Central San MABR Nitrogen Pilot

In July 2024, the San Francisco Bay Regional Water Quality Control Board adopted a Regional Nutrient Watershed Permit requiring all Bay Area wastewater agencies to cut seasonal total inorganic nitrogen loads by 40% by May 2035. Meeting this goal will require major treatment upgrades across the region, estimated at a cost of US$14 billion. This prompted the Central Contra Costa Sanitary District (Central San) to launch an innovative nitrogen removal pilot in 2024 to help reduce the economic burden of compliance.

Instead of constructing new treatment tanks costing over US $600 million, Central San is retrofitting part of its existing biological process with membrane aerated biofilm reactor (MABR) technology to achieve nitrogen removal within the current footprint. This reliable, cost-effective pathway protects San Francisco Bay and benefits Central San ratepayers and other wastewater agencies facing nutrient limits. Full-scale MABR testing in one of four existing aeration tanks will begin in 2026 to validate pilot results and guide long-term strategies for meeting nitrogen permit limits.

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CHALLENGES FACED

- The lack of full-scale performance data for MABR operating in low sludge age mode created uncertainty about its success in this application.
- Site-specific challenges included addressing cyanide inhibition concerns from incinerator air pollution control equipment return water.
- The pilot needed to determine optimal locations within the existing treatment process for installing MABR cassettes.

TECHNOLOGIES & SOLUTIONS USED

- MABR technology uses gas-permeable hollow fiber membranes to support biofilm growth as an alternative to conventional aeration.
- MABR delivers up to 50% oxygen transfer efficiency, compared to approximately 20% in typical aeration systems.
- Central San piloted MABR in a hybrid, low sludge age configuration (<1.3 days) where biofilm is dedicated to nitrogen removal.

IMPACT & INSIGHTS

- Ammonia removal rate (mass of ammonia-N removed per day per m^2 of MABR surface) reached 2.1 $g/m^2/d$, comparable to typical full-scale MABR systems (2.0–2.5 $g/m^2/d$).
- This performance demonstrated MABR's viability even under cyanide presence and a novel low sludge age operating mode.
- Total inorganic nitrogen removal increased from minimal in Phase I to 40% in Phase II and 50% in Phase III when additional carbon was available.
- Results showed that nitrogen removal was limited by carbon availability, not by the low sludge age hybrid configuration.

LESSONS LEARNED

- Test new or unproven technology at pilot scale before committing to full-scale testing. This pilot confirmed that MABR could achieve nitrogen removal under challenging conditions, suggesting it is a potential alternative to conventional treatment configurations that require new tankage.
- Move from pilot to full-scale demonstration to full implementation to manage technical and financial risk.
- Communicating results through open houses and conference presentations helped advance industry understanding and supported others evaluating MABR for similar challenges.

> **The modular nature of MABR can help Central San accommodate uncertainty in future population projections and adapt to changing regulatory requirements—providing ratepayer value through flexible infrastructure investment.**

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