URBANIZATION AND WATER QUALITY

A Guide to Protecting the Urban Environment

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A Guide to Protecting the Urban Environment

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Foreword

Despite the gains achieved by Clean Water Act requirements and the installation of municipal sewage treatment systems in most communities, water pollution still remains a problem. Although industries and municipal treatment systems continue to affect water quality, states estimate that nonpoint source pollution causes one- to two-thirds of the impairment or threats to waterbodies.

Nonpoint source pollution results from land runoff, precipitation, atmospheric deposition, drainage, seepage, and hydrologic modifications. In urban areas nonpoint source pollution is created when sediment, toxic substances, nutrients, pathogens, and even garbage wash off fields, lawns, and impervious surfaces into our nation's waterbodies.

This guide is intended to help decisionmakers, such as local government officials and planners, understand the causes of nonpoint source pollution and design and implement a program to control this pollution. The guide provides a framework for developing a nonpoint source program tailored to an individual community. It includes examples of successful runoff management programs that illustrate the variety of strategies state and local governments have adopted.

Technical guidance and expertise, however, are essential components in this process. *Urbanization and Water Quality* lists a number of sources for such expertise: publications, contacts, and summaries of several federal programs mandated by the Clean Water Act and Coastal Zone Management Act. Applied within the community's structure, this information can help improve and protect the quality of nearby waterbodies.

Chapter 1

How Urban Runoff Affects Your Community: The Problem

The thirsty earth soaks up the rain,
And drinks, and gapes for drink again.
Abraham Cowley (1618-1667)

While centuries of poets have praised the virtuous qualities of rain, urban decisionmakers are forced to face the harsh reality — rain and its close relative, snow, are the major carriers of nonpoint source pollution. Such pollution occurs in developed areas when water runs off the land and streets — gathering pollutants in its path and depositing them in nearby waterbodies.

Urban runoff carries pollutants from many sources and activities — automobiles, oil and salt on roads, atmospheric deposition, processing and salvage facilities, chemical spills, pet wastes, industrial plants, construction site erosion, and the disposal of chemicals used in homes and offices. In fact, pollutant levels in urban waterbodies are generally much greater than in forested watersheds.

Runoff water quality worsens as urbanization increases:

- Trees that once intercepted rainfall are gone.
- Natural dips or depressions that had formed temporary ponds for rainwater storage are lost by grading and filling for development.
- Thick, absorbent layers of natural vegetation and soils are replaced by paved (impervious) surfaces such as roads and roofs.
- Eroded paths such as streambanks become channels, increasing the amount of sediment carried by runoff.

As asphalt and concrete replace vegetation, runoff increases and reaches waterbodies faster and with greater force. And when the land loses its capacity to absorb and store rainwater, the groundwater table drops and stream flows decrease during dry weather.

The Symptoms

Local governments must be alert to the obvious symptoms of water pollution. They include

- scum and algal mats floating near lake shores,
- excessive plant growth choking waters used by boaters and swimmers,
- sediment-clogged drainage ditches and sewers,
- decreasing depth of a lake,
- fewer fish and wildlife,
- contaminated water supply for drinking, recreation, or industry,
- fish kills that may destroy sport fisheries or close beaches,
- fish advisories caused by bacteria or toxic substances found in fish, and
- extreme flooding or streambank erosion.

The Sources

Pollution from urban runoff can affect water in various ways, depending on the pollutant. The impacts and sources of pollutants have been researched by many organizations, including the Metropolitan Washington Council of Governments, from which much of this information was extracted (see Table 1).

■ **Sediment.** Sediment — organic and inorganic material suspended and settling in water — clogs storm drains; fills river channels, lakes, wetlands, and reservoirs; and increases the potential for flooding downstream. Sediment may fill in water supply reservoirs, eventually requiring costly dredging or new water sources.

These suspended solids make the water appear muddy, decreasing its value for fishing and recreation. As sediment settles to the bottom, phytoplankton, fish, and invertebrates have difficulty feeding and reproducing. Other aquatic life may be smothered or deprived of essential sunlight. Sediment can also carry other materials — such as nutrients, pesticides, and trace metals — that can harm both aquatic life and human health.

