

A Critical Review of Water Quality Impacts by Golf Courses: Update and Trends

Stuart Z. Cohen

Environmental & Turf Services, Inc.

Objectives:

1. Obtain, screen (quality control), and evaluate all relevant and valid water quality monitoring studies for North American golf courses, with a focus on pesticides, nitrate-N, and phosphorous.
2. Enter the data into a database that will be used for statistical analysis.
3. Conduct an analysis of detections and exceedances.
4. Expand this analysis to include contaminant trends.
5. Prepare a manuscript suitable for publication in a peer-reviewed journal.

Start Date: 2005

Project Duration: two years

Total Funding: \$50,000

Potential and documented impacts by golf courses on ground water and surface water quality is an issue during the permitting and operational phases of golf course development and management, respectively. Historically, the perception by many members of the public has been that golf courses are significant sources of pesticide and fertilizer loading to ambient water.

The first national assessment of this issue was supported by the GCSAA, with a grant issued to ETS in 1996. Work was performed with the GCSAA to identify all available golf course water quality monitoring studies. The nitrate, pesticide, and solvent results obtained indicated low frequencies of concentrations that exceeded human health and aquatic organism standards and guidelines. The update of this metastudy is being co-funded by the GCSAA's Environmental Institute for Golf. Its scope has been expanded to include phosphorus.

One goal of this new study is to use the water quality monitoring data from a greater number of North American golf courses and from a much wider geograph-



Dr. Stuart Cohen takes a water sample as part of this study, jointly funded by USGA and the Golf Course Superintendents Association of America, to assess water quality as affected by North American golf courses.

ical distribution. Scientists at ETS have analyzed the concentrations of nutrient and pesticide detections, identified when they exceed current environmental health standards, and are using the analyses to identify trends. The results of this research will provide scientifically valid, updated information that can be used in public hearings, regulatory decisions on golf course permitting, and pesticide registration. Equally important, it will help the industry better understand the extent to which - if any - it is impacting water quality. Potential contamination problems may be identified that

indicate the need for improved or better informed turf management. It may be determined that certain costly analyses that rarely yield positive results should be excluded from monitoring programs, thereby providing money-saving advice. Trends may be identified that could be significant for national perspectives on the focus of water quality monitoring.

Summary Points

- Data files from the original water quality study (1996/1997) have been imported manually from Paradox into the Microsoft Access database.
- Attempts were made to update monitoring data from the original studies included in the 1999 publication.
- Solicitation of new monitoring studies was completed.
- Quality control procedures were developed for reviewers to follow during the study acceptance phase.
- We have evaluated 29 new studies, of which 27 passed QC review and were incorporated into the database (in addition to the 1996/1997 studies).
- The database now includes 44 studies of 80 golf courses, totaling 40,791 data points representing the analyses of pesticides, pesticide metabolites, nitrate-N, and total phosphorus (see table).
- Average contaminant concentrations in surface and ground water have been computed and compared against various water quality criteria (MCLs, HALs, and MACs for aquatic life)
- Rates of exceedances of the water quality criteria have been computed.
- Statistical analyses are mostly complete.
- Preparation of manuscript for submission to a peer-reviewed journal has begun.

	Organics*	Nitrate-N	Phosphorus	Total Totals
Ground Water	16,172**	1,683	970	18,825
Surface Water	18,044	2,493	1,429	21,966
Totals	34,216	4,176	2,399	40,791

* "organics" includes pesticides and metabolites.
 ** one data base entry equals one analysis for one chemical in one water sample

Number of data base entries for ground water and surface water analyzed for organics, nitrate-N, total phosphorus, and their totals for the critical review of water quality impact of golf courses.