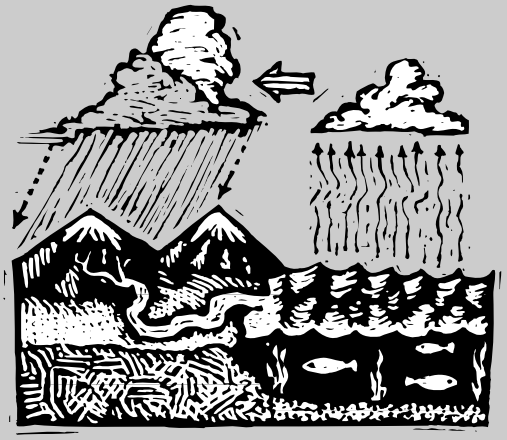
Land Use and Associated Watershed Health Topics



Land Use and Associated Watershed Health Topics

Preventing Runoff and Erosion

The Streambank Stabilization Solution

BY HARDY VANRY
VanRy is former Assistant Director of the French Creek Project.

When many people think of water pollution, they picture an oil spill, or purple ooze pouring out of a factory pipe, or a little kid catching an old shoe on a fishing pole. However, up to 65 percent of water pollution in the United States and Pennsylvania stems from nonpoint sources—those that can't be traced to one identifiable source. Nonpoint source pollution comes from many different small contributing sources, which often makes it difficult to reduce or prevent. The three causes of nonpoint source pollution are:

- Stormwater runoff—rainwater running across land and entering streams and lakes;
- Erosion—the breaking up of soils and detachment of soil particles due to the force of runoff; and
- Sedimentation—the buildup of these detached soil particles in nearby streams and rivers.

Same stretch of French Creek after streambank fencing.

Erosion along French Creek before streambank fencing.

Although these are all natural processes, human decisions and land-use practices can accelerate the degree to which the processes occur, thereby contributing to water pollution in Pennsylvania's streams, rivers and lakes. This pollution can be reduced significantly by making sure that adequate stream-side vegetation is planted along the banks of Pennsylvania's 83,261 miles of streams and rivers.

Many environmental scientists believe that stream-side vegetation can remove up to 95 percent of the nonpoint source pollution that would otherwise enter a stream system. Unfortunately, however, much of the vegetation that once existed along Pennsylvania waterways has been removed over time through a variety of human activities. These have included unwise logging practices, overdevelopment, poor land-use planning, and the location of croplands, buildings, yards and cattle grazing too close to waterways.

The Impacts of Erosion

So why should we care? Why is it so important to restabilize a streambank that is eroding at an unnatural rate? The answer: If left uncontrolled, erosion has the potential to cause a variety of economic and environmental damage. Among the negative impacts:

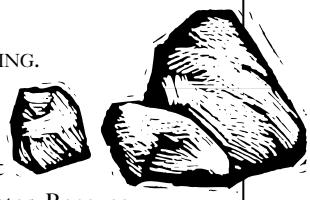
- Further loss of vegetation and topsoil, including grazing fields and cropland;
- Contamination of water by heavy metals, phosphorus and excessive nutrients that otherwise remain bound within soils;
- Increased suspended and settled sediments that destroy habitat and impact the ability of fish to feed and reproduce;
- A reduction in drinking water quality together with the added costs associated with water purification;
- In cases where cattle are allowed direct access to the stream, an increased potential for leg injury as streambanks crumble and increase drop-off;
- In extreme cases where sediment partially clogs a stream channel, an increase in flooding and a disruption in the volume and/or velocity of stream flow.

What Is Streambank Stabilization?

Stream corridor management and riparian buffers are two methods of protecting Pennsylvania's waterways from various types of pollution, including sedimentation, nutrient loading, pesticides, flood damage and habitat loss. (More information on these issues is provided elsewhere in this publication.) Unlike these other methods, streambank stabilization is normally used to reduce pollution in streambank areas that are already suffering from vegetation loss and erosion. In this sense, streambank stabilization is more than stream protection; it's stream restoration.

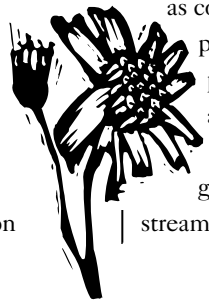
There are two principal reasons why a streambank becomes unstable. They are: removal or disruption of stream-side vegetation and/or soils by humans or cattle; and erosion resulting from the movement of water past the streambank site. Often, a streambank's instability results from a combination of these two things. And, depending on the cause and the pollution occurring at a specific site, there are a variety of streambank stabilization methods that can be used. These include:

STREAMBANK FENCING. Fencing can keep cattle away so that their hooves do not trample vegetation and disrupt soil. Streambank fencing also can help prevent the removal and erosion of vegetation, except through natural processes. Fencing is especially beneficial when used in conjunction with streambank stabilization methods to ensure that any reestablished vegetation has a chance to take root without risk of injury from cattle, humans or all-terrain vehicle traffic. (For more information on fencing, see the article, "Stream Corridor Management on Agricultural Lands: Stream-Friendly Farming," page 23.)



"RIP-RAP," OR STREAMBANK STONING. This means placing concrete or stone between the streambank and the stream so that soils cannot be eroded by the movement of water. Because the particles that make up rocks are much more tightly packed than those in soils, placing stones along streambanks can be an effective means of stabilization. This method is particularly useful in areas where the banks have too steep a slope for vegetation to take root, or in areas where vegetation otherwise would not flourish—for example, in highly shaded areas where low-growing vegetation cannot get light, or in urban areas with nutrient-poor soils.

Note: Rip-rapping activities should be carefully planned. Normally, the energy created by the movement of water through a stream channel is dissipated by the break-up of soil particles. In other words, some of this energy is "used up" through the process of erosion. However, placing tightly packed substances such as concrete or stone on a section of streambank will prevent erosion, and therefore prevent the dissipation of the water current's energy. Therefore, as the water moves past the rip-rapped site, it brings almost all of its energy with it. This energy is then used to erode soil particles downstream—often on the opposite streambank. As a result,



heavy reliance on concrete or stone for stabilization can often simply move an erosion problem downstream.

REVEGETATION. Planting grasses, shrubs and trees along a streambank can accomplish a number of important functions to prevent erosion. First, leaves, blades and branches absorb the energy impact of falling rain, so vegetation serves as a sort of umbrella for the soil particles. Vegetation also helps maintain the soil's "absorbative capacity"—water is more likely to soak into vegetation-rich soil than to run over its surface and create erosion. In addition, vegetation slows runoff velocity and "catches" some runoff sediment before it enters a stream system. Lastly, once their root systems are established, plants can help to anchor streambank sediments and prevent them from washing out into the stream. (See sidebar for more information.)

Making Sure Your Streambank Stabilization Project Is Effective

Streambank stabilization projects are under way all across Pennsylvania as farmers and other landowners attempt to reclaim miles of eroded streambanks. Although it is often difficult to measure the water quality improvements that result from restoring a single stretch of bank, there is no doubt that all the work is paying off. Here are a few more things to keep in mind as you undertake a streambank stabilization project on your property or in your area.

- Any stream restoration project should be approved by your county conservation district and/or by the Pennsylvania Department of Environmental Protection (DEP). Unless the project will result in major soil disruption, the permitting process for streambank stabilization efforts is very straightforward. Moreover, DEP and county personnel often can provide suggestions to enhance the benefits of the stabilization work.

- It's important to take steps to minimize erosion and protect water quality during the actual stabilization itself, especially if heavy equipment such as a backhoe is going to used to slope a streambank or place materials. To have well intentioned volunteers scrambling up and down a muddy streambank, inadvertently kicking eroded sediment into the stream, would be counterproductive. Often, a sediment fence (usually a strip of black plastic, about two feet high) can be staked along the edge of the stream to catch all or most of the sediment that is disrupted during a restoration project. Other times, this is not necessary—consult with your county conservation district for recommendations.

The Best Plants for Streambank Revegetation

The most effective plant species to use in streambank revegetation will vary depending on the soil make-up of the area, the slope of the streambank, the volume of water passing the site and other factors. However, any plants used for revegetation should possess the following characteristics:

- They should be native to the watershed in which you are working and should resemble, as closely as possible, the vegetation in the immediate vicinity of the restabilization site.
- They should be species that thrive in wet soils. Because the restabilization area is on a streambank, it will be prone to flooding at various times throughout the year.
- They should be relatively fast-growing and able to firmly establish themselves within one or two seasons, so that a harsh winter or heavy rain will not wash them out before they even take root.
- They should have a wide and deep enough root system to make a significant difference in holding soil in place and preventing erosion.

Cool-season grass species commonly used for streambank stabilization include reed canary grass, redtop, perennial ryegrass, Johnstone tall fescue and red fescue. Planting warm-season grasses such as switchgrass, deertongue, indiangrass and big bluestem will provide protection when cool-season grasses have become dormant and lose much of their erosion-control effectiveness.

In addition, some species of shrubs can provide stabilization to streambanks. Effective shrub species include basket willow, bankers dwarf willow, red-ozier dogwood, silky dogwood, alder and ninebark. Generally speaking, shrubs with deep and thickly spreading root systems provide more stabilization potential than do trees, because most trees do not extend their roots very deeply in wet soils. Trees can also become top-heavy and fall over relatively easily. Still, trees set back from the streambank can provide an added means of erosion control when used in addition to grasses and shrubs.

Also, pay close attention to the weather both before and after a stabilization effort is set to begin. If the site is going to be too muddy to work on, or if a heavy storm is going to wash much of it away within a week, you should think about postponing your project.

- Except in some cases of concrete or rip-rap stabilization, the streambank should be sloped whenever possible before stone and/or vegetation is reestablished on the site. The more gradual the slope, the less erosion will occur. Typically, you should allow a slope ratio of 3:1, grading back at least three feet horizontally for every one vertical bank foot. Sloping the streambank will prevent undercutting of the banks by stream flow, which in turn will prevent cave-in. It does little good to establish thick vegetation at the top of a steep streambank that will be undercut and fall in anyway.

- Streambank stabilization should be a final solution to a problem that already exists. In other words, it should only be used on sections of streambank that have already begun to erode. The best way to prevent erosion of one's property and to protect water quality is to implement best management practices before a problem occurs. Preventive efforts covered in other sections of the primer—such as streambank fencing, stream corridor management and vegetative buffer zones—are often easy, cheap and low-labor measures that can vastly reduce the likelihood of erosion and resulting sedimentation. In many cases, a landowner can lose several feet of streambank per year, so it certainly pays to take a good look at preventing erosion rather than attempting to reduce it once it has begun.

- Quite often, a streambank stabilization project does not require a great deal of time, energy or money in order to have success. Sometimes merely putting up a fence along a streambank is enough because it keeps cattle from walking there and allows the existing vegetation to grow up again. In addition, many tree-planting projects can be finished in an afternoon with only a handful of volunteers, and hundreds of small saplings can be purchased for less than $100. Always consult with your county conservation district before doing any work on your streambank. County personnel can give you a lot of free advice and help you find materials.

Education is Key

For conservation organizations or environmental groups thinking about conducting streambank stabilization projects in their own watersheds, education is an essential component of the effort. Quite often, landowners are skeptical of such projects, believing they will lead to increased government regulation, or that they will negatively impact their ability to tend their fields, access the stream or provide water for their cattle. Still others do not see streambank erosion as a real problem unless they are losing significant amounts of their property. Consequently, it is critically important to discuss the goals and benefits of streambank stabilization with landowners before work begins so that the stabilized streambank will remain so in the future.

Some amount of streambank erosion, of course, is naturally occurring. Streams meander. They cut away at one bank and deposit sediment on the other. Human beings, however, have disrupted this natural process in a major way, and we must all do what we can to restore unstable streambanks—not just for aesthetic reasons but to improve water quality in our streams, rivers and lakes. One specific streambank might not normally contribute a huge discharge of pollution into the stream, but it makes a smaller contribution to a very large cumulative problem as erosion occurs at perhaps thousands of sites. The more stretches of streambank we can stabilize, the more we can reduce, little by little, this major form of nonpoint source pollution.

It may be pie-in-the-sky to think that every stream mile in Pennsylvania will someday have a 50- to 100-foot strip of buffer vegetation on either side, but with every stabilization project we undertake, the water quality of Pennsylvania's streams and rivers improves. ■

For more information contact your County Conservation District or the Pennsylvania Department of Environmental Protection at (717) 787-5267

Riparian Forest Buffers:

Protecting Streams With Nature

BY MATT EHRHART

Ehrhart is Pennsylvania Habitat Restoration Specialist with the Chesapeake Bay Foundation (Reprinted with permission).

The proper development and management of riparian forest buffers is an issue of increasing importance in the Chesapeake Bay watershed and throughout the country. A little-understood resource, riparian forest buffers play a vital role in promoting healthy ecosystems and a healthy environment.

What is a Riparian Forest Buffer?

To understand what a riparian forest buffer is, it's important to look first at the meaning of the word "riparian." When something is described as "riparian," it means it has something to do with the bank of a natural course of water such as a river or stream. The U.S. Forest Service defines a "riparian area" as:

> The aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes and bays and their adjacent side channels, flood plain, and wetlands. In specific cases, the riparian area may also include a portion of the hillslope that directly serves as stream side habitats for wildlife.

For its part, a "riparian forest buffer" has been defined by the Executive Council of the Chesapeake Bay Program as:

> An area of trees, usually accompanied by shrubs and other vegetation, that is adjacent to a body of water nd is managed to maintain the integrity of stream channels and shorelines, to reduce the impact of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and chemicals, and to supply food, cover, and thermal protection to fish and other wildlife.

Simply put, a riparian forest buffer consists of a forest ecosystem existing in the riparian zone, with the forest protecting that riparian zone from adjacent land-use practices.

Why Are Riparian Forest Buffers Important?

Riparian forest buffers (RFBs) have a tremendous impact on their immediate surroundings. RFBs provide nutrient uptake, sediment and nutrient filtering, bank-stabilizing root mass, and enhanced stream and riparian habitat. The woody stems, herbaceous vegetation, and detritus on the forest floor filter overland runoff, trapping sediment and nutrients before they can make it to the river or stream. The dense network of woody vegetation in a forest ecosystem, both above and below ground, creates a massive demand for nutrients. Thus, once the nutrients are trapped, they are rapidly utilized by the vegetation and the microbial community in the forest floor.

During large rainfall events, rainfall infiltrates into the soil. As the soil becomes saturated, this moisture

What About Nonforested Buffers?

While nonforested buffers provide some of the same benefits as forested ones—e.g., filtering and trapping nutrients—it is generally accepted that they do not accomplish these tasks as well as forested buffers. They provide a minimal amount of bank stabilization and little, if any, benefit to the aquatic ecosystem in the form of organic input, large debris and shading. As a result, while a nonforested buffer is definitely better than no buffer at all, it is decidedly inferior to a forested buffer.

begins to flow downslope under the influence of gravity in a process called subsurface flow, or interflow. This subsurface flow, in turn, can transport large volumes of nutrients and other soluble chemicals into the nearest waterway. The deep-reaching root mass and "duff layer" of a forest can intercept some of this flow and utilize the dissolved nutrients.

The dense root mass of the forest community has other environmental benefits as well. One of these is that it creates an ideal stabilizer for the streambank. Observe the bank of any stream with a mature forested buffer, and you'll see the network of roots holding the soil in place. The cost of artificially providing the same kind of erosion protection along a stream or river is staggering, ranging from $50 to $500 per linear foot, depending on the terrain, access and other environmental factors.

RFBs also provide excellent wildlife habitat. The trees and shrubs, with the mast crops and berries they produce, provide food, cover and nesting habitat for a variety of birds and animals. Riparian forests also provide essential cover adjacent to water for reptiles and amphibians.

Equally important, however, is the habitat provided to the adjacent stream or river. The forest canopy shades the stream, reducing peak temperatures in the summer and providing a more steady temperature throughout the year. The reduced temperatures contribute to high levels of dissolved oxygen in the water, which is essential for fish and macroinvertebrates (primarily insects, crustaceans and bivalves). The forest buffer also is a source of large woody debris for the stream. Far from a nuisance, the boles and branches that wind up in the water serve as essential cover and habitat for fish, turtles, insects and more.

Perhaps most importantly, the forest's contribution of detritus (fallen leaves) to the stream provides the organic material that serves as the base of the food web in an aquatic ecosystem. The native stream community in northeastern North America has developed for thousands of years with leaf litter as the prime source of organic carbon. Recent studies at Stroud Water Resources Research Center indicate that without these native leaves, a large number of species could not survive.

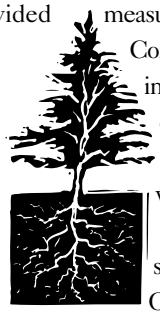
The positive impact of RFBs on their immediate surroundings thus are many and varied, but riparian forest buffers also are essential in the context of the larger landscape. In addition to the benefits described above, RFBs serve as important travel corridors for wildlife. These protected pathways are all the more essential in areas with intense agriculture or development.

Last but not least, forested buffers provide excellent recreational opportunities. They can be used for hunting, fishing, birding, wildlife observation, hiking, bicycling and even running.

The Status of Pennsylvania's Riparian Forest Buffers

Dr. Rick Day at the Pennsylvania State University has conducted the only comprehensive inventory of forested buffers in Pennsylvania. Dr. Day's inventory used satellite imagery to evaluate forest buffer widths in the Chesapeake Bay Watershed. His key finding: 40 percent of the stream miles in Pennsylvania's portion of the watershed have less than 100 feet of forested buffer.

Dr. Day's findings shed some light on the issue, but the reality of the situation is that we don't have any accurate measure of riparian forest buffer areas in the Commonwealth. All we know is that streams and rivers in the northern tier of Pennsylvania are better protected than those in other areas, and that urban and agricultural areas across the Commonwealth have a very low proportion of RFBs.



Pennsylvania's RFBs have been under siege since the Commonwealth was an English colony. Over the centuries, vast amounts of forest have been cleared for agriculture, cities and the timber industry—the supply of trees in "Penn's Woods" must have seemed endless. While the timber industry was initially responsible for the majority of the lost acreage, much of this acreage has since returned to a forested state. The current shortfall of RFBs in Pennsylvania can be explained by two factors: 1) economic demands on the agricultural community that compel farmers to force every possible

acre into production; and 2) the predominant view among urban, suburban and even rural residents that manicured landscapes are desirable and that natural areas are "messy and unkempt."

Nevertheless, more and more people now are beginning to recognize the importance of riparian forest buffers. Why has it taken so long? The answer is fairly simple. For the past three decades, society has been addressing more pressing environmental problems such as air and water pollution—problems that, in many senses, are relatively easy to deal with. Now that we've cracked down on point-source discharges of pollution, however, it has become increasingly apparent that nonpoint source (NPS) discharges are an issue of equal if not greater concern.

Agriculture, of course, is a leading source of NPS pollution, but it is not the only source. Other sources contributing substantially to the problem are construction and earth disturbance, which send large volumes of sediments and attached nutrients to streams and waterways throughout Pennsylvania. The most widespread nonpoint source of pollution, however—not by volume but by number of polluters—is us. American homeowners, businesses and municipal governments are using increasing amounts of fertilizer, herbicides and pesticides every year. And these compounds often make their way into streams via storm sewers, drainage swales and overland flow.

Key Issues and Programs

The Chesapeake Bay Program Executive Council has called for the restoration of 2,010 miles of riparian forest buffer throughout the Chesapeake Bay watershed by the year 2010. The "2010 by 2010" effort has pushed RFBs to the top of the list of urgent environmental issues in the watershed, even though the Executive Council has yet to decide how much funding and how much "on-the-ground" support will be provided for the campaign.

Fortunately, a number of state and federal agencies and private groups have been avid supporters of efforts to protect and restore riparian forest buffers, and can be counted on to continue their support in the future. Among these are: the U.S. Fish and Wildlife Service; the Natural Resources Conservation Service; the U.S. Forest Service; the Pennsylvania Department of Conservation and Natural Resources; the Pennsvlvania Department of Environmental Protection; the Pennsylvania Game Commission; the Pennsylvania Fish Commission; the Chesapeake Bay Foundation; the Alliance for the Chesapeake Bay; Ducks Unlimited; Trout Unlimited; and the Isaac Walton League. These and many other organizations provide technical advice and financial support for riparian restoration. However, site requirements, easement lengths, landowner compensation, and support of forested vs. nonforested buffers will differ. The Alliance for the Chesapeake Bay has published an excellent brochure that lists and describes many of the available programs (see resource and contact information below).

How Wide's Your Buffer?

The width of a riparian forest buffer can vary. While there is general agreement that wider is better, opinions differ over the minimum width necessary to provide a functional forest buffer. Many factors, including slope, soils, watershed and hydrology, can influence the effectiveness of the forest buffer. The Chesapeake Bay Program has established a minimum width of 35 feet for the "2010 by 2010" initiative.

Physically establishing more forested areas around Pennsylvania's streams isn't the only priority. In agricultural areas, streambank fencing is essential to establishing and maintaining functional RFBs. Forests will not develop in areas with free cattle access. As a result, landowner education and technical guidance are essential and can be as helpful in suburban and urban settings as in agricultural areas. In order for people to support the establishment of RFBs, they need to understand the many benefits that society receives from these areas.

Perhaps the most effective means of ensuring the development and protection of RFBs in Pennsylvania is to generate more support among local citizens and local government officials. Municipal ordinances to protect existing riparian forest buffers and provide incentives for establishing new buffers will promote RFBs as an effective land management tool. Several communities throughout the state already have adopted ordinances that could serve as models for other communities to modify and improve upon.

