Golf Course Water Resources Handbook of Best Management Practices

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Acknowledgments

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Mark Johnson, Senior Manager, Environmental Programs
Golf Course Superintendents Association of America, Lawrence, Kan.

Christopher Kocher, President
Wildlands Conservancy, Emmaus, Pa.

We appreciate the time and knowledge contributed by those working daily in the golf course industry. Many golf course superintendents contributed their experiences implementing best management practices on their own courses. We hope the examples and contact information found on the following pages will encourage other superintendents to consider implementing these important best management practices.

Introduction

The *Golf Course Water Resources Handbook of Best Management Practices* provides a concise overview of 18 Best Management Practices (BMPs) to help improve and protect water resources.

As you read through the various BMPs, you will notice that prior planning and knowledge are recurring themes. Your job will be easier in the long run and you will achieve better results if you know ahead of time what you want to accomplish and how to go about it.

In spite of the highly manicured and managed nature of most in-play areas on golf courses, superintendents and managers have made a substantial shift from working *against* to working *with* biological systems, creating courses that, to a great extent, are ecologically functional and healthy open spaces.

The Handbook begins with the Foreword, which will familiarize you with the foundations used to compile the Handbook as well as give you guidance on making the connections between BMP implementation on your golf course and:

- Audubon International certification
- the Pennsylvania State Water Plan,
- Pennsylvania's Nutrient Trading Program,
- economic opportunities through stormwater management, wetland banking, and other regulatory fulfillment; and
- creating mutually beneficial partnerships to implement BMPs.

Sections on Mapping, Monitoring, and Working with Conservation Organizations will provide you with a few tools you should use in the planning process, before you begin implementation of the BMPs.

For each of the 18 BMPs, you will find one or two pages in the Water Resource BMPs for Golf Courses section, providing:

- a summary of the BMP,
- a list of benefits you can realize from implementing the BMP,
- information about a golf course that has already implemented the BMP (including the person to contact),
- a brief list of references you can use to find extensive, more detailed information about a given BMP.

The Handbook also includes an Environmental Benefits and Credits section with a convenient fold-out chart to show you, at a glance, the list of BMPs, implementation benefits, and whether or not credits or offsets are or could be available.

The final section of the handbook provides Additional Resources citations for further information.

Foreword

The Golf Course Water Resources Best Management Practices Handbook brings together goals, objectives, and program information from several sources:

- The Environmental Institute for Golf
- Golf & The Environment
- Audubon International
- The Pennsylvania State Water Plan
- The Pennsylvania Nutrient Trading Program

The Handbook has been compiled and arranged to show you how implementing BMPs on your golf course connects to these and other organizations and programs, extends the benefits of your improvements far beyond the boundaries of your course, and can pay you back in ways you might not have imagined.

Environmental Institute for Golf

The Environmental Institute for Golf (http://www.eifg.org/) is the philanthropic arm of the Golf Course Superintendents Association of America. The Institute is "committed to strengthening the compatibility of the game of golf with our natural environment." In pursuit of that mission, they have implemented a multi-part Golf Course Environmental Profile that covers golf courses throughout the United States.

Surveys are being used to produce a series of detailed reports for the Profile. Volume I, "Property Profile and Environmental Stewardship of Golf Courses," was published in the *Applied Turfgrass Science Journal* in November 2007 and is available on the Institute's web site (http://www.eifg.org/programs/GCRPfullreport.pdf)

Volume II, "Water Use and Conservation on U.S. Golf Courses" is of particular interest in conjunction with this Handbook, was published January 2009 in the *Applied Turfgrass Science Journal* and is also available on the Institute's website (http://www.eifg.org/programs/EIFG_GCEP_Vol_2.pdf). Additional volumes will report on nutrient use, pesticide use, and energy use.

Many of the BMP topics included in the Handbook were derived from a list of environmental improvements reported on in Volume I of the Golf Course Environmental Profile (Table 22, page 40). We combined these topics with areas of interest contained in the Audubon Society's Certification Program as well as Pennsylvania's State Water Plan and Nutrient Trading Program so that, through an interdisciplinary effort, you can derive the maximum benefit and recognition from each of the BMPs you implement on your course.

Golf & The Environment

Golf & The Environment, according to its web site (www.golfandenvironment.com), "is a partnership of the United States Golf Association, The PGA of America, and Audubon International dedicated to the game of golf and the protection and enhancement of our natural environment. Your involvement can make our partnership a winning foursome. Together with the help of other golf organizations, we are striving to foster environmental awareness, action, and positive results throughout the game."

The Golf & The Environment web site is an excellent resource for information related to the environmental stewardship and management of golf courses. You will find a vast library of information on this highly recommended web site.

Audubon International

To achieve Audubon Certification, a golf facility is required to demonstrate that it is maintaining the highest degree of environmental quality in several areas including Environmental Planning, Wildlife & Habitat Management, Outreach & Education, Chemical Use Reduction & Safety, Water Conservation, and Water Quality Management.

Some years ago, Audubon International recognized that, with stewardship-based management, golf courses hold enormous value as environmental havens. They have become extensively involved with golf course superintendents, managers and owners, and architects and builders who recognize that golf courses are a valuable part of the conservation landscape and practice eco-friendly management. Audubon International is a partner in Golf & the Environment (see above).

Audubon International programs of particular interest are the Audubon Cooperative Sanctuary Program for Golf Courses and the Audubon Signature Programs. Learn more about these programs at www.auduboninternational.org.

Pennsylvania State Water Plan

The State Water Plan Principles is built on the theme of protecting and enhancing Pennsylvania's water resources in terms of supply and quality over a 15-year horizon. The focus is on integrated water resources management, which recognizes "the critical link among water quality and quantity, surface and ground water, and land use and water resource management." Many of the goals and objectives outlined in the State Water Plan Principles are addressed through implementation of the 20 BMPs contained in this Handbook. Water conservation and efficiency, water withdrawal and use management, water quality, floodplain and stormwater management problems, connecting stormwater management to floodplain management and flood protection, water supply alternatives – these areas of water

resource management are discussed in the State Water Plan Principles and also are targeted in the Handbook BMPs.

The State Water Plan Principles emphasize the use of natural systems rather than hard-engineered solutions. This approach recognizes the value of properly functioning systems as well as the obvious and sometimes subtle connections among the multiple elements of a natural system. The BMPs in this Handbook are, to a great extent, built on the same assumptions. For example, in the discussion of "Connecting Stormwater Management to Floodplain Management and Flood Protection," the State Water Plan observes that "reestablishing natural stream corridors and floodplains through local stormwater management requirements could offer more environmentally friendly flood control options than concrete structures."

The document recognizes that outdated engineering standards, municipal zoning, subdivision and land development ordinances, and other regulations at the local and state levels can be impediments to this new way of thinking about water resource protection, but times are changing. Approaches to water resource management in Pennsylvania are undergoing "revolutionary changes." One of those changes is the recognition that golf courses offer some of the best areas to implement water resource BMPs that benefit entire communities and, in some cases, entire watersheds.

Pennsylvania Nutrient Trading Program

Nutrient trading is another way for golf courses to potentially defray the cost of BMP installations and, in some cases, provide additional revenue. In January of 2005, the Pennsylvania Chesapeake Bay Tributary Strategy, developed by the PA DEP and approved by the U.S. Environmental Protection Agency (EPA), mandated reductions in nutrient discharges. This means wastewater treatment facilities are, in many cases, facing costly facility infrastructure upgrades to meet nutrient load reduction requirements.

Nutrient credit trading is a potential solution that can provide an alternative to the costly infrastructure upgrades facing wastewater treatment facilities. The higher levels of nutrient removal can be cost prohibitive per pound of nutrient reduction. Instead of upgrading the facilities to achieve these very high levels of nutrient removal, treatment facilities can purchase nutrient credits to offset discharges that do not meet regulations.

A nutrient credit is created when best management practices are implemented that reduce the nutrients polluting the watershed above and beyond what is required by law or baseline conditions. A farmer can implement an agricultural BMP that can generate nutrient credits, which can be sold to the wastewater treatment facility at a cost savings compared to a hard infrastructure upgrade.

Pennsylvania's nutrient trading program has numerous BMPs that can generate nutrient credits. In this handbook we examine what golf course BMPs could potentially generate nutrient credits if implemented on a golf course.

Partnerships

You will learn as you read about the individual BMPs, that implementing many of the BMPs will provide you with an opportunity to comply – or help others comply – with guidelines included in the State Water Plan. This compliance can be the source of economic benefit and, in some cases, may provide the source of funding needed to implement certain BMPs on your course.

Partnerships among golf courses, developers, and municipalities are already forming for the benefit of all concerned. Regional stormwater management and flooding reduction is being achieved through stream and floodplain restoration in areas where there is sufficient land to install such a project. Golf courses are prime areas for such a restoration. Besides stormwater and flood management benefits, such a project also can provide increased surface water infiltration and filtration, groundwater regeneration, wetland mitigation banking, native plant community installation, increased and improved wildlife habitat, and reduced maintenance and chemical use.

These additional benefits tie back in to the goals and objectives of the Golf & The Environment Initiative and Audubon International programs. Sediment reductions through floodplain restoration in the Chesapeake Bay watershed help meet the goals of the Chesapeake Bay Tributary Strategy. You should already be able to see how one BMP can have many far-reaching benefits.

You will find more information about creating partnerships to implement golf course BMP projects in the section, *Working with Conservation Organizations*.

Getting Started with Best Management Practice Implementation

Getting Started…The Importance of Golf Course MAPPING

Before you implement or expand any Best Management Practices to improve water resources on your golf course, you should begin by mapping the course and, if possible, conducting an environmental inventory. Mapping will give you the big picture, revealing connections between resources and land use, and will help ensure the long-term success of your efforts. Planning and project implementation focused on water resources will benefit from mapping that includes at least several if not all of the following elements:

- the golf course, noting play and non-play areas
- management zones, by maintenance levels
- vegetation and habitat types
  - habitat that supports rare, threatened, or endangered species
  - habitats of higher value because of species maturity, density, or diversity
  - highly productive habitat
  - areas of special commercial, economic, or recreational value
- soil types
- surface water
  - ponds
  - streams
- groundwater
- wellheads
- topography
- drainage
- environmentally sensitive areas
  - wetlands, including vernal ponds
  - sinkholes
  - flood-prone areas
  - seasonal high water tables
- existing irrigation and sewerage lines

Having a graphic representation of your water resources, associated in-play and out-of-play areas, and vegetation and habitat types will make it much easier to plan successful projects and improvements involving or affecting water resources. In many cases, these types of inventories will uncover potential BMP opportunities that might otherwise be overlooked.

Resources:

Golf and the Environment Fact Sheets. 2006. Audubon International. http://www.audubonintenational.org/e-Source/

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Protection. http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Getting Started…The Importance of Resource MONITORING

Monitoring is an important part of successfully implementing water resource-related BMPs on your golf course. Monitoring will help you measure the success of an implemented BMP, adapt changes to the BMP for better efficiency, or determine where additional BMPs are needed. Early discovery of water quality issues and corrective actions can be achieved by creating and following a monitoring plan.

Monitoring can help determine the success of golf course management practices and the positive or negative effect of that practice on water resources. Monitoring programs can be developed for:

- Pest management programs
- Nutrient and chemical applications
- Irrigation practices.

