Achieving Significant Year-Round Nutrient Removal in Aerated Wastewater Lagoons

Project Location: Rehberg Ranch Residential Subdivision, Billings, Montana USA

A floating treatment wetland (FTW) incorporating circulation and aeration was installed in an aerated wastewater lagoon. This first generation of Floating Island International's Streambed technology improved removal rates for ammonia, total nitrogen and total phosphorus by 24%, 20% and 5%, respectively, compared to a control lagoon operated in parallel. *Ammonia and phosphorus removal were even higher during the winter months.*

Overview

Located on the outskirts of Billings, Montana (pop. 120,000), the Rehberg Ranch residential subdivision (pop. 560) was built beyond the reach of the city's municipal sewer system. Developers constructed an aerated lagoon wastewater treatment system designed to meet U.S. EPA secondary standards for BOD and TSS.

Discharge options were limited to land application or surface water discharge, and nutrient levels in treated wastewater needed to be lower than the lagoons alone could deliver. In this case, the treated wastewater is being land-applied to surrounding prairie grasses, rather than discharged into surface or groundwater. Prairie grasses are able to assimilate only low nutrient loads.

In November 2009, the City of Billings and Floating Island International (FII), supported with funding from the Montana Board of Research and Commercialization Technology (MBRCT), installed an experimental FTW design in one of the subdivision's two aerated lagoons. The City implemented a rigorous monitoring regime to record efficacy of the FTW system in comparison to the control lagoon with no FTW. Both lagoons received the same wastewater.

Bi-weekly samples were taken for ammonia, total nitrogen (TN), total phosphorus (TP), biochemical oxygen demand (BOD), total suspended solids (TSS) and several other parameters, and were analyzed at the City's wastewater lab.

Installation Data

Location	Billings, Montana USA
Parameters Studied	Ammonia, total nitrogen, total phosphorus, TSS, BOD
System Type	Aerated lagoon
FTW Size	2300 ft^2 (214 m^2) FTW (with 1300 ft^2 submerged treatment area and 1000 ft^2 elevated plant growth

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	perimeter). Thickness: 8 inches (20 cm)
Water Source	Municipal wastewater from approximately 140 households
Installation Date	November 2009
Flow Rate	12 gpm (2.7 m^3/hr)
Water Body Depth	Estimated at 12 ft (3.7 m)
Water Body Area	36,000 ft^2 (3,345 m^2)
% Coverage	6.4% of lagoon covered by FTW

Results

The FTW increased nutrient removal while reducing costs. For the monitored period of December 2009-October 2010, FTW nutrient removal, compared with the control lagoon, was substantial. Ammonia removal improved by an average of 24%, TN removal improved by 20% and TP removal improved by 5%. TN improvement was consistent year-round but TP removal improvement was much better during the winter (December-March), when the water temperature averaged less than 1°C, and ammonia removal was slightly better.

Winter removal in the FTW lagoon was 26% higher for TP and 27% higher for ammonia than in the control lagoon. It is theorized that during the summer, when both lagoons had substantial evaporation and little to no outflow, phosphorus may have become concentrated.

Both lagoons removed over 90% of the BOD and over 70% of the TSS, with little to no improvement in the FTW lagoon compared to the control lagoon.

Parameters	FTW Total Removal Rate (lb/yr/ft^3)	FTW Improvement: Year-Round (Winter)
Ammonia	0.9	24% (27%)
Total Nitrogen	1.3	20% (20%)
Total Phosphorus	0.01	5% (26%)

Operational Data

Average O&M Costs (Labor, Materials)	2 hours/week; no materials
Training Required to Operate	1 day training seminar
Required Additional Inputs	Electricity for pump (1.5 hp/Aquamaster)
Anticipated Lifespan	10 years

Costs were reduced because lower nutrient levels allowed treated water to be applied to less land area at higher rates, reducing overall discharge costs by 50%.

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FTW after installation, November 2009

FTW, July 2010

Conclusion

The need to reduce nutrient levels in wastewater, especially during cold winter months, is increasingly critical as rivers, lakes and coastal waters become more nutrient-loaded worldwide. This is the entry point for cutting-edge, "green" FTW technology.

Although facultative and aerated lagoons can reduce BOD and TSS, their ability to remove nitrogen and phosphorus from municipal wastewater is limited. FII's FTW technology enhances these lagoons with the "concentrated wetland effect," facilitating compliance with increasingly stringent wastewater nutrient criteria.

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