Improving Riparian Forest Buffer Protection and Restoration

Ultimately, the fate of riparian forest buffers depends on people. Individually and collectively,

Pennsylvania Stream Releaf—
A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams.

In cooperation with American Forests Global Releaf 2000, Pennsylvania has launched a statewide effort known as Stream Releaf to replant the Commonwealth's streamsides. This initiative identifies objectives for streamside buffer restoration, conservation, education and outreach, public relations, and tracking progress. Projects will be locally driven with assistance from state agencies. For more information, including a forest buffer toolkit or a list of resources, contact DEP's Bureau of Watershed Conservation at 717-787-5267 or visit their website www.dep.state.pa.us

we must take ownership of and responsibility for this vital resource. One important step to protecting and promoting riparian forest buffers is the formation of local watershed organizations. These organizations typically form alliances with citizens' and sportsmen's groups, landowners, government, planning and zoning boards, utilities, and others to protect local water resources. Watershed organizations promote ordinances, volunteerism and management practices addressing not only RFBs, but a vast array of other environmental concerns.

The scientific and academic communities also play a crucial role in protecting and restoring riparian forest buffers. The physical, chemical and ecological complexity of riparian zones dictates a multidisciplinary approach to their protection and restoration. Engineers, hydrologists, ecologists, soil scientists and others must work together to solve problems and answer questions, and, most importantly, to communicate possible solutions and answers to individuals working at the local level.

Riparian forest buffers are an integral part of the landscape in communities across Pennsylvania. Today, the challenge is to convert the recent surge in media and political interest in these little-understood yet environmentally vital areas into actual measures to protect and restore RFBs. ■

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Streambank Stabilization and Management Guide for Pennsylvania Landowners (1996); PA Department of Environmental Resources, Office of Resource Management, Bureau of Water Resource Management, Division of Scenic Rivers.

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Wetland and Riparian Stewardship in Pennsylvania: A Guide to Voluntary Options for Landowners, Local Governments and Organizations (1997); The Alliance for the Chesapeake Bay.

For More Information:

Alliance for the Chesapeake Bay—717-236-8825
Chesapeake Bay Foundation—717-234-5550
Chesapeake Bay Program—800-YOUR-BAY
PA Association of Conservation Districts—717-236-1006
PA Department of Conservation and Natural Resources—717-787-2869
PA Department of Environmental Protection—717-787-5267
U.S. Department of Agriculture, Natural Resources Conservation Service—717-782-4403
U.S. Department of Agriculture, Forest Service—304-285-1592

Stream Corridor Management on Agricultural Lands

Stream-Friendly Farming

BY JOHN DAWES

Dawes is Administrator of the Western Pennsylvania Watershed Protection Program of The Heinz Endowments.

The sound management of stream corridors by the agricultural industry is vitally important to stream protection in Pennsylvania. Farmers and others involved in agriculture have more miles of streams under management than any other group. Combine this with the fact that agricultural practices can have an enormous impact on stream quality, and it's easy to see why the agricultural industry needs to be a key player in cleaning up Pennsylvania streams.

Farming's impacts on stream quality are many and varied. The chief problems are soil erosion and runoff, both of which can result in excess pesticides, fertilizers and animal nutrients being carried into waterways. Historically, the combination of overgrazing, the clearing of forests for farming and certain cultivation practices has increased the amount of soil washed away by rainfall. A large proportion of the nonpoint source (NPS) pollution that is today's biggest threat to stream quality in the Commonwealth comes from agricultural activities in the form of sediment, pesticide and nutrient pollution. Excess nitrogen from farm fertilizers also makes its way to streams through groundwater.

The Problems:

- Historically, the clearing of forests for agriculture has increased the amount of soil washed away by rainfall.
- Additional problems have been caused by the introduction and use of chemicals and fertilizers near streams lacking buffers.
- Livestock grazing in riparian areas has produced a variety of herd health issues as well as further sedimentation.

The Solutions:

- Streambank fencing programs and funding.
- Planting of native tree and understory species and warm season grasses.
- The use of rotational grazing, livestock watering facilities, filter strips and other practices.

Unmanaged stream corridor.

Cows In the Stream: A Special Problem

One of the most serious agriculture-related impacts on stream quality stems from the fact that cows often are allowed free access to streams. By defecating directly into the streams, cows can contaminate huge amounts of water every day. The following are a few of the alarming facts about the problems caused by cows in and around streams:

- One cow produces approximately 5.4 billion fecal coliform bacteria per day. If a cow is allowed to graze for a 24-hour period with unrestricted access to a stream, approximately 565 million fecal coliforms could enter the stream.
- Water with a fecal coliform count of 100 per 100 milliliters is unsafe for swimming. A fecal coliform count of 2 per 100 milliliters means the water is unsafe to drink.
- One defecation by a dairy cow produces enough bacteria to make the equivalent of six backyard swimming pools unsafe for swimmers.

Streambank fencing project in Southwestern PA.

- Fifty cows allowed unrestricted access to a stream for a 24-hour period could contaminate the equivalent of one day's water supply for the city of Baltimore.
- Bacteria entering a stream can result in disease transmission between and within livestock herds.
- Persistent exposure to wet conditions can lead to soft hooves and lame cows.
- Cows with free access to streambanks can eliminate fish habitat by trampling and silting, destroying habitat and elevating stream temperatures.

The best solution to keeping cows out of streams is streambank fencing on agricultural lands, considered the first step in sound management of stream corridors. (See page 25 for program and contact information.)

Planting in Riparian Areas— The Three-Zone Buffer

Centuries of horticultural experimentation have led to the introduction of many nonnative plants to western Pennsylvania. The majority of these plants can "muscle out" native plants, generating a habitat that is unfamiliar or undesirable to wildlife. Moreover, when a non-native pest plant such as the multiflora rose is removed, the native plants do not return to the riparian area. Thus, there is an urgent need to develop replanting initiatives in riparian areas throughout the Commonwealth.

A recently developed method for replanting riparian zones is the "Three Zone Buffer System," which is designed to incorporate the filtering systems of a forest into a smaller tract of land next to a stream. The zone closest to the stream is a wood lot managed with the stream in mind, with little or no impact by people. The middle zone contains woodland that can be used by the landowner. The outside zone consists of grasses planted to filter and permit infiltration of runoff.

The three-zone buffer won't necessarily work in every situation; riparian planting should be done on a case-by-case basis. One of the major design challenges is deciding on a width for the riparian forest buffer. Factors including slope, soil type, adjacent land uses, floodplain, vegetation type and watershed condition influence what can and should be created. The most commonly prescribed minimum buffer widths for use in water quality and habitat maintenance are 35 to 100 feet. Buffers of less than 35 feet cannot sustain long-term protection of aquatic resources.

Trees for Zones One and Two

In order to select trees for riparian buffers in zone one, several factors must be considered. Trees located close to the waterway are most likely to be flooded, and require a high tolerance of high water tables. If the area has been recently disturbed, trees with a quick growth rate will establish soil stabilizing root systems more quickly. Fast-growing trees aren't necessarily long-lived, however. Therefore, an interplanting of slow-growing trees is also advised.

Eventual tree heights are another important issue. Some questions to consider: At maximum height, will the tree provide enough shade for the stream? What are the landowner's aesthetic preferences (to screen or frame a view, for example, or to provide a windbreak)? Are there safety concerns such as avoiding power and telephone lines?

Trees with shallow root systems hold surface soils well but don't provide as much stability on high banks and steep slopes as trees with deep root systems. Deep root systems also anchor trees better where there are repeated flooding and drying cycles. The following are

Streambank Fencing Available to Landowners

A number of streambank fencing programs are available to farmers and landowners from the federal and state governments and other sources. These streambank fencing programs provide a variety of cost-sharing options up to a 100-percent match. Also, several of the programs have provisions for funding of limestone-lined livestock crossings. The following is a summary of available programs and contacts.

Government Agencies

Pennsylvania Department of Environmental Protection (DEP)—Streambank Fencing Program. Funds are available for fencing, energizers and crossings. This program provides up to 100-percent funding. Fencing must be 12 feet from the streambank and must meet DEP specifications. There may be a waiting list for this program. Another DEP program for streambank fencing, the Financial Assistance Funding Program, focuses on sediment control. The cost share is 80 percent to a maximum of $30,000. Fencing is five strands of high-tensile wire. CONTACT: DEP Streambank Fencing Program, 717-772-5645

Pennsylvania Game Commission. The Game Commission will pay for a contractor to build a fence on farm property and will provide a solar charge unit if necessary. Fencing must be placed a minimum of 10 feet from the streambank. The landowner must agree to cooperate with either the Farm-Game or Safety-Zone public access programs that require continuous maintenance of the fencing. There may be a waiting list for this program. Two-strand electric fencing is standard. Cost share is 100 percent within the Chesapeake Bay drainage system. CONTACT: Pennsylvania Game Commission, RD 2, Box 2584, Reading, PA 19605, 1-800-228-0791 or 717-787-6400.

Pennsylvania Forest Stewardship Program. This is a statewide program, with 65-percent cost sharing, administered by the Pennsylvania Department of Conservation and Natural Resources' Bureau of Forestry. Fencing consists of wood posts and high-tensile wire. CONTACT: Pennsylvania Forest Stewardship Program, 7 Ferguson Building, University Park, PA 16802, 814-863-0401.

Chesapeake Bay Program. Funds are available for fencing, crossings and bank stabilization for farms within the Chesapeake Bay watershed. The cost-share rate for stream protection best management practices is 50 percent. Fencing is normally part of a comprehensive program that includes erosion control, a conservation plan and a nutrient management plan. The limit for all cost-share monies received under this program is $30,000 per person or farm. All best management practices must meet Natural Resources Conservation Service (NRCS) specifications and be certified by NRCS. A demonstration site shows best management practices in action. A streambank planting program is in the planning stages. CONTACT: Chesapeake Bay Foundation Pennsylvania Office, 717-234-5550.

U.S. Fish and Wildlife Service. This federal organization, part of the Department of the Interior, has the mandate to protect migratory species that naturally cross state boundaries. Funding is cost-shared at 100 percent, and fencing is two strands with wood posts. Pennsylvania Game Commission cooperators receive priority. CONTACT: U.S. Fish and Wildlife Service, Allenway Building, State College, PA 16801, 814-234-4090.

Pennsylvania Fish and Boat Commission. This program provides technical guidance and planning for comprehensive stream corridor management and can provide up to $500 for materials per project year. Participating landowners must agree to open their land for public fishing purposes for 10 years. CONTACT: Pennsylvania Fish and Boat Commission, Habitat Management Section, 450 Robinson Lane, Bellefonte, PA 16823, 814-359-5185.

Chesapeake CARE—Pennsylvania. This program provides 100-percent funding for wetlands and riparian restoration in the Octoraro Creek watershed. Funds are available for fencing, energizers, crossings and wetland creation. CONTACT: U.S. Fish and Wildlife Service, 315 South Allen Street, Suite 322, State College, PA 16801, 814-234-4090.

Donegal Creek Restoration Project. Funds are available for fencing, crossings, tree planting, bank stabilization and fish habitat improvement. The cost-share rate is 100 percent for landowners in the Donegal Creek watershed. Fencing must meet Conservation District specifications. All fencing systems will be maintained by the Conservation District and the Donegal Creek Fish and Conservation Association. CONTACT: Donegal Creek Conservation District, Farm and Home Center, Room 6, Lancaster, PA 17601, 717-299-5361.

Pequea—Mill Creek Project. Funds are available for fencing, energizers, crossings and bank stabilization. This program provides 75-percent cost-sharing within the Pequea-Mill Creek Project area. The landowner must be a conservation district cooperator. Funds are also available for crossings and bank stabilization if the stream has been fenced previously through the Pennsylvania Game Commission's public access programs. Located east of Lancaster, this Conservation District Office-led project is not looking for more cooperators because of large demand. Partnerships include Trout Unlimited chapters and Pheasant Forever. CONTACT: Pequea-Mill Creek Project, P.O. Box 211, Smoketown, PA 19565-0211, 717-396-9423.

Conservation Reserve Program. This is a federally funded USDA program administered through the Farm Service Agency. An underutilized program, it makes payments to farmers for acreage in a riparian zone, much like payments made to farmers for crop acreage that is set aside. The program pays approximately $40 per acre to a farmer for leaving these environmentally sensitive areas alone. Contracts are for 15 years, 30 years or in perpetuity. CONTACT: Farm Services Agency, State Office, 717-782-4547.

Private Organizations

French Creek Project. Sponsored by the Pennsylvania Environmental Council (PEC) and the Howard Heinz Endowment, this project provides 75-percent cost sharing for streambank fencing. The initiative focuses on in-stream preservation of endangered species, as well as the health of the watershed. Wood posts and three strands of high-tensile wire are standard. CONTACT: French Creek Project, Box 172, Allegheny College, Meadville, PA 16335, 814-332-2946.

Partners for Wildlife. This streambank fencing program is targeted at 10 demonstration areas across the state, mostly in western Pennsylvania so far, to provide and create woodlot-field interfaces with crop fields to benefit wildlife. Warm-season grasses are planted in the riparian zone. Funding is from the Richard Mellon Foundation, Howard Heinz Endowment and the Foundation for the California University of Pennsylvania. Projects are 100-percent cost-shared with permanent high-tensile wire and wood posts. CONTACT: Partners for Wildlife, California University of Pennsylvania, California, PA 15419, 412-938-4215.

Octoraro Watershed Association. This private, nonprofit education organization works in the Octoraro watershed and has coordinated streambank stabilization projects along the west and east branches of the Octoraro Creek. The Octoraro Watershed Association has cooperated successfully with FFA students, the Farmer's Sportsmen Association, Trout Unlimited, the Game Commission, and the U.S. Fish and Wildlife Service. CONTACT: Octoraro Watershed Association, P.O. Box 98, Kirkwood, PA 17536, 717-529-2607.

a few of the trees that could be used in zones one or two (This is a general list and is not site specific):

- Willow Oak
- Sycamore
- Black Walnut
- Hackberry
- American Beech
- White Ash
- Eastern Cottonwood
- White Oak
- Silver Maple
- Red Maple
- Red Oak

Understory for Zones One and Two

The understory plants of a riparian zone are in both zones one and two. Understory tree shrubs are tolerant to shade but some are more adapted to an edge situation. Most native shrubs in riparian zones prefer moist growing conditions and are good filters for overland waterflow. Planting understory trees and shrubs increases the biodiversity of the riparian buffer and enhances both water quality and wildlife habitat. Following are understory species that could be used in zones one or two:

- Buttonbush
- Arrowwood
- Box Elder
- Witch Hazel
- Pussy Willow
- Bayberry
- Common Alder
- Shadblow
- Winterberry
- Silk Dogwood
- Sweet Bay
- American Holly
- Elderberry
- Spicebush
- Flowering Dogwood

Grasses for Zone Three

Zone three is the interface between the wooded area of a riparian buffer and any other adjacent land use. Its width may range in size from a few feet to an entire pasture. This zone spreads waterflow, filters sediments from runoff and absorbs nutrients. This is an excellent place to establish native warm-season grasses for wildlife.

It is a common misconception that improving wildlife habitat means providing winter foods. Much of the decline seen in populations of ground-nesting birds, in fact, results from a lack of nesting and brood-rearing cover. By planting native, warm-season grasses rather than foreign or exotic species, a landowner can meet the needs of quail, turkeys, meadowlarks, songbirds and other species. Small mammals such as voles, mice and cottontail rabbits will inhabit these areas as well and provide food for birds of prey and foxes. In addition, by including some wildflowers and forbs in a zone three planting, the landowner will be supporting a variety of valuable insects such as butterflies.

Recommended warm-season grasses should have the following characteristics:

- A strong root system to hold the soil;
- A tendency to grow in bunches (these are not turf grasses);
- The ability to remain standing during the winter, providing cover and continuing to filter sediment from runoff;
- The ability to grow well in low-fertility soils;
- The ability to provide high-quality pasture forage and hay if use is controlled to prevent negative impacts on nesting birds.

Warm-season grasses are slower to establish than the more familiar cool-season grasses that are normally planted. It may take two growing seasons for a zone planted with warm-season grasses to establish itself. Once a stand is established, however, the benefits of

low maintenance, increased wildlife and improved water quality far outweigh the initial effort.

Three known types of warm-season grasses are Big Bluestem *(Andropogon gerardii)*, Little Bluestem *(Andropogon scoparius)* and Switchgrass *(Panicum virgatum)*.

BIG BLUESTEM. Big Bluestem is a long-lived erosion control plant for stream sides, mine spoil and road sides. It is excellent forage for livestock and cover for wildlife. Big Bluestem should be seeded in the early spring. Seed at 15 to 20 pounds per acre, and compact the soil after seeding. Big Bluestem is slow to germinate. Although it establishes the first year, it will not produce fair to good cover until the end of the second year. It tolerates medium- to low-fertility, acid, sandy, loamy, and clayey soils, has poor shade tolerance, and prefers well-drained sites.

LITTLE BLUESTEM. Little Bluestem is a persistent, low-maintenance, warm-season, bunch-type perennial grass. As a native grass, Little Bluestem is almost always incorporated into mixes used to produce long-living native stands. It is drought tolerant and adapts to a wide variety of soil types but is not very shade tolerant. Seed at 12 pounds per acre when used alone and at four pounds when used in mixes. Little Bluestem reaches two to three feet in height.

SWITCHGRASS. Switchgrass is a valuable stabilization plant for streambanks, strip mine spoil and other critical areas. It provides food, excellent nesting, and fall and winter cover for wildlife. Switchgrass should be seeded at 10 pounds per acre and requires one to two years to become totally established. Little or no management is required after that.

Project Grass

Project Grass, an outgrowth of the Commonwealth's Nutrient Management Law, is a "grassroots effort"—excuse the pun—to teach and promote best management practices on livestock farms. Operating for several years in the 15 counties of southwestern Pennsylvania, the project promotes rotational grazing as a nutrient management tool, as well as a low-input farming method that will lead to cleaner streams.

Research has shown that rotational grazing cuts production costs, but it also has other benefits that are often overlooked. When a good rotational grazing system is adopted and livestock are rotated through the system, forage quality and yield are improved. The forage is kept in a vegetative state, meaning it is constantly growing and absorbing nutrients from the soil .

Another benefit of rotational grazing is less pollution. One of the main sources of agricultural nonpoint source pollution is concentrated animal populations around animal housing facilities. When the livestock are out on pasture grazing, however, the amount of time the livestock spend around animal housing is reduced, along with the chances of pollution.

Rotational grazing also means the farmer has less manure to handle. When the livestock are on pasture, the manure is distributed onto the fields by the animals. In a confinement system, however, manure has to be hauled and spread daily, or an expensive storage facility must be built to hold it. Among the many downsides of daily spreading is that the heavy spreader-tractor combinations compact the soil, whereas livestock do minimal compaction.

Among its other benefits, rotational grazing reduces the amount of farm equipment a farmer has to use. If the animals are harvesting their own feed for a portion of the year, the farmer has less feed to harvest mechanically. In addition, when a grazing system is installed, the amount of row crops is usually reduced—along with person hours, wear and tear on equipment, fuel usage, pesticide and herbicide usage, and soil erosion. A reduction in fuel use has the added benefit of reducing the nitrogen and carbon dioxide emissions that contribute to acid deposition.

In addition to promoting rotational grazing, Project Grass promotes streambank fencing and improved water quality in waterways on the farm. Project Grass farms are also required to develop and implement a nutrient management plan. This is a tool that tells farmers how much manure and fertilizers to apply to the land at safe levels to insure both that the impact on the environment is minimal and that crop nutrient needs are met.

The following are initial results from surveys of 13 of the 38 demonstration farms installed in 1997 by Project Grass:

Average size of grazing system:	42.5 acres/farm
Average amount of soil saved as a result of grazing:	54 ton/yr/farm or 1.3 ton/acre/yr
Average amount of commercial fertilizer saved:	1.4 ton/yr/farm
Average number of days the grazing season was extended:	57 days/yr/farm
Average amount of money saved as a result of grazing:	$62.76/animal/yr
Average amount of diesel fuel saved as a result of grazing:	188 gal/yr/farm
Average amount of oxides of nitrogen not emitted to atmosphere:	0.75 lb/yr/farm
Average amount of carbon dioxides not emitted to the atmosphere:	3,122 lb/yr/farm
Total amount of streambank fencing installed:	11,710 feet

Although these numbers are impressive, they are the result of installing fence for paddocks and streambank fencing only. If more best management practices were used on the surveyed farms, these numbers would be even better.

Conclusion

According to the Bureau of Watershed Conservation at DEP, there are 1,168 miles of impaired rivers and streams in the Allegheny Watershed alone. While resource extraction (acid mine drainage) is the main culprit, agricultural runoff is the second largest factor in the pollution problem. And, more importantly, it is a factor that can be easily changed. Pennsylvania has an established system of Conservation Districts, Farm Service Agency and Extension Service offices to teach best management practices to those managing agricultural lands.

According to research done for Pennsylvania's Chesapeake Bay Program, 60,000 tons of nitrogen are deposited into waterways that feed the Susquehanna River each year. The Allegheny Watershed—home to as much or more agricultural activity as the Susquehanna basin—suffers from a comparable volume of pollutants, including both nitrogen and phosphorus. These excess levels of nutrients result in harmful algae blooms that deplete oxygen supply and block out sunlight necessary to aquatic plant and animal life.

