HANDBOOK of Integrated Pest Management for Turf and Ornamentals

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Chapter 15

Siting and Design Considerations to Enhance the Environmental Benefits of Golf Courses

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A golf course that is carefully sited, designed, and managed can provide many benefits to the aquatic environment. The recommendations presented in this chapter are derived from a study of 11 golf courses located in Maryland and Pennsylvania,[6] in addition to a review of the literature.

The results of the study indicated a general relationship between the quality of a waterway and the percentage of the drainage area which is in use as a golf course. As the percentage increases, the quality of the waterway declines. When a golf course accounts for more than 50% of the drainage area, then the receiving waters usually exhibit a moderate to severe level of degradation. Such a waterway would be unfit for most beneficial uses. This relationship applies to watersheds where the only other land uses are woodland, pasture, or cropland. Intense residential or commercial development can cause environmental impacts which obscure effects associated with a golf course.

The potential causes of the degradation revealed by our study include:

- stream channelization,
- destruction of wetlands,
- lack of a wooded buffer along waterways,
- elevated water temperature due to;
  - lack of shading vegetation,
  - reduction of groundwater inflow,
  - release of heated water from the surface of ponds,
  - entry of heated stormwater runoff from impervious surfaces,
- reduction of base flow due to ground or surface water withdrawals,
- release of toxic substances and oxygen deficient water from ponds,
- intermittent pollution incidents such as spills of pesticides, fertilizers, or fuel,
- loss of pesticides or fertilizers by way of ground or surface water runoff,
- entry of stormwater pollutants washed from parking lots and the other impervious surfaces associated with a golf course,
- accelerated channel erosion due to increased stormwater runoff velocity or prolonging the amount of time channels are exposed to erosive velocities,
- elimination of the scouring benefits of flooding by altering the frequency and/or magnitude of flooding,
- poor erosion and sediment control during the construction phase, and
- inadequate treatment of sewage and other wastewaters generated on the golf course.

After a list was compiled of the potential causes of degradation, an extensive search of the scientific literature was conducted. Experts throughout the nation were consulted to develop a better understanding of the relationships between a golf course and the aquatic environment. Finally, we analyzed the results of all this research and concluded it is possible to construct and operate a golf course without damaging the aquatic environment. The design and management recommendations presented in this

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chapter, however, must be closely followed in order to reduce the likelihood of environmental degradation.

The purpose of this chapter is not how to design a golf course to maximize the quality of the game, but how to minimize the impact upon the aquatic environment. Our study revealed that the typical golf course has the potential to negatively affect the quality of aquatic resources. Yet, if designed correctly, a golf course can be a method of clean water generation through an actively growing biological filter. If this potential is to be realized, then environmental protection must become a primary factor in all aspects of golf course design and management. The best place to begin is the site selection process.

SCREENING POTENTIAL SITES FOR NEW GOLF COURSES

When screening a number of tracts as a possible location for a golf course, it is suggested that priority be given to sites with the following characteristics.

(1) Pesticide and fertilizer movement will be lowest on sites with soils which are medium-textured, have a high organic matter content, a high cation exchange capacity, a low erosion and runoff potential, and where the water table and bedrock lie at least 4 ft below the surface.[1,3,4,7,13,15]

(2) The layout of the course should permit a vegetated buffer of 75 to 150 ft in width along all streams, wetlands, lakes, ponds, or other waterways. Ideally the buffer should be composed of trees and shrubs. A buffer of this width will serve to retard floodwaters, slow channel erosion, shade the waterway from the heating effects of the sun, filter a portion of the pollutants entrained in surface runoff, and contribute leaves and other plant parts to the food web of small, headwater streams.[9,12]

(3) Waterway crossings should not be needed, or the site selected should require the fewest number of crossings. By minimizing crossings, the disturbance of wetlands, stream channels, and the buffer will be diminished.

(4) Sites should be avoided where extremely sensitive species of aquatic life, such as trout, or rare, threatened, or endangered species may occur in downstream waters.

(5) Constructing a pond on a flowing stream can create a number of impacts, which include: barriers to fish migrations, thermal pollution, reduced stream flow, and the proliferation of algae with accompanying dissolved oxygen deficiencies.[7,14] If a pond is needed at all, then site conditions should allow for construction of the pond without impounding an intermittent or perennial stream.