Mapping of surface water bodies and other environmentally sensitive areas will help determine where monitoring is needed. Water quality monitoring should occur in areas where pollution is likely to occur as well as in protected areas that can serve as baseline or control points. Monitoring locations can also be chosen to determine the success of a specific best management practice. Examples of areas that could be monitored include:

- Areas where runoff carrying pollutants can discharge or could accumulate in surface water bodies
- Areas where soil properties and chemical or nutrient applications may increase the potential of ground water contamination
- Streams as they enter the golf course property and leave the golf course property.

There are many water quality parameters that can be examined depending on the goal of the sampling program. Water monitoring can include the following practices:

- Visual assessments of algae and sediment build up
- Physical assessments of temperature, specific conductivity, pH, and dissolved oxygen
- Chemical testing of nitrogen and phosphorus concentrations
- Biological sampling for aquatic organisms.

Consider utilizing volunteers to perform the water quality monitoring tests. Watershed groups and environmental community organizations often perform water quality testing and analysis. Public involvement in monitoring provides positive public relations for the course and creates educational opportunities.

Keep written records of all monitoring results. Records may be required for permitting and other developing regulatory programs. When applying for potential credits and offsets for nutrient reductions, stormwater management, and similar regulatory concerns, you will need to quantify and document the improvements you have made. Monitoring and record keeping will provide that information.

Resources:

Golf and the Environment Fact Sheets. 2006. Audubon International.
http://www.audubooninternational.org/e-Source/

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection.
http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Working with Conservation Organizations

Non-Profit conservation organizations can play an important role in successfully implementing BMPs on your golf course. Golf courses that involve a conservation organization can tap into a wide-range of expertise and experience. Non-profits can provide expertise on grant writing, the regulatory process (permitting), monitoring assistance, community outreach, and educational outreach assistance. In general, Non-profits can provide experienced guidance through the process of implementing BMPs on your course.

Grant Writing

One of the most helpful roles of a non-profit conservation organization is the ability of those entities to secure funding from grant programs and/or foundations to help implement BMPs on your course. Many grant programs exist to improve water quality and restore streambanks and floodplains. Funding from those programs can be applied for by non-profit conservation organizations and utilized to implement BMPs, therefore improving water quality and aquatic resources.

The Regulatory Process (permitting)

Depending on the type of BMP being implemented on your golf course, permits may be needed. Again, non-profits can provide guidance on whether or not permits are needed and what types of permits will need to be secured in order to complete your project. Conservation organizations that work on water-quality improvement projects have gone through the permit process before and should be considered a valuable resource in navigating the sometimes complex permitting process.

Monitoring Assistance

As discussed in other sections of this handbook, monitoring is an important part of successfully implementing water resource-related BMPs on your golf course. Monitoring will help you measure the success of an implemented BMP or determine where additional BMPs are needed. Conservation organizations that work to restore water resources have long known the value that monitoring can play in implementing BMPs. Some groups can help take water samples, help golf course managers meet their permit requirements by conducting long-term monitoring of completed BMPs, monitor riparian areas for invasive species, and generally monitor the success of your BMP implementation. By partnering with a non-profit conservation organization, you can harness their experience and expertise to help you monitor your BMP, and more importantly, scientifically document its affect on the local environment.

Community Outreach

Another component of successful BMP implementation is community outreach. Non-profit conservation organizations typically deal with the general public on many of their conservation projects. This experience can be utilized on your course to ensure the public is appropriately involved in your project and they are aware of the conservation work you are engaging in. Non-profits can host public

forums to discuss the BMP work, help you partner with other community groups, and work with the media to highlight your conservation work.

Education Outreach Assistance

Education and outreach about your BMP project is critical to the success of the overall project. Non-profit organizations can assist your course in successful outreach activities. Non-profit groups can help with the education of the membership and committees of your course to help your constituents understand the value of implementing BMP projects. In addition, they can help your course in offering tours and other educational opportunities for other groups to learn from your successful BMP implementation project.

Creating a successful partnership with a non-profit conservation organization could mean the difference between success and failure of your BMP implementation projects. Significant expertise exists among these groups and your courses ability to tap into this expertise is critical. This involvement may add cost to your overall project, but the benefits of involving non-profit conservation organizations will more than pay for itself in the success of your project.

Where to find a non-profit conservation organization in your region:

Pennsylvania Organization of Watersheds and Rivers (POWR):
http://pawatersheds.org
This website provides a directory of PA watershed associations

Pennsylvania Land Trust Association (PALTA): www.conserveland.org
Click on the Find A Land Trust Link at the top of the left-hand corner of Website

Pennsylvania Association of Conservation Districts:
www.pacd.org/districts/directory.htm
This website provides a directory of Conservation Districts. Conservation Districts can provide technical assistance and contact information of local watershed associations.

Trout Unlimited: www.patrout.org

BMP #1: Know How to Select and Maintain Irrigation Equipment

It goes without saying that irrigation equipment should use water as efficiently as practicable. However, the equipment is only as good as the manager who ensures it is properly installed, maintained, and managed. Consult with qualified irrigation specialists when you are preparing to renovate or install new irrigation systems.

Maintenance Musts

>Check nozzle wear, valves, pumps, fittings and sprinklers for leaks and efficiency on a regular basis. You should check your system for leaks *frequently*.

>Check pump performance and other pump house systems.

>Test sprinkler application rates and evenness often.

Example:

In spring 2006 Spring Ford Country Club replaced its entire irrigation system. The course is now irrigated more effectively and efficiently.

1) Coverage is greatly improved from accurate head spacing, use of part-circle head, and proper nozzle selection. Low precipitation rate misters are used on steep bunker faces to minimize losses from runoff.

2) Irrigation water is treated in the pump house to improve pH. Lowering the pH treats high bicarbonates associated with the water source. This adjustment to the water improves infiltration.

3) Fertigation is used to apply fertilizer. Fertilizer can be slowly metered out through the heads at light rates that are readily absorbed by the turf.

4) A central computer system was installed with many programming functions (e.g. cycle and soak). Individual head control allows customized run times to meet site conditions.

5) A weather station was installed that allows extensive adjustment to meet current incoming weather data. It can determine when and how much to irrigate (See BMP #2). In the driest part of the season, they irrigate to return 70% of the water lost through evapotranspiration. Daily scouting is then used to further adjust individual heads as needed.

Spring Ford Country Club
48 Country Club Road
Royersford, PA 19468

Mark Rubbo, GCS
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markrubbo@comcast.net

Desirable Features

>Use equipment such as low-volume sprinklers with sprinkler heads and watering rates that will irrigate regions uniformly and slowly to prevent runoff. Your system should have adequate pressure to maintain uniform irrigation even during peak-use periods.

>Both new and existing systems should have rain sensors that shut the system off during adequate rainfall. High- and low-pressure sensors are also important to shut down the system in case of a malfunction.

>To reduce the effects of wind on evaporation, choose low- or adjustable-trajectory nozzles.

>Automatic sprinklers and irrigation equipment have been documented to significantly reduce water use compared with manual systems. Automated systems enable the user to adjust and program watering times based on actual site conditions for each head within each established region. They also can be managed remotely from a computer. Automated sprinklers should be paired with sensors that can give actual on-site feedback about weather and/or soil moisture data and will calculate the evapotranspiration occurring and the water needs of the turf.

>Use half-circle sprinklers where applicable.

☞

Benefits of using and maintaining the right equipment:

- Conserves water.
- Reduces runoff and leaching.
- Protects surface and ground water from pesticide and nutrient contamination.
- Efficient water use reduces stress on streams and ground water levels.

Resources:

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection. http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Best Management Practices for Golf Course Water Use. 2006.Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Fact Sheet: Golf and the Environment. 2006. Audubon International. http://www.audubоninternational.org/e-source.html

Delaware River Basin Commission. October 2002. Water Conservation Guidelines for Golf Courses. http://www.state.nj.us/drbc/golfcourses.pdf

BMP #2: **Know When and Where to Irrigate**

Use irrigation controllers and automated devices combined with weather predictions and site conditions to improve efficiency.

Use drip irrigation for trees, shrubs, and other out of play areas requiring water. Choose landscaping plants that are drought resistant and mulch to conserve moisture.

Many older, timer-controlled irrigation systems are still in use. Irrigation should not be based on a time or calendar schedule but rather on site-specific conditions. This means your staff must monitor soil and weather conditions and operate the system accordingly.Take the time you need to evaluate your golf course. Consider the soils, topography, course layout, grass species, acreage, and the irrigation system design. Mapping your course (see earlier section, The Importance of Mapping) will make this easier.

Consider, too, cultural practices such as mowing height, proper fertilization, and aeration that can reduce plant stress and, therefore, water needs.

Armed with this information, you can then begin to identify areas with similar water needs and irrigate each region accordingly. Prioritize areas to irrigate, making reductions in the fairways, roughs, and driving ranges.

Consider narrowing fairways and planting warm-season grasses in the roughs to reduce irrigation requirements. Warm-season grasses include Bluestem, Switchgrass, and Indiangrass. Fine-leaf and tall fescues will work in these areas as well. (Warm-season grasses not only provide improved soil stabilization because of their deep and extensive rooting system, but they also add soft reds and browns to the course landscape.) ☞

RiverCrest Golf Club and Preserve
100 Golf Club Drive
Phoenixville, PA 19460

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At RiverCrest Golf Club and Preserve the rain can, shown in the photo above, prevents over irrigation during a rain event. The rain can is hard wired to the irrigation system and contains a sensor to pause an irrigation cycle after a threshold amount of rainfall has been met. When the rain stops, the computer recalculates the amount of irrigation needed, compensating for the rainfall received. The rain can costs approximately $1,200 but conserves water and reduces energy needs.

Other Considerations...

> Consider factors that affect plant water needs including evapotranspiration rates, recent rainfall, temperatures, exposure to prevailing winds, and soil moisture.

> Irrigate when wind speeds are minimal. Higher winds increase evaporation and blow water into non-targeted areas, both of which are a waste of water.

> Plant native species that are better adapted to local conditions, and whenever feasible, select drought-tolerant species.

> Spot water whenever possible to limit water use to those plants that truly need the water. Over-watering can cause nutrients to leach below the root zone where they are useless to the turf.

> Be aware of existing local and state regulations for ground water and surface water withdrawals.

Benefits of knowing when and where to irrigate:

- Reduces runoff and nutrient and chemical leaching.
- Conserves water.
- Protects surface and ground water from pesticide and nutrient contamination.
- Efficient water use reduces stress on streams and ground water levels.

> Document actual watering practices and set goals for yearly reductions. You might want to make this part of your monitoring program. (See earlier section, The Importance of Monitoring.)

> When chemicals require water, try to plan irrigation times to coincide with chemical applications and synchronize fertilizer application with light irrigation.

Resources:

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection. http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Fact Sheet: Golf and the Environment. 2006. Audubon International. http://www.audubonintemational.org/e-source.html

Water Conservation Guidelines for Golf Courses. October 2002. Delaware River Basin Commission. http://www.state.nj.us/drbc/golfcourses.pdf

Water Quality Best Management Practices: Nutrients, Irrigation and Pesticides for Golf Course, Athletic Turf, Lawn Care and Landscape Industries. 2006. Delaware Nutrient Management Commission. http://dda.delaware.gov/nutrients/forms/BMPnonagforprinter.pdf

BMP #3: Store and Handle Chemicals Properly

The primary goals of storing and handling chemicals properly are to ensure the safety of your employees and to reduce impacts on soil, groundwater, surface water, and wildlife. Also, cleanups resulting from accidental spills and contamination are costly.

