Running Off The Golf Course

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What would you say is the fair price for destroying a river and all of its ecosystems? In 1996, the developer of a Malaysian golf resort was charged in court for polluting and silting the Gombak River. The Cabinet ordered the project to be stopped. The worst that happened was the company paid a fine of RM10,000 and would likely go on to pollute the environment once more. A Malaysian resident, asks, "Do you seriously believe that any managing director of a golf resort would go to jail for such a trifling offence, especially when the cost to him is equivalent to only one third of a meal fit for an Emperor, a price which men of his ilk would only be too willing to fork out?" The problem is that, when making money conflicts with preserving the environment, moneymaking almost always wins. Slaps on the wrist for breaking the law are just a minor inconvenience. It would seem that priorities need re-evaluating. Not just in Malaysia, but on a worldwide basis.

Runoff

The problems at the Malaysian resort involve stormwater runoff. Urban runoff is toxic to fish and other wildlife. It threatens all of us who use and enjoy our most valuable natural resource - water.

Runoff comes from:

- Motor oil and fluids which leak from cars onto roads, highways and parking lots
- Antifreeze, oil, paint or household cleaners dumped in the gutter
- Smog and air pollution carried by rain into storm drains and creeks
- Soap and dirt from washing your car in the driveway or street
- Dirt, leaves, and lawn clippings in the gutter
- Litter and grime that collects on parking lots and sidewalks
- Bare soil that erodes or blows into the street
- Weed killers, fertilizers and pesticides that are washed off lawns
- Pet waste left on lawns, streets, in the gutter or on sidewalks

Rain and water from our lawns and gardens washes these pollutants off streets, sidewalks, roofs, driveways, parking lots and other surfaces, and carries them into the storm drain system. Storm drains are separate from the sanitary sewer system. Unlike the water that goes down the toilet or sink, water - and pollution - that enters the storm drain system flows directly to our creeks, ponds, streams, lakes, and oceans...with no treatment. Golf courses are another source for this witches' brew of chemicals, fertilizers and sediment.

Why is this a problem? This toxic brew degrades our lakes, rivers, wetlands, and ocean bays. Soil clouds water and degrades habitat for fish and water plants. Nutrients such as phosphorus promote the growth of algae, which crowds out other aquatic life. Chemicals such as antifreeze and oil from leaking cars, carelessly applied pesticides, and zinc from galvanized metal gutters and downspouts threaten the health of fish and other aquatic life. Boil, boil, toil and trouble.

On a global scale, runoff occurs because of the imbalance between evaporation and precipitation over the Earth's land and ocean surfaces. The distribution of runoff per continent shows some interesting patterns. Areas having the most runoff are those with high rates of precipitation and low rates of evaporation.

Continent	**Runoff Per Unit Area** (*mm per yr*)
Europe	300
Asia	286
Africa	139
North and Central America	265
South America	445
Australia, New Zealand and New Guinea	218
Antarctica and Greenland	164

This witch's soup of stormwater runoff might not be so damaging if it didn't contain chemicals and fertilizers. According to Grounds Maintenance magazine, pesticides (the generic term for insecticides, herbicides and fungicides) control weeds, insect pests and fungal and other diseases. It seems reasonable to agree that some pesticides are beneficial. How can we abandon our homes to termites or roaches? But is it really crucial to our well being as a species to eradicate dandelions from our lawns and golf courses?

Golf Courses, Erosion, and Runoff

The booming golf trade in Asia creates a haven for golfers and a nightmare for environmentalists. Southeast Asia's golf courses offer greens carved out of paddy fields or virgin forest; breathtaking views of the sea or mountains are the norm and cable cars are often necessary to transport golfers from one hole to the next. This golfer's paradise has become a disaster for environmental activists. The beauty found in the setting of a golf course often hides many of the environmental, social, and health problems that environmental activists call the steep price of the game.

