Article 135

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Groundwater Impacts of Golf Course Development in Cape Cod

Golf courses are a unique form of urban development in that they produce relatively little runoff but possibly a great deal of pollution. The unusually high rates of fertilizers and pesticides applied to tees, greens, and fairways have always made golf courses a prime water quality suspect. Until recently, however, no monitoring data was available to support or refute the argument that golf courses can contaminate groundwater.

Three years of detailed groundwater monitoring has recently been completed on four golf courses near Cape Cod, Massachusetts by Cohen and his colleagues (1990). Sandy soils in this coastal region contribute to a sole-source aquifer, so concerns about the quality of groundwater supplies are paramount. Each of the four golf courses were selected to represent the worst risk for possible groundwater contamination: each was underlain by sandy soils of glacial origin, had above-normal pesticide and nutrient applications, and had been continuously operated for up to 30 years. Each of these three factors likely promote greater movement of pollutants in groundwater.

Three years of monitoring at 19 test wells detected 10 out of 17 pesticides (see Table 1). Most pesticides were present in low concentrations (less than five ppb), and were associated with greens and tee areas. The most frequently detected compound was DCBA, an impurity associated with herbicides. Technical chlordane was also frequently detected, despite the fact that its use on turfgrass had been banned since 1978. Chlordane is highly persistent, but relatively immobile in the soil environment (see Table 2), and appears to be leaching slowly into the groundwater in the 12 years since it was banned. With the exception of chlordane, no pesticide found in groundwater exceeded health guidance levels.

The monitoring study also tracked nitrate-nitrogen levels in the golf course groundwater (Table 3). Current golf course standards require that the soil medium underlying greens and tees be composed of at least 95% sand, so it is not surprising that nitrate levels were considerably elevated compared to non-golf course control sites. Maximum nitrate levels in excess of 10 mg/l were occasionally recorded, but averaged one to six mg/l. While the groundwater nitrate levels were thought to be no worse than reported for intensively fertilized agricultural areas, they are clearly high enough to create eutrophication problems in coastal or near coastal nitrogen sensitive waters.

Table 2: Relative Mobility and Persistence of Selected Pesticides (Cohen *et al.*, 1990)

Mobility in Soil Environment

High Mobility	Medium Mobility	Low Mobility
2,4-D	Siduron	Chlordane
Dicamba	PCP	Heptachlor epoxide
Dachtal diacid	Iporodione	Dachtal
MCPP	Diazinon	Chlorothalonil
	Isofenphos	Chlorpyrifos
		Anilazine

Persistence in Soil Environment

High Persistence	Medium Persistence	Low Persistence
Chlordane	Dicamba	2,4-D
Siduron	Dachtal diacid	Dachtal
PCP	Iprodione	MCPP
Heptachlor epoxide	Diazinon	
	Isofenphos	
	Chlorothalinol	
	Chlorpyrifos	
	Anilazine	

Table 1: Pesticides Detected in Golf Course Groundwater Wells

Pesticide	Detection Rate
2-4-dichlorobenzoic acid (DCBA)	63%
Technical Chlordane *	44%
Total Dachtal residues	19%
Chlorothalonil	13%
Isofenphos	13%
Chloropyrifos	6%
Dicamba	6%
2-4-dichloro-phenol (2-4D)	6%

* banned on turfgrass since 1978

Table 3: Nitrate-Nitrogen Levels in Groundwater of Four Golf Courses in Cape Cod, Mass All Values in mg/l (Cohen *et al.*, 1990)

Golf Course	Green	Tees	Fairway	Reference Site	Maximum Value (d)
Bass River	2.79	1.03	4.16	8.0 (b)	10.0
Eastward Ho!	6.31	1.0	6.66	0.10	30.0
Falmouth (a)	2.44	1.54	ND	0.10	6.5
Hyannisport	5.82	2.24	3.24	0.10	10.2
MEAN	4.34	1.45	4.68	0.10 (c)	—

(a) Falmouth course utilized slow release fertilizers during study.
(b) Background reference site appears to have been contaminated.
(c) Mean computed without outlier.
(d) Recorded from green, tee, or fairway well.

The researchers found considerable evidence that nitrate leaching could be reduced through better fertilizer management. For example, Cohen *et al.* noted that the golf course (Falmouth) that utilized slow release fertilizers had sharply lower groundwater nitrate levels than all other sites. They also observed a significant decline in nitrate levels in years where fertilizer applications were below normal.

The researchers caution that the findings pertain to only one of many hydrogeologic settings, and more extensive groundwater monitoring in other regions is needed to fully define the water quality risks of golf courses. Southern courses in particular remain a monitoring priority as their irrigation rates and nematicide and fungicide applications tend to be much greater than Northern courses.

Although much more monitoring needs to be done to fully assess the groundwater impact of golf courses, Cohen's study does reinforce the great potential for improved nutrient and pest management practices to protect groundwater at golf courses. Through relatively simple changes in how and when chemicals are used, golf course managers can help protect water quality and still provide an attractive and durable playing surface.

—TRS

References

Cohen, S., S. Nickerson, R. Maxey, A. Dupuy and J. Senita. 1990. "A Groundwater Monitoring Study for Pesticides and Nitrates Associated With Golf Courses on Cape Cod." *Groundwater Monitoring Review*. Winter 1990:160-173.

Petrovic, A. 1990. "The Fate of Nitrogenous Fertilizers Applied to Turfgrass." *Journal of Environmental Quality*. 19(1): 1-14.