Follow state laws for pesticide application, including licensing requirements. The Pennsylvania State Code, Chapter 128 states all laws relating to pesticide handling and use. See the following website for further information: http://www.pacode.com/secure/data/007/chapter128chap128toc.html

Store chemicals in a secure building so only authorized employees have access. The floor should be impervious and have a curb, sump, and/or lip to contain any spilled materials. Proper ventilation is extremely important. Research proper construction materials and layouts for storage and handling facilities. Provide secondary containment that will hold a larger volume of chemical than the largest container or tank used.

Store chemicals in their original containers with the original labels. Organize chemicals so that labels are clearly visible and separate different kinds of chemicals (herbicides, fungicides, insecticides) to avoid contamination or misapplication.

Before chemical application, ensure equipment is properly calibrated and not leaking. Be aware of valves and overflowing tanks.

Despite using a high level of caution, concentrations of pesticides will build up in areas where they are frequently handled. To address this concern, construct a permanent mixing/loading and washing facility on an impervious surface that can be easily cleaned and spills and washwater contained and collected. Pesticide washwater should be handled separately from other equipment washwater unless a treatment system is installed to handle these contaminants.

Benefits of storing and handling chemicals properly:

- Protects surface and ground water quality.
- Protects air quality from chemical drift.
- Prevents soil contamination.
- Saves expensive chemicals through spill prevention, or by containment and reuse when appropriate.

Always store, mix, handle, and dispose of chemicals according to label directions. All storage, mixing, and chemical clean-up areas should be located away from areas of possible surface, ground, and well-water contamination. Mix and apply chemicals only when weather conditions are appropriate (see BMP #4).

Maintain a current material safety data sheet (MSDS) for each chemical on site. Communicate safe chemical application policies with employees. Have an on-site emergency response plan in case of an uncontained spill, and know how to contact the proper authorities. ☞

Lehigh Country Club constructed a 25' x 30' stand alone concrete block pesticide storage building that is very secure and well marked with warning signage. The pesticide business license is displayed prominently in the window. Within the building they are replacing the metal storage racks with fiberglass shelving to prevent corrosion. A metal grate floor covers a sub-containment area about 3 feet deep with the same outside dimensions of the building. The grates are removable for easy clean up and pumping of the contained pesticide spill or water in the event of a fire. The building has flashproof lighting and electric outlets. A small ceiling mounted electric thermostat heater prevents products from freezing. An electric cross ventilation system removes fumes from the building.

Lehigh Country Club
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Allentown, PA 18103

John Chassard, Director of Grounds
(610) 967-4643
jchassard@verizon.net

Resources:

Fact Sheet: Golf and the Environment. 2006. Audubon International.
http://www.audubonintemational.org/e-source.html

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection.
http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Water Quality Best Management Practices: Nutrients, Irrigation and Pesticides for Golf Course, Athletic Turf, Lawn Care and Landscape Industries. 2006. Delaware Nutrient Management Commission.
http://dda.delaware.gov/nutrients/forms/BMPnonagforprinter.pdf

Best Management Practices for Golf Courses. Pinellas County Government Department of Environmental Management Pollution Prevention and Resource Recovery Section.
http://www.p2pays.org/ref/16/15858.pdf

BMP #4: Select and Apply Chemicals Knowledgably

Before you select and use chemicals on your golf course, evaluate your current chemical use and determine where and how you might make reductions. Integrated Pest Management (IPM) is a widely accepted management system that you should consider if you are not already using it. IPM integrates genetic, biological, cultural, and chemical controls to keep pest populations (insects, fungal diseases, and weeds) below an established tolerable level; for example, threshold (or tolerable) levels for putting greens are much lower than for fairways and roughs. IPM also considers physical factors affecting chemical mobility, including soil properties, topography, drainage, and the location of surface waters. (This is another area in which course mapping – see The Importance of Mapping section - makes your job much easier.) IPM typically results in a more efficient use of chemicals, benefiting both your budget and the environment.

Benefits of proper selection and application of chemicals:

- Protects surface and ground water quality.
- Protects air quality from chemical drift.
- Prevents soil contamination.
- Protects beneficial organisms and wildlife.

Selection

- Choose chemicals with low toxicity, medium sorption rates, and short half lives to reduce runoff and leaching.
- Consider the ability of the chemical to build up in live tissues.
- Broad-spectrum herbicides can harm beneficial insects as well as problem insects, so use the most specific chemical possible to do the job.
- As a general rule, limit the use of pesticides with a soil persistence of greater than 21 days, a soil adsorption value of less than 300, and a solubility of greater than 30mg/l (per the Delaware River Basin Commission).
- Avoid using wettable powders, which have a greater probably of runoff.
- Vary your selection of chemicals to reduce pest resistance.
- Select turf species that are resistant to pests and disease.
- Use products and practices that reduce the potential for pollution.

Application

- Pay attention to current and predicted weather conditions. Spray drift is affected by wind conditions and spray particle size. Heavier rains, especially within 12 hours of chemical application, cause a substantial increase in chemical runoff. Depending on the mode of action of the chemical, a light rain or post-application irrigation can be beneficial to increase the amount of pesticide reaching the soil surface.
- Calibrate equipment to ensure appropriate rates are used.
- Adhere strictly to product labels.
- Regularly work to improve soil health, which will improve the health of the turf, making it more resistant to pests and disease and requiring reduced chemical treatment.
- Time chemical application with the life cycle and vulnerability of the pest
- Use records of chemical applications and their effectiveness to determine future management.
- Consider environmentally sensitive areas including groundwater recharge areas (sinkholes, wells, highly permeable soils, soils with poor adsorptive capacity), surface water bodies, and non-target areas (water bodies, wildlife and natural areas) when deciding if treatments are necessary and what chemicals to use. Consider using spot treatments and covered booms when near sensitive areas. ☞

Resources:

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection.
http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Best Management Practices for Golf Courses. Pinellas County Government Department of Environmental Management Pollution Prevention and Resource Recovery Section.
http://www.p2pays.org/ref/16/15858.pdf

Branham, B.E. & Kandil, F. Z. & Mueller, J. September 1, 2004. Best Management Practices to Reduce Pesticide Runoff from Turf. *Turfgrass and Environmental Research Online, 3 (17).*
http://usgatero.msu.edu/v03/n17.pdf

Fact Sheet: Golf and the Environment. 2006. Audubon International.
http://www.audubonintemational.org/e-source.html

Landschoot, Peter. Developing and Integrated Tufgrass Pest Management System: Penn State Department of Crop and Soil Sciences-Cooperative Extension. The Pennsylvania State University.
http://turfgrassmanagement.psu.edu/turfipm.cfm

Water Conservation Guidelines for Golf Courses. October 2002. Delaware River Basin Commission.
http://www.state.nj.us/drbc/golfcourses.pdf

Water Quality Best Management Practices: Nutrients, Irrigation and Pesticides for Golf Course, Athletic Turf, Lawn Care and Landscape Industries. 2006. Delaware Nutrient Management Commission.
http://dda.delaware.gov/nutrients/forms/BMPnonagforprinter.pdf

BMP #5: Select and Apply Fertilizers Knowledgably

Use proper nutrient management to improve turf health and reduce negative environmental impacts to ground and surface waters. Golf course fertilization progams should incorporate turf grass nutrient requirements with fertilizer types, application timing, and application rates that minimize potential for nutrient runoff and leaching.

Factors Affecting Nitrogen Application Rates (from University of Maryland):

1. Turfgrass species
2. Age of turf
3. Length of growing season
4. Soil type and organic matter levels
5. Clipping removal
6. Irrigation intensity
7. Intensity of traffic
8. Prevalent weed and disease problems

Nitrogen is an important nutrient, affecting many turf properties including growth rate, turf density, color, disease and insect resistance, weather stresses, and putting speeds. Phosphorus is also critical for turf performance. Proper phosphorus levels are needed for establishing new turf, however established turf can tolerate lower levels of soil P.

Environmentally, both of these nutrients are pollutants when not applied with precision. Many factors affect nutrient needs. Application rates should be evaluated throughout the growing season and annually. Soil tests are important to determine phosphorus levels in the soil and appropriate application rates. At a minimum, perform soil tests once every three years.

Nutrients can be applied in soluble, quick release forms or insoluble, slow release forms. Quick release fertilizers are rapidly available for plant use, cause fast results, are lower in cost, require frequent, low application rates, and have a high potential for nutrient loss through leaching and runoff. Slow release fertilizers are in a form that is not readily available for plant use. Water penetration, weathering, or microbial action changes the nutrients into a useable form at a rate more consistent with plant nutrient needs. They are generally more expensive, however require fewer applications and therefore labor. Slow release fertilizers may be better for sandy soils and other environmentally sensitive areas near surface water bodies. Quick release fertilizers may be necessary during turf establishment.

Equally if not more important than the type of fertilizer used is proper fertilizer application. For example, soluble fertilizers can have very few environmental impacts when fertigated frequently at low application rates. To ensure nutrients are not over applied follow nutrient recommendations from a reliable source, maintain calibrated application equipment, do not apply when heavy rains or storms are expected, never apply nutrients on frozen ground, and use cultural practices such as topdressing, aeration, and vertical mowing to maximize nutrient effectiveness.

Benefits of proper nutrient management:

- Protects surface and ground water quality.
- Reduce fertilization costs.
- Improve turf health

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Example:

Green Valley Country Club purchases bulk quantities of organic pasteurized chicken manure. By using this source of nutrients they have drastically cut down on the amount of synthetic fertilizers used on the course. The pasteurized chicken manure is high in nutrient content and was developed to release nutrients slowly reducing nutrient loss to surface and groundwater. Manure is stored in a silo until land applied.

Green Valley Golf and Country Club
201 West Ridge Pike
Lafayette Hill, PA 19444

Sean Remington, GCS
greenvalleycc@comcast.net
(610) 825-2520

Other considerations to minimize nutrient runoff and leaching...

> A nutrient management plan is a useful tool to evaluate and map environmentally sensitive area on the course. Nutrient management plans balance nutrient needs with fertilizer types, application timing, and rates. Nutrient management plans also evaluate sensitive areas and make management recommendations for their protection.

> Apply appropriate fertilizers and amounts considering the different management needs of greens, tees, fairways, and roughs.

> Create non-fertilized buffer strips adjacent to water bodies.

> Identify areas with steep slopes and sandy soils. Slow release fertilizers are better for these areas.

> Do not use fertilizers as deicing agents on sidewalks, ect.

> Quickly stabilize disturbed soils.

> Route drainage systems to low maintenance filtering areas such as rough.

Resources:

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection.
http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Water Quality Best Management Practices: Nutrients, Irrigation and Pesticides for Golf Course, Athletic Turf, Lawn Care and Landscape Industries. 2006. Delaware Nutrient Management Commission.
http://dda.delaware.gov/nutrients/forms/BMPnonagforprinter.pdf

Turner, Thomas. Nitrogen, Phosphorus, and Potassium Recommendations for Golf Courses in Maryland. Febrary 2007. University of Maryland Turfgrass Technical Update.
http://www.mda.state.md.us/pdf/nmgolf.pdf

BMP #6: Use Native Plants

Golf courses are ideal locations for native plant establishment. Native plants can be used in areas of play, as well as landscaping around buildings, driveways, parking lots, and in designated natural areas and buffer zones. Native plants include grasses, reeds and sedges, wildflowers, shrubs, and trees. Audubon International recommends that at least 80 percent of the landscaped vegetation on a golf course should be native to the region.

Establish a variety of native plants to support greater species diversity and balance. Choose species by matching their growth characteristics to the growing conditions (sun, shade, wet, dry, acidic, or neutral soil). The resources listed on the next page provide abundant information about specific native plant species.

