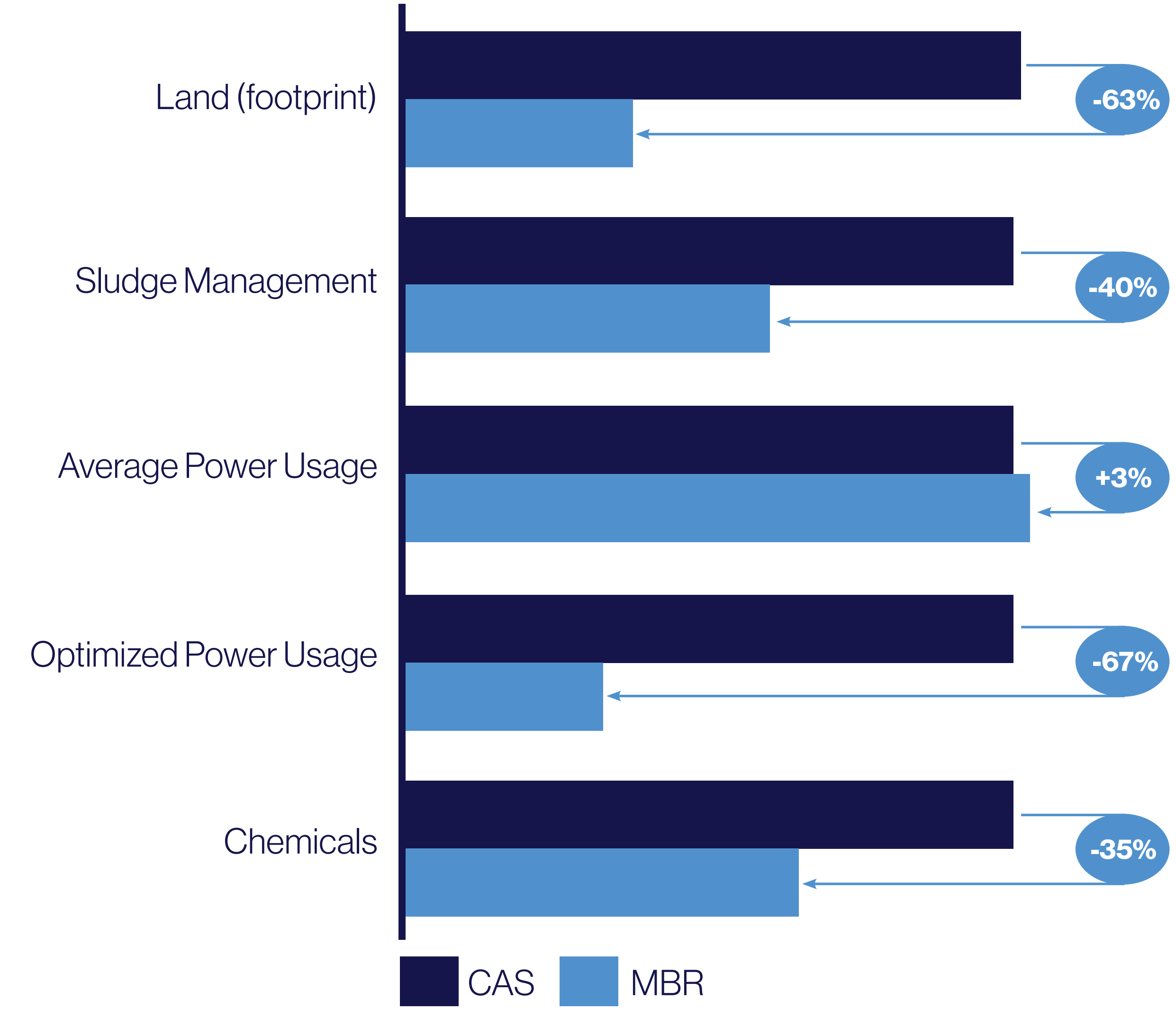
The straight wall or rectangular geometry supports space efficiency and modular site planning. Straight-wall construction simplifies integration with process zones and mechanical equipment while maintaining structural robustness.