On a global basis, conflicts often occur between farmers and the golf industry. Farmers have been forced to sell their land to golf course investors. Also, the fertile land used for farming becomes obsolete with the development of golf courses. The environmental damage varies and is worse in highland areas, where the ecosystem is fragile. Along with the growth of golf courses, luxury hotels, condominiums and chalets also continue to grow. The sport of golf has turned into a business with high-class stakes.

And sometimes "high stakes" means life threatening. Nathaniel Diegelman states in *Poison In The Grass* that former Navy Lieutenant George Prior developed a fever, headache, and nausea after playing on a golf course treated with Daconil. It was later discovered he was suffering from toxic epidermal necrolysis, which causes skin to fall off in sheets and massive organ failure. Prior died soon after. Diegelman also says that the latest findings prove the theory that most danger from pesticides comes through dermal absorption, not ingestion. A University of Iowa study of golf course superintendents found abnormally high rates of death due to cancer of the brain, large intestine, and prostate. Other experts are beginning to link golfers, and non-golfers who live near fairways, with these same problems.

Before we all go off on a crusade to implement George Carlin's suggestion of turning all golf courses into subdivisions for the homeless, we need to look at the other side of the story. According to the Society of Australian Golf Course Architects, well-designed golf courses can benefit the community and environment. They state that environmental awareness has significantly increased in recent years, and that today's society is far better informed and reacts more quickly to the pressures on the environment and natural resources.

Golf courses are contiguous with green belts and compatible land uses such as sporting reserves, wildlife sanctuaries, wetlands and forest. Golf courses serve as a 'buffer' between sensitive natural environments and cities and industrial areas.

Golf courses play a significant role in the management of water, aiding in the conservation and preservation of water resources. Golf courses act as a natural filter of stormwater and runoff. Often economic limitations make it difficult to rehabilitate scarred and degraded landscapes such as landfill, quarries, tip sites and barren rural land. The SAGCA reminds us that golf courses provide a viable land use for land degraded over time by intensive land use or mismanagement. Golf courses can contribute to the reinstatement of the natural processes of a healthy environment by reconditioning degraded soils and restoring natural systems.

Turfgrass, together with the natural landscape, functions in trapping sediment and pollutants before they enter into common waterways. The containment of water on site helps in flood control and filtration whilst contributing to the recharge of aquifers and groundwater which may otherwise pollute nearby waterways.

The reliance upon potable water to irrigate a golf course is an issue gaining increased attention. Golf courses must strive for sustainability while seeking alternate water sources and more effective water usage/management practices. Whenever possible, golf courses offset their potable water usage by the use of alternative water sources. As the costs of potable water rise, there is an economic incentive to supplement potable water with effluent and/or stormwater. Filtering effluent and stormwater through a golf course lessens the pollution and sedimentation of our waterways. The use of secondary treated effluent has the added advantage of supplying more than half the nutrient requirement needed to maintain `quality' turfgrass, lessening the need for chemical support.

Of the stream and river miles which the states reported as "impaired" in the U.S. Environmental Protection Agency's (EPA's) latest National Water Quality Inventory Report to Congress (1992), siltation was to blame in 45% of the cases in which state officials could determine the cause. Silt and other suspended solids are easily washed from urban areas, logged hillsides, residential and commercial construction sites, plowed fields, strip-mines, and eroded river banks and shorelines when heavy rainfall occurs. Golf courses are all too frequently a contributor of silt. These sediments may not seem harmful to the average person, but they can cause plenty of problems when they enter waterways and wetlands. Not only can silt carry potentially toxic compounds into waterways, it can directly interrupt essential biological processes -- with devastating effects.

Silt can cause abrasions in gills, killing fish directly by interfering with their respiration; it can suffocate fish eggs and bottom dwelling organisms; and it can destroy spawning beds when it settles to the bottom of rivers and streams. Siltation also creates turbid, murky water, which decreases photosynthesis and reduces the productivity of aquatic plants. A build up of silt and other sediments can radically alter water depth and change an entire aquatic habitat over time.