Establishing native plants can be difficult; spot treatment with chemicals, mowing, and spot watering might be necessary for the first growing season or two. After establishment, native plants tend to be self-sufficient and require little attention. Native grasses can be used in play areas such as the rough, areas bordering the rough, and edging of bunkers. Research has helped determine which native grass species work well environmentally with minimal impacts on play. Most native grasses require lower seeding rates and less watering than turf grass. Using the appropriate seeding rate and not over-watering will produce a thinner stand, better for finding balls and playability.

The Advantages of Using Native Plants: Native plants are adapted to the climatic and competitive conditions of their indigenous area and, therefore, need less maintenance. Each native plant has also evolved to fill a specific function, or niche, within the ecological community. Every living organism evolves in the company of other species, both plant and animal, which helps create a stable and balanced ecosystem under all but the most extraordinary conditions. Stable and balanced means less need for human intervention, either to help the organisms (in this case, plants) stay alive, or to keep them from overrunning the ecosystem. Native plants tend to provide better habitat for native wildlife, from insects on up, thus supporting many other species.

At TPC Potomac Golf Course at Avenel Farm, care was taken to use native trees and plants within streamside buffers enhancing the course aesthetics and wildlife habitat and mimimizing highly managed areas. Species planted include soft rush, bull rush, silky dogwood, red osier dogwood, and buttonbush.

TPC Potomac at Avenel Farms
10000 Oaklyn Drive
Potomac, MD 20854

Michael Sullivan, General Manager
Chad Adcock, GCS
(301) 469-3700

Native grasses and wildflowers create a buffer around this private pond.

Benefits:

- Creates natural beauty.
- Increase biodiversity and healthy, well-rounded ecosystems.
- Creates habitat and food opportunities for beneficial insects, birds, and mammals.
- Reduces the need for water, chemicals, and labor.
- Creates a positive image and educational outreach opportunity within the community.

Other Considerations...

> Research native species before planting.

> To control unwanted trees and vegetation, mow natural areas when birds are not nesting.

> Consider that many plants regarded as weeds are important within the ecological community before removing them.

> Communicate the benefits of natural areas to your membership and others who enjoy your golf course.

> Use signs and/or fencing to protect natural areas and educate golfers.

> Purchase native vegetation from reputable local nurseries. Local nursery personnel are an excellent source of information and advice.

Resources:

DCNR: Landscaping with Native Plants in Pennsylvania.
http://www.dcnr.state.pa.us/forestry/wildplant/native.aspx

Fact Sheet: Golf and the Environment. 2006. Audubon International.
http://www.audubonintemational.org/e-source.html

Nelson, Matt. (1997) Natural Areas. *USGA Green Section Record, 35 (6).*
http://www.usga.org/turf/articles/management/bunkers/natural_areas.html

Ross, Kevin J. (2004). Managing Native Grass. *Golf Course News, June 2004.*
http://findarticles.com/p/articles/mi_qa4031/is_200406/ai_n9416849/pg_1?tag=artBody;col1

United States Department of Agriculture Natural Resources Conservation Service Plant Database.
http://plants.usda.gov/

BMP #7: Increase Naturalized Areas

Audubon International recommends creating wildlife habitat in at least 50 percent of minimally used areas on the property, including 50 percent of all out-of-play shorelines. Although natural areas will inevitably create a less manicured appearance, the environmental benefits are great and, with education, golfers will understand the many important reasons for creating areas of natural beauty.

Creating a natural area can be as simple as designating no-mow, no-spray zones. Ideally, natural areas should contain a variety of vegetation including grasses, shrubs, and trees. Wildflowers are also a great addition for attracting butterflies, insect-eating birds and mammals, and for increasing the aesthetic value of the course. When creating new natural areas, try to connect existing buffers and natural areas, providing corridors for wildlife movement. If you have mapped your property (see earlier section on "The Importance of Mapping"), it will be easy to see how to make these connections.

Benefits of creating natural areas:

- Increases natural beauty.
- Creates habitat for beneficial insects, birds and mammals.
- Reduces water consumption, chemical use, and labor.
- Stabilizes soils and reduces flow forces in drainage zones.

Natural areas will require some minimal management. Mowing meadow areas once a year will help control undesirable vegetation. Do not mow during bird-nesting seasons, and leave debris to complete the natural succession of decomposition and nutrient recycling. Invasive species must be controlled. If invasive species are present you can remove them by hand, or chemically spot treat them.

Adding bat boxes and bluebird houses to natural areas are easy ways to encourage wildlife. Wildlife housing can also serve the dual purpose of marking irrigation valve locations or other equipment located in the area.

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Kennett Square Golf Course and Country Club continues to work to remove invasive species from a 3 acre natural area. Invasive species removal will increase the competetiveness of the existing native plants. They also strive to leave woodland as natural as possible by leaving downed branches and brush for wildlife habitat.

Kennett Square Golf and Country Club
100 East Locust Lane
Kennett Square, PA 19348

Paul Stead, GCS
(610) 444-3550
pstead@ksgcc.com

Over the past 20 years St. Davids Golf Club has converted acreage previously managed as rough to tall grasses. They now have 10 acres of hard fescues that encourage wildlife inhabitance and reduce nutrient application, pesticide requirements, and labor needs.

St. Davids Golf Club
845 Radnor Road
Wayne, PA 19087

Henry Wetzel, Superintendent
(610) 688-2010
sdgreens@verizon.net

Other Considerations...

> Consider converting high-maintenance, problem areas not critical to play.

> Buffer zones and undeveloped upland areas, especially those in drainage ways, are ideally suited for naturalization.

> Using vegetation native to the region will decrease maintenance, improve survival, and increase wildlife value.

> Establish aquatic vegetation in shallow water areas to encourage wildlife inhabitance.

> When not a safety concern, leave standing or fallen dead trees. They provide a food source for insect eaters, and cover and nesting sites for numerous birds and mammals. They also return nutrients to the soil as they decay.

> Use signs and/or fencing to protect natural areas and educate golfers.

Resources:

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Fact Sheet: Golf and the Environment. 2006. Audubon International. http://www.audubonintemational.org/e-source.html

Marcinek, Daryl. Quail Brook Golf Course: River Friendly Golf Course. (2008). Golf Course Superintendent Association of America.http://www.eifg.org/portal/portal/portal.aspx?menu_type=category&identifier=2

Nelson, Matt. (1997) Natural Areas. *USGA Green Section Record, 35 (6).* http://www.usga.org/turf/articles/management/bunkers/natural_areas.html

BMP #8: Control Erosion

Most areas on a golf course are vegetated and stable. However, stream channel erosion as well as topsoil erosion resulting from construction activities can be sources of soil loss. Stream bank erosion is addressed in BMP #15 - Floodplain Restoration. Construction activities are addressed on this page.

Earth-moving activities are regulated under Title 25 PA Code Chapter 102. Most earth-moving projects require an approved erosion and sedimentation control plan, which identifies how the potential for erosion during construction will be addressed. During construction, minimize the size of the disturbed area and follow an approved construction plan or sequence. The construction plan should include installing erosion control measures. After earth moving is complete, the area should be stabilized as quickly as possible through seeding, mulching, and/or netting until vegetation is established.

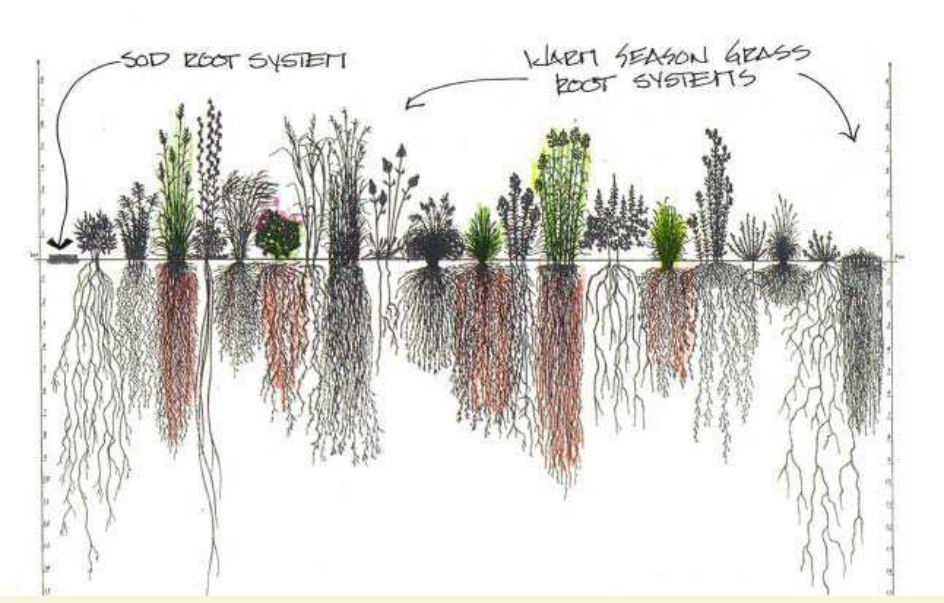
Erosion and sedimentation plans normally specify seeding mixes to stabilize disturbed areas. There are many mixes that can be utilized depending on the situation.

Benefits of proper erosion control:

- Improves water quality in streams and wetlands.
- Improves aquatic habitats
- Conserves valuable topsoil.

Warm season grasses develop a large root mass, excellent for holding soil in place. See the diagram below for an illustration of warm season grass root systems compared to turfgrass root systems.

The size of the project, location of surface water, and runoff patterns will dictate which best management practices are necessary to retain soil on the construction site and prevent its movement into nearby surface water bodies. Your local county conservation district is a key resource for more information about erosion control BMPs and regulations. ☞



Root systems of warm season grasses compared to turfgrass root systems (far left).

Image created by Heidi Natura, The Conservation Research Institute

Jute netting protects the soil and prevents erosion while still allowing the seed mix underneath to germinate and grow.

The black silt fence (right) prevents disturbed soil from leaving the construction site. Erosion control fabric protects newly seeded areas on the left side of the photo.

Resources:

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Pennsylvania Department of Environmental Protection Erosion Control Program. http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/wwec/general/wetlands/wetlands.htm

Pennsylvania Department of Environmental Protection Watershed Management Program. http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1422&q=502134

Your local County Conservation District
http://www.pacd.org/

BMP #9: Establish an Equipment Washing Station

Washwater can contain organic material such as grass clipping and soil as well as soaps, oil residue, fertilizer, and pesticide residue. These materials can degrade water quality and should never be allowed to flow directly into surface water. There are many options for washing sites.

Benefits of utilizing a wash pad:

- Reduces surface and groundwater pollution.
- Can reduce water consumption, in a closed loop system.

Minimally, washwater should be directed to a location where water can spread out and be filtered, away from any environmentally sensitive areas. This type of system is not appropriate for water used to wash the inside and outside of pesticide equipment. That water must be collected and handled according to pesticide label instructions.

Constructing an impervious wash pad to divert water to a collection system is another option. The collected water could connect to a sanitary sewer for off-site treatment or be treated on-site in a closed loop system and reused. Closed loop systems can be designed to treat pesticide equipment washwater. The type of system appropriate for the course will depend on the volume of water generated, contents of the washwater, and the potential for pollution in the surrounding area.

There are many types of systems varying in complexity. All systems must comply with any federal, state, or local water quality regulations and obtain any necessary authorizations.

Always try to minimize the volume of water used when washing equipment. Conserve water by using nozzles that produce high-pressure spray at a low volume. Keep an air hose nearby to blow off equipment before washing. Consider using the clippings in compost (see BMP #12).