Compared to traditional cast-in-place approaches, the turnkey design/build system offers faster design to construction commencement, shorter construction durations, reduced field variability, with no division of responsibility between the designer and contractor. The structural design is intended to serve as a long-life asset capable of supporting decades of operation with maintenance focused on equipment rather than tank remediation.

For municipalities and private utilities evaluating long-term reinvestment risk, structural permanence influences financial modeling as much as process performance.

Process Platform: *MBR Performance & Operational Economics*

Figure 7: MBR costs 30% to 60% less than CAS



Integrated Water Services. (2025). The real cost of wastewater treatment: MBR vs CAS [White paper]. https://integratedwaterservices.com/mbr-vs-cas-why-mbr-is-the-smarter-long-term-investment/

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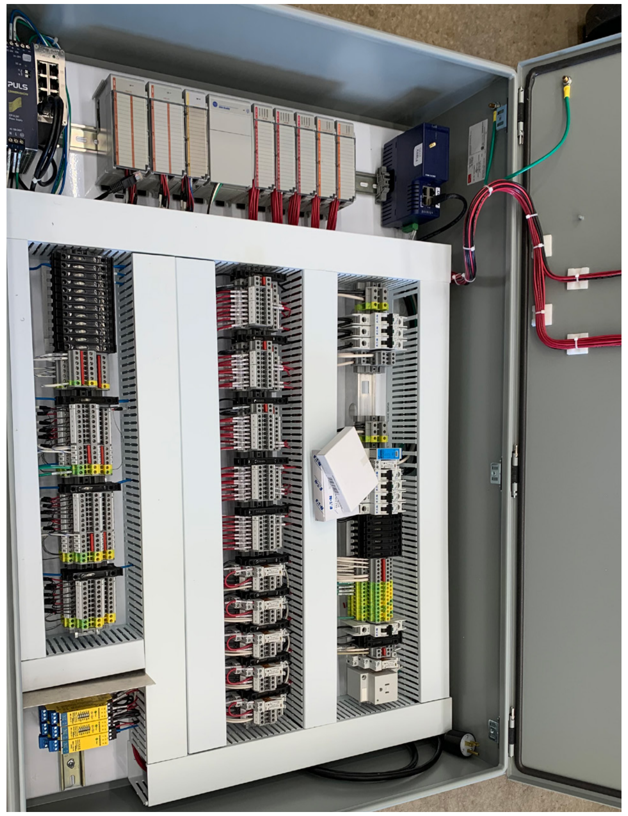
The membrane bioreactor process forms the performance core of the platform. MBR systems provide superior effluent through membrane-based solids separation integrated with biological treatment. This configuration supports low turbidity and strong nutrient removal, producing effluent suitable for non-potable reuse applications such as irrigation and industrial cooling.



Effluent quality is increasingly tied to reuse planning. In water-scarce regions or areas with high potable water costs, treated wastewater represents a strategic resource. By reducing reliance on potable supplies, reuse integration can offset long-term operating costs and support sustainability objectives.