An overabundance of nutrients such as nitrogen and phosphorous is another of the most serious problems facing the Nation's lakes, estuaries, rivers, and streams. In 1992, more states reported lake and estuarine impairments due to nutrients than any other single pollutant; for rivers and streams, nutrients were second only to siltation as the most serious cause of harm. Research has shown that nutrients can come from point sources (sewage and wastewater treatment flows), nonpoint sources (agricultural and urban run-off, primarily from fertilizers and manure), and from the atmosphere as well.

Run-off from feedlots, pastures, and suburban development - such as golf courses - can carry organic material in the form of grass clippings, leaves, and other debris into waterways; sewage often contains organic solids as well. While these materials are often broken down by natural microorganisms in the water, the break down process uses up valuable dissolved oxygen, creating a Biochemical Oxygen Demand (BOD). A lack of dissolved oxygen affects many aquatic organisms, including invertebrates, crustaceans, and many species of fish -- and if a system's BOD is too high, other chemical and biological processes are affected as well.

"Our generation will leave a powerful legacy if we leave water that is cleaner than the water we were given," write the authors of Water: A Story of Hope. "Through such a gift, we would not only ensure that Chinook salmon and great blue herons will be able to thrive, but that water supplies can be used by our children, and their children, without an intensified fear of waterborne sickness or disease. Most of all," concludes the report, "we will have demonstrated that each of us has the power to care for our Earth. We are the problem, but we are also the solution."

Case Studies

Many solutions to the problems of runoff and erosion control exist and are being used in golf course design, construction, and maintenance.

Minami Golf Course, Hawaii

On the Hawaiian island of Oahu, erosion control blankets by North American Green were used to establish grass cover on the Minami Golf Course designed by Dick Nugents Associates (Chicago) and developed by Minami Group Inc. (USA).

Perched on the windward side of the Koolau Mountain Range, warm moist winds sweeping-in off the ocean dump tremendous amounts of water in the Minami area each season. From November through May, the 1989-90 rainy season delivered 134 inches of precipitation, much at tremendous intensities. In a two-week period, over 20 inches of rain fell on the golf course site, 8 inches of which was in a 24-hour period. Rainfall at this intensity causes severe erosion damage to unprotected, freshly excavated soil.

In late August of 1990, with threat of another severe rainy season, the Project Architect Scott Fisette, and Course Superintendent Sean Holehan, realized that erosion protection would be necessary to establish grass on the newly prepared Minami Course in the coming months. 40 GPM sprinklers and heavy rains necessitated the use of erosion blankets to prevent rill and gully formation.

After an erosion control plan was developed in conjunction with erosion blanket and vegetation recommendations from Gilbert Araki of Pacific Agricultural Sales and Services, course revegetation activities began. Bermuda grass (328 hybrid) was hand sprigged on fairways and hydromulched. Double-netted straw erosion control blankets were then installed on steep undulation and bunker faces to control soil loss and hold sprigs in place. A heavy-duty blanket made from a combination of wheat straw and coconut fiber was used to line drainage swales and cover steep slopes. For those high-flow channels designed to carry runoff water from large drainage areas on the course, coconut and nylon channel liners provided maximum scour protection.

Undulations formed from erosive soils proposed problems to superintendents who tried to stabilize them. The ECBs provided temporary stability until grass establishment, so undulations could challenge golfers, not the superintendent.

The nylon channel lining was used to stabilize the ditch skirting this cart path. The non-degradable blanket will remain in place under the grass, increasing its resistance to damage from high velocity flows and golf cart tracking.

On the first fairway, where hydromulch provided the only protection, a 2 foot by 200 foot gully, requiring expensive rework and reshaping of the landscape, was formed by rainfall and irrigation runoff. On the second fairway where ECBs were used, no significant erosion occurred. According to Hoolehan, "If we had not used blankets on the second fairway, the amount of finish work would have been a lot greater. Since the blankets effectively controlled the erosion, we can concentrate our efforts on fine tuning the hole".

The coconut fiber blanket used on the side slopes of this high-flow drainage-way enabled vegetation establishment through heavy rains. This ECB is a slow-degrading blanket, providing extended erosion protection for gradually maturing vegetal stands.

