Baker National Golf Course Leachate Study

Part II

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DATE	TOTAL KJELDAHL NITROGEN (mg/l)	SOLUBLE REACTIVE PHOSPHORUS (mg/l)	TOTAL PHOSPHORUS (mg/l)	BANNER (µg/l)	DACONIL (µg/l)	DYRENE (µg/l)	CHIPCO (µg/l)
11-Jul-90	4.8	0.56	0.65				
26-Jul-90	2.6	4.87	3.87				
31-May-91	1.9	3.2	3.2				
21-Jun-91	2	2.5	2.5	ND	0.33		
12-Jul-91	2.1	2.5	2.5	ND	0.34		
02-Aug-91	2.4	2	2.1	ND	ND		ND
02-Jul-92	2.4	1.5	1.7		ND	ND	0.91
12-Jul-92	2.2	1.9	1.9		ND	ND	6
16-Sep-92	2.1	2.1	2.2		ND	ND	ND

NOTE: ND indicates that the parameter was not detected

Table 5. Concentration of Leachate Contaminants, Green 7, 1990 to 1992

As Figure 7 shows, the concentrations of nutrients in the leachate water during the different rainfall events were very consistent during the three-year study with the exception of 1990.

The total quantity of phosphorus and nitrogen in leachate water from measured storms during the three-year study was 0.09 pounds and 0.1 pounds respectively, less than 0.1 percent of the amount applied as fertilizer.

Of the fungicides applied to Green 7 in 1991 and 1992, only two, Daconil 2787 and Chipco 26019 were present in the leachate, (Figure 8). Daconil 2787 was present in 1991 and Chipco 26019 was present only in 1992 although both were applied to Green 7 in both years. Banner and Dyrene were not detected in any leachate samples. In 1992, Chipco 26019 was detected in the sample collected on July 2 although the first Chipco application occurred on July 6. This suggests that carryover of Chipco from 1991 occurred. Due to laboratory problems, no fungicide analysis was done in 1990. The total quantity of fungicides flushed through Green 7 during the study was very small, 0.0000096 oz of Daconyl in 1991 and 0.0000049 oz of Chipco in 1992. These quantities amounted to less than 0.01 percent of the Daconyl and Chipco applied to the Green during the study.

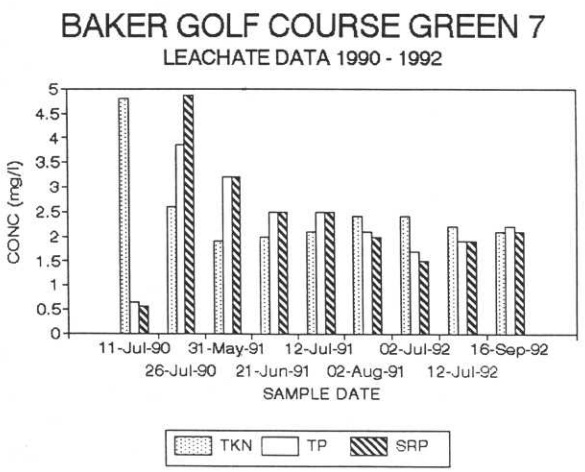

Figure 7. Green 7 Leachate Nutrient Concentrations 1990 to 1992.

Discussion

The data from the monitoring project suggests that there is no significant movement of fertilizer or fungicides from Green 7 to the underlying groundwater table. Although phosphorus and nitrogen were present in all leachate samples at fairly high concentrations, only trace quantities were flushed through the green. Only trace concentrations of fungicides were present in leachate water and, therefore, even less of these chemicals were flushed through the green. The lack of movement of significant quantities of

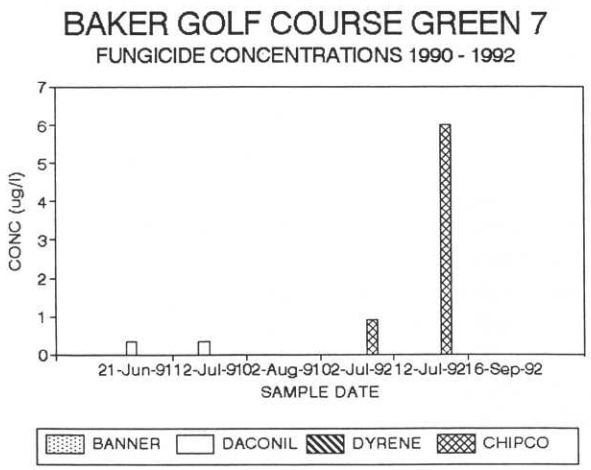

Figure 8. Green 7 Leachate Fungicide Concentrations, 1990 to 1992

fertilizer elements and fungicides from the green surface to the underground tile line was a function of the small amount of leachate generated by the rainfall events. Overall 214,000 gallons of rain fell on the green during 63 monitored rainfall events, but only 5,200 gallons of the rainfall passed through the green.

