Floating Treatment Wetland Technology: Total Nitrogen Removal from Wastewater

This case study illustrates the Floating Island International (FII) patented floating treatment wetland (FTW) technology and its ability to reduce total nitrogen levels in wastewater. Constructed of post-consumer polymer fibers ("matrix") and vegetated with native plants, FTWs mimic the ability of natural wetlands to clean water by bringing a "concentrated wetland effect" to any water body.

Since their initial implementation nearly a decade ago, one of the primary objectives of FII's floating treatment wetlands has been to reduce objectionable nutrient levels. Potential applications include waterways degraded by agricultural runoff, ponds and lakes impacted by waterfowl and/or septic systems, polishing of municipal wastewater and even treatment of raw wastewater.

Table 1 illustrates total nitrogen removal in five studies equipped with FTWs. The table includes nitrogen concentrations, percent removals and removal rates in pounds of total nitrogen removed per year per cubic foot of FTW material.

TABLE 1. FTW TOTAL NITROGEN REMOVAL

	Nitrogen Concentration (mg/L)			Percent Removal		Removal Rate (lb/yr/ft^3)	
Study	**Influent**	**FTW**	**Control**	**FTW**	**Control**	**FTW**	**Control**
MBRCT Test Pond	172	22	112	87%	35%	0.9	0.4
Rehberg Ranch	50.2	14.1	24.5	72%	51%	1.2	0.8
Wiconisco	46.3	18.6	20.9	60%	55%	2.5	2.3
McLean's Pit	NA	NA	NA	40%	NA	2.4	NA
Shepherd Pond	0.5	0.1	NA	80%	NA	0.1	NA

The first four systems presented in Table 1 are wastewater lagoons at relatively small scale, while the Shepherd Pond is a lake restoration effort. Total nitrogen removal ranged from 40% to 87% in the five systems. The MBRCT, Rehberg Ranch and Wiconisco studies included "control" lagoons, which were parallel lagoons treating the same influent wastewater but without FTWs. FTW total nitrogen removal was better than the control by 52% and 21% in the MBRCT and Rehberg Ranch studies.

The McLean's Pit (New Zealand) and Shepherd Pond (Montana) systems have FTWs but no parallel lagoons to serve as controls. Monitoring data at McLean's Pit is limited to the percent removal and removal rate.

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Rehberg and Wiconisco are full-scale systems treating average flows of 12 and 16 gallons per minute (gpm), respectively. Both treat municipal wastewater, which contained high ammonia concentrations but low initial nitrate concentrations. In all five systems listed, ammonia was reduced to nearly zero while the nitrate concentrations (including the nitrate converted from ammonia by biological nitrification) were still relatively low after treatment.

Researchers have estimated that approximately 80% of the FTW efficacy is due to bacteria attached to plant roots and the FTW polymer matrix itself, with the other 20% attributed to nutrient uptake by plants. The plants create the platform for biological activity in a biofilm, while also contributing nutrient uptake and aesthetic benefits. This is illustrated in Figure 1.