The need for high-performance erosion control materials in golf course construction is obvious. With the newly successful establishment of vegetation on the Minami Course, Superintendent Sean Hoolehan and Project Architect Scott Fisette are firm believers in erosion control blankets for the protection and revegetation of critical course areas. As Hoolehan concludes, "ECBs saved us a lot of repair work".

Radnor Country Golf Course, Pennsylvania

Tom Dale, CGCS (Certified Golf Course Superintendent), struggled with Ithan Creek since he became Superintendent of the Radnor Country Golf Course, at Radnor, PA, over 13 years ago. He remembers how the creek banks eroded and caved in, sometimes nearly filling the stream with soil. "This was not only unsightly and bad for us but also for our neighbors downstream."

Today, however, the creek is under control and the Radnor Club "problem" is history. Commenting on the completed work, Tom says, "As a result of what we did here, the creek banks are now tied down and have safely handled several 'fifty-year' rains. On top of that, `the area is much more attractive for our members. The Radnor Creek erosion problem was similar to those affecting many golf courses. "This is a good example of what other clubs can do to solve problems like we had here," says Tom.

The "beginning of the end" of the creek erosion problem started when the Board of Directors of the Club authorized their Construction Committee to find a solution. All County Engineers, Oley, PA, was employed to develop an engineering plan.

A problem arose however, when all construction bids for the plan exceeded the amount of money the Club was willing to spend. This stumbling block was only temporary, however, because it ultimately led to a unique cooperative effort by All County Engineers, The Dawson Corporation of Clarksburg, NJ and Pinelands Nursery in Columbus, NJ.

Pooling their expertise, this "team" developed a different plan to bring the wayward creek under control at a cost even lower than the Club's construction money allotment. The plan and bid were accepted and construction was done mid-summer of 1995.

Bob Swain, president of The Dawson Corporation, is a well-known east coast landscape construction contractor with extensive experience in golf course construction and ecological restoration.

Pinelands Nursery produces a wide variety of native plants for landscaping and erosion control. Don Knezick, president of Pinelands Nursery, is also the Master Distributor of BonTerra America wetland products for the Mid-Atlantic and New England states.

The Nursery and the Hackensack (NJ) Meadowlands Development Commission (HMDC) recently co-sponsored the 1st Environmental Restoration Symposium at the Meadowlands Environmental Education Center.

The final plan developed by the team called for the use of biodegradable coir fiber logs at the base of the streambanks and coconut erosion control blankets and geotextile mats for rehabilitation of the side slopes.

The Dawson Corporation was the construction contractor and Pinelands Nursery provided the native plants and erosion control materials.

The primary objective of the team was to control the erosion on the creek banks and side slopes. Aesthetics was a secondary, but highly desirable, consideration. "The work had to solve the problem," explains Don, "but we also wanted the finished job to look nice. That is why we included a number of flowering plants and attractive grasses, sedges and rushes in the plantings."

Since Ithan Creek runs through the center of the golf course, there were special constraints on the methods used to control the erosion. The vegetation selected could not be tall trees. Rather, it had to be low growing and heavy rooting planting material that would be attractive to the golfers. Coir fiber logs would provide a planting medium and several years' protection before they biodegraded. In the meantime, vegetation would be established to provide permanent cover. Since several fairways crossed the creek, construction activities were done in such a way as to interfere as little as possible with golfers on the course. "We had excellent cooperation from Tom as we scheduled our work," says Fred Rapp, Project Manager for the job. "The players played while we worked, and everybody was satisfied."

About 4,000 feet of the logs were installed - one of the largest installations ever done using this material. Construction was done in increments, starting where the creek enters the course at the north end. The following sequence of six steps was followed at a typical increment:

1. Silt fence installed at the base of the bank.
2. Coir fiber ECB unrolled down the slope to the toe of the bank.
3. Logs laid along the base of the bank over, and staked through the blanket. This helped to anchor the bottom end of the blanket.