> Do not discharge washwater to surface water directly, or indirectly through ditches and storm drains.

> Construct a roof over the wash pad to prevent clean rainwater from being collected into a filtering system.

> Minimize detergent use and use only biodegradable, phosphate-free detergents.

> Handle water used to clean pesticide equipment in its own system.

> Washing equipment on a pesticide loading pad will contaminate clippings and other debris.

> Research local requirements for washwater treatment.

Washwater from the wash pad shown to the left is collected in the adjacent rain garden and held until it filters into the ground. The rain garden contains native plants and cost approximately $1,500 to install.

Kennett Square Golf and Country Club
100 East Locust Lane
Kennett Square, PA 19348

Paul Stead, GCS
(610) 444-3550
pstead@ksgcc.com

Other examples for Utilizing Washwater ...

Nemicolin Woodlands Resort installed a new water recycling system that collects and treats equipment washwater from a roofed wash pad. Floor drains from the mechanics shop and equipment storage building are also routed to the treatment system in case a spill occurs. The system removes hydrocarbons and turf chemicals from the water using EPA-recommended Best Available Technology (BAT). The system uses carbon and sand filters in combination with chemical treatment. Solids and clippings are screened at the beginning of the process and require the most attention. Other system maintenance has been minimal. The cost of the treatment system was integrated into the cost of constructing a new maintenance facility. The approximate price of the system itself was $50,000. The system has had many positive returns. Environmentally, 100% of washwater is reused, reducing water withdrawals and eliminating the possibility of runoff into local streams. In addition the operation has gained efficiency.

Nemacolin Golf and Woodland Resort
1001 LaFayette Drive
Farmington, PA 15437

Brian Anderson, GCS
(724) 329-6353
brian.anderson@nwlr.com

Resources:

Anderson, Brian D. (August 2006). Keeping it Clean: Constructing a Wash Pad Facility. Golf Course Superintendent Association of America.
http://www.eifg.org/portal/portal/portal.aspx?menu_type=category&identifier=12

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection.
http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Equipment Washing on Golf Course Properties. Michigan Turfgrass Environmental Stewardship Program. http://www.eifg.org/energy/washpad.pdf.pdf

Fact Sheet: Golf and the Environment. 2006. Audubon International.
http://www.audubonintemational.org/e-source.html

Guide to Best Management Practices 100% Closed-Loop Recycle Systems at Vehicle and other Equipment Wash Facilities. Florida Department of Environmental Protection.
http://www.dep.state.fl.us/water/wastewater/docs/GuideBMPClosed-LoopRecycleSystems.pdf

Petrovic, Martin A. Ph.D. Evolving Equipment Washing Technology and What's in that Water. *USGA Green Section Record*, September/October 2005.
http://www.usga.org/turf/green_section_record/2005/sep_oct/evolving.html

BMP #10: Choose the Right Plants for Buffer Strips

Selecting vegetation is an important aspect of implementing and managing buffer strips. One strategy is to just stop managing an area and see what grows. However, depending on the site and the purpose for the buffer, and because of widespread problems with invasive, non-native vegetation, a more precise approach may be necessary.

Buffer location influences vegetation selection. Buffers along in-play areas typically consist of grass mowed at increased heights as the distance from the fairway increases. Keep vegetative heights high enough to filter and remove pollutants, but low enough that play is not hindered. Vegetation should be highest along pond and stream edges. Native warm-season species with deep rooting systems are best for wildlife habitat and for stabilizing soils, but cool-season grasses can be used as well. See the NRCS website for various seeding recommendations.

Buffers in out-of-play areas can and should include a wider range of vegetation. Maintain a variety of grasses, shrubs, and trees in these buffers. If space permits, consider using the Natural Resource Conservation Service (NRCS) three-zone strategy for riparian buffers (see image below). Buffers in wet areas should contain native wetland plants, both herbaceous and woody.

Benefits of choosing the right vegetation:

- Reduces stream bank erosion, lowers water temperature, and improves aquatic habitat.
- Controls Canada Goose populations. Taller vegetation can hide predators.
- Slows surface runoff and increases infiltration to groundwater.
- Filters pollutants from runoff such as nitrogen, phosphorus, and sediment.
- Breaks down herbicides, insecticides, and fungicides.
- Creates wildlife habitat.
- Increasing unmanaged, natural areas results in reductions in water consumption, chemical use, and labor.

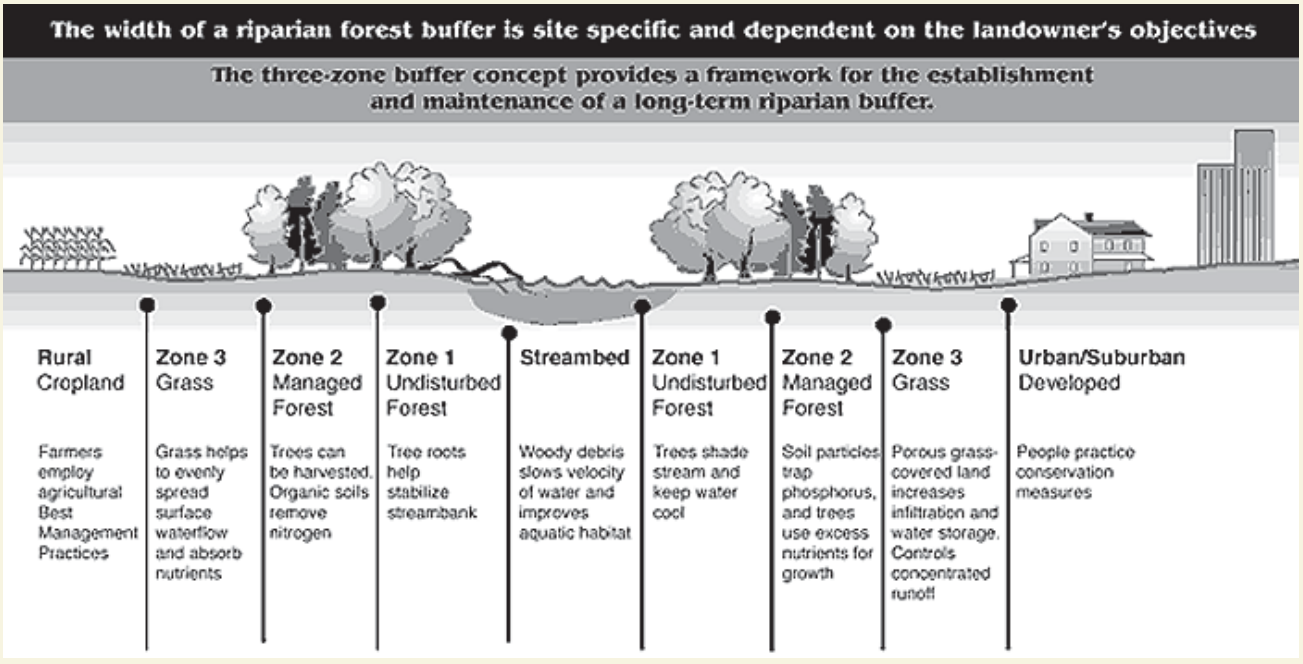


Image from, "Riparian Buffer Design, Establishment, and Maintenence" - Maryland Cooperative Extension

Other Considerations:

> Reduce or eliminate fertilizer and chemical inputs in the buffer to maximize its ability to capture runoff from managed turf.

> Use vegetation native to the region (less maintenance, better wildlife value).

> Purchase vegetation from local nurseries.

> Monitor vegetation health and treat using an integrated pest management plan.

> Use signs and/or fencing to protect buffers from foot and cart traffic and frequent maintenance activity.

> Do not dispose of grass clippings or prunings in the buffer area.

> Mow grass buffer once or twice a year, but avoid mowing while ground-nesting birds are nesting.

Newly installed stream buffer in a restored floodplain at Saucon Valley Country Club.

Saucon Vally Country Club planted native tree, shrub, and herbaceous species along the Saucon Creek stream corridor. These species provide habitat for wildlife, filter pollutants, and protect against stream bank erosion. Species planted include: red chokeberry, elderberry, arrowwood, silky and red osier dogwoods, soft rush, sensitive fern, swamp milkweed, fox sedge, and Virginia wild rye.

Saucon Valley Country Club
2050 Saucon Valley Road
Bethlehem, PA 18015

James Roney, GCS
(610) 758-7170
jroney@sauconvalleycc.org

Resources:

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Fact Sheet: Golf and the Environment. 2006. Audubon International. http://www.audubonintemational.org/e-source.html

Natural Resources Conservation Service: Buffer Strips: Common Sense Conservation. http://www.nrcs.usda.gov/feature/buffers/

Three Article Serices from Golf Course Management Magazine: Environmental Institute for Golf EDGE portal: http://www.eifg.org/portal/portal/portal.aspx?menu_type=category&identifier=2

1. Lyman G.T & Staton, E & Kogge, S. & Bennet, T. (November 2005). Buffer Strip Basics for Golf Courses. *Golf Course Management, 73 (10).*

2. Lyman G.T & Staton, E & Kogge, S. & Bennet, T. (December 2005). Buffer Strip Techniques for Golf Courses. *Golf Course Management, 73 (12).*

3. Lyman G.T & Staton, E & Kogge, S. & Bennet, T. (January 2006). Buffer Zone Vegetation. *Golf Course Management, 7 (1).*

BMP #11: Choose the Right Place and Size for Buffers

Buffers should protect sensitive areas from more intensely used and managed areas. Water resources such as streams, ponds, wetlands, and wellheads are prime targets for vegetated buffers zones intended for minimal active use and management.

Buffers bordering parking lots and fairways are useful to *contain* chemicals and other pollutants present in runoff from these surfaces.

Buffer zone width depends on soils, vegetation, topography, intended purpose, and available space. It is always best to make the zone as wide as possible.

In-play buffers typically are more limited in size and vegetation selection. Usually they are grass strips next to fairways and are managed with increasing grass height as you move farther away from the fairway.

Buffers in out-of-play areas can be more varied. For example, the Natural Resources Conservation Service recommends that riparian buffers intended to reduce stream pollution should be at least 55 feet wide, but if you don't have that much space available, a narrower buffer – even 10 feet – is better than none at all.

Other Considerations:

> Determine water flow paths from in-play areas and paved surfaces to water resources. The task will be easy if you already mapped the drainage on the property. (See earlier section on "The Importance of Mapping")

> If the buffer width in one area is not adequate to address runoff, consider diverting water to adjacent buffer areas that can accomplish your purpose.

> Let a professional landscape architect who specializes in native plant communities help you plan your buffers.

> Use signs and/or fencing to protect buffers from foot and cart traffic and maintenance activity.

> During the planning process, educate your members about the value and benefits of the buffers you plan to install. ☞

Lehigh Country Club installed a riparian buffer of native grasses and shrubs along the Little Lehigh Creek as part of a stream stabilization and restoration project. The buffer reduces maintenance time and costs, helps protect the in-play areas from flooding, and has attracted many new wildlife species, which the club members enjoy. Wildlands Conservancy partnered and played a leading role in the entire project.

Lehigh Country Club
2319 South Cedar Crest Boulevard
Allentown, PA 18103

John Chassard, Director of Grounds
(610) 967-4643
jchassard@verizon.net

This buffer at Bedford Springs Resort helps filter pollutants from runoff before pollutants reach the stream.