The wide availability of streambank fencing programs in Pennsylvania is a sign that the Commonwealth is prepared to stand up to the problem of agriculture-related stream and river pollution. But streambank fencing alone is not the answer to soil erosion and other problems. The planting of native species in our agricultural riparian zones—together with other environmentally beneficial practices from planned grazing to diversions and filter strips (see below)—all are important elements of stream corridor management on agricultural lands. ■

Other Farming Practices That Are Good for Streams

Livestock Watering Facilities. Troughs or tanks installed to provide livestock water supplies from a spring, pond, well or other source. This keeps cows out of the stream and does not require a pump to fill because it is placed downhill from the water source. Key benefits: permits piping of water to rotational pastures; provides clean water supply for livestock; improves forage utilization through distribution of grazing.

Filter Strips. Strips of vegetation—a minimum of 15 to 25 wide—that remove sediment, organic matter and other pollutants from runoff. Key benefits: can be used on cropland next to streams to reduce sediment loads.

Diversions. Channels and ridges that divert excess runoff for use or safe disposal in other areas. Key benefits: can be used to divert water from a feedlot, cropland or farm buildings.

Water and Sediment Control Basins. Short earthen dams built across slopes and minor drainageways. Key benefits: traps sediment, reduces gully erosions and reforms the land surface.

Reducing Nutrient Pollution in Pennsylvania's Streams and Rivers

Too Much of a Good Thing

BY LAMONTE GARBER

Garber is former Agriculture Policy Analyst with the Chesapeake Bay Foundation.

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Nutrients are essential to life. Nitrogen, for example, is used by organisms in the production of plant and animal tissue. And phosphorus is essential to cellular growth and reproduction. This is why most agricultural crops require ample amounts of these and other nutrients in the soils in which they grow. Corn, the most widely planted row crop in Pennsylvania, requires roughly three-quarters of a pound of nitrogen for every bushel of corn that's harvested.

When nutrients from farming make it into Pennsylvania streams and rivers, however, they can cause very serious problems. Excessive nutrients in streams, rivers, lakes and estuaries spur the growth of algae, particularly single-celled plants called phytoplankton. Dense populations of phytoplankton, called "blooms," usually occur in slow-moving or stagnant water bodies and can cause all kinds of trouble for other aquatic life. Algae compete for sunlight that other, more beneficial plants need for photosynthesis. And when the algae die, the oxygen in the water is consumed as bacteria decompose the dead plant material. This, in turn, reduces oxygen levels to the point where aquatic organisms cannot survive.

A Real Threat to the Chesapeake Bay and Other Water Bodies

Excessive nitrogen and phosphorus are the most damaging pollutants in the Chesapeake Bay. During the summer, when algae production is at its highest, the water in many areas of the Bay becomes dangerously low in oxygen. When all dissolved oxygen is depleted from water, a condition known as "anoxia" results. Watermen who work on the Bay refer to anoxic

water as "dead water," a reflection of the uninhabitable conditions for fish, crabs, oysters and other aquatic life. Recently, excessive nutrients have been implicated as a contributing factor in the outbreak of *Pfiesteria piscicida*, a single-celled organism that killed tens of thousands of fish in the Chesapeake Bay during the summer of 1997.

Excessive nutrients and algae also have caused the loss of many thousands of acres of bay grasses, called "submerged aquatic vegetation." These grasses, which provide important food and shelter for many organisms, once blanketed hundreds of thousands of acres in the Bay. Although they have begun to make a comeback in recent years, bay grasses have reclaimed only a small fraction of their potential habitat.

Estuaries such as the Chesapeake Bay are not the only water bodies to suffer from nutrient pollution. The cycle of high nutrient levels leading to algae production and low dissolved oxygen plagues many lakes and rivers in the Commonwealth and throughout the country. This cycle, also called "eutrophication," is driven primarily by the presence of phosphorus in freshwater systems. According to a 1991 study, nutrients are the leading cause of degradation in 59 percent of lakes

and 13 percent of U.S. rivers that do not meet water quality goals.

The problem is especially pronounced in Pennsylvania. Pennsylvania's Department of Environmental Protection (DEP) has measured the trophic status, or degree of nutrient enrichment, of several of Pennsylvania's publicly owned lakes. According to DEP's 1998 Water Quality Assessment, there are many lakes affected by nutrient loading. The same report classified 4,407 miles of Pennsylvania rivers as totally impaired, that is, not fully supporting swimmers, fishing, or both. Of this total, 1,297 river miles were degraded by pollution related to agriculture. It is important to note here that acid mine drainage is the leading cause of degradation of Pennsylvania streams.

Nitrogen:

A Health Concern for Humans and Animals

Nitrogen is a concern for groundwater quality because nitrates can leach readily through soils and contaminate groundwater. According to the U.S. Environmental Protection Agency, contamination exceeding 10 parts per million (ppm) for nitrate nitrogen is unsafe for infants less than six months old. At high levels, nitrates can lead to methemoglobinemia, a condition called "blue baby syndrome," in which an infant's blood cannot carry sufficient oxygen. In Pennsylvania, high nitrates in groundwater typically are observed in areas underlain by carbonate bedrock and supporting intensive agricultural production (mainly southeastern and southcentral counties).

Controlling Nutrient Pollution: What's Happening?

Reducing nutrient pollution is so critical to the health of the Chesapeake Bay that Pennsylvania, Maryland, Virginia, the District of Columbia and the U.S. Environmental Protection Agency (USEPA) have pledged to reduce nitrogen and phosphorus "loadings" to the Bay by 40 percent by the year 2000. This is an especially ambitious goal for Pennsylvania because the Susquehanna River is the largest tributary to the Chesapeake Bay and carries more nitrogen to the Bay than any other waterway. To meet the 40-percent nutrient reduction goal, Pennsylvania will have to reduce the Susquehanna River's nitrogen load by roughly 20 million pounds and the phosphorus load by roughly 2.5 million pounds.

Pennsylvania's efforts to reduce nutrient pollution to waterways in the Commonwealth began in the 1970s with new limits on phosphorus discharged by sewage treatment plants in the lower Susquehanna River basin. Additional reductions in point-source discharges of phosphorus came in 1990 with the adoption of a phosphate detergent ban in Pennsylvania.

As sewage treatment improved throughout the state, attention shifted to reducing nutrient runoff from farms. Pennsylvania officially entered the Chesapeake Bay Program in 1984 as part of a major initiative to reduce nutrient and sediment pollution in the Susquehanna and Potomac River watersheds. This voluntary program provides up to $30,000 of state and federal funds for individual farmers to implement agricultural best management practices (BMPs). These BMPs emphasize the proper collection, storage and application of animal manures and control of stormwater runoff and cropland erosion. Program funding has grown from approximately $2 million in 1984-85 to $6 million in 1997-98. As of June 1996, the Chesapeake Bay Program has helped farmers implement animal waste management systems on nearly 700 Pennsylvania farms.

Also helping to reduce nutrient pollution from farms are streambank fencing programs administered by the Pennsylvania Game Commission, the U.S. Fish and Wildlife Service and the Pennsylvania Department of Environmental Protection (DEP). Streambank fencing enables landowners to restrict cattle from stream banks. This prevents animals from defecating in streams and allows natural buffer strips to develop that help filter runoff from adjacent pastures and cropland. (For more information, see "Stream Corridor Management on Agricultural Lands: Stream-Friendly Farming," page 23.)

Although most programs to reduce nutrient pollution from Pennsylvania farms emphasize voluntary measures, a number of regulatory requirements also exist. First, the Pennsylvania Clean Streams Law includes animal waste in its definition of sewage and prohibits the discharge of these wastes into state waters. This law also gives DEP broad authority to regulate all potential sources of pollution, including nutrients from agricultural waste. Under regulations implementing the Clean Streams Law, the State developed a special publication—"Manure Management for Environmental Protection" (also called the "Manure

Management Manual")—that serves as a compendium of BMPs for manure management. Farmers are required to follow the Manure Management Manual or to get a permit from DEP if they cannot. As of this writing, however, no manure handling permits have been issued.

In addition, the federal Clean Water Act gives DEP added regulatory authority and responsibilities with respect to certain large livestock operations, which the federal act refers to as "Concentrated Animal Feeding Operations," or CAFOs. CAFOs that have potential to discharge to a waterway are required to get point-source permits. As of 1997, DEP adopted an independent permitting program to address large animal operations.

The Nutrient Management Act

Despite the many voluntary and regulatory measures in place to reduce nutrient pollution from agricultural operations, documented progress has been modest. In the hopes of accelerating the adoption of nutrient management plans on farms, the Pennsylvania General Assembly passed the Nutrient Management Act in May 1993. The Act's requirements became effective on October 1, 1997.

The Nutrient Management Act calls for mandatory nutrient management plans for all concentrated animal operations, or CAOs. Defined differently than the federally designated CAFOs described above, a CAO is a farm having at least 2,000 pounds of livestock or poultry per acre. In other words, the Act focuses its mandatory measures on farms producing a high number of animals on limited acreage. Only approximately 5 to 10 percent of Pennsylvania farms fall into the category of a CAO. The majority of these are located in southeastern Pennsylvania, primarily in Lancaster County. Under the Nutrient Management Act, farms that violate the state's Clean Streams Law may also be required to implement nutrient management plans. In addition, non-CAOs are encouraged to implement plans of their own on a voluntary basis.

Nutrient management plans are designed to balance applications of fertilizer, manure and other nutrients with the nutrient needs of crops receiving those applications. Plans also address manure storage construction, proper management of barnyards and control of concentrated stormwater runoff. CAOs with too much manure for their cropland must record how and where it is disposed. They must also maintain records of soil tests, nutrient applications, crop yields and annual manure production. Plans can be developed by private consultants or individual farmers and must be certified by the Department of Agriculture before their submittal to a conservation district for review and approval.

There are several important aspects of the Nutrient Management Act to which farmers and others need to pay close attention. These include:

- In addition to encouraging voluntary compliance with the Act, the State Conservation Commission is charged with taking enforcement actions and imposing civil penalties of not more than $500 for the first day of each offense and $100 for each day of continuing violation. In the event of a violation,

Sources of Nutrient Pollution

Nutrients that contribute to water pollution come from many human and natural sources. These generally fall into two categories: point sources and nonpoint sources. Point sources are those sources discharging pollutants into waterways from a "discrete conveyance," such as a pipe. The primary point sources of nutrient pollution are municipal sewage treatment plants, which typically discharge nutrients from treated human waste directly into streams. Nonpoint sources, on the other hand, convey nutrients to waterways and groundwater from more widespread and dispersed sources. Nonpoint source pollution—also called "polluted runoff"—includes stormwater runoff from the land, pollution from septic systems and air pollutants that wind up in the water.

Statewide, nonpoint sources contribute much more nutrient pollution to Pennsylvania waterways than do point sources. Moreover, of all pollution sources, agriculture contributes nearly 70 percent of the nonpoint phosphorus load and 40 percent of the nonpoint nitrogen load to surface water and groundwater in the state (The Pennsylvania State University, 1997). Agricultural nutrient pollution originates mainly from fertilizers and animal wastes. The next largest nonpoint pollution source is air pollution, which contributes 49 percent of the nonpoint nitrogen load of Pennsylvania water resources. Airborne nitrogen comes from automobiles, utilities and animal wastes.

the existence of a fully implemented and approved nutrient management plan may be used as a mitigating factor in assessing any penalties or damages.

- CAOs had one year from October 1997 to develop nutrient management plans and to have them approved by the State Conservation Commission or by a county conservation district that is delegated this authority. Once its plan is approved, a CAO has three years to fully implement it.

- The Nutrient Management Act preempts local ordinances "related to the storage, handling, or land application of animal manure and nutrients if the local ordinance or regulation is in conflict with this Act or its regulations."

- In addition to its requirements regarding nutrient management plans, the Act established an educational program for nutrient management and required DEP to assess other sources of nutrient pollution. It also created a financial assistance program to help farmers finance the costs of implementing nutrient management plans.

- The State Conservation Commission and county conservation districts administer the nutrient management program with assistance from DEP and the Pennsylvania Department of Agriculture. Penn State's Cooperative Extension Service is contracted to provide educational services.

The impact of the Nutrient Management Act on water quality in Pennsylvania and the Chesapeake Bay will probably not be evident for several years. Given the limited number of farms that are required to develop plans, the impact may be small in regions outside of southeastern Pennsylvania. Moreover, there are serious weaknesses in the requirements for nutrient plans. For example: soil testing is required only once every six years; manure can be spread throughout the year, including during winter months; there are no limits placed on phosphorus applications; erosion control plans are not required by the Act as part of the nutrient management plan; and no groundwater or surface water monitoring is required.

Nevertheless, passage of the Act represented a positive step in Pennsylvania's efforts to reduce nutrient pollution from agricultural sources. This is the first law in the Commonwealth that requires regulatory oversight of nutrient management plans on farms. Also of note, it established requirements for farms with the intent of preventing pollution, in contrast to the traditional policy of reacting to pollution events. While it relies on voluntary measures, which may reduce its effectiveness, the Nutrient Management Act provides Pennsylvania with the foundation for a more comprehensive and proactive regulatory program to reduce nonpoint source nutrient pollution from agriculture.

What Citizens Can Do

County conservation districts play a central role in implementing the requirements of the Nutrient Management Act, as well as other programs dealing with agriculture and the environment. In recent years, district offices have taken on increasing responsibilities in outreach and enforcement of a wide variety of state regulatory programs. Unfortunately, however, districts in many counties have very limited staff and funding to implement these programs. Moreover, the degree to which districts have made the transition from their traditional role of providing education and technical assistance to one that includes regulatory responsibilities has been inconsistent.

Citizens need to work with their local district to increase recognition of the district's roles in protecting the local environment and to advocate for additional financial and human resources for the district. At the same time, citizens need to monitor how effectively county conservation districts, DEP and the Department of Agriculture are addressing agriculture-related pollution problems.

Last but not least, it's important to remember a vital but often-overlooked role for citizens—that is, reporting any and all pollution events to DEP or a local conservation district so that action can be taken to address the problem (For more information on citizen involvement, see the articles in *What Citizens Can Do.*) By working together, citizens, farmers and government can help reduce nutrient pollution in Pennsylvania and the Chesapeake Bay—and protect our waterways for future generations. ■

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For more information:

For those interested in more information on the Nutrient Management Program, ask for Penn State Cooperative Extension's Agronomy Facts 40 - Nutrient Management Legislation in Pennsylvania: A Summary of the Final Regulations. This publication is available from your local legislator or the State Conservation Commission, Agriculture Building, 2301 N. Cameron Street, Harrisburg, PA 17110-9408; or call (717) 787-8821.

7

Forestry Best Management Practices

The Woods and the Water

BY CAREN GLOTFELTY
Glotfelty is Goddard Chair at Pennsylvania State University.

Over the centuries, Pennsylvania's vast forests have been a vitally important resource, both economically and environmentally. Before European settlement in the 17th century, Pennsylvania was almost completely forested. The Commonwealth's early economy was built on timber and wood products. By 1920, nearly every acre from east to west and north to south had been clearcut at least once to fuel iron furnaces, supply mine and building timbers or make turpentine, varnish and other wood-based compounds.

Approximately 60 percent of Pennsylvania's land, about 17 million acres, is now reforested, more than half of it growing trees that are 70 to 100 years old. This is the most forest the Commonwealth has had since the mid-1800's. Although forests are more abundant in the northern half of Pennsylvania, there are significant reforested areas throughout the state; Philadelphia is the only county with less than 15 percent of its area in forest cover.

With timber prices now at an all-time high, Pennsylvania's renewed forests have become a vital economic resource once again. Often overlooked, however, is the status of the Commonwealth's forests as an environmental resource as well. The fact is that forests play a crucial role in promoting and maintaining environmental quality in Pennsylvania. Forests help protect water resources and promote water quality. They are also important for wildlife habitat, biological diversity and the promotion of healthy ecosystems.

Insuring that forests remain an important environmental resource for Pennsylvania is the goal of efforts to promote best management practices (BMPs) for forestry. The primary benefit of BMPs is that they can help prevent any environmental degradation that might result from increased timber harvesting.

Characteristics of Forest Land in Pennsylvania

Compared to other states, Pennsylvania has a large proportion of its forest land in public ownership—about 29 percent. More than one-third of the public land in the state (12 percent of forest land) is owned and managed by the Bureau of Forestry as state forest. Another 9 percent of forest land is managed by the Pennsylvania Game Commission. The Allegheny National Forest comprises 3 percent of Pennsylvania's forest land, and other public entities, such as county and local parks and water suppliers, own another 5 percent.

The remaining 71 percent of forest land in Pennsylvania is in private ownership, with farmers owning 15 percent and corporations 16 percent. Individuals own about 40 percent of the state's forest land. There are approximately 500,000 individual private forest landowners in the state.

The forest products industry in Pennsylvania is currently a $5 billion per year enterprise, employing more than 90,000 workers. It is the fourth-largest sector of Pennsylvania's economy, and it is growing. Pennsylvania has the largest hardwood inventory in the nation, with standing timber in the state valued at more than $15 billion, as estimated by the U.S. Forest Service. The predominant timber species are Allegheny hardwoods (cherry), northern hardwoods and mixed oak. Forests also contribute indirectly to the state's economy as an important resource for recreation and tourism, the state's second-largest economic sector.

In addition to the economic pressures resulting in an increase in timber harvesting on both public and private lands in Pennsylvania, suburban sprawl throughout the state continues to fragment forest ecosystems and threaten forest uses, including timbering, recreation, water resource protection and biological diversity conservation.

Forest Impacts on Water Quality and Quantity

More than half of Pennsylvania's total stream miles flow through totally forested watersheds. These are the cleanest of Pennsylvania's clean streams. Forests are good for water quality and quantity because their soils have a high "infiltration capacity." Forest soils, in other words, are able to act like a sponge, absorbing large quantities of water. For this reason, rainfall or melting snow in forests produces relatively little surface runoff. Rather, the water is held for a long time in the forest soil and is gradually released to a surface stream or groundwater. Streamflow in a forested watershed is therefore more even over time—less "flashy"—than in an agricultural or urbanized areas. Forested watersheds also are less prone to flooding than nonforested watersheds.

Generally, streams flowing through stable forests have very low turbidity (cloudiness due to suspended sediments) because the problems of soil erosion and sedimentation associated with high surface runoff are less in forested than in nonforested areas. Sediment harms water resources by degrading or destroying fish habitat, reducing the storage capacity of reservoirs and increasing treatment cost for water supplies.

Trees are a major contributor to the high infiltration capacity of forest soils; a large leafy tree can take up as much as a ton of water from the soil every day through its root systems. In addition, because of their rich organic content, forest soils are well-structured and contain a great deal of interconnected pore space through which water can easily drain; soil pores thus act as miniature reservoirs for the storage of additional water. Also contributing to the forest soils' porous structure are microorganisms, insects and small animals living on or under the forest floor and growing tree roots.

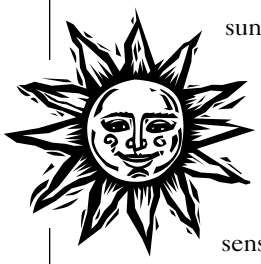
Soil pores in forested areas are able to stay unclogged and open for water storage because much of the rainwater and snowmelt never even makes it into the soil. Rain falling on the forest is intercepted by the leaves and branches of canopy trees and understory vegetation, allowing as much as 70 percent to evaporate back into the atmosphere and reducing the impact of raindrops on the soil.

Forests that are substantially thinned or clearcut can cause increased runoff to streams because there are fewer leaves and branches to intercept rainfall—and also fewer roots take up water from the soil. In the northeastern United States, the greatest increase in streamflow occurs during the first growing season after harvesting. In subsequent years, as the forest grows new vegetation, stream flow lessens, usually returning to pre-cut levels within five to ten years.

Timber harvesting doesn't just affect water quantity, however. It also can affect water quality, not only by increasing the soil erosion and sedimentation that accompanies increased runoff, but also by potentially accelerating soil erosion through logging practices. The greatest problems do not occur from the cutting of trees, but from their removal from the forest, which requires heavy equipment on a system of cleared trails, landings and roads. In fact, erosion and sedimentation from logging roads accounts for most of the water quality problems associated with timber harvesting.

Another critical environmental benefit of forests is their ability to hold and recycle nutrients, particularly nitrogen, instead of allowing them to pass into nearby waterways. Erosion and sedimentation can produce increased phosphorus concentrations in streams because phosphorus binds to sediment. Moreover, studies in Maine have shown that nitrate concentrations in streams may rise after timber harvesting; the remaining vegetation is insufficient to utilize the nitrogen in the soil. This "nitrification" also can lead to soil and stream acidification, which in turn results in high aluminum concentrations in soil solutions and surface waters.

Logging can also cause thermal impacts on water quality. Removal of trees and understory vegetation from the bank of a stream often allows direct sunlight to shine on the stream's surface. The temperature of the stream will increase as a result, affecting the cold water-dependent aquatic ecosystem. Warmer streams may be unsuitable habitats for sensitive fish species such as trout, which thrive within a narrow range of temperatures. Trout have high oxygen requirements, and warm water contains less dissolved oxygen than cold water.



Debris from logging is another problem. When debris from logging ends up in a stream, it creates dams and channel splits that can cause stream bank erosion and new channel or pool formation, producing a negative effect on water quality. While some in-stream woody debris provides essential cover for aquatic wildlife, excessive amounts can be detrimental.

The Regulatory and Legislative Picture

Theoretically, state environmental laws and regulations protect water quality and aquatic habitat from damage due to logging. These regulatory requirements include the Chapter 102 and Chapter 105 regulations resulting from the Clean Streams Law and the Dam Safety and Encroachments Act. Under these regulations, any activity that disturbs more than 25 acres of earth at one time requires a permit from the state Department of Environmental Protection (DEP). Most timber cutting operations disturb less than 10 percent of the harvested area, so a permit is not usually required for logging a site of fewer than 250 acres. However, all timber harvesting operations of any size must prepare a site-specific erosion and sediment control plan and keep it on site during the operation.