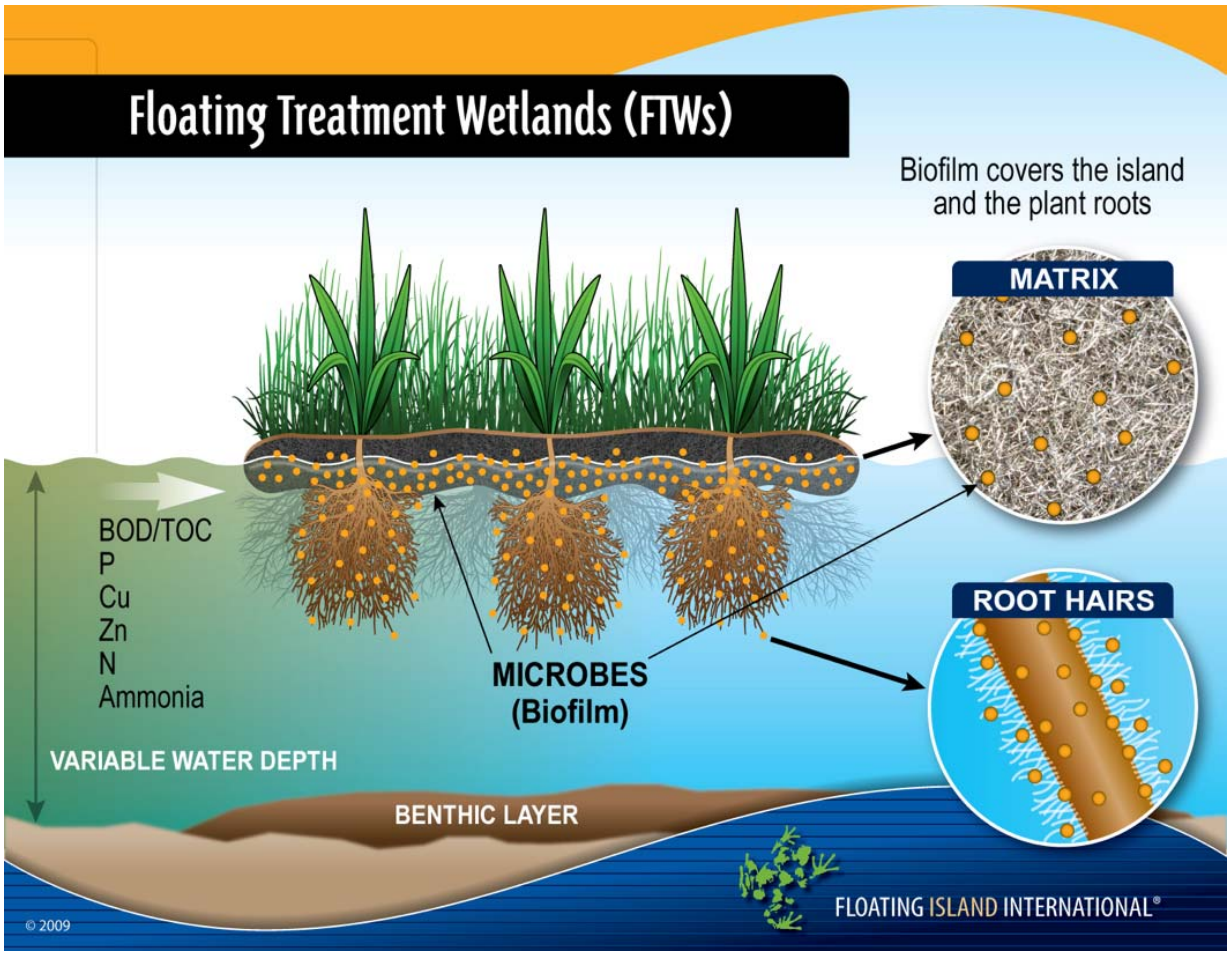

Figure 1. Illustration of FTW biological activity

For total nitrogen removal, both aerobic and anoxic conditions (either in different locations or in treatment stages) are required. Nitrification (biological conversion of ammonia to nitrate under aerobic conditions) is the primary mechanism for ammonia removal in these systems. Denitrification (biological reduction of nitrate to nitrogen gas under anoxic

conditions) is the primary mechanism for nitrate removal. Although the Rehberg and Wiconisco FTWs were aerated for ammonia removal, both systems achieved anoxic conditions (and subsequent nitrate removal) in the presence of dissolved carbon in the wastewater, which acts as a food source for denitrifying bacteria. Both the Wiconisco (Pennsylvania) and Rehberg Ranch (Montana) FTWs are located in cold-weather climates, which has traditionally limited biological nitrate removal.

The Rehberg Ranch system, installed in late 2009, is the latest-generation FTW as it includes a pump for circulation and aeration. The Wiconisco system was one of the first full-scale FTWs installed in 2005. The FTW at Rehberg Ranch (Billings, Montana) is shown in Figure 2.

Figure 2. Rehberg Ranch FTW, July 2010

Conclusion:

The need to reduce nutrient levels in wastewater is increasingly critical as rivers, lakes and coastal waters become more nutrient-loaded worldwide. This is the entry point for cutting edge, "green" floating treatment wetland (FTW) technology.

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

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