Bedford Springs Resort
2138 Business Route 220
Bedford, PA 15522

Dave Swartzel, GCS
(814) 623-3932
dswartzel@benchmarkmanagement.com

Benefits of Proper Buffer Placement and Size:

- Slow surface runoff and increase infiltration.
- Filter pollutants such as nitrogen, phosphorus, and sediment from runoff.
- Break down herbicides, insecticides, and fungicides.
- Create habitat for wildlife.
- Reduce inputs such as water, chemical use, and labor by creating natural areas.
- Reduce stream bank erosion, lower water temperatures, and create ideal aquatic habitat.

Resources:

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Natural Resources Conservation Service Buffer Strips: Common Sense Conservation. http://www.nrcs.usda.gov/feature/buffers/

Three Article Serices from Golf Course Management Magazine:
Environmental Institute for Golf EDGE portal:
http://www.eifg.org/portal/portal/portal.aspx?menu_type=category&identifier=2

1. Lyman G.T & Staton, E & Kogge, S. & Bennet, T. (November 2005). Buffer Strip Basics for Golf Courses. Golf Course Management, 73 (10).

2. Lyman G.T & Staton, E & Kogge, S. & Bennet, T. (December 2005). Buffer Strip Techniques for Golf Courses. Golf Course Management, 73 (12).

3. Lyman G.T & Staton, E & Kogge, S. & Bennet, T. (January 2006). Buffer Zone Vegetation. Golf Course Management, 7 (1).

BMP #12: Use Composted Materials

Enriching soil with compost is an old idea that has regained popularity as research proves its undeniable benefits. Before World War II, many golf course superintendents relied heavily on compost to create productive soil and healthy turf grass. After the chemical revolution, many switched gears to chemical fertilizers and pest controls that tend to work against instead of with biological systems.

Compost produces a healthy biological system that can regulate itself without the use of many applied chemicals. Compost can be made on site or off site, or brought in from private or municipal operations. Whether or not you make your own compost, you should be able to identify a quality product. Materials selected for composting affect the type of organisms and fertility of the finished product, so you should know what materials are in the compost you plan to use.

Try using compost materials such as grass and other herbaceous clippings, green leaves, or non-animal/non-fat food wastes, with some small, woody material added. These materials create compost full of good bacteria and fungi that help suppress disease.

If you are planning to do your own composting, you'll need to understand the components and conditions for making good compost. The proper proportions of air, water, carbon, nitrogen, and pH are important to monitor. Proper ingredients will also create the heat needed to kill unwanted weed seeds.

Compost application rate recommendations vary. You may want to consult more than one source before you begin – especially other superintendents who have experience making or using compost. You will soon learn what works best for you.

Benefits of using compost:

- Improves soil structure.
- Increases soil organic matter.
- Increases nutrient-, mineral-, and water-holding capacity.
- Reduces water, fertilizer, and pesticide needs.
- Mature, well-made compost can suppress disease.
- Provides fertility and slowly releases nutrients over time.
- Increases soil biological activity.

At Kennett Square Golf and Country Club, they established a compost pile in the location of a future flower bed. The compost pile will provide labor savings for bed preparation including chemicals to remove exisitng vegetation and soil ammendments needed to prep the bed. Materials sent to the dump are also reduced and put to a good use.

Kennett Square Golf and Country Club
100 East Locust Lane
Kennett Square, PA 19348

Paul Stead, GCS
(610) 444-3550
pstead@ksgcc.com

Other Considerations:

> In clay soils compost can improve soil structure, reduce surface crusting and compaction, promote drainage and provide nutrients.

>In sandy soils compost can increase water and nutrient holding capacity, supply nutrients, and increase microbial activity.

> Core aerating before and after compost applications helps incorporate compost into the soil.

> The ideal carbon-to-nitrogen ration is 3:1 – usually 3 parts lighter, carbon-rich material (dried leaves) to one part heavier, nitrogen-rich material (clippings) by volume will produce the right balance.

> Mature products that have been composting for approximately two years have the most benefits for turf.

> Compost slowly releases nutrients to the turf. Test compost for nutrient content and adjust fertilization accordingly. According to Penn State Cooperative Extension, a 1-2 inch layer of compost tilled into the soil 4-6 inches can supply the nutrients necessary for turf growth for one year.

> If course-managed composting is not an option, try working with a commercial operation to produce compost according to your requirements.

Manure based composts are another way to improve soil organic matter content, increase pH of acidic soils, and reduce compaction on turfgrass. Long term observations include improvement in turfgrass quality, weed reduction, and increase grass cover. Some sites using compost reported an earlier green up.

High salt levels, weed problems and vegetation burning can result from manure based compost. The latter two problems can be avoided by making sure the compost is mature.

The benefits of manure and clipping based composts are similar. As the Chesapeake Bay Tributary Statregy continues to implement nutrient trading programs, manure based composting systems may provide the added benefit of generating credits that can be sold to polluters within a watershed.

> Good compost has a dark color; a light, crumbly structure; and an earthy smell.

> Spent mushroom substrate provides many of the same benefits as compost.

> Review local regulations before starting an on-site composting operation.

Resources:

Cornell Waste Management Institute, Department of Crop and Soil Sciences. (2007). *Using Manure Based Composts in Turf Maintenance*. Cornell University. http://cwmi.css.cornell.edu/usingmanure.pdf

DEP Bureau of Waste Management Guidelines for Yard Waste. http://www.depweb.state.pa.us/landrecwaste/cwp/view.asp?A=1338&Q=497969

Landschoot, Peter. *Using Compost to Improve Turf Performance: Penn State Department of Crop and Soil Sciences - Cooperative Extension*. The Pennsylvania State University. http://turfgrassmanagement.psu.edu/composts.cfm

Landschoot, Peter. *Using Spent mushroom Substrate to Improve Turf: Penn State Department of Crop and Soil Sciences – Cooperative Extension*. The Pennsylvania State University. http://spentmushroomsubstrate.turfgrass.psu.edu/pubs/spentmushroomsubstrate.cfm

Sachs, D.S. & Luff, R.T. (2002). Ecological Golf Course Management. Hoboken, NJ: John Wiley and Sons, Inc.

BMP #13: **Collect, Cleanse, and Store Stormwater**

Stormwater management is an important aspect of protecting water resources. Stormwater is generated from impervious surfaces such as clubhouse and maintenance building roofs, parking lots, and roads. Runoff can contain nutrients, pesticides, sediment, and other pollutants. Stormwater management is also imperative during construction activities when bare soils are most vulnerable to erosion.

Benefits of Stormwater BMPs:

- Increase infiltration and groundwater recharge
- Capture surface runoff and reduce peak flows
- Remove pollutants from surface water runoff improving surface water quality
- Slow water velocities

Stormwater BMP's should address both the quantity and quality of the runoff. A good way to improve the quality of stormwater runoff is to use appropriate irrigation, fertilization, and pesticide use BMPs discussed earlier in this manual. In addition, stormwater detention, filtration, and infiltration treatment techniques will lessen the quantity and improve the quality of stormwater reaching sensitive watercourses. Minimizing parking lots and encouraging water to sheet flow over flat grassy areas instead of channelizing flow will increase infiltration. Detention basins can be used to store water to reduce flooding and peak flows. Reuse of this water for irrigation is discussed on the next BMP sheet. Grassy swales, filter strips, and constructed wetlands can be used to filter pollutants such as nutrient, sediments, chemicals, and heavy metals from stormwater. Stormwater runoff should be directed through a filtering buffer or constructed wetland before flowing into surface waters off-site.

There are many available stormwater BMP's. The PA Stormwater Best Management Practice Manual contains detailed information about approved methods. All stormwater BMP's should be designed by an engineer on a site specific basis and conform to local and state regualtions. ☞

St. Davids Golf Course installed a water retention basin to capture and infiltrate rainwater from their clubhouse and cart barn. Water is allowed to infiltrate into the soil, reducing peak storm flows and recharging groundwater.

St. Davids Golf Club
845 Radnor Road
Wayne, PA 19087

Henry Wetzel, GCS
(610) 688-2010
sdgreens@verizon.net

Resources:

Pennsylvania Department of Environmental Protection. 2006. Pennsylvania Stormwater Best Management Practices Manual.
http://www.depweb.state.pa.us/dep/site/default.asp Keyword: Stormwater

Example BMPs: Grass Swales 6.4.8
Grass filter strips 6.4.9
Constructed Wetland 6.6.1
Wet Pond/Retention Basin 6.6.2
Riparian Buffer Restoration 6.7.1
Floodplain Restoration 6.7.4

BMP for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection.
http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

BMP #14: **Reuse Stormwater**

Stormwater can be collected and reused to provide supplemental irrigation for turf. Ideally storage ponds are constructed not only for aesthetic beauty and water hazards but also to hold stormwater runoff. Locate new ponds in areas where surface water can naturally reach the pond or be diverted to the pond. Impervious areas such as parking lots will generate a large amount of stormwater during rain events.

Wildlife value should be a design consideration for storage ponds. Irregular shorelines and areas of shallow water improve habitat. Work with an engineer to design a system to work specifically with site needs.

Benefits of Stormwater Reuse:

- Increase irrigation flexibility during times of peak use
- Take the stress off of wells and watercourses during droughty conditions and peak use
- Increase infiltration through reuse
- Remove pollutants from surface water runoff
- Create wildlife habitat
- Reduce peak flows during rain events

Stormwater Retention for Golf Course Irrigation

No local examples of stormwater reuse were found or submitted for use in this project, however, it is a viable BMP for this region. An excellent example can be located on the Environmental Institute for Golf - Edge Online Resource: http://www.eifg.org/portal/portal/portal.aspx?menu_type=category&identifier=12 under the "Case Study" section. The article is titled "Stormwater Retention for Irrigation Purposes." This course, located in Washington State, used increased development to their advantage. They enlarged an existing pond to hold stormwater from new developments. Most years the pond is full and provides them with enough water to irrigate for the entire season. They have drastically reduced water expenses as well as improved water quality. The turf filters the stormwater before it reaches streams and eventually, the ocean.

This photograph is of the stormwater pond in the article metioned above, "Stormwater Retention for Irrigation Purposes."

Please see the article for further information

Resources:

Pennsylvania Department of Environmental Protection. 2006. Pennsylvania Stormwater Best Management Practices Manual.http://www.depweb.state.pa.us/dep/site/default.asp
Keyword Stormwater
Example BMPs: Runoff Capture and Reuse 6.5
Wet Pond/Retention Basin 6.6.2

BMP for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection.
http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

BMP #15: Get Multiple Benefits from Floodplain Restoration

Current Riparian Problems…

Current riparian problems include high sediment and nutrient loads, vertical and lateral stream migration causing unstable and collapsing banks, flooding, and reductions in groundwater recharge. Modern development activities and agricultural practices are often blamed for polluted waterways and unstable streams. However, a great portion of the problem, especially in the Chesapeake Bay region, can be attributed to common land and water uses of the 18th through the early 20th centuries.

During this time frame poor logging and farming practices resulted in extensive erosion, depositing millions of tons of soil into our local streams, valleys, and floodplains. Concurrently, hundreds of mills and dams were built along Pennsylvania waterways. The dams reduced water velocity in the impounded stream, causing sediment deposition upstream of the dams. These sediments, deposited throughout our stream and river valleys within the past two centuries, are called "Legacy Sediments." In the 1950's urbanization brought increased roads, industrial complexes, shopping centers, and homes. Stormwater greatly increased due to these impervious surfaces and a lack of stormwater regulations. The increased stream flows began cutting through the accumulated legacy sediments increasing sediment and nutrient loading in waterways.