Also requiring permits are timber harvesting operations that require access roads and skid trails to be constructed across streams. To minimize impacts on water flows or quality, stream crossings are allowed only under certain circumstances. Chapter 105 requires permits for all types of crossings, including culverts, bridges and fords. Permit applications must be accompanied by an erosion and sedimentation control plan approved by the county conservation district.

Also, permits are required under both state and federal law for all crossing of wetlands by logging access roads and skid trails. Wetlands are regulated jointly by the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers and Pennsylvania DEP. Timber harvesting in forested wetlands is not regulated, but road and skid trail crossings, considered "encroachments," are. DEP Chapter 105 prohibits the encroachment into any wetland without a permit. Although the Army Corps of Engineers issues a separate permit, the DEP permit requirements will satisfy federal rules as well.

Fish habitat is protected by Chapter 25 regulations under the Pennsylvania Fish and Boat Code, which requires permits for any alteration or disturbance of streams, fish habitat or watershed that in any way may damage or destroy habitat. Chapter 25 also prohibits any substance harmful to fish life to run,wash or flow into the waters of the Commonwealth. Enforcement of the Fish and Boat Code is the responsibility of the Pennsylvania Fish and Boat Commission.

Despite these and other requirements, it is difficult to monitor compliance of logging operations in order to protect water quality and aquatic habitat from the negative effects of timber harvesting. Although responsibility for permitting and inspection has been delegated by the state DEP to many county conservation districts, the remote nature of many logging sites and the staffing limitations of conservation districts make enforcement a real challenge. Some municipalities have enacted local ordinances to regulate timber harvesting, earth moving and other activities associated with forest management, but in most areas there is little active enforcement.

In addition, there are no state-level legal requirements in Pennsylvania that govern other aspects of

logging, such as potential damage to non-timber plant species, terrestrial habitat, aesthetics or the standing timber that is left behind. There is also no certification or licensing program to help ensure that foresters or loggers in Pennsylvania are educated in proper forestry practice.

The Right to Practice Forestry Act was passed by the Pennsylvania General Assembly in 1992 to prohibit local governments from using zoning ordinances to unreasonably restrict landowners and others involved in timber harvesting. In response, Penn State University Cooperative Extension and the Pennsylvania State Association of Township Supervisors have developed a model timber harvesting ordinance for adoption by local government that would meet the requirements of the law.

Actions Needed Now

A timber harvest assessment of 85 randomly located sites in Pennsylvania was conducted in 1995 and 1996 under the direction of Penn State University researchers. The study showed that only 53 percent of the sites—all of which were timbered during the period of 1992–94—appeared to be "sustainable" or "possibly sustainable" after harvesting. The assessment used the American Forest and Paper Association's (AFPA) definition of forest sustainability, which defines sustainable operations as those that conduct timber operations "without compromising the ability of future generations to meet their own needs." For the purposes of the Penn State study, the AFPA guideline was interpreted to mean that following the timbering operation, there was evidence that the forest appeared capable of producing a future forest with timber value. The researchers' key conclusion: relatively simple forestry practices, including the use of BMPs, could have prevented the "unsustainable" outcome for 47 percent of the timbered sites.

While it could be argued that additional state-level regulation of forest management activities to protect water quality and other values is required, it has become increasingly clear that the regulations that already exist have not been aggressively enforced. Many responsible forestry professionals believe that a better approach to improving environmental compliance would be to certify professional consulting foresters and loggers. A certification system would promote minimum acceptable standards while creating a system of peer accountability.

Two important initiatives are under way in Pennsylvania to increase the sustainability of forest

Forestry Best Management Practices

Because there are so few practical legal restrictions on logging practice in Pennsylvania, compliance with best management practices (BMPs) is essential to protect water quality and quantity, as well as the other environmental values of the forest. BMPs are widely accepted activities that have positive effects or that minimize negative effects on the forest ecosystem from timber harvesting and other forest management activities. Some BMPs serve multiple purposes. Buffer strips along streams, for example, are designed to control erosion and sedimentation but can also serve as wildlife movement corridors, protect habitat diversity, and maintain stream water temperature and nutrient levels.

The following BMPs are the minimum acceptable standards of good forest management to protect water quality and quantity. Forest landowners should be encouraged to do these things and more:

- Comply with all provisions of Chapters 102 and 105 of the DEP regulations.
- Design roads to shed surface water quickly.
- Design roads and landings to prevent or divert surface water flow.
- Avoid locating roads and landings on seasonally wet soils associated with wetlands.
- Lay out roads and landings along the contour as much as possible.
- Provide adequate riparian buffers between disturbed areas, such as roads or landings, and streams or wetlands.
- Wherever possible, use bridges and culverts to cross streams, both intermittent and perennial.
- When fords are used for crossings, stabilize the stream bed with clean rock.
- Cross wetlands only when absolutely necessary.
- If logging requires moving heavy equipment into wetlands, do so during the driest periods of the year or when the ground is solidly frozen.
- Do not skid through water courses or spring seeps.
- Do not contaminate water bodies and soil with forest management chemicals, fertilizers and pesticides and petroleum products.
- Retire the road system properly upon completion of the logging operation.

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management practices. The first is the "green certification" program managed by the Bureau of Forestry. The Bureau of Forestry hopes the program, which certifies timber harvested with environmentally sound methods, will accomplish two important objectives: 1) increase the supply of "green-certified" timber in the marketplace to satisfy and further stimulate consumer demand; and 2) serve as a model for other public agencies and private landowners of how to practice sustainable forest management. The second initiative was launched by forest industry leaders to promote the AFPA's Sustainable Forestry Initiative (SFI). The ultimate goal of the industry-led effort: to encourage sawmills and pulp mills to exclusively buy logs that are harvested in a sustainable way.

Pennsylvania's SFI program already has resulted in the training of several hundred loggers, landowners and other forest industry personnel to use best management practices for logging operations. These practices promote: optimum forest regeneration and renewal; residual stand protection; management of insects, disease and fire; and protection of site and water resource quality.

Both of these programs are laudable and could potentially yield improvements in forest management throughout the state, but for true progress to happen more outreach is required to Pennsylvania's private forest landowners. Only a small percentage of private forest landowners in the state have written forest management plans.

Encouraging more private

landowners to adopt forest management plans is the goal of Pennsylvania's Forest Stewardship Program. Managed cooperatively by the Bureau of Forestry and Penn State University Cooperative Extension, the program has produced many fine written materials for landowners (see page 38). The Forest Stewardship Program also has conducted many educational and training programs. Nevertheless, it has been unable to reach the vast majority of private forest landowners in the state.

Surveys have shown that the vast majority of private forest landowners own their land for reasons other than to produce timber. Yet when a financial crisis occurs, these same landowners often decide to sell their trees to raise cash. It is important that these landowners have a good understanding of how forests contribute in a positive way to the environment and how forest management plans can help protect this vital resource. This is the challenge and the opportunity for the future. ■

8

Dirt and Gravel Roads

Road Maintenance Ahead . . . for a Cleaner Environment

BY KEVIN ABBEY AND WOODROW COLBERT

Abbey is former Executive Director of the Senate Transportation Committee and President of Abbey Associates; Colbert is Dirt and Gravel Road Program Coordinator, on loan from the Pennsylvania Department of Transportation to the State Conservation Commission.

(This article is adapted from The Status of and Future Directions for the Pennsylvania Task Force on Dirt and Gravel Roads 1997 Status Report)

Pennsylvania's dirt and gravel roads are here to stay. Although many people perceive of dirt and gravel roads as a nuisance—relics of a slower-paced time in our history—the facts show that these roads are important links in Pennsylvania's overall transportation network. Covering more than 27,000 miles throughout the Commonwealth, dirt and gravel roads provide vital access for Pennsylvania's major industries—agriculture, mining, forestry and tourism—while weaving the fabric of rural community life for more than 3.6 million residents.

Paved roads and highways carry high maintenance costs. Local municipalities and state agencies—with jurisdiction over more than 90 percent of the state's dirt and gravel roads—can ill afford to pave dirt roads and then adequately maintain them. Given their dual purpose of carrying low traffic volumes yet accommodating high-weight loads, dirt and gravel roads are ideally suited for their job as low-maintenance pathways to Pennsylvania's remote areas.

Paved Roads Waiting to Happen?

For many people, a dirt road is nothing more than a paved road waiting to happen. One might call it a "paved road wannabe." From this perspective, an ideal world is one where all roads would be wider, flatter and straighter. Line-of-sight problems would be "corrected" and speeds would be "enhanced." The nuisance of dirt roads would be eliminated. Such a world, of course, does not exist, and we are left with a mix of paved and dirt roads.

Although both dirt roads and paved roads are part of the same transportation network, they do not—and, more importantly, should not—look alike. Their form and function are significantly different. They both provide access but only one provides speed. They both play a role in tourism—dirt roads by conveying quaintness, and paved roads by getting people where they want to go as quickly as possible. The geometry and architecture of each are different (as evidenced by line of sight, contour, base, surface and curvature), and it only makes sense that their maintenance standards and management requirements be different as well.

Dirt roads play a different game with different rules. It is wholly inappropriate to apply the same standards, the same engineering assumptions and, worst of all, the same operating expectations to dirt roads as we commonly apply to those that are paved.

Environmental and Health Hazards

If not properly cared for, dirt and gravel roads can become a source of sediment-laden runoff that finds its way into streams and adjacent waterways, choking off the insect populations and ruining the aquatic habitat that supports trout and other fish. Known as "nonpoint source pollution," this "poison runoff accounts for up to 80 percent of the degradation of U.S. waters," according to a 1996 National Geographic article on the subject. The U.S. Environmental Protection Agency cites nonpoint source pollution as the most common cause of stream habitat damage in our nation's forests. Curbing this problem is now a national goal.

Fugitive dust from dirt roads is a serious human health hazard as well. Long known as a cause of allergies, dust and its companion particulate matter have been shown in a preponderance of recent studies to contribute to lung disease and to precipitate thousands of respiratory-related early deaths each year.

Task Force on Dirt and Gravel Roads Created in 1993

Pennsylvania Trout, a Council of Trout Unlimited, brought the problem of sediment pollution in the state's premier trout streams from dirt and gravel roads to the attention of government officials and advocated that a "no nonsense" working group tackle the issue. In response, the Task Force on Dirt and Gravel Roads was created in 1993.

Participants in the task force include: state agencies (PennDOT, Department of Environmental Protection, Department of Conservation and Natural Resources); sportsmen (Pennsylvania Trout and the Pennsylvania Federation of Sportsmen's Clubs); environmental resource agencies (Fish and Boat Commission, Game Commission, U.S. Fish and Wildlife Service, County Conservation Districts); local government (Pennsylvania State Association of Township Supervisors); private companies (Pennzoil, Penelec); Penn State University researchers and training specialists; legislative staff; and citizen environmental groups.

From its creation, the Task Force was directed to recognize and promote the value of unpaved roads in Pennsylvania's overall transportation scheme and to find ways to reduce the erosion, sedimentation and other pollution occurring along these rural roadways.

Legislation Enacted to Promote Environmentally Sound Maintenance of Roads

After a number of unsuccessful attempts, the Pennsylvania General Assembly on April 17, 1997, approved the Transportation Revenue Bill (House Bill 67). Governor Ridge promptly signed the measure into law as Act 3 of 1997. This new legislation generates over $400 million per year for transportation investments in highway/bridge construction and improved road maintenance.

Included in the law is a new Section 9106 of the Motor Vehicle Code creating a $5 million annual, nonlapsing appropriation earmarked for "Dirt & Gravel Road Maintenance." This appropriation, targeted for environmentally sound maintenance of the Commonwealth's unpaved roads, has been a high priority of the Dirt and Gravel Road Task Force since the group's inception.

The new program is unique. To achieve its streamlined purpose and bypass state level bureaucracy, the bulk of the new funding is directed to the State Conservation Commission as a "pass through" agency. Created by Pennsylvania's Conservation District Law more than 50 years ago, the Commission's purpose is "to provide for the conservation of the soil, water, and related resources of this Commonwealth...and protect and promote the health, safety and general welfare of the people (of the Commonwealth)."

Under Section 9106 of the Motor Vehicle Code, the Conservation Commission will administer and apportion the new monies for dirt and gravel road maintenance based on written criteria for the prevention of dust and sediment pollution. An important consideration in the Commission's allocation criteria is the total miles of dirt and gravel roads within watersheds protected as Exceptional Value or High Quality Waters (as of November 1996).

At the local level, County Conservation Districts (CCDs) will create Quality Assurance Boards (QABs) to define and administer a grant program for local municipalities and/or state agencies with jurisdiction over dirt and gravel roads. Municipalities may submit a grant application "not to exceed one page" with "mini-

mal handwritten information" to the local QAB for funding consideration.

The legislation provides a unique opportunity for local decision-making about local pollution problems. Education and training grants, road demonstration projects, maintenance project work, and skills training for road managers and equipment operators will be eligible activities for funding. The new program became effective on July 1, 1997, and was up and running in the spring of 1998.

Resources from the Task Force

The Task Force has produced a multimedia education and training program for those involved in the maintenance of dirt and gravel roads. The program emphasizes low-cost techniques and environmentally sensitive procedures. Developed by technical experts and training specialists from the Pennsylvania Transportation Institute (PTI) at Penn State University, the program consists of seven interrelated modules—ranging from "road surface drainage characteristics" to "erosion control measures" and "laws, regulations, and compliance." The education and training is targeted at policymakers (e.g., township supervisors, planning commissions, and state agency personnel), as well as road maintenance personnel (road managers and equipment operators). The goal: to promote common-sense principles based on available equipment and machinery. Participation in the training program will be a pre-condition of Section 9106 grant eligibility.

The Task Force also has prepared reports on pertinent dirt and gravel road topics and created demonstration areas to highlight techniques that prevent erosion and runoff pollution. In addition, the Task Force is developing a baseline Geographic Information System on a watershed basis. ■

For More Information

Until a permanent Center for Dirt & Gravel Road Maintenance is created, questions or information requests about this important pollution prevention topic should be directed to the following address:

Dirt & Gravel Road Maintenance Program
C/O State Conservation Commission
2301 North Cameron Street
Harrisburg, PA 17110-9408
717-787-2103 (voice); 717-705-3778 (fax)

Environmental and Watershed Impacts of Extractive Industries in Pennsylvania

Natural Resources, Unnatural Hazards

BY RICHARD DIPRETORO
diPretoro is a Registered Professional Geologist.

The federal Surface Mining Control and Reclamation Act of 1977 sums up the potential impacts of extractive industries on the environmental health of the state:

> ...mining operations result in disturbances of surface areas that burden and adversely affect commerce and the public welfare by destroying or diminishing the utility of land for commercial, industrial, residential, recreational, agricultural, and forestry purposes, by causing erosion and landslides, by contributing to floods, by polluting the water, by destroying fish and wildlife habitats, by impairing natural beauty, by damaging the property of citizens, by creating hazards dangerous to life and property, by degrading the quality of life in local communities, and by counteracting governmental programs and efforts to conserve soil, water and other natural resources.

Sixty-three of the 67 counties in Pennsylvania are home to extractive industry operations that have the potential to adversely affect watershed health. The major extractive industries include coal, oil and gas, and industrial minerals such as stone, sand and gravel. The following is a discussion of how the extraction of these natural resources can cause environmental problems to waterways throughout the state.

Coal Mining in Pennsylvania

Coal mining creates the most profound and widespread effects on watersheds of any extractive industry in Pennsylvania. Even if we ignore, for the moment, the acid and alkaline drainage that is carried

from abandoned mines into waterways throughout the state, coal mining still has all other extractive industries beat. (For more information on acid mine drainage, see "Abandoned Mine Drainage: Cleaning Up After a Century of Mining," page 48.) Compared to the extraction of other minerals, such as limestone, coal mining requires the disturbance of significantly larger areas of land for a given ton of minerals. There are two reasons for this:

1) Coal beds are much thinner than limestone beds; and

2) Coal weighs less than most mined minerals in Pennsylvania; by volume it weighs 70 percent of sand and gravel and 52 percent of limestone. The result is that while one acre may yield 10,000 tons of coal, another acre may yield several hundred thousand tons of limestone.

Pennsylvania contains two basic varieties of coal, bituminous and anthracite, which are mined in different parts of the state. In 1996, 19 western counties produced about 75 million tons of bituminous coal, with Greene County producing about half the total.

The next five counties in order—Washington, Somerset, Armstrong, Indiana and Clearfield—produced 40 percent of the total, meaning the top six counties produced 90 percent of the bituminous coal in the state in 1996. Underground mining accounted for 77 percent of the state total for bituminous coal, which is generally found in seams that cover large areas and lie nearly flat.

At the other end of the state, seven eastern counties—Schuylkill, Luzerne, Carbon, Northumberland, Lackawanna, Columbia and Dauphin, in that order — produced almost all of Pennsylvania's 12 million tons of anthracite coal in 1996; Schuylkill County produced almost half the total. Nearly 70 percent of this was produced from waste piles left by older mining operations. Remining of existing sites accounted for most of the rest. Anthracite seams can lie in any posture, from flat to vertical to folded over on themselves.

Environmental and Watershed Impacts

Mining operations use two basic methods to extract coal from coal seams: surface and underground mining. For surface mining, the operator removes the vegetation, soil and rock from coal seams that lie near or at the surface of the land. The operator then removes most of the coal, typically more than 90 percent, and fills and revegetates the void. The backfill takes up about 25 percent more space after mining than before. This is because the recovered coal removes only a small part of the total volume and the remaining mined material swells by bridging over voids. Sometimes operators dispose of the excess material by placing it in stream valleys.

For underground mining, operators gain access to the coal either directly from the surface, in a procedure similar to surface mining, or through shafts excavated down to the seam from the surface. Mining proceeds to remove typically between 50 and 80 percent of the coal. Upon abandonment of the mine, the operator leaves the rest of the coal behind along with voids. Most underground mines eventually cause subsidence, or cave-ins that affect the surface. In areas with low stream gradients, underground mine subsidence can cause ponding of streams and the creation of wetlands or marshlands where dry land had existed before.

Underground mines also may capture streams or cause them to run below the surface. Examples of places where this has occurred are Sugar Run in Washington County, Two-Lick Creek in Indiana County and Roaring Run in Cambria County.

Underground coal mining also can cause streams to experience greater-than-normal flow. The Jeddo Tunnel in the anthracite fields near Hazelton discharges 50,000 gallons of water per minute from an area of several square miles. Had it not been collected by the system of underground mines, this water would have discharged elsewhere into other streams. The stream resulting from the Jeddo Tunnel discharge is much larger at its discharge point than the original stream for which the valley is suited.

Underground mines essentially act as reservoirs, accumulating water during the winter and spring and releasing it slowly during summer and fall. The changes in water flow to receiving streams can affect their ecological health. Surface mines, on the other hand, often act as a sponge, soaking up more rain and melting snow than natural land, and then letting it out more slowly over a longer period.

Another environmental impact of mining results not from the mining process itself, but from what happens after the coal is mined. Coal usually requires cleaning before delivery to the market—typically an electric power plant. Since up to 40 percent or more of the material removed from the mine may be unusable rock, voluminous waste results from the cleaning process. Leaving mining waste on the surface is less costly than returning it underground, a process known as "backstowing," as is often done in Europe. One result is that operators increasingly are placing the waste in "valley fills" that often cover headwater streams. Allowing the encroachment of fills into valleys is an important regulatory issue involving coal mining and watersheds.

Operators abandoned more than 250,000 acres of

surface mines in Pennsylvania before 1977, the year the Surface Mining Control and Reclamation Act was passed; thousands more acres have been abandoned since. Before 1977, many mines were abandoned with little or no reclamation. Today, many of these mines are causing erosion and sedimentation in streams. This sedimentation, in turn, can smother aquatic life and fill voids in gravel stream bottoms needed for reproduction of aquatic insects and fish. The cumulative impact of this sedimentation can affect fishing birds and animals whose diets rely on aquatic life.

In efforts to reclaim these abandoned mines, state government officials in Pennsylvania increasingly stress the beneficial use of industrial wastes to aid in the filling and revegetation of abandoned mines because the mines often lack organic matter and/or are producing acid that needs neutralization. These wastes include power plant ash, flue-gas desulfurization sludge, paper mill waste, incinerator ash, cement kiln dust and East Coast harbor dredgings, among others. Such wastes may well contain elevated levels of toxic or hazardous components such as lead and dioxin, leading to new questions and problems even as we try to address historic impacts.

The largest single type of industrial waste used in mine reclamation is coal-fired power plant waste. However, as air pollution regulations tighten and higher-ash fuels are used, power plants produce more and more waste. At the same time, space in ash landfills is becoming scarcer and more expensive. Because of these trends, ash disposal has been identified as a major constraint on expanded coal use. This, in turn, provides the strong incentive to find ways to dispose of the ash beneficially, especially on abandoned mine lands.

Regulatory Issues Affecting Coal Extraction

Among the top regulatory issues involving underground coal mining are valley fills (see above), Cumulative Hydrologic Impact Assessments (CHIAs), and the definition of a perennial stream.