Sediment and erosion are at their peak when the soil is disturbed along with the vegetation that stabilizes it. And once sediment enters a stream, it can take many years to travel through the waterway. As silt, clay, and sand move downstream, they erode the streambank, affecting fish and wildlife habitat along the way.

■ **Nutrients.** Nutrients — excessive levels of phosphorus and nitrogen — pose a severe problem as urban development intensifies. Nutrients encourage undesirable algal blooms and excessive aquatic weed growth. This nutrient-rich process, called eutrophication, greatly decreases the water's quality.

In lakes, for example, decomposing plants can cause surface scums and unpleasant odors, discolor water, and decrease oxygen. This breakdown limits swimming, boating, fishing, and other recreational uses; reduces fish and wildlife habitat; and contaminates water supplies. The water-holding capacity of lakes and reservoirs may also decrease.

Urban runoff carries nutrients from roads, sidewalks, and parking lots, and from lawns, golf courses, parks, cemeteries, homes, and commercial sites. In some areas, improperly maintained household septic systems add to the problem.

■ **Bacteria.** Urban runoff often contains high levels of harmful bacteria and viral strains, including fecal streptococcus and fecal coliform from human and animal wastes. When these levels exceed public health standards, as they often do, water is unsafe to drink, beaches are closed, and harvesting shellfish beds is restricted.

Older, more intensively developed areas produce the most bacteria from organic wastes and sanitary sewer overflows. In addition, pet and bird wastes increase the nutrient and bacteria content of runoff.

■ **Oil and grease.** Oil, grease, and other petroleum-based substances contain hydrocarbons, some of which are harmful to sensitive animal species and aquatic life. Hydrocarbons attracted to sediment settle in the bottom of waterbodies, where they may harm bottom-dwelling organisms and be transferred through the food chain.

Hydrocarbons also degrade fisheries habitats and damage the appearance of the water's surface. They lower dissolved oxygen by limiting the interaction of water and air. Oil and grease problems are highest in the runoff from parking lots, roads, and service stations. Oil held in the soil can eventually seep through to the groundwater and be carried to the streams.

■ **Heavy metals.** Heavy metals — including lead, copper, cadmium, zinc, mercury, and chromium — can be toxic to aquatic life and contaminate drinking water supplies. Heavy metals affect sensitive animal species, plants, and fisheries and enter the food chain through animal tissue ingested by humans and other animals.