The coir fiber logs were 12" thick and 25' long. "Normally, they are 20' long, but because the distances there were greater than most installations, these were made longer to cut down the number of splices," explains Don. "Any time you splice two sections together, there is a possibility of water getting under the logs and causing washouts. So, the less splices, the better."

The logs are ideally placed at a level where, the majority of time, the bottom half will be underwater and the top half above water. Don explains that the exposed portion gives better protection to the bank from the scouring action of the creek water. Also, some plants grow better if their roots are not fully immersed in water.

4. The portion of the blanket on the slope is now rolled temporarily back downslope over the log to allow access to the slope for grading and shaping.

5. Slope is graded, shaped, raked and seeded. Grading was done with the excavator, using a 48" wide bucket, without teeth. A Dawson mechanic had customized the excavator using a Balderson Swinger so the bucket can be tilted and turned. This enables the operator to work across the slope instead of up and down. Seeding was done with a Cyclone hand seeder. The grass seed used was dwarf tall fescue. It grows about 12" high. "This seeded area will be treated as a 'rough' on the course and won't be mowed," says Tom.

6. Blanket is unrolled from the top of the log at the water's edge and placed back on the slope and pinned in place. The upper end is anchored in a 6" deep trench at the top of the slope. The trench was dug by the tilted excavator bucket.

"The sedges (Fox, fringed, and shallow), rushes (spike and soft rush) and rice cutgrass were our 'nuts and bolts' for controlling erosion," explains Don. "We added different herbaceous wetland plants with ornamental flowers for various colors at different seasons of the year. The blue flag iris, joe pye weed, cardinal flower, blue lobelia, lizard's tail, New York ironweed, swamp milk weed and swamp rose mallow were among those we used."

Fred adds, "We scattered the different plants along the banks, using small-sized groupings. We want a variety of plant textures, heights and colors instead of a manicured and monoculture look."

The logs, the coconut fiber mats and fabric are living up to all expectations. Having already successfully handled several heavy rains, the erosion control work will become more effective as the plantings become better established. Not only are the plants doing their intended erosion controlling work, they will become increasingly attractive as they burst into bloom throughout the seasons. The plants work as filters, preventing much of the pesticides and fertilizers used on the course from entering the stream.

Tom Dale, as the Radnor Golf Course Superintendent, must keep the grounds in shape, including the once troublesome Ithan Creek, is delighted with the restoration. "I spend a lot less time maintaining this creek. The time I save can be spent elsewhere on the grounds. And I don't have to worry anymore about the cart path being washed away." Then, chalking up the extra benefit, Tom adds, "Instead of being an eye sore, this creek now is a part of the attractiveness of our course."

Michigan City, Indiana

Deer Creek meanders through the Michigan City Municipal Golf Course. Forty years ago, Deer Creek was put into culverts beneath the golf course. The 1000 foot culvert was overwhelmed by increased runoff from developments upstream, so the creek began to fail in several areas, and the golf course was literally falling into the culverts. This presented some rather challenging holes for the course patrons. On Hole 5, the cart path disappeared, and the course staff had to design alternative routes for the golfers to follow in order to prevent further damage to the course. "Suck holes," areas where the culvert collapsed and left a gaping hole in the ground, were flagged so golfers could see potentially dangerous areas from a distance. The last five sections of the culvert failed totally and washed away.

J. F. New & Associates, Walkerton, Indiana, were the prime contractors and handled all permits for the restoration project. They also designed the bridge and culverts and functioned as the Project Managers. Inter-Fluve of Bozeman, Montana, provided all hydrology and stream channel design as well as drainage design for this project. E. F. M. Excavating of Mishawaka, Indiana handled all earth-moving operations. The goals of the team and the golf course superintendent were to remove all the culvert, replace all cart path crossings and all other stream crossings while designing the restored creek to be able to handle anticipated runoff and prevent future damage from erosion.

The watershed for this project encompasses 1.9 square miles; there were no hydrologic records, so the designers used regional regression method USGS WR-84-4134. The team designed the stream channel to contain bankfull discharge of 109 cubic foot/second based on two year return interval flows.

