Constructed Wetlands for the Regeneration of Water Supplies
Water Quality Management of Purdue's Kampen Golf Course

Zachary Reicher, Vickie Poole, Ron Turco, Amanda Lopez and Jon Harbor

Purdue University

Goals:

Our over all goal is to evaluate the use of a "closed-loop" constructed wetland treatment system to improve urban water quality.

- Develop the use of a golf course constructed wetlands to improve residential runoff;
- Assess the ability of a constructed wetlands to protect adjacent and highly sensitive natural wetland environment;
- Evaluate the Regeneration of water supplies for golf course use.

Previous USGA-funded studies have documented the chemical makeup of water formed during golf course runoff and leaching events. Our work goes beyond monitoring to assess how innovative golf course water quality management, based around a constructed wetland, can not only reduce golf course water quality concerns but how this approach can be made part of a system that reduces water pollution concerns from adjacent non-golf course sources. Not only do the wetlands accept water originating from the golf courses but also runoff from a watershed that includes a gas station, retail businesses and parking lots, over 500 residences, and 2 major city highways. The quality of water will be monitored throughout the system for nutrients, pesticides, salt, automobile fluids, and other possible contaminants. From earlier results from across the country, the quality of water originating from the golf course is expected to be good. We have established an innovative management scheme in which golf course runoff and urban runoff are passed through created wetlands and then used as the primary water source for golf course irrigation. This arrangement is designed to both reduce impacts from the golf course and commercial / residential runoff, on an important wetland adjacent to the golf course and to provide a reliable source of water for golf course irrigation. This approach will provide a blueprint that allows for a reduction in golf course nutrient applications and groundwater withdrawals for irrigation. USGA funds are will providing for the research efforts to develop and disseminate information on performance of this system.

This project is a model for any location where a golf course interfaces with natural areas or other high value property. The ability of the constructed wetland to remove contamination is being evaluated and documented. The use of the wetland system to clean and remediate roadway water and water from commercial and residential areas is also being followed. For locations where water is expensive or not available, this approach may prove to be an extremely useful way to improve water supply. This approach will add environmental value to the golf course, as roadway water that would have been directly discharged, untreated, to surface water will be treated before release.

Rationale

It is established that pesticides and fertilizers when applied properly to golf course turf do not move off-site through runoff or leaching. Golf courses may actually improve the water quality in streams and rivers flowing through the course. This project takes this idea one step farther to determine if the created wetlands on Purdue's new Kampen Golf Course can filter possible impurities in runoff from the adjacent neighborhood. The neighborhood includes two residential highways, parking lot of a motel, a gas station, and 200 residences. The water flowing through the Kampen Course eventually enters Celery Bog, a nature center which contains a natural wetland prior to reconstruction of the Kampen Course, residential runoff entered Celery Bog directly through drainage tiles and overland transport. This five-year study is part of a larger project monitoring the larger watershed including industrial, agricultural, and commercial sites.

Progress Report:

Results to Date

- Since only two storm events were analyzed thus far, limited construction is still occurring in and around the created wetlands, and the wetland vegetation is still establishing and maturing, it is too early to draw definite conclusions.
- In the November 1998 sampling (Table 1), 14 parameters or contaminants indicated a decrease in water quality from the urban runoff (Site 1) to the water exiting the golf course (Site 6). Four parameters or contaminant levels indicated an improvement in water quality between the urban input and the water exiting the course. However, key parameters such as ammonia and nitrate-nitrite nitrogen and pesticide levels were either decreased as the water circulated through the golf course wetlands or were not detectable at either sampling site.
- Just the opposite was true in the June 99 sampling, 15 parameters or contaminant levels indicated an improvement in water quality from the urban runoff (Site 1) to the water exiting the golf course (Site 6). Only 4 parameters or contaminant levels indicated a decrease in water quality between the urban input and the water exiting the course. This suggests that the golf course's created wetland system is functioning to improve the water quality. Two parameters of interest include nitrate-nitrite N and ammonia-N, which were undetectable in water exiting the course, but at 2.1 and 31 ppm, respectively, in water flowing onto the course.
- No unusually high levels of any of a wide array of potential pollutants, including pesticides and metals were detected in the golf course sampling sites. However, atrazine and simazine were detected at site #7 which measures the water quality of the entire watershed. The watershed includes chemical manufacturing, farmland, subdivisions, apartment complexes, trailer courts, gas stations and other commercial areas. Atrazine was also detected in water exiting the neighborhood and entering the golf course (Site 1).