Table 1.—Pollutants typically found in urban runoff.*

COMMON URBAN RUNOFF POLLUTANTS	SOURCE	AVERAGE CONCENTRATIONS	NONPOINT SOURCE IMPACTS
Sediment	Urban/ Suburban	average 80 mg/L	Fills in ponds and reservoirs with mud; contributes to decline of submerged aquatic vegetation (SAV) by increasing turbidity and reducing the light available for photosynthesis. Acts as a sink for nutrients and toxicants and as a source when disturbed and resuspended.
Total Phosphorus	Urban Suburban	1.08 mg/L 0.26 mg/L	A contributing factor cited in eutrophication (nutrient over-enrichment) in receiving waterbodies and subsequent algal blooms. Algal blooms contribute to the decline of SAV by reducing light available for photosynthesis, further degrade water quality by decreasing the level of dissolved oxygen (DO), and may cause changes in the composition of plankton and fish species.
Total Nitrogen	Urban Suburban	13.6 mg/L 2.00 mg/L	Like total phosphorus, contributes to eutrophication and algal blooms.
Chemical Oxygen Demand	Urban Suburban	163.0 mg/L 35.6 mg/L	Decreases the concentration of dissolved oxygen. Low DO concentration and anaerobic conditions (complete absence of DO) can lead to fish kills and unpleasant odors. Primarily released as organic matter in the "first flush" or urban runoff after a storm.
Bacteria	Urban/ Suburban	average — 200 to 240,000 MPN/L	High concentrations can lead to closure of shellfish harvesting areas and prevent swimming, boating, or other recreational activities.
Zinc	Urban Suburban	0.397 mg/L 0.037 mg/L	Most commonly found toxic metal in the mid-Atlantic coastal region; chronically exceeds EPA water quality criteria. Primary cultural source is the weathering and abrasion of galvanized iron and steel.
Copper (Nationwide Urban Runoff Program average)	Urban Suburban	0.105 mg/L 0.047 mg/L	Chronically exceeds EPA water quality criteria. Primary cultural source is as a component of antifouling paint for boat hulls and, in urban runoff, from the leaching and abrasion of copper pipes and brass fittings. An important trace nutrient, it can be bioaccumulated and, thereby, create toxic health hazards with the food chain and increase long-term ecosystem stress.
Lead	Urban Suburban	0.389 mg/L 0.018 mg/L	Lead from gasoline burning in automobiles is less of a problem today because of unleaded gasoline use. However, lead from scraping and painting bridges and overpasses remains. Chronically exceeds EPA water quality criteria. Attaches readily to fine particulates that can be bioaccumulated by bacteria and benthic organisms (e.g., oysters and mussels) while feeding. Lead has adverse health impacts when consumed by humans.
Oil and Grease	Urban/ Suburban	average 2-10 mg/L	Toxicity contributes to the decline of zooplankton and benthic organisms. Accumulates in tissues of benthic organisms; a threat to humans when consumed directly or when passed through the food chain. Primary cultural source is automobile oil and lubricants.
Arsenic	Urban/ Suburban	average 6.0 µg/L	An essential trace nutrient. Can be bioaccumulated; creates toxic health hazards within the food chain and increases long-term stress for the entire ecosystem. Accumulates within tidal, freshwater areas, increasing the toxicity for spawning and juvenile fish. Primary cultural source is fossil fuel combustion.
Cadmium	Urban/ Suburban	average 1.0 µg/L	Urban runoff contributes a major portion to the mid-Atlantic coastal region. Primary cultural source is metal electroplating and pigments in paints. Can be bioaccumulated; creates toxic health hazards within the food chain and increases long-term toxic stress for the entire ecosystem.
Chromium	Urban/ Suburban	average 5.0 µg/L	Primary cultural source is metal plating and as a component of paint pigments. An essential trace nutrient, it can be bioaccumulated, creating toxic health hazards within the food chain and increasing long-term toxic stress for the entire ecosystem
Pesticides	Urban/ Suburban	average <0.1 µg/L	Primary urban source is runoff from home gardens and lawns. Can bioaccumulate in organisms and create toxic health hazards within the food chain. Observed levels currently below standards.

***Based on mid-Atlantic Coast data.** *Source: Metropolitan Washington Council of Governments, 1993.*

Most metals found in urban runoff come from corroding, decaying surfaces, often accelerated by acidic rain, and from dissolving or leaching materials. Among the sources of metals are roofing materials, downspouts, leaded gasoline, galvanized pipes, metal plating, paints, wood preservatives, catalytic converters, brake linings, and tires. Maintenance of bridges and other structures can also contribute paint scrapings and abrasives.

■ **Toxic substances.** Toxic chemicals, including pesticides and polychlorinated biphenyls (PCBs), can seriously impair water quality and threaten human and animal health. In addition to pesticides, toxic wastes are found in fertilizers, herbicides, and household substances such as paints and cleaning materials. Proper use and disposal of these substances are mandatory.

■ **Chlorides.** Chlorides or salts are toxic to many freshwater aquatic organisms, which can tolerate only a certain level of salinity. Increased levels of sodium and chloride in surface and groundwater can also affect soil structure, stressing plant respiration and lessening viability.

The main source of chlorides is road salting to remove ice and snow. Chlorides run off roads, parking lots, and sidewalks, and find their way into wetlands, streams, lakes, and groundwater. Because of their high mobility, chlorides can have a major impact on groundwater.

■ **Temperature.** Even a slight rise in water temperature can adversely affect some aquatic life and insects in and around a waterbody, including stoneflies, mayflies, and trout. This is particularly true of streams that alternate between cold and warm water.