CHIAs. Because of the importance of the flow of water above and below the ground (hydrology) on natural systems, the Surface Mining Control and Reclamation Act requires the state to conduct a CHIA for every mine. This CHIA must be based on hydrologic information supplied by the mine operator, as well as other information available to the state. Pennsylvania prepares CHIAs for surface coal mines. It does not, however, do so for underground mines, which can and do create significant cumulative effects on the hydrology. This is significant in that the mines in the Pittsburgh Coal Seam in southwestern Pennsylvania, along with the mines across the state line in West Virginia, probably represent the largest set of potentially interconnected mines in the world and therefore the largest impact on hydrology. The Office of Surface Mining, the federal agency charged with overseeing Pennsylvania's coal regulatory program, is conducting an investigation into the state's performance of CHIAs with respect to underground mines.

DEFINING A PERENNIAL STREAM. For underground mining, the state defines a perennial stream simply as "a stream or part of a stream that flows continuously throughout the calendar year as a result of ground water discharge or surface runoff." This is a different definition than the one used in other environmental regulations in the state, even those covering surface coal mines. For all activities except underground coal mining, the state defines a perennial stream as: "A body of water flowing in a channel or bed composed primarily of substrates associated with flowing waters and is capable, in the absence of pollution or other manmade stream disturbances, of supporting a benthic macroinvertebrate community which is composed of two or more recognizable taxonomic groups of organisms which are large enough to be seen by the unaided eye and can be retained by a United States Standard No. 30 sieve (28 meshes per inch, 0.595 millimeter openings) and live at least part of their life cycles within or upon available substrates in a body of water or water transport system."

The difference between the two definitions — hydrology controls the first and biology the second — makes it legal for the state to allow more damage to streams from underground mines than from other activities. According to the first definition, operators can say a stream is not perennial — that it is "intermittent" — based on one documented occurrence of dryness. For instance, an operator can use data from the early 1950s to show that a stream went dry once. If the company were to succeed, it would reduce the level of protection the stream would enjoy if it were judged according to the second definition.

Another problem with using the hydrologic as

opposed to the biologic definition of a perennial stream is that there is no turning back. Once a stream experiences a single dry episode, it is permanently consigned to intermittent status, no matter how continuous its flow might become or how prolific it is as a biological ecosystem.

Oil and Gas Extraction

Pennsylvania has the oldest commercial oil industry in the world. State officials estimate that some 200,000 to 300,000 wells have been drilled in the state since the famed Drake well was drilled in Titusville in 1859. The state has information on the location of some 160,000 wells, which means that many wells are uncharted. About 130,000 wells are either in active production now or were in the recent past. The state closes, or "plugs," about a dozen wells per year based on their danger to lives, properties and the environment. At the same time, about 1,000 new wells are drilled each year, a number that is higher than the number plugged by operators.

The state began regulating the oil and gas industry's impact on the environment in April 1985, after the passage of the Oil and Gas Act of 1984. Regulations were adopted in 1989. Therefore, the program is relatively new and still maturing.

The major environmental and watershed threats posed by oil and gas extraction are associated with two things: the extraction of large volumes of brine along with the oil and gas; and the spreading of waste pit sludge.

WASTE PIT SLUDGE. A waste pit is built to contain fluids drawn from the well during drilling. A surface impoundment study in 1980 located about 19,000 open pits connected to oil and gas activities; about 10,000 of these were associated with oil. Most of the pits were unlined and subject to leakage into groundwater, which eventually discharges to surface water. Adding to the environmental threat, operators can legally spread the sludge from the bottom of the oil well pits on the land nearby. This sludge contains metals, oil, salinity, additives and radioactivity, all of which have the potential to impact surface water quality.

BRINE. Perhaps the most significant watershed issue stemming from oil and gas extraction, however, is the disposal of unwanted brine, which is salt water that is often saltier than ocean water. This brine contains all the same pollutants as oil pit sludge, and large amounts of the brine are spread on the land for dust control and road stabilization. In 1995, Pennsylvania produced about 75 million gallons of brine; 5.8 million gallons were spread on roadways and other land areas across the state. This marked a 55-percent increase in brine spreading from the previous year and reversed a three-year decline. Of the 17 western counties where brine was spread, Clearfield, Crawford, Indiana and Armstrong counties, in that order, accounted for about two-thirds of the total. Other counties with significant volumes (more than 100,000 gallons each) were Cambria, Centre, Somerset, Erie, Jefferson, Forest and Mercer. Spreading took place on township roads (59%), mining haulroads (22%), race tracks (8%), private lots and roads (7%) and Pennsylvania Department of Transportation roads (4%).

Industrial Minerals

Pennsylvania produces more tonnage of industrial minerals than of coal. In 1996, more than 400 operators produced 113 million tons of these minerals from almost every county in the state. The leading counties, in order of production, are Bucks, Lancaster, Northampton, Berks, York and Montgomery. Each of these counties produce more than 5 million tons of industrial minerals; together they are responsible for 38 percent of the state total. Most of the extracted minerals are limestone, and public authorities use much of this for public roads. Extraction of these minerals needs to occur in scattered locations because crushed rock, sand and gravel are high-volume, low-value products which cannot economically be transported long distances.

A small but environmentally significant component of the state's industrial mineral economy involves commercial dredging of rivers for sand and gravel. Dredging takes place on the Allegheny and Ohio Rivers and has taken place on the Beaver River in the past. These rivers have significant (but finite) sand and gravel resources. They have special value because they are in areas of the state that lack high-quality limestone deposits near enough to the surface to be quarried. Several of the dredging companies have appealed various permits required by the DEP for the protection of freshwater mussels.

Conclusion

The Commonwealth's extractive industries have played a long and important role in the development of Pennsylvania and the nation. But this development has come with environmental and social costs for which we continue to pay. Because mineral resources are finite and because of potential increases in other sources of energy and raw materials for industry, extractive industries will, eventually, greatly lessen their impacts on our watersheds.

However, until this happens it is vitally important that the state as well as citizens ensure that regulatory programs be enforced to their full extent.

10

Abandoned Mine Drainage

Cleaning Up After a Century of Mining

BY ROBERT S. HEDIN, PH. D
Hedin is President of Hedin Environmental.

Pennsylvania has a long and rich coal mining history. Some of the most heavily mined areas are in the Allegheny River watershed of Western Pennsylvania. Among the distinguishing features of the near-surface geology in the watershed are sedimentary strata that contain economically important coal reserves. Important coal seams, typically named for the locality where they were first described and exploited, include the Clarions, the Kittannings and the Freeports. These coal seams have been mined throughout the watershed for approximately 100 years.

Before 1940, all significant mining was done underground. During the first half of this century, the Allegheny River watershed was home to dozens of mining towns where the economic and social life revolved around the underground coal mines. With the development of large earth-moving machinery in the latter half of the century, however, surface mining became the dominant coal extraction technique. Tens of thousands of surface mines were operated and abandoned in the watershed during the last 50 years.

A century of mining has had a major effect on the Allegheny River basin. The exhaustion of many coal reserves resulted in the shutdown of dozens of large underground mines and a dramatic decline of once-thriving mining towns. Surface mining, which concentrates for economic reasons on coal near the surface of the earth, has removed significant portions of the most desirable, "low-cover" coal reserves. As a result, the mining industry in the watershed today is less than half the size it was earlier in the century. Currently, there are less than a dozen underground mining operations in the watershed and between 50 and 75 active surface mining operations. These numbers are dwarfed by the thousands of abandoned mine sites that continue to impact environmental quality and land values throughout the watershed.

Tinkers Run, Irwin.

Stream Quality Improvements: What's Happening?

For decades, the polluted condition of many Pennsylvania streams was accepted as an unavoidable consequence of the economic prosperity that

accompanied coal mining. Recently, however, it has become clear that water quality in many streams in the watershed is improving. The improvement is a likely result of a variety of developments over recent decades:

REGULATORY CHANGES. For most of its history, the mining industry in Pennsylvania operated under minimal regulation. Coal mines in the basin were run for decades without significant concern for the environmental problems they created. Mining regulations stiffened considerably during the 1970s, however. Currently, all mining operations must obtain permits that regulate reclamation activities and the quality of water discharged from the site. Bonds are required that assure that mining and reclamation will occur as planned and remain in compliance with current regulations. When mining companies declare bankruptcy, these bonds can be used to finance reclamation of the abandoned mine sites by the Commonwealth. The result of the current regulations is that mining is more responsive to environmental concerns.

Today, many permitted mine sites exist in Pennsylvania. Where the mine drainage is contaminated, the responsible parties treat it with chemical or other procedures. In many cases, stream quality has been significantly improved by inflows of treated alkaline water from permitted mine sites. As long as these sites are operated under permits by financially solvent companies, they pose no threat to the waters of the basin.

NATURAL AMELIORATION. In some watersheds, water quality improvements over the last 20 years have resulted in part from the "natural amelioration" of contaminated discharges from unpermitted, abandoned sites. In laymen's terms, the sites have cleaned themselves up. The improvements most likely stem from a variety of causes, including: decreased contaminant production by aging mines, natural revegetation of unreclaimed mine surfaces, and the natural development of filtering wetlands between discharges and receiving streams.

RECLAMATION THROUGH REMINING. Reclamation of abandoned mine sites can dramatically decrease AMD production by lessening the contact of water with acidic materials. On many abandoned mine sites, acidic materials produced during the processing of coal were left on the surface in piles that readily contaminate surface water. Surface mining creates pits that, when abandoned in an unreclaimed state, can collect water that eventually becomes an acidic discharge. Reclamation lessens the production of AMD by burying toxic acidic materials, filling in abandoned pits, promoting the revegetation of the mine surface, and recontouring the mine so that water flows rapidly off the site.

The most cost-effective way to achieve the reclamation of abandoned sites is through the "remining" of the abandoned site for remnant coal reserves. During the remining process, the abandoned AMD-producing mine is reclaimed to current standards. Because current mining and reclamation practices are less likely to produce AMD than older, unregulated ones, the net result of a remining process is usually decreased production of untreated AMD.

Pennsylvania mining regulations were amended in the 1980s to encourage remining. Mining companies that remine abandoned sites are absolved of any water treatment liability as long as the mining activities do not increase contaminant production by the abandoned site. Experience has shown that the reclamation of abandoned mines almost always decreases contaminant generation. As a result, there is little financial risk to the mining companies, and the environmental benefits to the Commonwealth are obvious.

Abandoned Mines:
The Threat Defined

Abandoned mines pose a threat to waterways because they discharge acidic, metal-contaminated mine waters. Under unmined conditions, the natural weathering of acidic strata in the earth is very slow, and acids often are neutralized by alkaline materials that naturally occur in coal-bearing sedimentary strata. The weakly acidic waters produced by this natural process pose little or no harm to indigenous aquatic insects and fish.

Mining, however, greatly accelerates the weathering process by exposing coal-bearing strata to oxidizing atmospheric conditions. Mining also eliminates the alkaline strata that can help reduce the acid content of the water. The result: a highly acidic drainage that is contaminated by elevated concentrations of iron and aluminum. Today, these inputs of acid mine drainage (AMD) pollute hundreds of miles of Pennsylvania streams.

RECLAMATION BY PUBLIC AGENCIES. Thousands of acres of abandoned mine lands in Pennsylvania have been reclaimed by public agencies, including: the Pennsylvania Department of Environmental Protection's (DEP) Bureau of Abandoned Mine Reclamation; and the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). These projects are generally funded by a tax on coal intended to finance reclamation projects on abandoned sites. For most of these projects, the primary focus has been the elimination of hazardous conditions such as highwalls, open pits or steep slopes. A side benefit of some of these reclamation projects has been improvements in water quality. During the last three years, the federal rules associated with spending these funds have been revised so that DEP can do projects whose primary focus is the treatment of contaminated drainage at abandoned sites.

The NRCS completed numerous reclamation projects in the 1980s under its Rural Abandoned Mine Reclamation Program (RAMP). Recently, funding for RAMP projects has been spotty, and most of NRCS's efforts have been focused on water quality projects conducted under Pamphlet Law 566 (PL 566). Under this law, projects must complete a watershed study that identifies specific water quality problems and solutions. Completion and approval of a PL 566 watershed study can lay the groundwork for subsequent funding of projects. The NRCS has approved PL 566 studies for the Oven Run and Monastery Run watersheds, both in the Allegheny basin. In addition, several NRCS mine water treatment projects have been completed or are in progress in these watersheds. A PL 566 watershed study currently is being developed for Mill Creek, a tributary to the Clarion River.

TREATMENT OF AMD BY PUBLIC AGENCIES. The Pennsylvania DEP's Bureau of Abandoned Mine Reclamation operates several active mine water treatment systems in the basin. These systems operate by adding lime or limestone to acidic water and using sedimentation ponds to separate metal contaminants from the water. During the last two years in the Toby Creek watershed, the Bureau has opened a new treatment plant and is planning a second one. The Bureau also is experimenting with automated "stream dosing" devices that add lime or limestone directly to an acidic stream.

TREATMENT OF AMD BY STREAM RESTORATION GROUPS. During the last ten years, new passive minewater treatment techniques have been developed that rely on natural chemical and biological materials and processes. The main attraction of passive systems is that they can operate for years with little operational oversight or maintenance.

Example of AMD treatment system.

The hope that passive treatment can provide cost-effective remediation of long-polluted headwater streams has prompted the formation of a dozen stream restoration groups in the Allegheny basin. These groups are using public and private resources to construct passive treatment systems throughout the basin. The result is that the basin, which for years was considered a hotbed of AMD production, is now considered a hotbed of innovative stream restoration activities.

A Passive Treatment System

Fourmile Run, near St. Vincent College, Latrobe, was polluted by a deep mine that discharged 300 to 550 gallons of polluted water a minute. A passive treatment wetland system was developed that reroutes the contaminated water to an uphill location, where it is released into a series of gradually descending treatment ponds called "cells." Iron oxide naturally settles to the bottom of the cells before the water is released to the stream. It is estimated that the cells will collect an inch to an inch and a half of iron oxide sediment each year, which can then be removed, allowing the ponds to be reused. Cattails that naturally grow at the site provide a surface to which iron-oxide particles can adhere and slow the water flow through the system. Additionally, the cattails provide habitat for wetlands organisms.

National attention has focused, in particular, on the Mill Creek Watershed in Jefferson and Clarion Counties, where a dozen passive systems have been constructed and where measurable improvements in water quality have been documented as a result. During the last two years, the Institute in Watershed Restoration at St. Vincent College has attracted students from throughout the basin to study the AMD-polluted Loyalhanna Creek and the passive systems constructed in Latrobe in an effort to clean up the waterway.

The Future of AMD Remediation

Water quality is improving in the Allegheny basin and across Pennsylvania, but AMD remains a devastating water pollution problem. Improved regulations have slowed the rise of new sources of mine water pollution. The remaining challenge is the remediation of thousands of discharges of contaminated water flowing from abandoned sites. Stream restoration, once considered technically and economically impossible, is now being discussed and attempted throughout Pennsylvania.

Achieving the Commonwealth's restoration goals will require a continued emphasis on a varied approach. Reclamation of abandoned sites by mining companies and government agencies must continue. Stream restoration groups, as well as government agencies, must keep working to construct passive treatment systems at appropriate sites. And to deal with the many serious AMD discharges that are not readily corrected with passive techniques, government and stream restoration advocates will have to work together to craft innovative solutions or to construct active chemical treatment plants.

Given the progress of the last 20 years, the remaining problems are not insurmountable. All it takes is the will to turn back the clock to the days a century or more ago when mine drainage wasn't an issue and Pennsylvania's streams flowed free and clear. ■

For more information on AMD remediation projects, contact:

Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) - 570-628-3377
Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR) - 724-837-5271

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Preventing Sanitary Sewer Overflows and Combined Sewer Overflows

When the Sewers Pollute

BY KEVIN J. GARBER, PH. D, ESQ.
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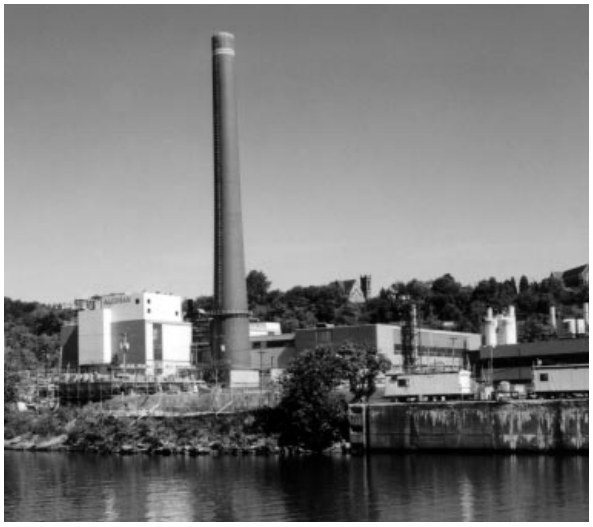
Sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) occur when raw sewage with or without stormwater flows directly into rivers and streams instead of a sewage treatment plant. Most SSO and CSO events occur during heavy storms. Some of these overflows significantly pollute the receiving waters, causing local health departments to issue warnings about human contact with water.

The U.S. Environmental Protection Agency (USEPA) recognizes that SSOs and CSOs are a serious water quality problem in the United States. According to recent USEPA estimates, $45 billion is needed over the next 20 years just to control CSOs. Another $32 billion will be necessary to upgrade existing publicly owned wastewater treatment systems and to construct new sewers to control SSOs. In all, USEPA estimates that $140 billion must be spent on wastewater treatment systems over the next 20 years. These are extraordinary costs.

Background: Who Pays?

Towns and cities often build and operate a central wastewater treatment facility to receive wastewater from the surrounding municipalities. There are presently about 16,000 publicly owned treatment systems serving about 72 percent of the U.S. population. The municipalities served by these systems typically own and maintain the sewers within their jurisdiction. Individual homeowners usually pay a treatment fee to the treatment authority and/or a service fee or other tax to their home township to maintain the treatment and collection system. Homeowners are then responsible for the sewer lines from their homes to the public connection point, which is usually at the street.



In Allegheny County, for example, the Allegheny County Sanitary Authority (ALCOSAN) owns and operates a large treatment plant in McKees Rocks that serves 83 surrounding municipalities and the City of Pittsburgh through several hundred thousand miles of pipelines, most of which are owned by the municipalities. Alcosan has "tap-in" and service agreements with each municipality but generally has only limited authority to require townships to correct problems in their municipal lines. The primary regulatory authority—and authority over SSO and CSO problems in general—rests with several agencies.

The federal Clean Water Act generally prohibits unpermitted overflows from municipal sewers and treatment plants. USEPA enforces this law. It has the power to assess civil penalties of up to $25,000 per day for each day of violation and can obtain a court order requiring a municipality to upgrade its sewage collection system to eliminate SSOs or CSOs. States often have similar laws. In Pennsylvania, the Department of Environmental Protection (DEP) enforces the

Pennsylvania Clean Streams Law, which, like the Clean Water Act, prohibits unpermitted discharges of pollutants into waters of the Commonwealth. DEP also can assess penalties and order municipalities to eliminate illegal overflows.

Finally, local health departments and municipalities sometimes have authority to order a township or homeowner to correct a public health hazard. The Allegheny County Health Department, for example, has authority to require municipalities in the County to adopt corrective action plans to eliminate sewer overflows and basement flooding.

The cost of correcting an SSO or CSO problem generally falls on individual homeowners through higher taxes, service fees or actual sewer replacement assessments. The federal, state and local government have authority to initiate a program to address SSOs or CSOs, but usually the federal government (acting through USEPA) prompts or actually orders a municipality to act. As a result, the extraordinary costs involved in correcting SSOs and CSOs ultimately become a local issue for individual residents and must be borne by them.

Sanitary Sewer Overflows

USEPA defines sanitary sewer overflows as "discharges of untreated water from a separate sanitary collection system which occur before the headworks of a sewage treatment plant." A "separate sanitary collection system" is one designed to collect sewage from homes and businesses and wastewater from industries and convey it to treatment plants without admitting storm water, snow melt or groundwater into the system. Water from these extraneous sources, if allowed to flow unchecked into a treatment plant, could overwhelm a treatment system during heavy precipitation, causing it to become "hydraulically overloaded." Incoming sewage and industrial wastewater would not receive the designed degree of treatment, and the effluent from the treatment plant might not meet its permitted discharge standards. Therefore, a well constructed and maintained separate sanitary system promotes the good operation of a treatment system by preventing the treatment plant from becoming overwhelmed with stormwater and groundwater.

Presently, there are about 18,500 separate sanitary sewage collection systems serving about 135 million people in the United States. Many of these systems, particularly those constructed in the early to middle part of the twentieth century, are now admitting storm water and groundwater through broken sections of pipe, unsealed joints in pipes, illegal connections—for example, from homes where gutters and downspouts are tied directly into the sewer system in violation of local building codes—and many other entry points. Treatment plants and sewer systems often have insufficient capacity to handle this extra water. As a result, SSO discharges may appear throughout the system, particularly at manholes, when the infiltrating stormwater and groundwater exceed the pipeline's design capacity. The resulting discharges of raw or diluted sewage from separate sanitary sewer systems before treatment can cause significant public health and environmental problems.

The federal Clean Water Act prohibits SSO discharges to surface waters of the United States unless authorized by a National Pollution Discharge Elimination System (NPDES) permit. Some treatment plants have permits that specifically allow SSOs under certain circumstances, such as when there are no feasible alternatives to a discharge or when circumstances arise beyond the plant's control. Other permits specifically prohibit SSOs, while others are simply silent on the issue. USEPA unequivocally states that SSO "discharges without an NPDES permit are illegal," but the agency recognizes that it has limited information about how permitting authorities are addressing the problem of SSOs.