Other deleterious impacts of legacy sediments include decreased groundwater recharge, increased flooding, poor aquatic habitat, and reduced native vegetation. Pre-historic floodplains that are naturally intended to store and infiltrate water are now filled with legacy sediments which impede that natural cycle. Streambeds that are perched above their historical gravel levels interrupt the natural interplay between stream flow and groundwater recharge. Clays and sediments built up between the gravels and current, bank elevations (often misnamed "floodplains") prevent flows on the surfaces of the legacy sediments from entering into the aquifer. Flow is directed, instead, into the channel and its downstream receiving waters. Floodplain restoration alleviates these problems and creates many environmental benefits.

☞

Negative Impacts of Legacy Sediment

Water Quality:
Increased sediment loading
Increased nitrogen loading
Increased phosphorus loading

Riparian Impacts:
Less denitrification
Reduced plant nutrient uptake
Reduced flood water retention

Hydrologic Impacts:
Less floodplain inundation
Greater downstream flooding
Reduced aquifer recharge

Biological Impacts:
Poor stream habitat quality
Reduced wetlands
Reduced wildlife - no connectivity

The Solution...

Floodplain restoration involves determining how the stream historically functioned and then restoring it to its original elevations where the stream, floodplain, and groundwater table interact frequently. Legacy sediments are removed to acheive the historical elevations correcting the problems previously discussed.

On golf courses which frequently flood, floodplain restoration is a viable option to alleviate this costly nuisance. After the legacy sediment is removed there is increased storage area for floodwaters. The floodwaters will infiltrate faster into a floodplain that has been reattached to the groundwater table. There are many other important benefits of floodplain restoration listed in the box to the right. Many of the benefits can add value and interest to your entire course while helping to improve your environment.

Benefits of floodplain restoration:

- flood reduction
- storm water management
- sediment and nutrient reduction
- groundwater recharge
- wetland creation
- riparian buffers
- wildlife habitat improvement
- invasive species removal
- aesthetic enhancement
- topsoil generation
- environmental education

Existing and pending regulatory issues are presenting opportunities for golf courses to serve as open -space areas for environmental compliance projects. Than means your golf course could provide the space needed by your municipiality or local developers for nutrient and sediment load reductions, storm water management, groundwater recharge, flood mitigation, and wetland mitigation.

Because of the multiple community-wide benefits of floodplain restoration there are a number of possible government and non-profit partners to help in many aspects of the restoration project, including funding.

☞

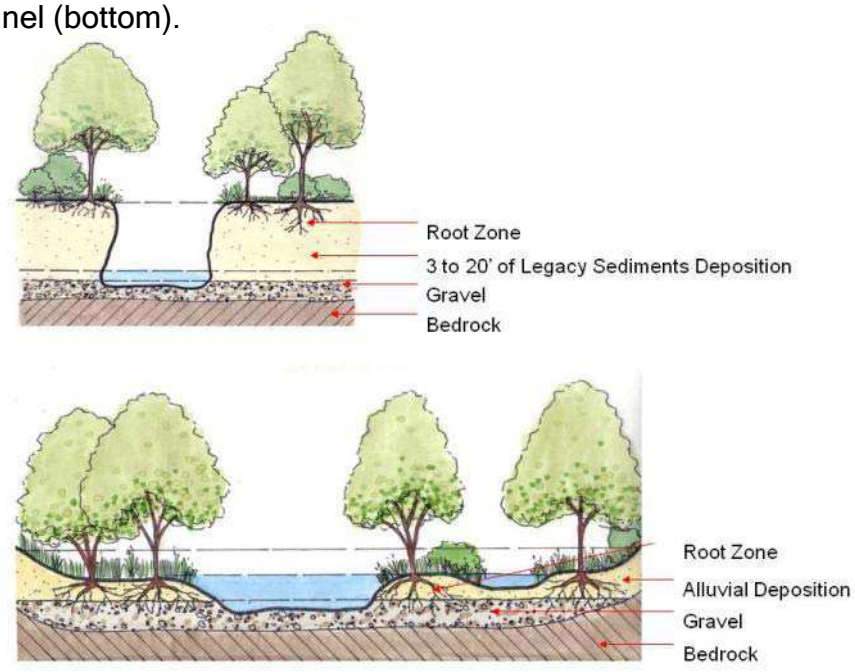
Bedford Springs Resort completed a stream and floodplain restoration on Shober's Run which flows through the length of the course. The restoration project ended stream bank erosion, stabilized the channel, provided acres of new wetlands (including wetland mitigation acreage required by DEP), established native plant communities, improved wildlife habitat, improved water quality, increased the difficulty and interest of play, and improved the course aesthetics.

Bedford Springs Resort
2138 Business Route 220
Bedford, PA 15522

Dave Swartzel, GCS
(814) 623-3932
dswartzel@benchmarkmanagement.com

BMP #15: **Get Multiple Benefits from Floodplain Restoration**

The diagram below depicts a stream channel impaired by legacy sediment (top) and a restored stream channel (bottom).



Legacy sediments perched above a gravel layer

Resources:

LandStudies, Inc. 2007. Floodplain Restoration. LandStudies, Inc., Lititz PA.

Pennsylvania Department of Environmental Protection. State Water Plan Principles. http://www.depweb.state.pa.us/dep/site/default.asp Keyword: State Water Plan

Pennsylvania Department of Environmental Protection. 2006. Pennsylvania Stormwater Management Best Management Practices Manual, BMP 6.7.4, Floodplain Restoration. http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1437&q=529063&watershedmgmtNavPage=l

BMP #16: Create or Restore Wetlands

Provide valuable ecological functions and improve aesthetics by creating or restoring wetlands on your golf course. Wetlands are identified by their soils, vegetation and hydrology. Wetland restoration means improving a degraded or recreating a destroyed wetland. Restoration occurs where a wetland currently or previously existed. Wetland creation means constructing a new wetland where a wetland did not historically exist. Wetland creation can be difficult, especially if there is no naturally occurring water source. Constructed wetlands are generally built to serve a purpose such as treating wastewater, stormwater, agricultural runoff, or acid mine drainage.

Professional consultants need to be involved in the wetland restoration or creation process because there are many site specific factors to consider. These factors include site selection, hydrologic analysis, water sources, soil and plant analysis, and permitting requirements.

As discussed in BMP #15, floodplain restoration creates and restores wetlands by reattaching the stream to the floodplain and can improve wetland function by reconnecting the wetland with the water table. Floodplain restoration projects improve wetlands onsite and increase wetland acreage.

Professional consultants are also needed to delineate existing wetland boundaries if a golf course project has the potential to alter or impact an existing wetland. Over the past 200 years 50% of wetlands have been lost. Regulations are now in place to protect wetlands. Any activities that impact wetlands require permits. Such activities might include culvert placement, subsurface drainage, bridge placement, dredging, or placing fill.


Before


After

At TPC Potomac at Avenel Farms in Potomac, MD, eight acres of wetlands were created as a result of a floodplain restoration project. These wetlands serve as a buffer between course maintenance activities and the stream as well as provide wildlife habitat, groundwater and surface water filtering, and increased groundwater recharge.

Potomac TPC at Avenel Farms
100000 Oaklyn Drive
Potomac, MD 20854

Chad Adcock, GCS
Michael Sullivan, General Manager
(301) 469-3700

Other examples of Wetland Creation...

Wetlands created at Bedford Springs Resort (See BMP #17 for a project description).

A great blue heron enjoys the newly created wetland at Potomac TPC at Avenel Farms. Potomac TPC also pictured below.

Benefits of wetland restoration and creation:

- Provide wildlife habitat
- Increase ecologic diversity
- Improve water quality
- Improve groundwater recharge
- Reduce surface water runoff rates and flooding problems
- Improve aesthetics

Resources:

Audubon International
http://www.audubonintemational.org/

An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement. 2003. Interagency Workgroup on Wetland Restoration.
http://www.epa.gov/owow/wetlands/pdf/restdocfinal.pdf

BMP #17: Re-Use Grey Water

Grey water is the wastewater from sources such as showers, washing machines, and air conditioning condensation. It does not include wastewater from toilets.

Irrigation of lawns and gardens is the only advisable application for grey water. Some additives in grey water can actually help plants grow. Cleaning agents from detergents that end up in grey water often contain nitrogen and phosphorus – the same nutrients found in commercial fertilizer. One caution, though: grey water is alkaline-rich and is therefore not suitable for acid-loving vegetation such as rhododendrons, azaleas, hydrangeas, white birch, and black spruce. Wetlands and reed beds are often a good target for grey water irrigation. Grey water should NOT be used on any plants – including roots, shoots, leaves, and fruits – that might be eaten by humans.

Professionally installed greywater collection systems are available, and some of them can be far more complicated and expensive than necessary. Some systems include purification, while others do not. It will pay to investigate what is available and find a system well matched to your needs and budget. You might even be able to rig your own system, depending on how easy it will be to move grey water from its source to its destination.

Benefits of using grey water:

- reduce the need for fertilization
- increase groundwater recharge
- reduce treatment plant load
- reduce fresh water use (and therefore the energy required to pump it)

> Grey water should be diverted to irrigation targets by a below-ground seepage pipe to reduce human exposure to the water.

> Use grey water during prolonged drought; divert it to the sewer during wet periods.

> Ensure there is no connection between your grey water system and the drinking water supply.

> Stop using grey water if you smell odors or if you notice a decline in the plants you are irrigating.

No local examples for grey water were found or submitted for use in this project, however, it is viable BMP for this area and has important environmental benefits.

Resources:

Clark, Josh. 2009. What is gray water, and can it solve the global water crisis?. How Stuff Works. http://home.howstuffworks.com/home-improvement/energy-efficiency/gray-water.htm

Gray Water Central. 2009. Oasis Designs. http://www.graywater.net/

Greywater Systems as Components of Alternative Septic Systems for Difficult Sites. 2009. InspectAPedia.com http://www.inspect-ny.com/septic/altgreywater.htm

BMP #18: **Wastewater Reuse**

Benefits of alternative water use:

- Nutrients and pollutants in wastewater effluent are filtered and utilized by the turf.
- Infiltration of irrigated water creates a greater balance between water withdrawls and returns
- Golf course use of potable water is drastically cut, saving money and conserving limited water resources.
- Fertilizer needs are reduced

Using partially treated water (effluent) from a nearby wastewater treatment facility is a creative, environmentally sound way to meet irrigation needs. Treated wastewater contains low levels of nutrients, salts, heavy metals, and bacteria and is therefore not potable. Rather than discharging this water into streams, the conventional method for disposal, water can be irrigated (at appropriate rates), and used by the turf for moisture and nutrients needs. The water is infiltrated into the soil where other contaminants can be broken down by soil biological activity. Golfers should not notice a difference in play however turf and soil management may have to be slightly adjusted to compensate for the salts and other pollutants. A superintendent in Texas noted that it may be necessary to add calcium to the soil to flush out salts and bicarbonates. ☞

RiverCrest Golf Club and Preserve receives 40-45,000 gallons of effluent wastewater per day (1.2 million gallons a month) from an on-site wastewater treatment plant. The wastewater treatment plant's effluent is recycled 6-7 months per year, reducing the amount of water discharge into the Schuykill River. Approximately $4,000 per month in water costs are saved during the golf season. The treatment plant serves 100% of homes, townhouses, and all of the Club's facilities on the site.

RiverCrest Golf Club and Preserve
100 Golf Club Drive
Pheonixville, PA 19460

Dean White, GCS
(610) 933-5675
dmw@rivercrestgolfclub.com

Tips for use of reclaimed wastewater:

> Account for nutrients in the reclaimed water when calculating fertilizer application rates.