Runoff can raise stream temperatures as a result of passing over an urban landscape warmed by structures and paved surfaces. Less shade because of fewer trees also raises stream temperature. Runoff stored in shallow ponds and heated by the sun between storms, especially pollution controls that hold runoff for extended periods, can also harm aquatic life.

■ **Trash and debris.** Floatable wastes collect at impasses in streams and lakes, disturbing water flow and impairing the aesthetic quality of the environment. This debris, from street litter and careless disposal practices, washes into waterbodies both over land and through the storm drain system.

■ **Impervious surfaces.** Paved surfaces absorb less rainfall, thus directly increasing water velocity. More sediment will be deposited downstream; and the rapid, forceful flow may drastically erode streambanks, making the area vulnerable to flooding. Increases in paved surfaces can be directly linked to the accelerated loss of aquatic habitat. Heavier sediment loads clog streambeds with sand and silt, destroying habitat. Pool and riffle stream areas also become severely degraded, leaving poor conditions for both the fish community and the macroinvertebrate insect community on which fish depend for food.

■ **Disturbance of stream habitats.** Development inevitably requires that roads and pipelines cross streams, rivers, and wetlands. Construction activities can upset ecosystems and habitats; permanent structures such as culverts can block the movement of fish, preventing recolonization.

Wildlife habitat may also be affected by the replacement of vegetation by roads and structures. Installation of concrete-lined storm drainage channels, for example, often requires removing tree canopies and results in a loss of riparian and aquatic habitats.

Open spaces play an important role in controlling nonpoint source pollution in most urban areas. Therefore, the whole watershed should be considered in making conservation decisions. Maryland, for example, has a Forest Conservation Act that protects existing forests while allowing continued development. It requires a developer to map existing forests and submit a forest conservation plan. This type of program can serve as a reference for urban communities facing similar decisions.

In the past, communities have treated pollution crises as they arose. They have built treatment plants to control point sources of pollution, and used various best management practices (BMPs) to address urban runoff (see Chapter 4). But today, communities are realizing that the hydrology and ecology of their entire watershed influence water quality (see Fig. 1).

Communities are also recognizing that the greatest loss from water pollution is that people can no longer use and enjoy the natural resource. They can't swim, boat, fish, picnic, or just enjoy a lake or river. As a result, the economic impact on the community is significant — people must go elsewhere for recreation, taking with them dollars that could be spent on gas, food, lodging, and entertainment. Pollution may also cause property values to fall, eroding the tax base.

With this increased awareness and knowledge, communities of all sizes are building two-pronged water quality programs: (1) they are identifying and correcting existing problems, and (2) they are focusing on preventing future problems. Communities are finding that a comprehensive nonpoint source management program will help them avoid many of the problems caused by urban pollutants *before* they occur.