To gather more information and to promote uniform enforcement, USEPA issued an important guidance document in 1996 entitled "Setting Priorities for Addressing Discharges from Separate Sanitary Systems." The document is official agency policy and has been incorporated as a chapter (Chapter X) in USEPA's Enforcement Management System for the Clean Water Act. USEPA relies on this enforcement document to evaluate compliance with the Act.

USEPA's guidance states that all SSOs should be considered high risk because discharges of raw sewage can present serious health or environmental threats. Separate sanitary systems that have SSOs during dry weather are the highest priority for enforcement and/or corrective action. Systems with wet-weather SSOs are the next highest priority. Enforcement responses

depend on the specifics of each case and can include telephone inquiries, notices of violation, administrative orders or lawsuits in state or federal court. Municipalities can be requested or ordered to implement a broad spectrum of corrective actions ranging from low-cost, "noncapital improvements" (such as improving daily operations and maintenance or replacing pipes) to more capital-intensive discharge control plans such as treatment plant reconstruction. USEPA and state agencies typically will allow a municipality to create a compliance schedule but often insist that timelines in the schedule be as short as possible.

The Chapter X guidance further directs USEPA and state governments to be sensitive to the special needs and financial capability of each municipality. Governmental agencies are therefore directed to consider a municipality's bond rating, indebtedness, grant eligibility, and population and income information when requiring the municipality to address SSO issues.

In Pennsylvania, a state law entitled the Pennsylvania Sewage Facilities Act (also known as "Act 537") seeks to prevent SSOs by requiring municipalities to develop comprehensive sewage plans for their jurisdictions. These so-called "537 Plans" must delineate existing SSO areas, account for sewage needs within a 10-year period, and provide for adequate treatment facilities to prevent the discharge of untreated sewage. The plans must be updated regularly and submitted to DEP, which can disapprove a 537 Plan if it does not serve present and future development. DEP is able to enforce Act 537 in several ways to minimize SSOs, including by banning additional tap-ins to hydraulically overloaded facilities.

Combined Sewer Overflows

Combined sewer overflows are overflows from combined sewer systems. Also called a CSS, a combined sewer system is one that's designed to carry sanitary sewage (i.e., domestic, commercial and industrial wastewater) and stormwater through a single pipe to a treatment facility. Unlike a separate sanitary system, a combined sewer system is intended to carry stormwater to a treatment facility for treatment and subsequent discharge. Presently, about 1,100 communities in the United States, serving about 43 million people, have combined sewer systems. Most of these communities are located in the Great Lakes and Northeast regions.

CSOs usually develop during wet weather when rain water or snowmelt exceeds the capacity of the combined sewer system and/or treatment system. A CSS is intentionally engineered to overflow directly to surface waters during these high-flow periods, and the resulting CSO discharge often contains untreated domestic, commercial and industrial wastes and other contaminants that are present in stormwater. USEPA estimates that CSOs discharge 1.2 trillion gallons of raw sewage and stormwater annually to streams, lakes and bays across the country. The agency has linked CSO discharges to degradation of waterways, shellfish bed closures, human health problems and fish kills.

On April 19, 1994, USEPA published a new national policy to control CSOs. "The Combined Sewer Overflow Control Policy" encourages states to coordinate the CSO planning process with their regular review of state water quality standards. Municipalities are encouraged to make environmentally sensitive receiving waters their highest priority for action. The policy requires municipalities to implement nine

The Costs of Compliance

Two studies have looked at the cost of complying with USEPA's policy on Combined Sewer Overflows (CSOs):

- A 1996 study sponsored by the Association of Metropolitan Sewerage Agencies (AMSA) concluded that CSO control is very expensive and largely dependent on local funding, in large part because Combined Sewer Systems and the impact of CSO discharges are very site specific.
- A similar 1996 survey of major cities by King County (Seattle, Washington) found that Detroit spent or will spend $20 million, Seattle $60.5 million and San Francisco $1.1 billion in total capital costs to comply with the USEPA policy. Average annual costs to implement the controls among the ten cities surveyed ranged from $42.9 million to $65.4 million depending on the city.

Both studies found that CSOs should be controlled through watershed management because there are a range of non-CSO sources that contribute to water quality. Non-CSO sources include stormwater runoff from urban areas, erosion and sedimentation problems from poor land-use practices, and runoff from agricultural lands. The AMSA study recommended a group of performance measures (e.g., nutrient loads, CSO frequency and dry weather overflows) that municipalities should use to track the results of CSO control.

"minimum technology controls" by January 1, 1997. These controls include: properly operating and maintaining the sewer system and CSO discharge points; maximizing the flow of water to the plant for treatment; controlling solid and floating material; notifying the public of CSO occurrences; and monitoring the collection system to assess the impact of CSOs.

In order to comply with the nine minimum controls, municipalities may use either the "presumption" approach or the "demonstration" approach. Under the presumption approach, compliance is presumed if four or fewer CSOs per year do not receive minimum treatment, if at least 85 percent of the combined sewage/stormwater flow is eliminated or treated, or if pollutants responsible for water quality problems are eliminated or reduced. Under the demonstration approach, a municipality must demonstrate how water quality standards will be attained through a monitoring and control plan.

In the Pittsburgh area, USEPA Region III (headquartered in Philadelphia) in 1994 requested 80 municipalities that contribute wastewater to the ALCOSAN system to submit information to help the agency identify CSO points. The goal was also to provide the affected communities with enough time to implement the nine minimum controls before the January 1, 1997, deadline. In March 1997, USEPA issued a separate request for information under the Clean Water Act to about 50 of these municipalities to check on their compliance with the CSO policy. The municipalities also were asked to begin daily monitoring of the flow of water at CSO points. Monitoring began in August 1997. In August 1998, EPA advised the communities that they could discontinue monitoring and encouraged them to address any overflows detected by their monitoring. Many municipalities believe they will have to undertake significant corrective action on their collection systems to achieve the USEPA's recommended flow rate. When this article was written, EPA had not taken any action to enforce its March 1997 information request or to penalize communities that missed the January 1, 1997 compliance date. ■

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On-lot Sewage Treatment and Disposal

The On-Lot Onslaught

BY MILTON LAUCH

Lauch is Chief of the Division of Wastewater Management with the Pennsylvania Department of Environmental Protection.

Many of Pennsylvania's non-urban areas are dependent on on-lot wastewater treatment and disposal systems. If improperly sited, constructed or managed, these systems have the potential to create both pollution and public health problems. There are currently more than 1.2 million homes served by on-lot systems in Pennsylvania. Many of these systems were constructed before siting or design standards were legislated by the Pennsylvania General Assembly in 1966. These older systems (cess pools, dry wells, seepage lines and abandoned wells) may discharge improperly treated sewage to surface water, groundwater or to the surface of the ground itself.

A recent evaluation of Pennsylvania's older systems indicated that a rural population of more than 997,000 may be served by substandard or malfunctioning on-lot systems; the cost of providing public sewers to this population was estimated at more than $1.6 billion. In many areas, public sewerage is simply not practical because of the terrain and/or the housing density. Moreover, repairing or replacing these systems one by one is hardly feasible because of the costs and/or the physical constraints related to site conditions and lot size. Local agencies across the state issue fewer than 2,250 permits per year to repair existing, malfunctioning on-lot systems.

New Systems Misunderstood

In addition to the substandard, existing on-lot systems throughout the state, about 25,000 permits are issued each year by local agencies for on-lot systems to serve new land development. These systems are permitted under siting, soil testing, design and construction standards established by the Pennsylvania Department of Environmental Protection (DEP) for the entire state. Sewage Enforcement Officers who issue these permits and inspect the systems prior to their use are certified by the Commonwealth and must attend mandatory training courses. If it is properly operated and maintained, the modern on-lot system will function for the life of the dwelling. On-lot systems consist of a septic tank designed to retain and digest solids; a distribution system made up of plastic piping with perforations to distribute treated effluent across a soil or sand absorption area (including a pump in some cases); and the underlying soil in which most of the treatment occurs.

Stream in Loyalhanna basin.

It is the owner's responsibility to insure the proper functioning of an on-lot system. However, past evaluations have documented that owners of new dwellings served by on-lot systems do not understand their systems. They do not know, for example, that septic tanks retain solids and must be pumped out at least every three years or more; if the solids are not removed periodically, they will move out of the septic tank and into the absorption area. Most owners also do not know that the mechanical parts of the system must be maintained

to prevent system malfunction, nor do most owners understand that the absorption area must be protected from heavy equipment and surface water runoff.

The failure to properly operate and maintain a new system means that the life of the system is shortened and a malfunction is likely to occur. This, of course, adds to the existing problem of malfunctioning on-lot systems in the Commonwealth and presents additional challenges to local agencies and municipalities in dealing with these problems.

Another problem is the fact that both new and older on-lot systems do not treat nitrogen loads well and transfer these directly to groundwater. Nitrate-nitrogen at levels of greater than 10 parts per million in drinking water is considered a public health hazard and is associated with cyanosis in infants.

What DEP Is Doing About On-lot System Malfunctions

The DEP has reevaluated its approach to the on-lot system problem in recent years. A number of new, key initiatives were put in place to direct new attention to the problem and to create the tools needed by local government to deal with old, substandard systems, as well as new land developments served by on-lot systems. Elements of DEP's new emphasis include the following:

Developing New On-lot Technology

The costs to replace malfunctioning on-lot systems with public sewers are prohibitive for some areas of the Commonwealth. In addition, many lots with malfunctioning systems have very limited soil suitability and require the installation of systems that are very expensive to construct or operate. Responding to these problems, DEP entered into a contract with Delaware Valley College (DELVAL) to do a worldwide search for new, low-cost on-lot technologies that could be used in the climate and soil conditions prevalent in the state. Once these systems were proven to work, according to the plan, their use would be expanded statewide through policy and regulation changes. The DELVAL project is in its third year of monitoring six new or modified technologies for a wide range of soil conditions across the Commonwealth. A drip irrigation system that will function in very limited soils will be released for statewide use during 1999.

In addition, DEP is cooperating with the Pennsylvania Department of Conservation and Natural Resources to use some of the DELVAL technologies, as well as other new systems, to repair existing, malfunctioning systems in state parks. DEP also is carrying out an experimental/alternate on-lot system program under which several private corporations have developed new technology to denitrify septic system wastes. In other developments, a technology has been approved that uses open, plastic-lined infiltration chambers to replace the gravel aggregate that is normally used in the absorption area of on-lot systems. This allows for a 40-percent reduction in the size of the absorption area. The use of the chambers also allows for a reduced-size system repair on lots that normally would be too small to support an on-lot system repair.

Recent regulatory changes have classified nine previously experimental systems or system components as standard technology. This will allow for their use without previous restrictions, including DEP review and monitoring. Also included in the regulations was a new spray irrigation system that is capable of functioning on sites with as little as 10 inches of soil. Other on-lot systems require between 20 and 60 inches of soil to treat sewage adequately before it reaches groundwater or bedrock. The new spray system can thus be used to repair malfunctions on lots that were previously unsuitable for on-lot technologies. Another benefit of spray irrigation is that it reduces the amount of nitrate-nitrogen reaching the groundwater.

Providing Financing for On-lot System Repairs

State and federal funding for sewage traditionally has been available only for pubic sewerage projects. But DEP, in cooperation with PENNVEST and the Pennsylvania Housing Finance Corporation, has created a low-interest (1%) loan program to help finance on-lot system repairs. These loans are available through local banks and have a generous payback term. Applicants must have a repair permit issued by the local agency or DEP prior to applying. To date, a total of $2.1 million has been loaned through this program.

In other activities, federal and state funding agencies are looking closely at financing strategies for those areas that must replace malfunctioning on-lot systems with

public sewers. The primary concern is how these agencies can make the sewerage systems more affordable to users. The problem is being evaluated both in terms of making affordable technology available and in terms of providing loans and grant money to reduce costs.

Stimulating Development of Up-to-Date Sewage Facilities Plans

The primary tool available to municipalities for evaluating the condition of on-lot systems is an Act 537 Sewage Facilities Plan. By developing and adopting such a plan, the municipality can help assure the provision of adequate on-lot systems, as well as public and private sewerage facilities. These plans:

- Identify areas where systems are malfunctioning and causing public health or pollution problems.
- Identify growth areas where some method of sewage treatment will be needed in the future.
- Assess all available options and identify which options will be implemented.
- Evaluate sources of financing available to implement the options selected.
- Establish an implementation schedule identifying major steps needed to carry out the plan.

An Act 537 plan, when closely linked with zoning and land-use ordinances, provides a roadmap portraying the future of the municipality in terms of anticipated development and needed infrastructure. These plans also serve as the basis for establishing priority to receive funds from PENNVEST and other funding agencies to finance sewerage projects. While urban areas have used the Act 537 planning process to their advantage, rural municipalities in Pennsylvania have not. A recent evaluation of the status of Act 537 planning revealed that 1,407 of the 2,571 Pennsylvania municipalities have sewage facilities plans dating to 1974 and earlier. This means that approximately 55 percent of all Pennsylvania municipalities have not evaluated the status of their sewage facilities for more than 24 years. DEP's new emphasis includes strategies to identify municipalities with the most critical, planning-related problems and to foster planning through outreach and assistance.

Encouraging Sewage Management Programs

In the early 1990s, DEP attempted to force municipalities to develop and implement sewage management programs through their Act 537 plans. These programs are intended to assure the long-term functioning of on-lot systems through system inspection, mandatory septic tank pumping and a maintenance program administered through local governments. Programs may also include the identification and repair of on-lot system malfunctions. While DEP was successful in obtaining from municipalities sewage facilities plans that proposed the establishment of such programs, few of these plans were implemented. The reason often was public opposition to the cost of such a program ($150 every three years to pump the septic tank plus fees charged by the municipality for inspection and record keeping). These costs, however, are minor compared to providing public sewers to an area because of the lack of maintenance and eventual failure of on-lot systems.

The Department has changed its approach from attempting to force municipalities to develop management programs to providing outreach and assistance to municipalities that want to develop these programs. In order to encourage sewage management programs, DEP has provided the Pennsylvania State Association of Township Supervisors (PSATS) with funds to develop the publication, "A Municipal Official's Guide to Managing On-Lot Sewage Disposal Systems," which is now available for use. DEP also has passed regulations to reimburse municipalities for between 50 percent and 85 percent of the annual administrative and staffing costs associated with running a sewage management program. In addition, DEP will reimburse a

Evaluating Your Municipality's Act 537 Plan

Citizens, government agencies and businesses can increase their knowledge of sewage facilities within a municipality by evaluating the municipality's Act 537 Sewage Facilities Plan. Key factors to consider when evaluating these documents include: the age of the plan, consistency of the plan with current land-use patterns and land-use planning/zoning ordinances, and the operational status of on-lot systems in the municipality. If your review reveals problems in any of these areas, it is time for municipal officials to consider an update to the plan. Citizens also should learn about the on-lot system serving their dwelling or business to assure that it is properly operated and maintained.

municipality for 50 percent of the cost of evaluating sewage management programs in its Act 537 Sewage Facilities Plan. This allows local governments to weigh the advantages of such programs without being put off by the costs.

The Future of On-lot Treatment and Disposal Systems in the Commonwealth

DEP's new focus on on-lot systems is already paying dividends. A number of municipalities strongly opposed to mandatory sewage management are beginning to embrace the concept as a good idea. This attitude should become increasingly prevalent as DEP's on-lot system research, education and outreach, and financial support activities become more firmly established. Many of the new on-lot technologies being developed by DEVAL require maintenance and periodic inspection. Municipalities with sewage management programs in place will be in an excellent position to provide these system options to their residents upon their release for statewide use.

It's a fact that Pennsylvania will continue to depend heavily on on-lot systems to serve at least one-third of the state's population well into the next century. The tools that are currently in place, as well as those that are being developed by DEP and others, will provide municipalities with the support they need to assure that these systems are managed to prevent public health or pollution problems in the future. ■

For more information:

The following information on on-lot systems is available from DEP:

Sewage Disposal Needs Identification Guidance - Act 537

Fact Sheets #1 through #10 regarding on-lot systems

Consumers Guide to On-lot Sewage Disposal System Operation and Maintenance

Consumers Guide to On-lot System Permits

A Guide to Multi-municipal Local Agencies

Sewage Facilities Planning Guidance for Municipal Officials

To obtain these and other materials, call the Division of Wastewater Management at 717-787-8184, or visit DEP's website at: www.dep.state.pa.us (choose information by subject/Water Management).

13

Wetlands

Nature's Water Quality Protectors

Information compiled by the Allegheny Watershed Network

Wetlands are complex ecosystems that can be found around the globe. Not all wetlands are alike, however. They can vary by location, hydrology, soil composition, vegetative composition, and function. Certain wetlands are flooded the entire year, while others have saturated soils for only part of the year. Despite these variations, wetlands are important elements in any watershed because of the many services they provide. A fuller understanding of wetlands and their functions will lead to better land-use decisions and positively affect the health of our watersheds.

What's A Wetland?

All wetlands share three main characteristics: wetland hydrology, wetland soils, and the presence of wetland plants.

WETLAND HYDROLOGY refers to the presence of standing water on the ground or within the root zone for at least part of the year. The depth and duration of this flooding varies.

WETLAND SOILS, OR HYDRIC SOILS, develop anaerobic conditions (i.e. they lack oxygen) due to their saturation. These soils are quite distinctive from other soils and usually can be identified by their bluish-gray appearance.

WETLAND VEGETATION, OR HYDROPHYTES, are plants that are adapted to living in wet conditions. Wetland plants can range from those that have adapted to living in either wet or dry conditions to those that only can live in a wet environment.

Black Moshannon State Park

All of these characteristics are used to determine the existence of a wetland and to define its boundaries, a process called wetland delineation. Because of the varying nature of wetlands, the delineation process can be difficult and requires expertise in botany, hydrology and soil science.

Pennsylvania's Wetlands

Less than 2 percent of Pennsylvania's land surface is covered by wetlands. The most concentrated areas of wetlands are in the glaciated northwestern and northeastern parts of the state. In these areas, glacial activities (scouring and deposition) created conditions favorable to wetland development. In unglaciated areas, wetlands typically are associated with headwaters and floodplains of streams and rivers.

Forested wetlands (often called swamps) are the most common type of wetlands in Pennsylvania. These wetlands, characterized by trees greater than 20 feet tall, are found on more than 220,000 acres. Other types of wetlands found in the Commonwealth are scrub-

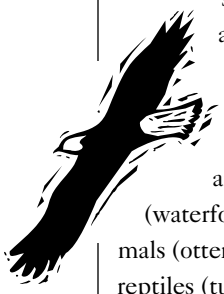
shrub wetlands and emergent wetlands (also known as marshes), covering approximately 139,000 acres and 70,000 acres, respectively. Scrub-shrub wetlands are characterized by woody plants less than 20 feet tall, while emergent wetlands contain primarily non-woody plants.

The Functions and Values of Wetlands

Wetlands serve a variety of functions in the natural environment and offer a variety of environmental values. Not all wetlands perform all of the functions outlined below. Factors such as vegetation, adjacent land use, location in a watershed and geology all can influence what a wetland can do.

Habitat

Wetlands are essential for the survival of many aquatic and terrestrial species. These habitats provide essential spawning, breeding, and feeding grounds for a variety of fish and wildlife. In Pennsylvania, more than 100 species of fish, including many sport fish, utilize our wetlands for reproduction and for food sources. Other animals that rely on wetlands include: birds (waterfowl, songbirds, shorebirds and raptors); mammals (otters, minks, raccoons, muskrats and beaver); reptiles (turtles and snakes); and amphibians (salamanders and frogs). Invertebrates also are important residents of wetland communities. Many of Pennsylvania's rare and endangered species are found in wetlands.



Flood Control

Wetlands provide natural flood control by intercepting storm runoff, snowmelt and high-water discharge from adjacent streams. Flood waters are slowed by wetland vegetation and are released gradually to adjacent lands or surface waters. For this reason, wetlands are sometimes referred to "natural sponges."

Nutrient and Sediment Removal

Water quality is improved as water passes through a wetland. As the water velocity is slowed by wetland vegetation, sediments can settle out of the water. Additionally, plants can use nutrients in the water, typically nitrogen and phosphorus from fertilizers, for growth and maintenance. Wetlands are so effective in improving water quality that artificial wetlands have been created to treat wastewater and water contaminated by mine drainage.

Buffering and Shoreline Stabilization

Wetlands act as buffers along shorelines during harsh storms and as a means of erosion control along the shores of rivers and lakes. Plants slow water velocity, while their roots anchor the soil, preventing it from being washed away with the flowing water.

Groundwater Recharge and Discharge

Wetlands can act as groundwater discharge areas when they receive their water supply from groundwater sources, such as springs or seeps. When water seeps from a wetland into a local aquifer, on the other hand, it is acting as a groundwater recharge area. Usually this occurs when the wetland is located above the water table.

Harvesting

Food products such as blueberries and cranberries are harvested from wetlands, along with other products such timber and peat. Some of these harvesting activities can have negative impacts on wetlands.

Recreation

Finally, wetlands are important recreation areas. Activities such as fishing, hunting, hiking, canoeing and wildlife observation are made possible or are enhanced by the presence of wetlands. These activities are important economically; water–related recreation expenditures nationally are in the billions of dollars.

Wetland Losses

Despite the many values of wetlands, wetland areas were seen by early settlers as unproductive and even dangerous places. The draining and filling of wetlands was common throughout our nation's history. About half of the 220 million acres of wetlands that existed in the contiguous 48 states prior to European settlement have disappeared. Most of the land was put into crop production and other development.