(6) Sufficient water must be available to meet irrigation needs without either causing a decrease of more than 5% in the low-flow (7-day, 10-year) of any waterway in the vicinity of the site or substantially reducing the yield of existing wells in the area.[7]

(7) Infiltration is the most effective means for controlling the effects of stormwater runoff.[14] Preferential consideration should be given to sites where parking lots, buildings, and other impervious surfaces can be placed near soils which are suitable for the infiltration of stormwater.[14]

(8) To minimize soil erosion and sediment pollution during the construction phase, sites with highly erodible soils or steep slopes (>15%) should be avoided, particularly if the course cannot be built without extensive disturbance on these soils and slopes.[5,7]

(9) Of all land uses, forest produces the least impact upon the aquatic environment.[5,8,20] Therefore preferential consideration should be given to sites with little forest cover or where opportunities to plant trees will be greatest.

(10) During a literature review a number of references were found to poisonings of waterfowl, raptors, and other birds as a result of ingestion of pesticides applied to turfgrass.[16-19] Sites should be avoided that are near congregating areas for waterfowl, raptors, or other birds, particularly if the golf course can only be built by bringing pesticide-treated turfgrass to the edge of a pond, lake, river, or other open body of water. But measures are also available for minimizing the threat to wildlife if a golf course is sited in the vicinity of congregation areas. These measures are described in the next section.

GOLF COURSE LAYOUT AND DESIGN

If the protection of aquatic resources were the sole consideration in selecting a site for a golf course, then the criteria listed above would render the choice an easy one. Of course, many other considerations must enter into the site selection process. As these considerations shift the selection in favor of sites which deviate from the criteria listed above, then the potential for impact increases. Fortunately mitigation measures are available which will reduce some of the impacts associated with golf courses.

Traditionally, one might look at a piece of raw land and lay out each fairway, green, tee, and rough in a way which will maximize the value of the course to the golfer. Once the site layout is "locked-in" one then looks for ways of mitigating the resulting impacts upon the environment. In some cases mitigation is successful, but in others the measures only partially offset the impact upon aquatic resources.

Instead, why not first identify all of the sensitive environmental features and avoid sites where a reliable means of mitigating impacts may not be available? Once these features are identified, the course can then be built around the sensitive areas. For example, the designer might identify all steep slopes, highly erodible soils, coarse-textured or shallow soils, and sensitive aquatic resource areas (streams, wetlands, etc.), then lay out the course so intrusion upon these features is minimized. By taking this approach, the dependence upon mitigation measures (particularly those with variable effectiveness) will be reduced. In other words, the most likely causes of environmental degradation will be "designed-out" of the course from the beginning. The golf course will reflect a "we care" attitude by protecting valuable environmental resources.

The following recommendations will aid the golf course architect in avoiding sensitive features and creating impacts which cannot be readily mitigated.

(1) An underdrain system should be installed beneath any portion of the fairways, greens, or tees which are sited on coarse-textured soils or where the depth to bedrock or the water table is less than 4 ft. The purpose of the drainage system is to collect water which may be contaminated with fertilizers or pesticides. The leachate should be treated by allowing it to soak into medium-textured soils lying 4 ft or more above bedrock and the water table. Or the leachate may be treated with a system such as a peat/sand filter.[2]

(2) If a waterway crossing must be used, then it should be designed to minimize the removal of trees and other shading vegetation. Cart paths should be constructed of permeable material, no wider than 8 ft, and placed on pilings from the edges of the floodplain. All streams should be bridged, not placed in a culvert.

(3) If a site is selected which may affect sensitive species, then a detailed analysis must be made of each impact associated with the golf course to determine if the degree of impact will exceed the level of this species' tolerance. Procedures for conducting such an analysis can be obtained from the local office of the U.S. Fish & Wildlife Service or the state natural heritage program.

(4) A pond should not be located on an intermittent or perennial stream. Upland ponds must not expose stream channels to an increase in either the rate or duration of floodwater velocity.[9a,9b] Upland ponds must not reduce flood-scour to a degree that silt and other fine material will accumulate within downstream channels. Ponds should be designed to minimize use by waterfowl, particularly geese. This can be done by keeping the pond small enough to interfere with the long take-off distance required by geese. Strips of tape or netting can be placed across the surface of the pond to reduce waterfowl use. Also, pesticide-treated turfgrass should not extend to the edge of the pond. If a buffer of tall grass or other dense growth is maintained between the pond and treated grass, then the potential for waterfowl grazing upon the turfgrass will be reduced. Local waterfowl biologists should be consulted when considering measures for a specific pond.

(5) If irrigation withdrawals will reduce the low-flow (7-day, 10-year) by more than 5%, then the Instream Flow Incremental Methodology, developed by the U.S. Fish & Wildlife Service,[10] should be used to determine if the reduction will significantly impact aquatic communities. Options to consider if the impact is deemed significant may include: installing runoff collection ponds in upland areas, extending an appropriation well to a deeper aquifer, using several wells located in different groundwater drainage areas to lessen the impact on any single waterway, or using treated wastewater to offset raw water needs.