Surprisingly, even from the urban runoff there is no measurable oil and grease. It is reassuring to note that heavy metals of concern, such as mercury and lead, are below detection limits in all samples. Recent samplings have been collected and sent for analysis. All of the flow data for the site is now available on CD-ROM and is currently being analyzed for patterns and characteristics.

Description of sample sites:

Site 1. Evaluation of the "typical" water flowing from a mature residential and light industrial setting to the golf course.

Site 2. By subtraction (site 1 from 2), water quality and quantity from a greens-fairway complex.

Site 3. The treatment ability of a single wetland cell for municipal water as well as golf course materials (site 2 from 3).

Site 4. Water quantity and quality as affected by treatment in cell series (site 1 from 4).

Site 5. Water volume and quantity for untreated conditions. By subtraction (site 4 from 5), the impact of a wetland series on the quality of discharge waters.

Site 6. Outlet to the Celery bog.

We are presently employing a technician on the project. To date, the funds for the technician have come from matching monies on the project. We are presently search for a student to be employed on the project. We have several excellent applications and hope to have someone in place by January of 1999.

Project Timetable

Item	**Finish Date**	**Projected Finish Date**
Finish Construction of Created Wetlands	March 1998**	
Secure Funding	June 1998	
Hire technician	June 1998	
Installation of sampling structures, wiers, etc	Aug 1998	
Installation of samplers	Sep 1998	
Begin water quality sampling		Oct 1998
Hired MS, PhD student	August, 1999	
1st complete year of data		1999
2nd complete year of data		2000
3rd complete year of data		2001
4th complete year of data		2002

Figure 1. Schematic of water sampling sites in Kampen Course water monitoring project (not to scale)