The lack of significant quantities of leachate suggest that the majority of rainfall either was absorbed by the soil or left Green 7 through surface runoff. Because Green 7 was irrigated between rainfall events and because some events less than 0.5 inches in volume did produce leachate, it is doubtful that the majority of rain in most events was adsorbed by the soil. It appears rather that the majority of rainfall left the green as surface runoff. This conclusion is supported by visual observation of the green during rainfall events. Significant quantities of runoff were unexpected, given the fact that the infiltration rate of Green 7 was in excess of 18 inches per hour as determined by a standard percolation test. The rainfall intensity data showed that most rainfall occurred at a rate of four inches per hour or slower. It appears therefore, that the percolation rate of Green 7 was significantly reduced by the development of the turfgrass over the underlying sand/peat soil mixture.

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On an annual basis, 20.3 inches or 90,879 gallons of rain fall on green 7 and generate an estimated 2,181 gallons of leachate. This volume of leachate will transport an estimated 0.05 pounds of phosphorus, 0.04 pounds of nitrogen, 0.0000025 ounces of Chipco, and 0.0000048 ounces of Daconyl to the ground water. Multiplying this by the 27 greens on the Baker National Course results in an estimated 1.4 pounds of phosphorus, 1.1 pounds of nitrogen, 0.00007 ounces of Chipco and 0.00013 ounces of Daconyl moving into the groundwater from all of the golf course greens annually. The Baker National Golf Course is approximately 300 acres in size. The small quantity of nutrients and fungicides leaching downward over this large an area is not considered significant.

The concentration of phosphorus in the leachate water was much higher than expected, exceeding the nitrogen concentration in the majority of samples. This was surprising given that nitrogen is very soluble and mobile in the soil but phosphorus is not. It is generally thought that phosphorus is bound up by soil particles and does not migrate through the soil. The leachate data from this study however, indicate that if high enough concentrations of phosphorus are applied to an area, the adsorption capacity of the soil can be exhausted. This appeared to have been the case in 1990 when 102.5 pounds of phosphorus were applied to Green 7. The 102.5 pounds on the 7,180 sq. ft. Green 7 is equivalent to 650 pounds per acre, much higher than University of Minnesota recommended application rates. The results suggests that if over-fertilization of turf with phosphorus occurs, the excess phosphorus is available to leachate water and potentially to surface runoff.

As stated in the results, some data was lost due to lightning strikes. During 1990 and 1991 the data logger was placed underground on top of the sample box. Although the data logger is insulated, electrical currents generated by lightning were apparently able to short the computer memory of the meter. In 1992 an above ground housing was constructed for the data logger and no memory crashes occurred.

The lack of sample data collection in 1990 was due to a problem with the analytical laboratory. In order to minimize study costs, the sample analyses were included with a bid proposal for a Minnesota Pollution Control Agency funded project. The bid documents required that the laboratory have a PCA-approved Quality Control/Quality Assurance Plan and specified minimum detection limits, sample holding times, and a time line for reporting results. The private analytical laboratory selected through the bid process was able to meet all these criteria.

Water samples were sent to the lab in early June, 1990, but test results were not reported until late July. The data received from the initial lake samples was very questionable. Phosphorus concentrations in some sampled lakes were twice as high as historical records indicated they should be, and algae levels were five times less than anticipated. Investigations into the problems revealed that the laboratory was using improper calibration curves when analyzing samples. Unfortunately, by the time the problems were discovered, the golf course samples had also been sent to the lab. Since no background exists on the expected quality of the golf course leachate, it was not possible to determine the accuracy of the reported results. However, because the lake data obtained on the same dates is erroneous, the golf course data are suspect.

A second problem with the laboratory was its lack of direction relative to the sample volume necessary to perform the required analysis. Three weeks after delivering samples to the lab in bottles supplied by them, we were informed that an additional liter of sample was required to complete the fungicide analysis. Unfortunately, all excess sample water was discarded once the sample bottles were filled. Therefore, no fungicide analysis was done in 1990.

Conclusions

The amount of fertilizer and fungicides lost from Green 7 by leachate does not appear to be significant. The lack of movement of significant amounts of contaminants from Green 7 was a function of the small amount of leachate generated by rainfall events. Data from the study indicate that most of the rain which fell on Green 7 left as surface runoff. Although the study data was collected from only one green, the results indicate that even if contaminant movement were an order of magnitude higher, it would still not be significant relative to the area over which it is spread.

The concentration of phosphorus in leachate samples was much higher than expected. The high concentrations are probably a result of the excess amounts of fertilizer which were applied to Green 7 in 1990. The high concentrations of phosphorus found in the leachate water suggest that phosphorus movement off of turf areas with surface runoff may be significant if excessive amounts of fertilizer are applied. Testing of soil nutrient levels to determine fertilizer needs could avoid potential runoff quality problems.

Treatment of leachate water from golf course greens, if desired, would be fairly simple because of the small quantities involved. Collecting the rainfall leachate water in a small manhole, similar to the one installed at Green 7, with a subsurface tile line and then reapplying the water to the green or adjacent fairways between rainfall events would prevent any fungicides on nutrients from reaching the ground water from golf course greens.

Since runoff from greens and presumably from other areas of golf courses appears to be significant, future research programs initiated by the MGCSA should focus on the quality of surface runoff water. Monitoring of nutrient and pesticide levels in runoff water from golf courses could help to eliminate the perception that golf courses are sources of pollution.