Water Quality Management on Purdue's Kampen Golf Course

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Objective

The objective of this study is to determine how effective created wetlands are in filtering water runoff from commercial, residential, and golf course areas before the water enters a highly valued environmental area. Our overall goals include:

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

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.

How It Was Done

After construction of the Kampen Course was finished in 1998, water quality samplers were installed at six points throughout the created wetlands. The samplers were located to track the progress of water as it enters the east edge of the courses, through the wetland system, and exits the far northwest edge of the course. The water is sampled continuously for temperature, pH, oxygen content and other quality parameters. During storm events, water is sampled for contaminants such as nutrients, pesticides, salt, metals, petroleum products, etc. It is thought if any contaminants will be identified in the system, it will most likely occur during or immediately after a storm event. All water samplers were installed by Sep. 1998 and storm events were analyzed in Nov. 1998, June 1999, Nov. 1999, and Aug. 2000.

Results to Date

- Four storm events have been analyzed thus far and it appears that as the golf course and wetlands mature, they are becoming more efficient in improving the quality of the water as it flows through the course. For instance, 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) in Nov 1998 sampling while only 4 parameters or contaminant levels indicated an improvement in water quality between the urban input and the water exiting the course. But in the Nov. 1999 sampling, 12 parameters or contaminants indicated an improvement in water quality from the urban runoff to the water exiting the golf course. Seven parameters or contaminant levels indicated a decrease in water quality between the urban input and the water exiting the course in that same sampling. In the Aug. 2000 sampling, 8 parameters or contaminants indicated an improvement in water quality from the urban runoff to the water exiting the golf course. Seven parameters or contaminant levels indicated a decrease in water quality between the urban input and the water exiting the course.
- Key parameters like N and pesticide concetrations were either decreased as the water circulated through the golf course wetlands or were not detectable at either sampling site on any of the sampling dates.

- Most of the parameters that indicate a decrease in water quality as the water moves across the course are minor parameters that would be typical of leaching out of sand bunkers such as calcium and magnesium. However, concentrations of potassium have increased on 3 of the 4 sampling dates and we are currently reviewing the application records to determine if golf course applications may be responsible.
- No unusually high levels of any of a wide array of potential pollutants, including pesticides and metals were detected at the golf course sampling sites. However, atrazine and simazine were detected in November 1998 at a site at the outlet of Celery Bog (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.
- All of the flow data for the site is now available on CD-ROM and is currently being analyzed for patterns and characteristics.

Acknowledgments
The work reported here would not have been possible without the support and assistance of numerous people and organizations. Thanks goes to Jim Scott, superintendent of the Birke Boilermaker Golf Complex for his patience and cooperation. Financial and in-kind support for water quality monitoring on the Kampen Course was provided by the United States Golf Association, Pete Dye, Inc, and Heritage Environmental.