Since the mid-1970s, however, wetlands have been offered more protection at the federal and state levels, and sometimes locally as well. Laws such as the Federal Clean Water Act and Pennsylvania's Dam Safety and Encroachment Act have reduced the acres of wetlands lost each year by requiring permits for dredging or filling wetlands. For a complete, and current, description of the wetland permitting process in Pennsylvania, contact the Department of Environmental Protection and the U.S. Army Corps of Engineers.

Replacement Wetlands

The creation or restoration of wetlands to compensate for those that are lost to some type of construction activity is a process known as mitigation. At one time, ponds were considered to be replacements for wetlands because they provided habitat for some species, primarily waterfowl. However, ponds do not necessarily provide habitat for other wetland species, nor do they accomplish many of the other environmentally beneficial functions of wetlands. Although it would be ideal to have replacement wetlands perform all the same functions as the wetlands that are destroyed, this is not always possible. As a result, the best option for protecting wetlands and their functions is to avoid disturbing them in the first place.

The success rates for replacement wetlands vary. Wetlands that were created where none have existed before are not as successful as wetlands that are restored after they were degraded or filled. Actions that help in the creation of a functional wetland include: selecting a site with appropriate water supply, such as an area that is fed by groundwater; using an area with nutrient-rich soil; locating the wetland in a similar area; designing the wetland for the desired functions; and using natural revegetation when possible.

Landowners often wish to have wetlands restored on their property, usually to support wildlife. The U.S. Fish and Wildlife Service's Partners for Wildlife Program cooperates with landowners, conservation organization and other government agencies to make wetlands restoration possible on private lands. Although the Partners for Wildlife Program originally was formed to restore degraded wetlands on nonfederal lands, the program has been expanded to restore forests, grasslands and riparian areas as well. ■

For More Information:

There is a wealth of information about wetlands available from government agencies, academia and environmental organizations. The following list is only a sample of the useful information available:

Department of Environmental Resources. 1990. *Wetlands Protection: A Handbook for Local Officials.* Environmental Planning Information Series Report #7.

EPA Wetlands Hotline: 1-800-832-7828

Heist, A.C. and A.G. Reif. (no date) *Pennsylvania Wetland Resources.* Published by U.S.G.S.

Mitsch, W.J. and J.G. Gosselink. 1993. *Wetlands.* Published by Van Nostrand Reinhold.

National Audubon Society. 1994. *Valuing Wetlands: The Cost of Destroying America's Wetlands.*

Natural Resource Conservation Service. (no date). *Wetlands: Values and Trends.*

The Volunteer Monitor. 1998:10 (1). "Monitoring Wetlands."

Wetlands Ecology and Conservation: Emphasis in Pennsylvania. Eds. Majumdar, S.K.; Brooks, R.P.; Brenner, F.J.; Tiner, Jr, R.W. 1989, The Pennsylvania Academy of Science.

Also, be sure to check the Internet for important wetland web sites such as:

The Wetlands Regulation Center: www.wetlands.com

National Wetlands Inventory: www.nwi.fws.gov

Protecting Groundwater

How Safe Is Your Aquifer?

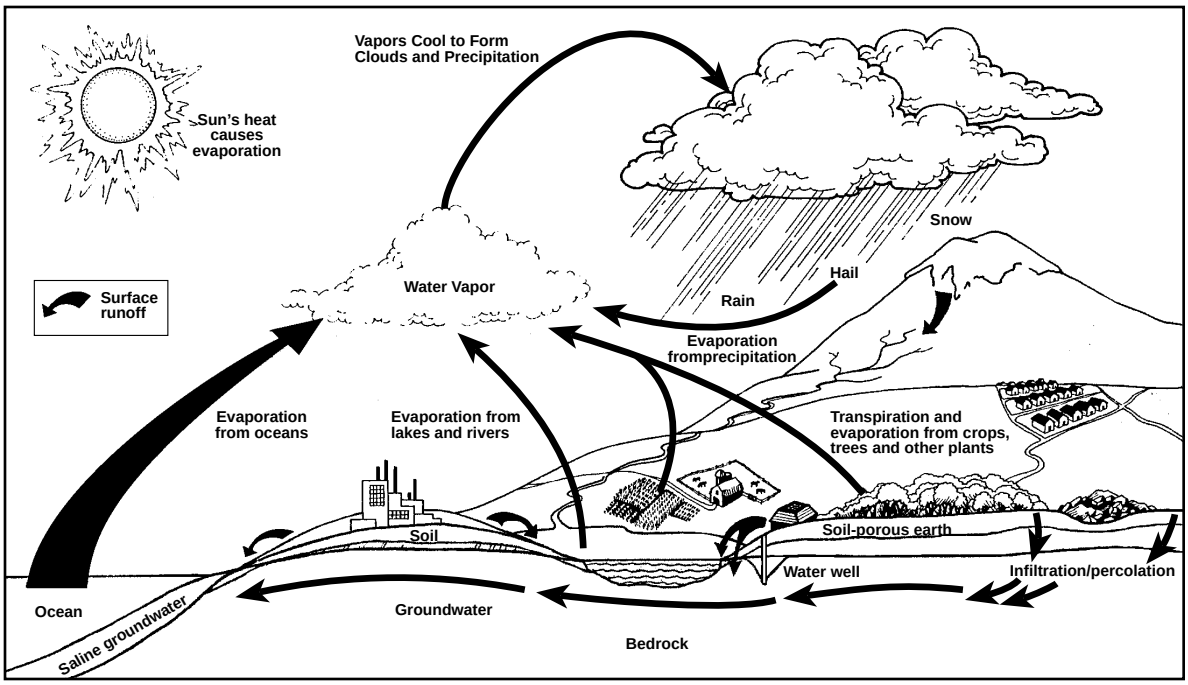
BY EDITH STEVENS

Stevens is Water Resources Specialist with the League of Women Voters of Pennsylvania.

Almost half of all Pennsylvanians get some or all of their drinking water from groundwater. It is a vital resource in more ways than one. In addition to providing drinking water, groundwater provides the base flow of water to streams. During dry periods, in fact, the water flowing in streams can be 100-percent groundwater. Year round, it is estimated that groundwater provides as much as 50 percent of stream flow. The relationship between streams and the aquifers that hold groundwater isn't entirely one-sided, though. During wet seasons, streams may contribute water to adjacent aquifers. At this time, the stream is called a "losing stream."

Groundwater provides protection for the quality as well as the quantity of water in our streams. A clean, cool discharge of groundwater to a stream is one of the

The Hydrologic Cycle



Source: Groundwater—A Primer for Pennsylvanians: PA League of Women Voters

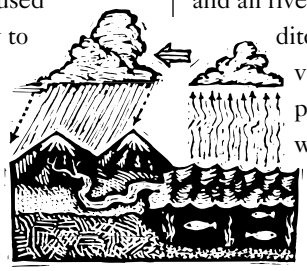
Groundwater is water at one stage of the hydrologic cycle through which all water moves. Water found underground gets there from precipitation falling on the land and infiltrating through the soil until it reaches an aquifer—a zone of saturation where all the spaces between soil particles or cracks in bedrock are filled with water.

Water on its way to the aquifer in the upper-layer soil is called "soil water." Some of this water will be taken up by plants and wind up back into the atmosphere—just one of the ways that the water cycle continues. Water that makes its way to the aquifer, on the other hand, continues its journey through the cycle, moving from the aquifer toward a discharge point—e.g., a spring, stream, lake, wetland or ocean. Most water seeping into the soil moves only a few miles to the point where it is discharged; in most instances it stays within the same watershed.

key predictors of a healthy stream, providing fresh water uncontaminated by surface impacts. On the other hand, if groundwater becomes contaminated, it will carry most of that contamination to the stream. A polluted stream can harm an aquifer in much the same way by contributing polluted water to the groundwater supply.

How is Groundwater Polluted?

The quality of our groundwater depends on how we use the land above it. Activities and land uses that have the potential for harming groundwater include: agriculture, mining, storage tanks, home lawns and gardens, golf courses, chemicals used on highways, landfills and storage lagoons, malfunctioning on-lot septic systems and improper disposal of used motor oil. While the soil has some ability to filter out harmful substances from the water moving through it, an excessive amount of pollutants can easily overwhelm the soil's filtering capacity.



Once contamination reaches groundwater it stays there and can be very difficult to detect. Depending on the type of contaminant, it may "float" on the top of the groundwater like gasoline, may dissolve in groundwater like highway salt, or may sink to the bottom of the aquifer like coal tar, a heavier-than-water substance that is a byproduct of the coal-gasification plants that dotted Pennsylvania in the early 1900s.

Cleanup of groundwater is also difficult. Sometimes, contaminated groundwater can be cleaned using a "pump and treat" method. Frequently, the treatment in these cases is air stripping, a process by which the contaminated water is allowed to flow through a column of air so contaminants are transferred to the air. A treatment method used for "sinkers"—pollutants that are heavier than water—is to install a pump in the solid bedrock below the aquifer.

Groundwater quantity is also dependent on what is done on the surface of the land. As wetlands are filled and the impervious cover of rooftops, parking lots and roads shuts off the passageways for rain and snow to infiltrate the soil, the replenishment of aquifers with rainwater and snowmelt decreases. This causes groundwater levels to drop and decreases the groundwater available to provide base flow to streams in dry weather.

Laws to Protect Groundwater

The best way to protect groundwater is to control activities on the land that have the potential for harm. Some of these activities, such as landfills or storage tanks, are regulated by the state or federal government. However, for the most part, it is up to local governments and individual citizens to take action to protect groundwater. Some of the laws and regulations applying to groundwater protection are explained below:

PENNSYLVANIA'S CLEAN STREAMS LAW. The Clean Streams Law was first passed in 1937 and has been strengthened by amendments a number of times, most recently in 1989. The law states that "... the waters of the Commonwealth shall be construed to include any and all rivers, streams, creeks, rivulets, impoundments, ditches, and other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of the Commonwealth." The Clean Streams Law thus provides a legal framework that could be used to protect groundwater quality in Pennsylvania. However, both the law and the regulations implementing it are most often used in relation to surface water.

WELLHEAD PROTECTION MEASURES. The Federal and state safe drinking water laws (See "Statutes and Regulation's Affecting Waterways Protection," page 143) contain provisions for the protection of groundwater that supplies public water supply wells. These "wellhead protection" measures establish rules for defining the land area that supplies the groundwater that reaches a well. Arriving at this definition can be as simple as drawing a circle around the well or as complicated as doing intense hydrological studies that determine how fast and from what direction ground-water is flowing toward the well. Wellhead protection plans focus on:

1) Identifying potential sources of contamination within the wellhead area; and

2) Developing and implementing strategies to limit the risk of contamination of the water supply.

In Pennsylvania, a wellhead protection plan is required for a new or expanding public water supply well. Water suppliers are required to develop such plans, although the plans can be hard to implement if the wellhead protection area falls on someone else's land. Municipal cooperation is necessary to enact zoning regulations or performance standards such as extra safety designs for underground storage tanks on this neighboring land.

SOURCE WATER ASSESSMENTS. In 1996, the federal Safe Drinking Water Act was amended to include "Source Water Assessment" provisions that require states to develop plans for assessing the water sources for all public drinking water systems and identifying contamination threats to those sources. The Pennsylvania Department of Environmental Protection (DEP) is developing plans for implementing this part of the Act and is currently planning to conduct the source water assessments itself for all public water supplies. The new rules will guide surface water suppliers on how to define their "source water" and how to identify and control possible sources of contamination within the source water area.

"PRINCIPLES FOR GROUND WATER POLLUTION AND PREVENTION AND REMEDIATION." This document was adopted in 1996 by DEP and provides the basis for all policy decisions relating to groundwater in the state. The goal of the principles is the prevention of groundwater contamination whenever possible and the protection of human health and the environment.

PENNSYLVANIA NUTRIENT MANAGEMENT LAW. This law applies to large agricultural operations and requires that such operations develop plans for controlling nutrient pollution. (See "Reducing Nutrient Pollution in Pennsylvania's Streams and Rivers: Too Much of a Good Thing," page 29, for more information.)

PENNSYLVANIA PESTICIDES PROGRAM. The Pennsylvania Department of Agriculture has adopted a Pesticides and Groundwater Strategy to provide a reasonable approach to managing pesticides and preserving groundwater quality. The goal of the strategy is to protect all drinking water sources from degradation. For more information on the strategy and its implementation, contact the Department of Agriculture at 717-787-4843.

MUNICIPAL PLANNING CODE. The Pennsylvania Municipalities Planning Code (MPC), also known as Act 247, gives municipal officials the right to regulate the use of land in their communities. Amendments to the MPC in 1988 provided specific authority to plan and zone for protection of natural resources and water supply. Section 604(1) lists among the purposes for which zoning may be enacted "...preservation of the natural, scenic, and historic values in the environment and preservation of forests, wetlands, aquifers and flood plains."

Sections 301(b) and 603(1d) of the MPC allow a municipality to plan and zone to regulate "the siting, density, and design of residential, commercial, industrial and other development in order to assure the availability of reliable, safe and adequate water supplies to support the intended land uses within the capacity of available resources." In other words, Pennsylvania municipalities are able to adopt ordinances requiring land developers to demonstrate an availability of safe and adequate water supplies for their proposed developments.

The MPC does not make it mandatory for municipalities to plan and zone to protect these resources, however, and few have adopted zoning rules with water resource protection goals in mind. Since this is a fairly new concept in Pennsylvania, any zoning adopted should be based on good science in order to survive a court challenge.

Water-based Land Use Planning Assistance Available

The Environmental Management Center at Brandywine Conservancy in Chadds Ford has developed a science-based program designed to ensure that the natural hydrologic system of a community or watershed remains unchanged as development occurs. The program, called the Water-Based Land Use Regulatory Program (WBLUR), uses a water budgeting computer model (WATBUG) and geographic information system (GIS) to evaluate the impacts of various land and water use scenarios or development proposals in a community to determine what will be a sustainable development pattern. WBLUR must be adapted to a community's resource protection goals and its ability to implement different regulatory programs. The Center has developed sample ordinances that can be adapted for water sustainability. For more information contact the Environmental Management Center at P.O. Box 141, Chadds Ford, PA 19317. Phone: 610-388-2700.

Next Steps

The quality of groundwater in your watershed, and thus the quality of water in your streams, will depend on the action, or inaction, of local citizens. Individuals need to understand the impact that their actions have on the water they drink and the water resources of their watershed. Municipal officials need to understand that the actions they take to regulate the use of the land will affect the drinking water of local residents, as well as the quality and quantity of water in local streams.

The key to groundwater protection is local action. And local education must precede local action. Water suppliers can be a key ally in your education efforts. Large suppliers are well aware that cleaner source water (whether ground or surface) reduces their treatment costs. They also understand that consumer faith in their product is shaken and needs to be restored. Small water suppliers, on the other hand, may need some help in understanding that educating the public about taking care of their groundwater will provide positive benefits for their water supply job.

Citizen groups, local officials and water suppliers can make a powerful team to get the message out about watershed and groundwater protection. ■

For More Information:

THE WATER RESOURCES EDUCATION NETWORK (WREN). A project of the League of Women Voters of Pennsylvania Citizen Education Fund, WREN supports local groups undertaking water resource education projects. Through the WREN Resources Center (call 1-800-692-7281), the WREN website (http://pa.lwv.org/pa/wren) and a quarterly newsletter, *Water Policy News*, WREN helps community groups share information, network and learn from each other. WREN also provides small grants to community coalitions working on water education projects.

Publications available from WREN include: *Groundwater: A Primer for Pennsylvanians*, 12 pages (1994); and *Groundwater Protection and Management in Pennsylvania: An Introductory Guide for Citizens and Local Officials*, 58 pages (1997). Also available from the WREN Resource Center is the Pennsylvania Department of Environmental Protection publication, *Sand Castle Moats and Petunia Bed Holes*, a book about groundwater for junior high students, 28 pages (1994). The Resource Center also maintains a collection of educational videos about groundwater.

THE GROUNDWATER FOUNDATION. Located in Lincoln, Nebraska, the Groundwater Foundation supports communities through its Groundwater Guardian program and Groundwater Festival training. Call 1-800-858-4844 or visit the foundation's website, http://www.groundwater.org.

Other Resources:

Penn State Cooperative Extension produces many useful publications on groundwater. Contact your county Cooperative Extension office.

DEP's guiding policy document, *Pennsylvania's Comprehensive Groundwater Protection Program*, was issued in May 1997 and is available from DEP

The Pennsylvania Environmental Council publication, *Guiding Growth, Building Better Communities and Protecting Our Countryside*, has useful information on groundwater and watershed protection. Contact: PEC, 64 S. 14th Street, Pittsburgh, PA 15203. 412-481-9400.

15

Water Toxins in Streams

Taking On Toxics

BY BARBARA L. KOOSER

Kooser is an Environmental Scientist with the Chesapeake Bay Foundation.

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TOXIC: adj. 1. of, affected by, or caused by a toxin, or poison. 2. acting as a poison.

—*Webster's New World Dictionary of the American Language*

The very definition of the word "toxic" illustrates the problem in trying to define "toxic pollutants" in relation to aquatic systems; the definition is often not very specific. At the federal level, the problem is illustrated when you look at the various toxics or hazardous substances that are covered by different regulatory programs. Each major federal program has a different list, and there is not much overlap.

According to John Dernbach, associate professor at Widener University School of Law, only 49 chemicals are covered in all five of the major environmental and worker health programs. On the other hand, one of these programs, by itself, covers 768 chemicals. The Clean Water Act, for its part, defines a "toxic pollutant" as one that, alone or in combination with other substances, will cause death, disease, behavioral abnormalities, genetic mutations or similar problems for organisms or their offspring.

How Do Toxic Pollutants Get Into Our Waterways?

There are four primary "pathways" for toxic pollutants to enter rivers, lakes and streams. The first is from "point sources" of pollution, which make direct discharges of toxics from a specific source such as a factory or a sewage treatment plant discharging through a pipe into a stream. Second, toxic pollutants can come from water running off of the land; this diffuse source of pollution is referred to as a "nonpoint source." Third, the deposition of toxic pollutants from the air can also

be a source of toxics in our waterways, affecting large lakes, bays and estuaries more than small streams. A fourth source of pollutants can be contaminated groundwater, if the stream is fed by water from the ground.

It is hard to say precisely how many chemicals get into our waterways. Currently, there are more than 73,000 chemicals in use (Kooser and Savitz, 1996). Large manufacturing facilities report the release of 599 chemicals through the federal government's Toxics Release Inventory (TRI). The U.S. Environmental Protection Agency (USEPA) has identified 126 of these chemicals as "priority pollutants." Confusing the picture even more, the Commonwealth of Pennsylvania regulates the discharge of approximately 140 toxic chemicals by setting specific water quality standards for each.

Data on the quantity of chemicals that reach our waterways is not much clearer. Looking at the TRI, we find that large manufacturing facilities discharged 22,736,860 pounds of specific toxic chemicals into Pennsylvania waterways in 1996, and the same group of facilities sent 8,461,731 pounds of toxic chemicals to local sewage treatment plants. Numbers aren't available to gauge water pollution stemming from other point sources that aren't required to report to the TRI—such as sewage treatment plants and smaller manufacturing facilities. Similarly, it is hard to measure

the extent of pollution from nonpoint sources and polluted air and groundwater. In other words, no one really knows how much of which toxic pollutants are entering our waterways each year.

How Are Toxic Pollutants Regulated?

Water quality standards are the tool used to protect streams from toxic pollutants. There are actually two parts to a standard. First, the state has to decide how a stream is used—i.e., who or what uses the stream and its water and for what purposes. This entails going out to a stream and assessing its use according to a list of designated uses developed by the state. These include:

- "Aquatic life"—cold water and warm water fishes, migratory fishes, and trout stocking;
- "Water supply"—potable, industrial, livestock or wildlife water supply, and irrigation;
- "Recreation"—boating, fishing, water contact sports and aesthetics;
- "Other"—e.g., navigation; and
- "Special protection"—high-quality and "exceptional-value" waters

Until recently, the state would assess streams on an as-needed basis, usually in response to a permit request to discharge into a specific stream or a request to change the stream's designation. As a result, less than half the streams in the state have been assessed to date. The state is now under a court order, however, to assess the remaining streams and plans to do so by examining stream "biota" (flora and fauna) and habitat. Based on its findings, the state will make a determination as to what use is appropriate for the stream, and will then decide whether the stream is meeting that use. Instream aquatic biota (macroinvertebrates such as mayflies and caddisflies) are often used as an indicator of the quality of a stream because they are not very mobile, live most of their life in the same area, and can be noticeably affected by changes in water quality.

To arrive at the second part of a water quality standard, the state has adopted "water quality criteria" for each chemical on its list of 140 toxics in order to protect the designated uses. When the waterway in question is a stream, the state uses the water quality criteria resulting in the most protection, thereby protecting all stream uses.

There are two types of water quality criteria: a narrative criteria and a numeric criteria. The following is an example of a narrative criteria found in the regulations: "Water may not contain substances attributable to point or nonpoint source waste discharges in concentrations or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal plant or aquatic life."

A numeric criteria, on the other hand, is the concentration of a chemical that can be allowed in a stream without harming the stream biota or affecting human health. An example of a numeric criteria would be 2.0 milligrams of fluoride per liter of stream water. Notice that water quality criteria apply to instream concentrations, not necessarily to the concentrations of a pollutant as it comes out of a discharge pipe. Because of this, USEPA allows states to adopt policies so that areas of a stream immediately downstream of a discharge pipe can have higher concentrations of a pollutant; this area is called a "mixing zone."