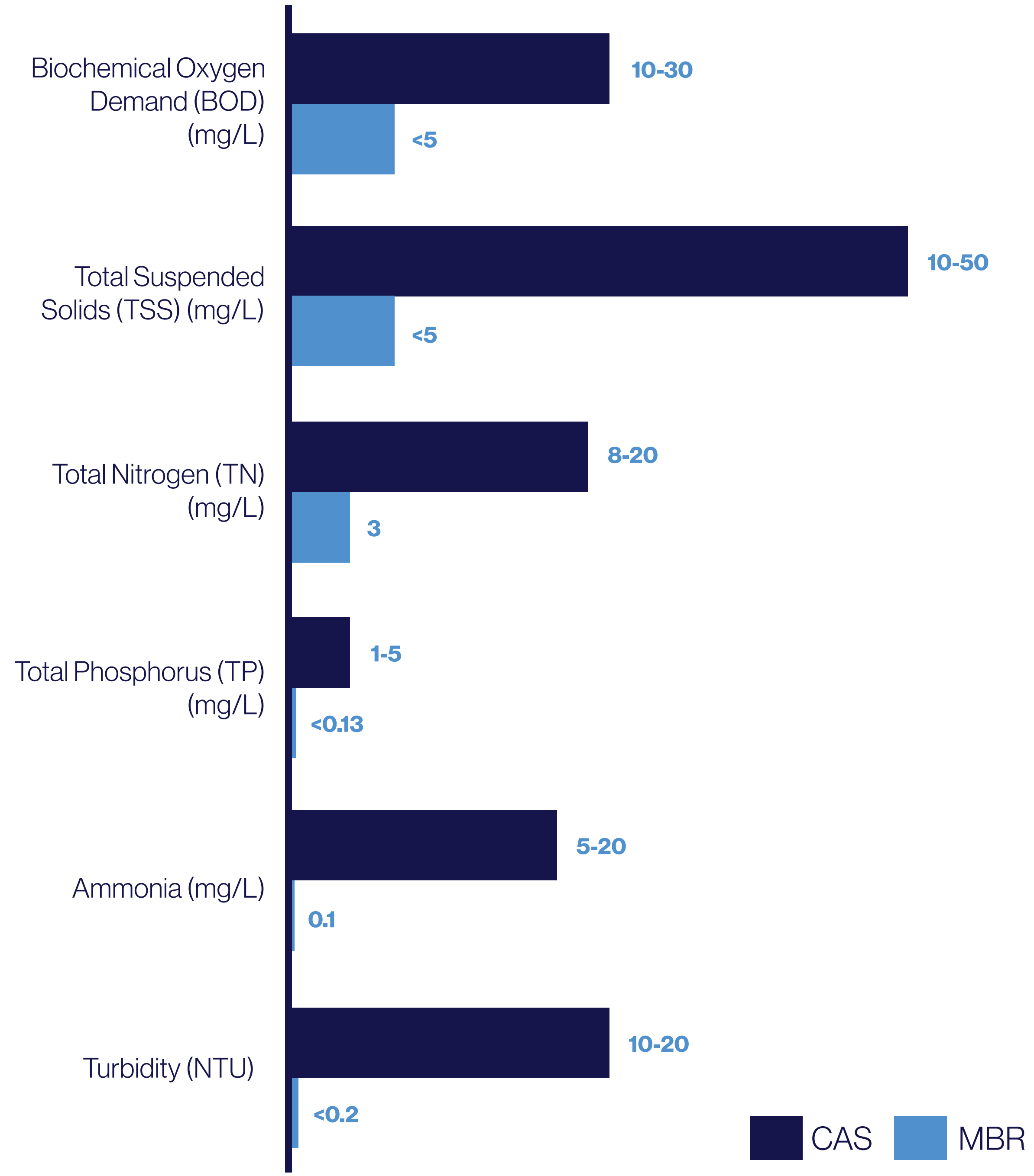
For industrial facilities, reuse reduces discharge fees and water procurement costs. For private utilities, it can provide additional revenue streams or enhance the value proposition of community systems. For municipalities, it strengthens conservation programs and long-term water resource planning.

Operating economics extend beyond energy consumption. Sludge management and chemical procurement often represent significant cost drivers in decentralized systems. MBR configurations typically produce lower volumes of excess sludge compared to conventional activated sludge processes, reducing hauling frequency and exposure to disposal cost volatility. Chemical demand can also be moderated depending on influent characteristics and nutrient removal strategy.

Energy requirements are managed through integrated control strategies. Variable frequency drives, dissolved oxygen control, and membrane flux management support responsive operation. Energy intensity is evaluated within the broader context of sludge hauling, chemical usage, staffing efficiency, and structural longevity. For many decentralized applications, the combined lifecycle profile remains competitive when viewed across the full operating envelope.

