

Technical Brief: Kaimana™ Wastewater System

Subject: Overview and Technical Capabilities of the Kaimana System

Developer: Hydros Agritech / Kaimana Regen, LLC

1. Executive Summary

The Kaimana™ System is a modular, decentralized, closed-loop wastewater treatment platform engineered to transform wastewater challenges into operational assets. Utilizing a unique biological biofilm-in-pipe mechanism, the system treats both sanitary sewage and high-strength industrial effluent directly on-site without the need for traditional sludge-intensive processes. Its primary objective is circular resource recovery: capturing, treating, and returning clean, non-potable water for irrigation, fire safety, and industrial process reuse. By actively managing organic and nutrient loads, the system drastically reduces both freshwater demand and environmental discharge liabilities.

2. Core Technology & System Architecture

The Kaimana system utilizes a robust, highly adaptable closed-loop architecture designed to withstand fluctuating organic loads by leveraging a specialized biological process housed within its internal network.

- **Biofilm-in-Pipe Treatment:** Unlike traditional tanks, the system utilizes a proprietary pipe-based biological reactor. Wastewater circulates through a network where naturally occurring bacteria form a biofilm on the pipe walls, efficiently breaking down organic matter as the water flows.
- **Advanced Biological Nutrient Removal (BNR):** The layered nature of the internal biofilm naturally establishes both aerobic and anoxic zones. This facilitates simultaneous nitrification and denitrification, allowing the system to effectively process and remove excess nitrogen and phosphorus without requiring separate, footprint-heavy treatment tanks.
- **Modular Footprint:** The platform is engineered to scale. It can be deployed with a minimal initial footprint and expanded as a facility's site demands grow, avoiding the heavy upfront capital expenditure associated with traditional centralized infrastructure.
- **Dynamic Load Handling:** Kaimana is specifically engineered to deliver reliable performance even with rapidly changing inflows and high-strength industrial effluent through its distributed biological contact surface.
- **Closed-Loop Resource Recovery:** The architecture minimizes or eliminates wastewater discharge. By treating the water to high standards on-site, the system closes the loop, turning a traditional waste stream into a secondary water source.

3. Loading Capabilities & Specifications

The Kaimana system is specifically engineered for "high-strength" environments, meaning it handles waste that would typically overwhelm standard septic or aerobic units. Because the biological surface area is distributed across a pipe network rather than a single tank, it maintains a higher stability during "shock loading"—sudden spikes in volume, concentration, or nutrient density.

Technical Specifications Summary

Feature	Kaimana™ System Specification
Primary Mechanism	Biological treatment via distributed biofilm network.
Process Type	Aerobic and anoxic sludge-minimized biological filtration.
Target Influent	Sanitary sewage and high-strength industrial effluent.
Footprint	Modular, scalable, and often stackable for space efficiency.
Output Applications	High-quality irrigation, fire safety, and process water.
Environmental Impact	Chemical-free, low energy, and zero-discharge capable.

Performance & Volume Metrics

Specification	Performance Target
Effluent Quality	Meets or exceeds NSF/ANSI 40 standards ($\leq 30\text{mg/L BOD}_5$ / $\leq 30\text{mg/L TSS}$).
Nitrient Removal (TN)	Capable of reducing Total Nitrogen to <10 mg/L .
Nutrient Removal (TP)	Capable of reducing Total Phosphorus to <1 mg/L .

Specification	Performance Target
Treatment Level	Advanced Secondary / Tertiary (R-1 equivalent for non-potable reuse).
Hydraulic Loading	Scalable from 5,000 to 50,000+ GPD per module.
Organic Tolerance	Optimized for high BOD/COD levels (5–10x domestic strength).
Power Consumption	Low-energy footprint; optimized for solar-off-grid compatibility.
Recovery Rate	Capable of 90%+ water recovery for reuse.

4. Operational Advantages

- **Regulatory Compliance & Regional Approvals:** Designed as a compliance-ready solution, the effluent generated meets strict local and environmental regulations for non-potable reuse. Notably, the Kaimana system has been approved for use under the **General Waste Discharge Requirements for Small Domestic Wastewater Treatment Systems (Order WQ 2014-0153-DWQ)** by the San Francisco Regional Water Board, significantly streamlining the permitting and deployment process for regional projects.
- **Sludge-Free & Chemical-Free:** The specialized biological process significantly reduces the production of waste sludge and operates without the continuous addition of harsh chemicals.
- **Cost-Effective On-site Treatment:** Eliminates the need to pump waste to municipal plants or pay for specialized hauling, reducing municipal surcharges.
- **Eutrophication Prevention & Nutrient Polish:** By effectively removing excess nitrogen and phosphorus, the system prevents harmful algae blooms in receiving waters and ensures strict compliance in ecologically sensitive, nutrient-restricted regions.
- **Energy Efficiency:** Less energy-intensive than conventional heavy aeration setups or traditional Membrane Bioreactors (MBRs).
- **Odorless Operation:** The closed-loop, pipe-based design ensures that the treatment process remains odor-free, allowing for installation in close proximity to residential or commercial spaces.

5. Target Applications

- **Agriculture & Agritech:** Recovering water for crop irrigation and reducing reliance on local aquifers. The system can be calibrated to leave beneficial nutrients in the effluent, turning it into a rich fertilizer stream.
 - **Industrial & Manufacturing:** Treating high-strength effluent (high BOD/COD/Nutrients) that conventional systems struggle to process efficiently.
 - **Decentralized Municipal/Commercial:** Providing autonomous water cycles for remote developments or areas facing strict municipal discharge limits.
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Conclusion

The Kaimana™ system represents a practical shift toward circular water infrastructure. It treats wastewater not as a liability to be discharged, but as a strategic resource to be recovered through its innovative biofilm-in-pipe technology, dynamic nutrient management, and robust loading resilience. Backed by critical regulatory approvals like **Order WQ 2014-0153-DWQ**, the Kaimana system provides a scalable, energy-efficient solution that enables facilities to achieve water independence and maintain strict compliance directly on-site.