The design is a compound channel - a channel within a channel within a channel. The smallest (low flow) channel is 5' across and 1' deep; it will handle 20-30 cubic feet per second flows. The bankfull channel (the middle channel) averages 20' wide and 2.25' deep and can handle 125 cubic feet per second flows. The largest channel, the floodway channel, is 50' wide and 4.25' deep and designed to handle 100 year discharge event flows of 356 cubic feet per minute.

The streambank restoration design focused on soil wrapped walls. The project built variability into the new design through sinuosity and a natural appearance. The channel had originally been approximately 800 feet long; with the new design, the channel gained 200' in sinuosity and is now 1000' long.

To begin the project, the contractor excavated the channel (a sandy clay mixture) down to solid clay. There was no rock foundation as this is a very low gradient stream. The topsoil, a good organic soil, was stockpiled. Three feet down, the contractor reached impervious clays which presented standing water problems. Lateral drainage lines were installed on either side of the new creek bed, and 200' long feeder lines were placed on each side. This system has worked very well.

There are three unique aspects to this project. The first is that the golf course remained in use during this major construction project. The project began downstream and involved only one hole at a time. Golfers were re-routed to keep them safely away from construction activities; this resulted in some holes that were shorter than normal, but there were no complaints.

The second aspect is that, rather than seeding the soil beneath the BonTerra CF7™ coir fiber netting used in the wrapped wall project, the design called for sod placement beneath the ECB. The project was installed in October 1997, and the growing season for NW Indiana is long over at that time. Hard freezes, temperatures dipping to 60 below zero, and snow cover often topping six feet make it difficult to predict that seeds will survive the winter and germinate in the Spring. Sod seemed a better choice than seeds. Sod rolls, from a local grower, were 3' wide and 8' long, making the rolls too heavy to be moved by flood waters. Two rows of sod were placed from the edge of the low flow channel to the top of the bankfull channel.

The coir fiber ECB was buried in a key trench, wrapped over the rows of sod. An additional two rows of sod were added to the outside, for a total of twelve feet. Silt fencing was trenched in at the edge of the flood channel. Jim Lovell of Inter-Fluve said, "We wanted something that was going to green up quickly. We didn't have much of a growing season, and the soil here wasn't the best for predicting good germination in the Spring." Inter-Fluve's experience on a New Jersey project was that coir fiber net could degrade in as little as two years in adverse conditions, so they wanted to be certain that strong vegetative cover was established long before the end of two years. Sod was the answer. Native sedges were also sprigged along the creek edge. "It worked great!," says Lovell. "The sod grew right up through the CF7. At project end, the entire site was green, and we haven't had any erosion on the site at all."

The third unique aspect of this project involved the old culverts. The culverts were sold to a local scrap yard for recycling, and this money was used to pay for hauling costs. The material didn't go to a landfill, and the contractor didn't incur fees for hauling or landfill use.

Brent Bachmann, Golf Pro and Club House Manager, stated that he was extremely happy with the project. "Nice project! It's done exactly what it was designed to do. We've eliminated flooding, and the two downstream ponds fill quickly with water which we use for irrigation." Using this "free" water has considerably reduced the course's cost for watering the grounds. Lovell, Project Construction Supervisor and Project Designer, said that this was the only capital project the golf course had that came in on time and on budget. Total design and construction costs for this project were $250,000.

Sport fishing is a major attraction for Michigan City, located on Lake Michigan's shoreline, just miles South of the Michigan state line and about sixty miles due East of the Chicago Loop. Steelhead swim up Deer Creek for spawning. Lovell says, "They can get up there a lot easier now!"

Mr. Bachmann is concerned about the enormous volumes of sediment that still come down the channel. "Our neighbors haven't dealt with their own erosion problems," he states, and the golf course is forced to handle the runoff and sediment that ends up on their property. The course maintenance supervisor anticipates that the upper pond must be dredged every 1-2 years because of this.