(6) If impervious surfaces cannot be sited on soils suitable for infiltration, then a peat/sand filter should be used to control stormwater pollutant loadings.

(7) If grading or filling must occur on slopes steeper than 15%, then clearance should be timed to occur during that portion of the year when the potential for erosion is lowest (generally late summer and early fall). Work on steep slopes should be staged so denuded soils can be stabilized within a maximum of 14 days following initial exposure. The use of a silt fence and establishing turf by sod will reduce potential erosion on sensitive slopes.

(8) Similar tree species should be planted for each native tree removed during site development. Replacement trees should be planted within the same watershed where the loss occurs. The survival rate for each tree species should be taken into consideration. If the survival rate

averages 25%, then four trees should be planted for each tree felled.

(9) Monitoring should begin 1 year prior to the construction of a golf course and continue throughout the construction phase and the first 5 years the course is used. Ground and surface water should be analyzed quarterly for ammonia, nitrate, phosphorus, and pesticides.

Biological sampling should be performed quarterly, then, beginning in the third year, once annually, in August. Fish tissues should be examined once a year for any pesticides used on the course which have the potential to bioaccumulate. A groundwater monitoring program should also be established to detect effects upon existing wells or wetlands. Baseflow and water temperature should be monitored in any streams or rivers in the vicinity of the course.

REDUCING THE IMPACT OF AN EXISTING GOLF COURSE

(1) A combination of physical, chemical, and biological monitoring techniques should be employed to determine if the course is causing an impact and, if so, to identify the probable causes.

(2) The maintenance personnel responsible for identifying and controlling pests should become proficient in the use of integrated pest management (IPM), but IPM alone will not eliminate the potential for contamination of ground and surface waters with pesticides.

(3) If any area of a fairway, green, or tee is located on coarse-textured soils, or if the depth to bedrock or the water table is less than 4 ft, then one or more of the following measures should be employed.

   (a) The area should be fitted with an underdrain system to collect leachate so it can be treated through application to suitable soils or with a sand-peat filter.

   (b) The area should be filled with material which will increase the clay and organic matter content, reduce soil permeability, and increase the depth to groundwater, or

   (c) The area should be replanted with a grass species requiring minimal fertilizers, pesticides, and irrigation.

   (d) The area should be converted to a use requiring minimal maintenance, such as a rough.

(4) Fertilizers with a low leaching potential should be applied at the lowest acceptable rate and applied during periods when grass is actively growing.

(5) Irrigation should be performed on the basis of evaporative demand (evapotranspiration rates), rather then on a set schedule. If irrigation water is drawn from a well, a stream, or a river, then an analysis of the impact upon low-flows and aquatic organisms should be conducted. An analysis should also be conducted of the effects upon well-yields in the area. If either analysis indicates a problem, then the following options should be considered.

   (a) The construction of an upland pond to capture and store stormwater runoff. If this option is used then the ponds must be designed and sited to avoid either a significant increase or decrease in floodflows.

   (b) Relocate production wells to several groundwater drainage basins to reduce the impact upon individual streams or rivers and to lower the impact upon other groundwater users.

   (c) Relocate a surface water intake to utilize a stream, river, or lake which can meet irrigation needs without a negative impact upon aquatic communities.

   (d) Reduce or terminate water withdraws during critical periods.

   (e) Replant the course with grass species having a higher drought-tolerance.

(6) The first inch of stormwater runoff from all impervious surfaces should be delivered to an infiltration device[14] or a peat/sand filter.[2]

(7) A 75- to 150-foot buffer should be established along all wetlands, streams, rivers, tidal waters, ponds, or lakes.

(8) The use of chemical measures for managing ponds and lakes should be reduced or eliminated. Rather than using chemical substances to control algae, techniques with fewer long-term impacts should be used, such as reducing nutrient inputs, dredging, and so forth.[11]

(9) Wherever possible, the number of trees and shrubs on the course should be increased.

(10) Pesticides, fertilizers, fuels, and other toxic substances should be stored in a location where a spill will not result in rapid, uncontrollable entry into ground or surface waters.

(11) If the golf course existed prior to 1980, then soils on the greens, tees, and fairways should be analyzed for organochlorine and metallic pesticide residues. If residues are present, then measures should be taken to minimize movement to ground or surface waters, such as increasing the organic matter content of soil.

In summary, a golf course can be a tremendous asset to the aquatic environment. Past approaches to the siting, design, construction, and operation of a golf course have resulted in damage to streams, ground water, wetlands, and other aquatic systems. The recommendations presented in this paper will allow society to continue to enjoy the benefits associated with golf, while maintaining and even enhancing the quality of our water resources. The basis for the recommendations presented above are provided in "Protecting the Aquatic Environment from the Effects of Golf Courses."[7]

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