In addition to state water quality criteria, some of the major drainage basins have specific criteria that need to be met. For example, the Delaware River Basin Commission has adopted its own toxics management strategy that in some ways is more stringent than the state program. Also, because of the Great Lakes Initiative, a federal effort to establish consistent requirements for certain chemicals in the entire

Water Quality Standards Needed

A water quality standard determines the amount of a toxic pollutant that can be found in a stream and still be considered "safe" for aquatic life and human health. Water quality limits in discharge permits are based on the instream limits set by water quality criteria. The state calculates what amount is deemed "safe" for the stream and then allows a facility to discharge up to that amount.

To determine limits for permits, the state currently uses a water quality model that looks at only one discharger at a time, and only one chemical at a time. The interaction between facilities discharging the same chemical, and the interactions between different chemicals, are not taken into account. In addition, discharge permits could well be too lenient and could cause damage if a stream is cleaner than it needs to be to protect its designated use. This is why is it so important to have a protective water quality standard for Pennsylvania streams.

drainage area of the Great Lakes System, there are more stringent controls in place in Great Lakes drainage areas than in the rest of the state.

Public Participation Opportunities

The public has several chances to provide input to DEP regarding toxic pollutants and streams. The first is in connection with the development of water quality standards for streams. Every three years, the state is required to review its water quality standards and present its proposed changes to the public; this process is called the "triennial review." The public usually has 45 to 60 days to submit comments. Notification of changes to regulations are published in the PA Bulletin, a weekly state government publication found in all county libraries. In addition, hearings are sometimes held to gather public comments. The state is required to publish both proposed drafts and final versions of changes to water quality standards found in the PA Bulletin; these drafts must undergo "complete regulatory review."

Changes to the toxics criteria (Pennsylvania Code, Title 25, Chapter 16) are different. This is because Chapter 16 is not a regulatory chapter, it is a statement of policy. Chapter 16 is thus reviewed annually, with only one opportunity for public comment. Full regulatory review is not in effect. This difference allows the criteria for toxics to be amended more quickly by the state.

Another opportunity for public input is in the implementation of these standards through water quality permits. Pennsylvania has been delegated the authority by USEPA to issue National Pollutant Discharge Elimination System (NPDES) permits for all point-source discharges. The state determines the amount of a pollutant a given facility is allowed to discharge, and then compares this amount with what is actually "coming out the pipes."

A limit for a toxic pollutant is written into a facility permit if: 1) the amount of a pollutant in the discharge has a "reasonable potential" to violate an instream water quality standard; or 2) the USEPA has issued discharge guidelines for that type of facility for a specific chemical. It is important to remember that facilities are not required to monitor for all the toxics that may be in their discharges—only for those identified by the state or federal government as a possible threat. The state

Ideas for Citizen Action on Toxics

1. **Get to know your stream.** If the water quality of your stream is better than needed to protect its designated use, put together a petition to have the stream redesignated. Citizens can petition DEP to get greater protection for high-quality streams.

2. **Become informed.** Find out who is discharging what into your waterways. The USEPA has a web site listing the discharge permits on an individual watershed basis, along with information on facilities reporting to the TRI and designated Superfund sites.

3. **Check up on facilities discharging toxic pollutants.** Arrange with DEP to do a file review. Ask not only for permit files and DMRs (discharge monitoring reports prepared by facilities as a permit condition) but for the correspondence files as well.

4. **Partner with local facilities to do a toxics audit showing what toxic chemicals are used and where they go.** You might also want to set up a Good Neighbor Agreement where local facilities pledge to reduce their use and discharges of toxic chemicals. This is a way to open up the lines of communication with local facilities and provides the facilities with input from citizens about problems they perceive

5. **Support efforts to get access to more information.** Currently, the best information available on the release of toxic chemicals comes from the TRI program. This program is scheduled for some revisions soon, and your comments can help get more information to the public. Join in the call for the reporting to cover a broader range of industries, smaller facilities, and the amount of chemicals that are used, not just released. Currently, a reduction in the release of a chemical could mean that the chemical is being incorporated into the product.

6. **Fight efforts to weaken current protections.** Every three years, the state evaluates the water quality standards. Watch for any changes, and fight efforts to reduce the number of water quality criteria. Except for a limited number of industrial guidelines established by USEPA, the state cannot regulate toxic pollutants in permits if it does not have criteria for those pollutants. Encourage the state and federal governments to start accounting for exposures to multiple chemicals, and to further examine the effects of hormone-mimicking chemicals. Challenge the state and federal governments to change their focus from end-of-the-pipe solutions to solutions that reduce the use of toxic chemicals.

7. **Make your own contribution to reduction.** Look under your sink and in your basement to see what ingredients are in the household cleaners you use every day. Often, there are alternatives to harsh chemicals and chlorine. Remember: what goes down the drain may make it into the stream. Think twice about the pesticides and herbicides you use on your lawn and garden. Try natural pest controls or less toxic chemicals first. Investigate other ways your household can reduce the amount of toxic chemicals getting into our streams!!

publishes proposed permits in the PA Bulletin as well. The public usually has 30 days to comment and can request a public hearing.

Toxic Trends

The TRI is the primary source of information on the release of toxic chemicals in the United States. Even though it includes only a portion of the total number of facilities releasing toxic chemicals, the TRI is one of the few places we can find readily available data on toxic releases. A review of the TRI data for Pennsylvania reveals some clear trends:

- Total production-related toxic waste has recently begun to decrease. In 1996, manufacturing facilities in Pennsylvania produced an astonishing 896 million pounds of toxic waste.

- Releases of toxics into streams were down from 0.42 million pounds in 1993 to 0.31 million pounds in 1995. However, due to an increase in chemicals reported, toxic releases increased to 22.8 million pounds in 1996.

- Transfers of toxics from manufacturing facilities to municipal sewage treatment plants were down from 7.4 million pounds in 1993 to 5.5 million pounds in 1995, and up to 8.5 million in 1996. This category is important because most sewage treatment plants are not designed to remove toxic chemicals, and these chemicals often get incorporated into the sewage sludge or are passed through the plant and discharged.

- Some of the recent declines in toxic discharges can surely be attributed to the fact that businesses now are realizing that reducing the production of toxic waste at a facility is actually a sound business practice, considering the costs of disposing of hazardous chemicals. Some businesses are truly attempting to reduce their release of toxic chemicals by incorporating pollution prevention techniques into their facilities. A number of these businesses have received recognition from the state through the Governor's Awards for Environmental Excellence.

The focus of toxics pollution to date, however, has been on how to reduce what comes out of the discharge pipe. Companies need to look at larger issues and to try to design products that do not use toxic chemicals in the first place. In addition, as mentioned above, the current regulatory program focuses on the toxic effect of each chemical separately. This despite the fact that facilities rarely release just one chemical; more often it is a mixture of different chemicals. The effect of all these chemicals together is not an issue when permit limits are written for each chemical. Periodically, the state will require a facility to examine "whole effluent toxicity" in an effort to determine the effect of its discharges on a culture of water fleas or small fish. But the use of this type of test is variable, with some regional DEP offices using it and other regions not using it at all.

Adding to the limitations of toxics regulation, USEPA has so far focused only on its 126 priority pollutants. Continuing this chemical-by-chemical approach will require a huge amount of research to determine the precise toxicity of all the chemicals that could possibly be discharged into our streams. At the same time, there is not much research being done on the chronic, or continuous, low-level exposure effects that chemicals have on organisms. Much more work needs to be done to determine the effects other than cancer that chemicals have on organisms and humans. A new area of research focuses on the hormone-mimicking effects of chemicals, where the effects of exposures cannot be seen until the next generation is of reproductive age. ■

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16

Preventing Flood Losses

The High Costs of High Waters

BY EUGENE E. COUNSIL, P.E.

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Coastal and river flooding is the most frequent type of natural disaster in the country, and it's happening with more and more frequency every year. In Pennsylvania, the combination of approximately 83,261 miles of streams and the existence of several major storm tracks across the state spells trouble. Storms in Pennsylvania produce average annual precipitation ranging from 36 to 39 inches of rain in the north and west of the state to 41 to 45 inches in the south and east. In addition, all parts of the state receive snowfall during the winter. Flooding due to excessive rains and snowfall has caused fatalities and major damage throughout the state.

Washington's Landing, Pittsburgh Flood of 1996.

Flooding in Pennsylvania: A Special Threat

Pennsylvania's rivers and streams are winding, sometimes with rapid rates of fall, and are often restricted by the rugged mountain ranges through which they flow. The development of towns, industry, highways and railroads largely followed the state's rivers and streams; they have served as pathways of commerce and development throughout Pennsylvania history. With over 90 percent of its municipalities having identified flood-hazard areas, Pennsylvania is one of the most flood-prone states in the country. The major floods that have hit the Commonwealth are widely known. The list starts with the Johnstown Flood in 1889 and continues through the twentieth century to the 1936 Flood, Hurricane Eloise in 1975, Gloria in 1985 and the 1996 ice floods. Between 1936 and 1976, Pennsylvania suffered 17 major floods that cost the state more than $5.3 billion in damage.

According to researcher William H. Shank, Pennsylvania can expect to be hit by major flooding once every 25 years or so. Locally damaging floods of great intensity occur almost yearly across the state but have not been well documented. Because of existing and continuing development in floodplains and construction of new impervious surfaces in watersheds, this pattern of localized flooding can be expected to continue—and with increasing frequency—in the years ahead.

Flood Protection in Pennsylvania: A Legislative and Regulatory History

The Pennsylvania General Assembly has enacted several laws aimed at reducing the threat of flooding. One of the earliest of these was the Water Obstructions Act of 1913, which required a state permit for the construction of any dam or water obstruction or the changing or diminishing of the course, current or cross section of any stream or body of water in the state. The provisions of the Water Obstructions Act

were expanded by the Dam Safety and Encroachments Act of 1978, which remains the primary law regulating dams and water obstructions in Pennsylvania to this day.

Under the law, applications to the Pennsylvania Department of Environmental Protection (DEP) for dam safety and water obstruction permits must be accompanied by engineering studies that analyze the effects of the proposed project on flood waters and life and property. Applicants must also provide an environmental assessment showing that the proposed project will have no significant environmental impacts. Applications and assistance for water obstruction permits are handled by the regional DEP offices listed in the Government Agencies section of the Primer. Applications for dam safety permits are administered by the Bureau of Waterways Engineering in the Harrisburg Central Office.

Other laws have authorized state and local governments to undertake public works to reduce the potential for flood damages. Under a 1931 law, the state Water and Power Resources Board (WPRB) was empowered to determine the course, width and depth of any river or stream and to have this determination fixed by recording it in the office of the county recorder of deeds. The WPRB was also authorized to protect the bed and banks of streams; to build dams, retaining walls and other structures; and to prevent "percolations from streams through holes in the beds and banks thereof for the protection of property, fish, life, and the lives of riparian owners." A subsequent review concluded that this authority had rarely, if ever, been used.

Two laws that did result in real changes were the Flood Control Law and the Stream Improvement Law, both enacted after the 1936 floods to provide local flood protection and stream improvements.[1] The Flood Control Law authorized the WPRB to make appropriate surveys and to prepare plans for any proposed flood control district in order to "control, store, preserve, and regulate the flow of rivers and streams and diminish or eliminate floods inimical to the public health and safety and destructive to public and private property and works."

Under the law, a flood control district is established when the WPRB adopts official plans for the district and publishes notice of these plans in two local newspapers for two consecutive weeks. In order to carry out the plans, the WPRB was empowered to: "clean out, widen, alter, deepen or change the course, current, or channel of any river or stream; fill up any abandoned canal or water course; construct and maintain levees, dikes, walls, revetments, dams, lakes, reservoirs, and other works and improvements deemed necessary to prevent floods; and control, preserve, and regulate the flow of rivers and streams." The agency also was granted other related powers including the acquisition of land by donation, purchase, lease, or condemnation, for which the act specifically granted power of eminent domain.

Under the Flood Control Law, a Flood Control Fund was established in the state treasury to receive monies appropriated by the general assembly or received from the federal government and other sources. The WPRB was also empowered and directed to aid, assist and cooperate in the carrying out of any

[1] These laws use the terms "flood control" and "stream clearance," but the current preferred terminology is "flood protection" and "stream improvements."

Why Floods Cost Us So

Flooding is a natural phenomenon that occurs when the capacity of a stream channel to move water is exceeded by the rate of inflow from rainfall or snowmelt runoff. As the stream fills up, it overtops the streambanks and sends water into the floodplain, which is the level land bordering the stream channel.

While floods may be natural, flood damage is usually the result of human activities and development of flood-prone lands. A major part of the problem is the almost mystical, innate human need to be close to and able to see the water. In addition, the ease of construction on the level lands of the floodplain—together with the need to be close to the river for water supply, transportation, waste water disposal and other economic uses—have resulted in homes, businesses, industries and entire communities being susceptible to damage from direct overbank flooding. Not only are houses and other structures in danger, but they also obstruct the flow of water and thereby cause even greater depths of flooding locally, plus increased downstream flooding due to loss of "floodplain storage."

In addition, flood damages can be aggravated by natural obstructions in the channel such as ice, brush, debris and gravel deposits, and by manmade impediments such as bridges, culverts, piers, abutments and fills on the floodplain. Moreover, the volume and velocity of runoff from a storm can be increased when development throughout the watershed replaces pervious soils with buildings, streets, parking lots and storm sewers.

federal flood control project. Subsequent amendments authorized flood forecasting and warning systems, and allowed the Department of Forests and Waters—which was merged into the Department of Environmental Resources in 1970, the precursor of today's DEP—to occupy and use as recreational areas any dams, reservoirs, and lakes and adjoining lands constructed and acquired by the WPRB for flood control purposes.

The Stream Clearance Law, for its part, empowered the Department of Forests and Waters to: dredge and remove flood waste, deposits, flood water obstructions, gravel, bars and debris from any river or stream; restore or rectify flood-damaged or destroyed stream channels; construct dams, lakes and other improvements to impound flood waters and conserve the water supply; provide additional recreation areas; and construct flood forecasting and warning systems. The department also was authorized to: purchase or lease power shovels, bulldozers, and other necessary equipment for stream clearance and stream channel rectification; execute contracts for construction of dams, reservoirs and lakes; purchase flood forecasting and warning systems; and acquire lands, easements and rights-of-way or other property by lease purchase or eminent domain.

While the powers granted by the Flood Control Law and the Stream Clearance Law may appear redundant for many purposes, several important distinctions can be made. First, the Flood Control Law is based on the establishment of flood control districts and the development and formal adoption of flood control plans. Also, the Flood Control Law devotes considerable attention to guiding the Commonwealth's participation in federal flood control projects. In fact, it appears that flood control districts have been formally established under the law only for the administration of Pennsylvania's participation in federal flood control projects.

The Stream Clearance Law, on the other hand, addressed the issue of removing flood wastes and deposits and restoring flood-damaged stream channels. Among its many provisions, the law allows expedient execution of smaller projects through the rental of equipment and the supervision of work by department engineers. Although awarding of contracts has become more commonplace in recent years, the Stream Clearance Law continues to provide the authorization to facilitate rapid response to needed restorations and other emergency work following flood disasters.

50 Years of Service

In 1997, the Flood Protection program of the Pennsylvania DEP celebrated its 50th year of service to the citizens of Pennsylvania. Since 1947, the Department has constructed more than 200 major flood protection projects with a 1996 dollar value estimated at about $400 million. In that same period, more than 1,250 smaller stream improvement projects have been constructed costing nearly $11.5 million (actual dollars).

The Department continues to participate with local sponsors as a financial partner in federal projects undertaken by the U.S. Army Corps of Engineers and the Natural Resources Conservation Service. These projects, both state and federal, have more than paid for themselves in damages prevented over the years. Nevertheless, despite the efforts of the state and federal flood protection programs, Pennsylvania continues to sustain substantial annual flood damages.

The Municipal Role in Flood Control

The laws discussed in the preceding section establish a clear role for state government in regulating activities in watercourses and in providing flood protection and stream improvement projects. Although these services are often viewed as the exclusive responsibility of the state, local governments also have been authorized, and in some cases required, to administer programs to protect their communities from flood damage.

Pamphlet Law 95 (PL 95), adopted in 1936, empowered cities, boroughs, towns and townships to construct dikes, river bank protection, and other flood-control works, and to widen, deepen, straighten and otherwise improve the channels and banks of creeks, streams and rivers. It is interesting to note that this statute authorizes the local government not only to undertake work within its own municipality, but also to construct public works outside its boundaries and even outside of the county, provided that benefits will accrue to the municipality's residents.

Under the law, a municipality may acquire property by purchase and by eminent domain and may make assessments against owners of private property within the municipality's corporate limits who benefit from

any public works or improvements; the county court is charged with appointing a "board of viewers" to make these assessments. The law stipulates that all property that would be damaged by flood waters should be considered to benefit, whether or not the property directly abuts the stream or river on which the work is done. Municipalities also are authorized to undertake joint flood protection projects with the federal government. Again, "authorized" is the key word here. As with the state programs discussed above, the law authorizes, but does not require, municipalities to provide flood protection and stream improvement projects.

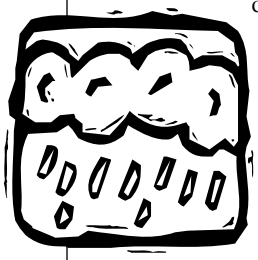
Two statutes enacted in 1978, however, go the next step and require local governments to take action in certain circumstances. The Flood Plain Management Act requires each municipality identified by the U.S. Department of Housing and Urban Development as having areas subject to flooding to participate in the National Flood Insurance Program (now administered by the Federal Emergency Management Agency). This means municipalities must adopt regulations, codes and ordinances to regulate development in the flood plains. Currently, approximately 2,400 of about 2,600 municipalities across the state are participating in the program, which provides 50-percent reimbursement to counties and municipalities for the costs of preparation of official plans, administration, enforcement and implementation. Since funding for the program kicked in in 1982, annual reimbursements by the Department of Community and Economic Development have averaged between $60,000 and $70,000.

The other 1978 law, the Storm Water Management Act, requires municipalities to enact and implement ordinances and regulations to control development in a manner consistent with a Watershed Storm Water Management Plan. These plans are required to be adopted by counties and approved by DEP for 356 watersheds designated by the Environmental Quality Board. The Storm Water Management Act provides 75-percent reimbursement to counties for watershed planning and to municipalities for enactment and administration of codes and ordinances. To date, 54 Watershed Storm Water Management Plans have been adopted with the participation of 38 counties and 541 municipalities. Over $7.5 million has been reimbursed since initiation of the financial assistance component of the program in 1985.

The Flood Plain Management Act and the Storm Water Management Act proceeded through the legislative process as a package. The idea was to prevent further damages by: 1) limiting future flood-susceptible development; and 2) encouraging the development of storm water management plans to prevent expansion of the flood plain by accelerated runoff.

What the Future Holds

The natural and random occurrence of intense rainfall and overbank floodflows will be a problem for Pennsylvanians and others as long as we live and conduct commerce on and near rivers and streams. As one hydrologist has commented, "It is certain that a devastating flood will occur (at any given location), we just don't know when." And as long as floods continue to be a problem, state, federal and local agencies will continue to provide disaster relief following each major flooding event. Humanitarian and financial relief will be offered to individuals, and the streams and floodplains will be cleaned up and restored to the greatest extent possible in light of increasingly limited government budgets. Likewise, state and federal agencies, within the limits of their budgets and eligibility criteria, will continue to construct flood protection and stream improvement projects.



Despite all this, however, there is always the concern that disaster relief efforts do not fully restore or make whole those who have been damaged. There is also concern that we never learn from our past mistakes. From a national perspective, despite the billions of dollars invested in structural flood protection and the demonstrated effectiveness of these measures, flood losses continue to rise because of unwise occupancy of the floodplains. This is as much a problem in Pennsylvania as it is anywhere else. Anecdotal evidence suggests, among other things, that despite the participation of some 2,400 municipalities in the National Flood Insurance Program, local floodplain codes are not vigorously implemented in many locations.

Nevertheless, it is abundantly clear that "nonstructural measures" such as flood warning and preparedness and clearing of floodplains can help reduce the cost of flood damage. Maintaining floodplains in open

space or allowing only land uses that could sustain inundation by floodwaters would be an ideal goal for all communities with flood-prone lands. Acquisition and removal of buildings and restoration of flood plains to open space uses would represent the ultimate non-structural solution for developed flood-prone areas. Although this approach hasn't been applied broadly in Pennsylvania, there is some experience. One example is in Homer City, where in the late 1970s state funding to the local redevelopment authority provided for the removal of flood-prone homes.

In March 1997, the Federal Emergency Management Agency (FEMA) published interim final rules for flood mitigation assistance, which can include acquisition of flood-prone properties. Following the series of disastrous floods in the summer of 1994 in Bradford and Tioga counties and the statewide ice floods in January 1996, more than 300 properties in Pennsylvania have been acquired under the FEMA hazard mitigation program. Although these have been disaster response actions, the future application and local eligibility for this program will stress flood plain management, land-use regulation and hazard mitigation planning by counties and municipalities.

As we look ahead to the future, it is important to remember that flooding is a natural phenomenon, but that flood damage is a result of humankind's economic use of flood-prone areas. Damaging floods occur somewhere in Pennsylvania every year. The Department of Environmental Protection continues to respond to the problem in many communities by providing structural flood protection and stream improvement projects. In spite of these investments, however, floods continue to inflict large economic losses and loss of life.

The only way to reverse the trend to ever-increasing flood losses is through increased efforts, primarily at the local government level, to control flood plain development and accelerated storm water runoff. Also necessary is the increased use of nonstructural measures by state and federal flood protection programs. ■