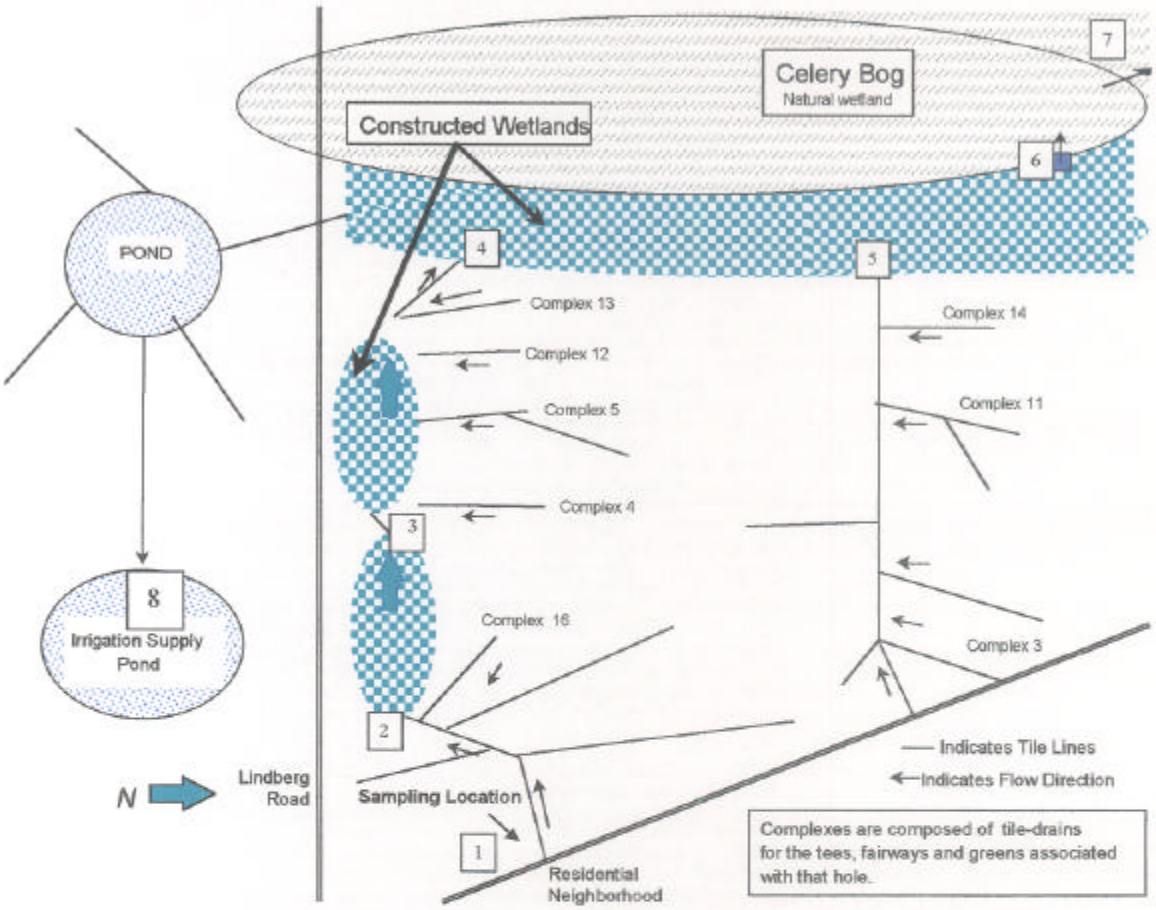

Table 1: Detailed chemical scan results from storm runoff on 30 Nov 1998 and 14 June 1999.

		November 1998			June 1999		
	Detection limit	Site 1 Urban runoff	Site 6 Outlet of Kampen created wetlands	increase/ decrease	Site 1 Urban runoff	Site 6 Outlet of Kampen created wetlands	increase/ decrease
Simazine	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Atrazine	0.10	BDL	BDL	BDL	0.1	BDL	-91%*
Oil and Grease	5	BDL	BDL	BDL	BDL	BDL	BDL
Chloride	2.5	8.6	22	+156%	32	20	-38%
Sulfate	2.5	11	55	+400%	18	31	+72%
Nitrogen nitrate-nitrite	0.01	1.1	0.06	-95%	2.1	BDL	-100%*
Ammonia nitrogen	0.12	0.23	BDL	-52%*	31	BDL	-100%*
Chemical O_2 Demand	10	40	37	-8%	480	25	-95%
Mercury	0.0002	BDL	BDL	BDL	BDL	BDL	BDL
Total Organic Carbon	1	8.2	10	+22%	240	1.6	-99%
Phosphorus	0.03	0.19	0.17	-11%	0.32	0.08	-75%
Dissolved Solids	10	91	270	+197%	240	220	-8%
Suspended Solids	1	17	290	+1606%	8	2	-75%
Silver	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Aluminum	0.10	0.31	5.8	+1771%	1.8	0.16	-91%
Arsenic	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Boron	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Barium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Beryllium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Calcium	0.10	29	61	+110%	40	34	-15%
Cadmium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Cobalt	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Chromium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Copper	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Iron	0.10	0.51	4.7	+822%	1.6	0.26	-84%
Potassium	0.10	2.3	7.8	+239%	2.2	0.37	-83%
Lithium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium	0.10	7.1	24	+238%	9.9	28	+183%
Manganese	0.10	BDL	0.21	+133%*	0.28	BDL	-64%*
Molybdenum	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Sodium	0.10	4.5	6.8	+51%	6.5	8.7	+34%
Nickel	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Lead	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Antimony	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Selenium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Silicon	0.10	2	14	+600%	2.0	4.8	+140%
Tin	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Strontium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Titanium	0.10	BDL	0.14	+56%*	BDL	BDL	BDL
Thallium	0.50	BDL	BDL	BDL	BDL	BDL	BDL
Vanadium	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Zinc	0.10	BDL	BDL	BDL	0.38	BDL	-74%*

Zirconium	0.10	BDL	BDL	BDL	BDL	BDL	BDL

BDL = Below Detection Limit.

* where contaminant was BDL, the detection limit was used for % increase/decrease calculations