Instrumentation and remote monitoring capabilities support stable compliance. Operators receive real-time data on flow, dissolved oxygen, membrane performance, and key process indicators. This visibility enables timely adjustments and supports multi-site oversight models common in private utility portfolios and distributed municipal systems. Explore more in our white paper, Integrated Water Services, (2025). MBR v. CAS.

Figure 8: MBR vs CAS Effluent Quality



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Application Fit & *Deployment Context*

NXT|MBR serves a variety of sectors where phased growth, compliance stability, and lifecycle durability are primary drivers.

Municipalities and government bodies face increasing pressure to meet stringent discharge standards while managing growth within limited footprints. NXT|MBR's compact footprint and high quality support facility upgrades in constrained sites and enable integration of reuse programs for parks, irrigation, and public facilities. The structural platform provides long-term reliability aligned with public infrastructure expectations.

Private utilities prioritize return on investment, asset longevity, and predictable operating cost. The modular expansion model allows capacity to be deployed incrementally in 250,000-gallon increments as communities grow. The vertically integrated delivery reduces coordination complexity across portfolios, while reuse-ready effluent enhances long-term value creation.

Industrial facilities must manage complex or high-strength wastewater streams while meeting pre-treatment requirements and corporate sustainability goals. The MBR configuration supports effective treatment performance and enables internal water reuse for process applications, reducing both water procurement and discharge costs. The watertight, tensioned shotcrete containment system provides durability suited to continuous industrial operation.

Commercial and real estate developments often require on-site treatment where municipal sewer access is limited or cost prohibitive. A compact footprint preserves developable land, and low odor and noise profiles support residential and hospitality environments. Reuse capability reduces operating expenses and strengthens sustainability credentials for tenants and buyers.

Engineering and construction firms benefit from predictable geometry, compact site integration, and a vertically integrated delivery model that simplifies coordination. Durable structural construction and long-term performance enhance client satisfaction and reduce post-construction risk exposure.

While the platform addresses a broad range of decentralized scenarios, it is best suited for applications where long-term service life, reuse readiness, and modular expansion are strategic priorities.

Implementation Path

A structured implementation process allows owners to evaluate fit and move from concept to commissioning with clarity. Early project stages focus on assembling baseline information, including flow projections, influent characteristics, discharge limits, and site constraints. This information supports preliminary configuration selection and cost modeling.

Once feasibility is established, design and permitting can proceed with defined configuration parameters.

Standardized structural and process elements allow for predictable scheduling and clearer coordination between engineering and construction. Construction and equipment installation follow a defined sequence, leading into startup and commissioning. Control systems and remote monitoring are integrated during commissioning to ensure operators have full visibility from the outset.

Long-term support options can include remote monitoring, operational guidance, and periodic performance review. Maintaining continuity between design and operation helps ensure the facility performs as intended over time. Owners benefit from a delivery framework that remains engaged beyond construction and into the operational life of the plant.

Closing Perspective

Decentralized wastewater facilities are expected to perform with increasing consistency while operating under tighter staffing and budget constraints. Infrastructure decisions made at the outset influence operating conditions for decades. Structural durability, process stability, and delivery coordination all play a role in long-term performance.

NXT|MBR reflects a shift toward treating decentralized plants as long-term infrastructure assets. The platform combines a stable treatment process with a durable and watertight structural vessel and a coordinated delivery model. It allows capacity to be deployed in stages while maintaining a consistent operational foundation. For owners and operators, this approach provides a path toward reliable compliance, predictable operating cost, and long service life.

Organizations evaluating decentralized wastewater projects can use early feasibility analysis to determine alignment with site conditions and long-term goals. Addressing these considerations together during early planning stages helps ensure decentralized facilities are built to perform reliably over the full life of the infrastructure.

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