> Bacteria can still be present in the irrigated water. Golfers should be aware of and avoid contact with water in the storage ponds. Warning signs are important.

> Negotiate a contract with the treatment facility that states the quantity and quality of water received. Consider provisions that can reduce the likelihood of over-irrigation during wet weather conditions. If water must be accepted consider constructing storage ponds or irrigating out of play areas.

> Consider well locations when irrigating reclaimed wastewater.

> Work closely and maintain a good working relationship with the water utility. Use of reclaimed water can be an important service provided to the community.

> Comply with all local and state regulations.

> In some states the use of wastewater effluent is mandatory. Nation-wide approximately 1000 courses utilize this BMP.

Resources:

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection.
http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Communities set plans for alternative water sources. January 14, 2009. Kuhles, Beth. Conroe News.
http://www.chron.com/disp/story.mpl/nb/conroe/news/6210487.html

Using Effluent Water on Golf Courses. Golf Course Superintendents Association of America.
http://www.gcsaa.org/news/articles/waterWoes.aspx
http://www.gcsaa.org/solutions/facts/effluent.aspx

Environmental Benefits and Credits

The best management practices provided in this handbook provide one or typically several benefits to water quality, water quantity (water conservation), stormwater management, or improved habitat for wildlife.

Environmental Benefits of BMPs

A matrix of the expected environmental benefits from the golf course BMPs is provided in the foldout Table 1. One thing that is striking is the multiple benefits from the majority of these BMPs. Some BMPs, such as floodplain restoration, have benefits across the board in Table 1.

There has been little research on the quantitative aspects or significance of these environmental benefits from the BMPs. It is clear that the significance of these benefits will vary from one golf course to another. Mapping and monitoring were emphasized earlier in the handbook, and this is critical to understanding the level of benefits that can be expected from these BMPs. Nevertheless, the cumulative benefits from multiple BMPs implemented on a golf course may be significant, even if individually the benefits are relatively small.

A number of the BMPs stand out as having the potential for significant environmental benefits on golf courses. The implementation of these BMPs may have significant costs, although grant funding could offset the costs associated with BMP implementation. These BMPs include riparian buffers, wetland creation, collection and re-use of stormwater, re-use of grey water, re-use of wastewater, increasing naturalized areas, and floodplain restoration.

The environmental benefits and potential credits from these BMPs may make them financially attractive for implementing on golf courses. Their applicability is not equally universal across various golf courses, however, and the feasibility of these BMPs needs to be evaluated on a site-specific basis. Conservation organizations and environmental restoration consultants can assist golf course superintendents in evaluating the potential costs and benefits from all the BMPs described in this handbook.

Environmental Credits and Offsets

The establishment of environmental credits and offsets is beginning to develop as government policies are established for the calculation, banking, and trading of these credits and offsets. In Pennsylvania, nutrient credit trading has been established as a policy, and approved by the Environmental Protection Agency. Wetland mitigation banking is well established in many areas, and carbon credit trading is beginning to emerge as well. The concept of habitat credits is in its infancy, but may develop as a means of banking habitat benefits from a site restoration to offset habitat losses from development projects elsewhere. Stormwater offsets from floodplain restoration are being considered by

Pennsylvania, and the means of calculating these offsets is being researched by the State. Groundwater recharge offsets are in the conceptual stage at this point.

The potential credits or offsets shown in Table 1 indicate whether nutrient credits, stormwater offsets, wetland credits, groundwater offsets, or habitat credits might be accrued from the implementation of a BMP. It should be pointed out that sediment credits are captured under the heading of nutrient credits in Table 1.

As mentioned above, stormwater offsets, groundwater offsets, and habitat credits are not yet fully developed and approved as government policies. Wetland credits are determined on a site-by-site basis. Approved nutrient credit calculation protocols exist for some BMPs, but not for all of the BMPs shown in Table 1. While Table 1 shows the potential for nutrient credits from BMPs such as *BMP 5 – Apply Fertilizers Knowledgably*, the protocols for calculating these credits for golf courses has not been established. The nutrient benefits for *BMP 15 – Floodplain Restoration* are recognized, but the calculation protocols for the credits are still being established.

In most respects, the potential environmental credits and offsets from these BMPs for golf courses are not yet realized in terms of governmental policy. Nevertheless, a case can be made that these BMPs provide the benefits as noted in Table 1. Monitoring and research are needed to assist in establishing the credit and offset calculation protocols for golf courses. Our experience with the implementation of some of these BMPs on golf courses clearly demonstrates that significant credits and offsets could be realized from some of the BMPs, and that progress should be made in the coming years to quantify those credits and offsets. The economic benefits of accruing credits and offsets from BMP implementation will make them even more attractive as management tools for golf course superintendents.

The Importance of Baseline Conditions

The policy of establishing nutrient credit and offset calculations for BMPs requires that a baseline be established. The concept of a baseline is that any one site (e.g. golf course) should already be doing what is typical for golf courses in terms of water resources management. This concept is taken from the nutrient credit trading policy of Pennsylvania, where a farmer has to be doing what is required by agricultural regulations before nutrient credits can be considered. For farmers, that is their baseline. Nutrient credits cannot be generated by a farmer, or a golf course for that matter, for simply doing what they are required by law to do.

The establishment of credit and offset protocols in trading and banking policies by governments will need to address baseline requirements for golf courses. Clearly, implementing floodplain restoration should not be a baseline requirement for golf courses. Some golf courses do not even have a stream and floodplain on their property. For golf courses, the concept of baseline has not been established. Several approaches for establishing golf course baselines are being proposed to the Pennsylvania DEP for credit and offset calculation purposes.

Economies of Scale

Another consideration with respect to credits and offsets is economy of scale. Just because a BMP can generate nutrient credits, for instance, doesn't mean it is economically worthwhile to pursue those credits. For example, suppose a particular BMP, once implemented on a golf course, can accrue 100 nitrogen credits per year. The costs for calculating the credits for that BMP, proposing them to the government agency for review and certification, and the banking or sale of those credits with associated legal documents could easily overwhelm the financial return for those credits. A nitrogen credit in today's market (June 2009) is worth about $9. From an economy of scale perspective, the potential financial return of $900 would easily be lost in the fees associated with getting those credits approved and the legal documents finalized.

From a credit and offset perspective, the best approach may be a combination of (1) implementing multiple BMPs, (2) implementing BMPs with multiple benefits and associated credits, or (3) implementing those BMPs that will likely have significant credits or offsets associated with them. As discussed previously, this would likely include BMPs such as riparian buffers, wetland creation, collection and re-use of stormwater, re-use of grey water, re-use of wastewater, increasing naturalized areas, and floodplain restoration.

Credits and offsets should not be the only motivating factor for implementing water resource BMPs on golf courses. Strong environmental stewardship is a cornerstone of golf course management, and these BMPs clearly support that endeavor. Any credits or offsets that make financial sense to pursue can serve to provide the financial incentive for additional BMP implementations.

Moving Forward

Significant progress is needed in quantifying the environmental benefits of golf course BMPs, establishing golf course baseline conditions, and developing the credit and offset calculation protocols for golf course BMPs. We intuitively know the kinds of environmental benefits that these BMPs provide, but the next steps are providing the mechanisms for establishing credit and offset policies for government agencies. It will take time to get to that point, and it will require BMP projects on golf courses where funding is provided to complete the mapping and monitoring before and after the BMP is implemented. This will require partnerships among golf course superintendents, government agencies, researchers, restoration consultants, and the academic community. Progress is being made on this front, and the development of this golf course BMP handbook is an important first step toward promoting the implementation of these BMPs.

Table 1. Water Resource Benefits of Golf Course Best Management Practices.

Best Management Practices	Water Quality Benefits			Water Conservation Benefits			Improved Stormwater Management and Runoff	Improved Wildlife Habitat	Credit or Offset Potential
	Nutrient Reduction	*Pesticides Herbicides*	*Sediment*	*Infiltration and Water Recharge*	*Water Use*				
					Surface Water	*Ground Water*			
1. Knowing how to select and maintain irrigation equipment					X	X	X		
2. Know when and where to irrigate				X	X	X	X		
3. Store and handle chemicals properly		X							
4. Select and apply chemicals knowledgably		X							
5. Select and apply fertilizers knowledgably	X								nutrient
6. Use native plants					X	X		X	
7. Increase naturalized areas					X	X	X	X	nutrient habitat
8. Erosion control	X		X				X		
9. Establish an equipment washing station	X	X					X		
10. Choose the right plants for buffer strips	X	X	X	X			X	X	nutrient habitat
11. Choose the right place and size for buffers	X	X	X	X			X	X	nutrient habitat
12. Use composed materials	X	X		X					
13. Collect, cleanse, and store stormwater	X	X	X				X		stormwater
14. Re-use stormwater	X	X	X		X	X	X		stormwater
15. Get multiple benefits from floodplain restoration	X	X	X	X		X	X	X	*-see below-*
flood reduction							X		
storm water management	X	X	X				X		stormwater
sediment and nutrient reduction	X	X	X						nutrient
groundwater recharge				X		X			groundwater
wetland creation	X	X	X	X		X		X	wetland
riparian buffers	X	X	X	X		X		X	nutrient habitat
wildlife habitat improvement								X	habitat
invasive species removal								X	
16. Create or restore wetlands	X	X	X	X			X	X	wetland habitat nutrient
17. Re-use grey water	X				X	X			nutrient
18. Wastewater reuse	X				X	X			nutrient

Suggested Resources

Audubon International Website http://audubonintemational.org/

Best Management Practices for Golf Courses. Pinellas County Government Department of Environmental Management Pollution Prevention and Resource Recovery Section. http://www.p2pays.org/ref/16/15858.pdf

Best Management Practices for Golf Course Water Use. 2006. Connecticut Department of Environmental Protection. http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf

Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses. 2007. Florida Department of Environmental Resource Protection. http://lee.ifas.ufl.edu/Hort/GardenPubsAZ/Golf%20BMP.pdf

Department of Environmental Protection. (2009). *Guidelines for Yard Waste Composting Facilities*. http://www.depweb.state.pa.us/landrecwaste/cwp/view.asp?A=1338&Q=497969

Environmental Institute for Golf: http://www.golfandenvironment.org/ Including EDGE, online environmental resource: http://www.eifg.org/edge/default.asp

Golf and the Environment Website http://www.golfandenvironment.org/resourcelinks.htm

Landschoot, Peter. *Developing and Integrated Tufgrass Pest Management System: Penn State Department of Crop and Soil Sciences-Cooperative Extension*. The Pennsylvania State University. http://turfgrassmanagement.psu.edu/turfipm.cfm

Landschoot, Peter. *Using Compost to Improve Turf Performance: Penn State Department of Crop and Soil Sciences - Cooperative Extension*. The Pennsylvania State University. http://turfgrassmanagement.psu.edu/composts.cfm

Landschoot, Peter. *Using Spent mushroom Substrate to Improve Turf: Penn State Department of Crop and Soil Sciences – Cooperative Extension*. The Pennsylvania State University.
http://spentmushroomsubstrate.turfgrass.psu.edu/pubs/spentmushroomsubstrate.cfm

Pennsylvania Nutrient Trading Program
Department of Environmental Protection Website: Keyword – Nutrient Trading
http://www.dep.state.pa.us/river/Nutrient Trading.htm

Pennsylvania State Water Plan
Department of Environmental Protection Website: Keyword – State Water Plan
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