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

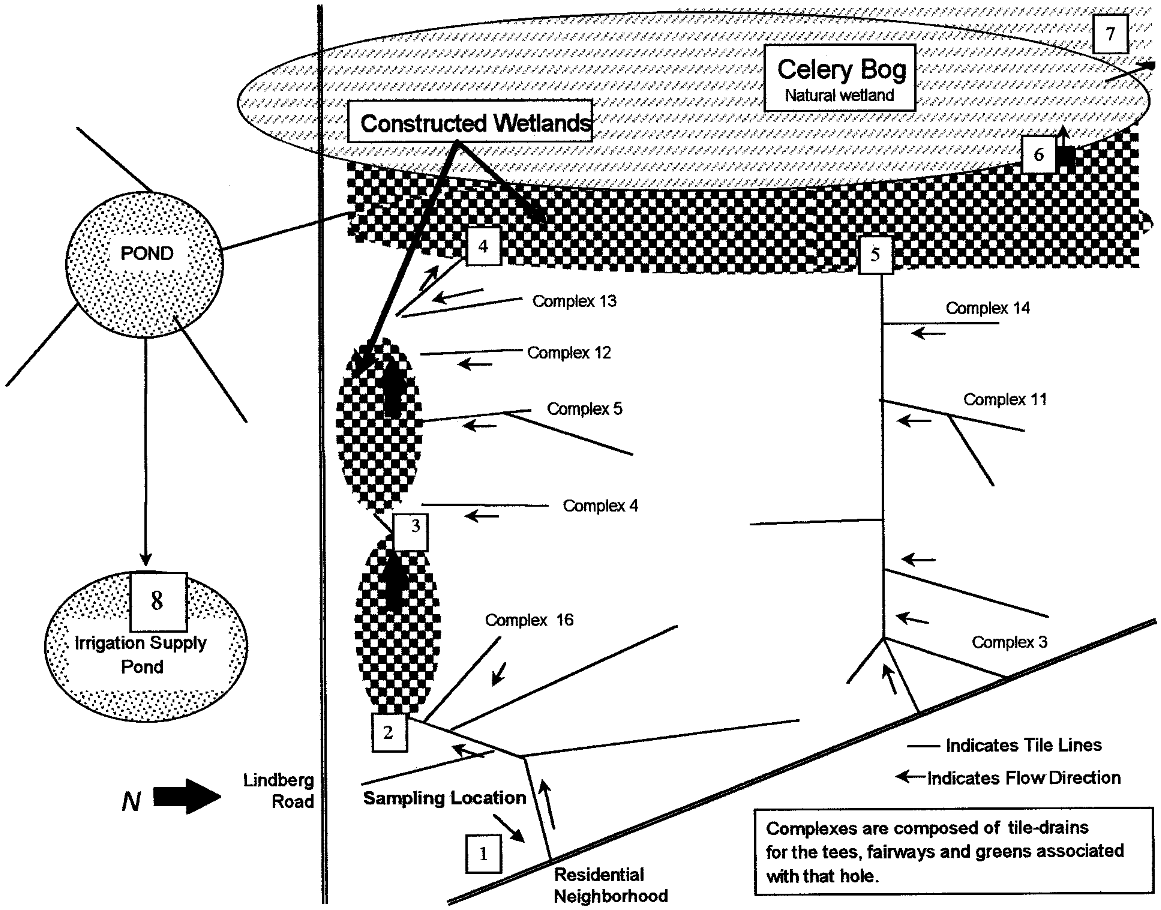

Table 1: Detailed chemical scan results from storm runoff on 30 Nov 1998, 14 June 1999, 1 Nov 1999, and 24 Aug 2000.

		November 1998			June 1999			November 1999			August 2000		
	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	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	BDL	BDL	BDL	BDL	BDL	BDL
Atrazine	0.10	BDL	BDL	BDL	0.1	BDL	-100%*	BDL	BDL	BDL	BDL	BDL	BDL
Oil and Grease	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chloride	1.3	8.6	22	+156%	32	20	-38%	100	22	-78%	14	18	+28%
Sulfate	1.3	11	55	+400%	18	31	+72%	43	59	+37%	13	54	+215%
Nitrogen nitrate-nitrite	0.01	1.1	0.06	-95%	2.1	BDL	-100%*	1.8	.36	-80%	0.3	BDL	-100%*
Ammonia nitrogen	0.12	0.23	BDL	-52%*	31	BDL	-100%*	8.4	.54	-94%	0.26	0.17	-34%
Chemical O_2 Demand	10	40	37	-8%	480	25	-95%	460	58	-88%	49	21	-57%
Mercury	0.0002	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total Organic Carbon	1	8.2	10	+22%	240	1.6	-99%	140	16	-89%	7.1	7.2	+1%
Phosphorus	0.03	0.19	0.17	-11%	0.32	0.08	-75%	0.57	1.7	+199%	0.12	0.12	NC
Dissolved Solids	10	91	270	+197%	240	220	-8%	640	330	-49%	140	270	+92%
Suspended Solids	1	17	290	+1606%	8	2	-75%	12	36	+200%	33	23	-30%
Silver	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Aluminum	0.10	0.31	5.8	+1771%	1.8	0.16	-91%	2.8	2.3	-18%	1.0	0.93	-7%
Arsenic	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Boron	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Barium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Beryllium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Calcium	0.10	29	61	+110%	40	34	-15%	68	56	-18%	32	44	+37%
Cadmium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cobalt	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Copper	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BD	BDL	BDL	BDL	BDL
Iron	0.10	0.51	4.7	+822%	1.6	0.26	-84%	1.3	2.4	+85%	1.4	1.1	-21%

BDL = Below Detection Limit.

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

NC = No change

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Potassium	0.10	2.3	7.8	+239%	2.2	0.37	-83%	4.9	14	+185%	3.0	4.4	+46%
Lithium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium	0.10	7.1	24	+238%	9.9	28	+183%	18	22	+22%	9.8	31	+216%
Manganese	0.10	BDL	0.21	+133%*	0.28	BDL	-64%*	0.43	BDL	-77%*	0.12	0.23	+91%
Molybdenum	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sodium	0.10	4.5	6.8	+51%	6.5	8.7	+34%	52	4.9	-81%	5.5	5.3	-4%
Nickel	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Antimony	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Selenium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Silicon	0.10	2	14	+600%	2.0	4.8	+140%	4.6	8.3	+80%	5.3	5.2	-2%
Tin	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Strontium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	0.16	BDL	-38%*	BDL	0.10	NC*
Titanium	0.10	BDL	0.14	+56%*	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Thallium	0.50	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Vanadium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc	0.10	BDL	BDL	BDL	0.38	BDL	-74%*	0.21	BDL	-53%*	BDL	BDL	BDL
Zirconium	0.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

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