Suggested Remedies

The Terrene Institute states, "Watersheds contain a mosaic of land uses that contribute to our vitality and enjoyment of life. Walk in any direction and you will see them: houses and neighborhoods and commercial districts, industrial developments and farms; and scattered here and there, the parks, golf courses and other open spaces that provide refuge, recreation, and relaxation. Look closer, and you will see that these open spaces have been designed to protect and enhance the quality of life. Golf courses, like parks and riverine areas, are managed, natural spaces that function best when they are managed naturally - when those who supervise and those who visit them know that only simple, non-intrusive actions are needed to preserve them. Properly managed golf courses are valuable community assets. From design to construction and on through long-term maintenance, the golf course is a model for ecosystem management and sustainable development."

The EPA offers many excellent suggestions in their booklet, *Environmental Principles for Golf Courses in the United States.*

- Place buildings and fairways within landscapes to protect critical areas from off-site water quality problems.
- Protect and enhance wetlands to increase their benefits to humans and wildlife.
- Establish or maintain buffer or riparian areas to protect the quality of small headwater streams.
- Reduce erosion through an erosion and sediment control plan that includes construction phasing.
- Manage runoff to prevent sediment from entering streams and wetlands.
- Choose a cluster design for new residential subdivisions to preserve greenways and other natural amenities.
- Use panoramic vistas and open spaces to provide a unique setting for many recreational activities.
- Golf courses are an attractive way to reclaim landfills, abandoned mines and quarries.
- Golfers have many opportunities to limit their impact on natural resources while enjoying a round of golf. Place signs in clubhouse and near golf tees and greens to remind golfers about treading lightly on the earth.
- Timed irrigation, water reuse and native plants help conserve water and reduce operating costs.
- Courses designed around natural features provide unique challenges and protect vital resources.
- Constructed wetland systems receive and filter runoff from upland areas before releasing it to streams.

- Reducing our dependence on pesticides protects animals living in streams and upland areas, thus maintaining biodiversity and improving water quality.
- Applying fertilizers only as needed and at appropriate times helps reduce nutrient loss to receiving waters.
- Conserving and reusing irrigation water helps maintain minimum instream flows for fish and other aquatic animals.
- Sharing our environmental interests and concerns with other golfers is good stewardship.
- Teach maintenance crews how to use, store and properly dispose of hazardous materials.
- Create or maintain forested buffer zones, riparian corridors or other vegetative practices to treat runoff.
- Careful management keeps our lakes clean and healthy.
- The wise use of lands and other resources benefits everyone - golfers, the community and all of nature.

James Achenbach, Senior Editor of GolfWeek magazine said, "What we have learned over the past several decades is this: we weren't put on this earth just to play golf. We were put here to care for the earth, to pass it on to new generations of people and golfers. Those who don't take environmental awareness seriously deserve our reproach. But they also deserve our help. The ecology of our world is nothing to scoff at. We cannot afford to be uneducated about it."

Author's Note: Thank you to all the contributors to this article. "Running Off the Golf Course" was previously printed in Erosion Control, journal of the International Erosion Control Association.

POSSIBLE SIDEBAR?

As golfers, we should….

- Recognize that golf courses are managed land areas that should complement the natural environment.
- Respect designated environmentally sensitive areas within the course.
- Accept the natural limitations and variations of turfgrass plants growing under conditions that protect environmental resources (e.g. brown patches, thinning, loss of color, etc.)
- Support golf course management decisions that protect or enhance the environment and encourage the development of environmental conservation plans.
- Support maintenance practices that protect wildlife and natural habitat.
- Encourage maintenance practices that promote the long-range health of the turf and support environmental objectives. Such practices include aeration, reduced fertilization, limited play on sensitive turf areas, reduced watering, etc.
- Commit to long-range conservation efforts (e.g., efficient water use, Integrated Pest Management, etc.) on the golf course and at home.
- Educate others about the benefits of environmentally responsible golf course management.
- Support research and education programs that expand our understanding of the relationship between golf and the environment.
- Take pride in our environmentally responsible courses.

Reprinted from Environmental Principles for Golf Courses in the U.S.