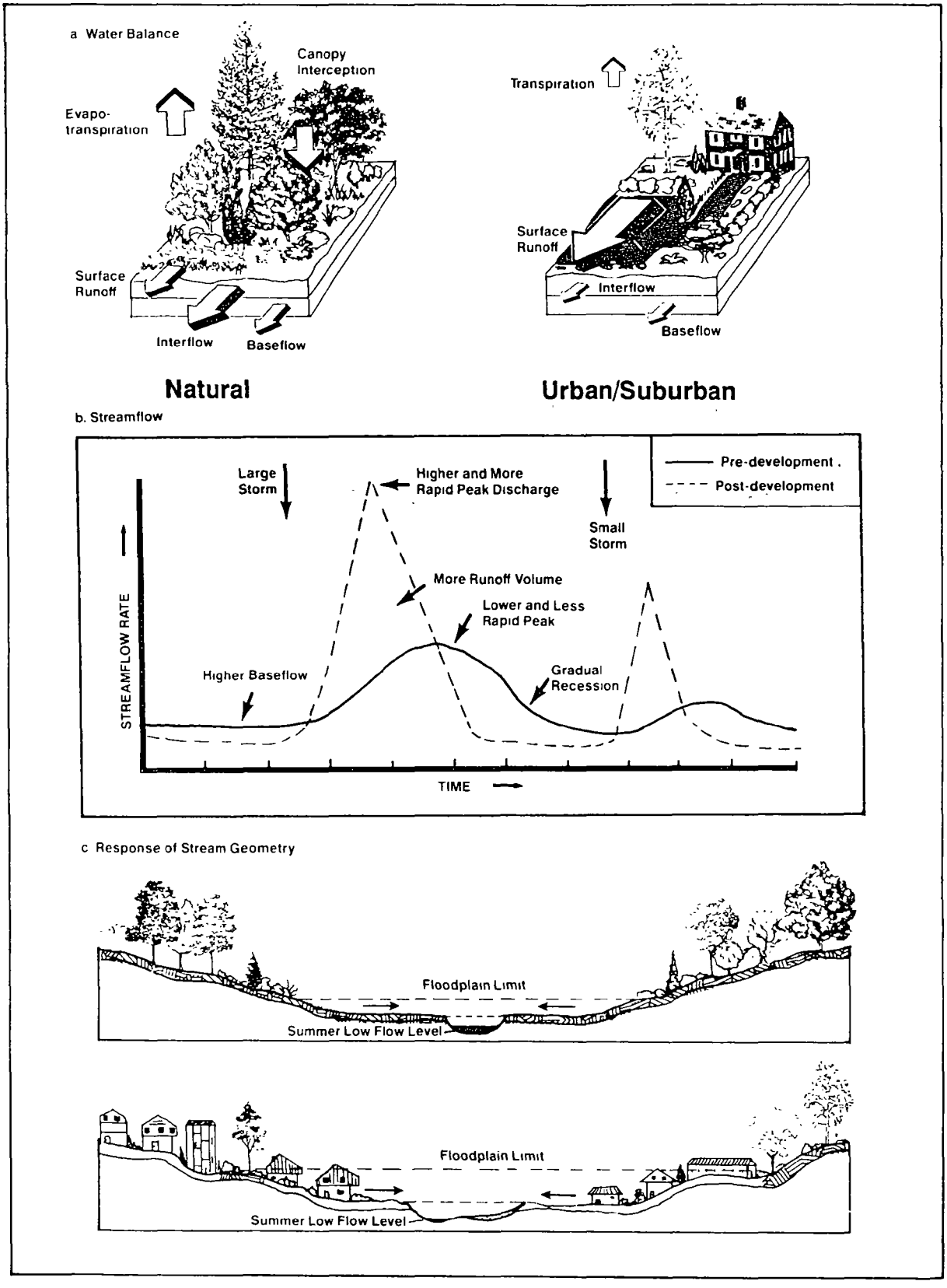


Figure 1.—Changes in watershed hydrology as a result of urbanization. *Source: Metropolitan Washington Council of Governments, 1987.*

Chapter 2

Controlling Urban Runoff: Designing a Nonpoint Source Management Program

With urbanization inevitably comes nonpoint source pollution. This pollution stems from the basic processes of urbanization and the individual lifestyles of citizens.

A nonpoint source management program is one element within a community's overall management plan, just as the effects of urban runoff are one concern. But each piece connects within the community puzzle, if only within the budget. Therefore, the task of controlling nonpoint source pollution must be accomplished by the entire community, planning and working together.

Conservation techniques on undeveloped land — floodplains, wetlands, stabilized streambanks, and slopes — go far in assuring water quality. These natural features play important roles in managing nonpoint source pollution in local communities and should be included in any comprehensive management approach.

This chapter describes a step-by-step approach to designing a nonpoint source management program, a process that a community can adapt to its own situation. Subsequent chapters contain information on the pollution prevention and control methods that can be applied to managing urban runoff.

Figure 2 charts some of the elements of a successful nonpoint source management program. While most programs begin with defining the problem, a program requires continued revisiting, reevaluating, and adjusting. A central element in all phases of program development and implementation is educating and involving the public. In fact, the program's success depends on public support and buy in. Chapter 5 discusses techniques to be incorporated at every phase of the program to keep the public aware and supportive.

The following is a step-by-step guide to constructing a successful nonpoint source management program:

Step 1: Define the current or potential problem.

Step 2: Evaluate existing programs and resources.

Step 3: Build program infrastructure.

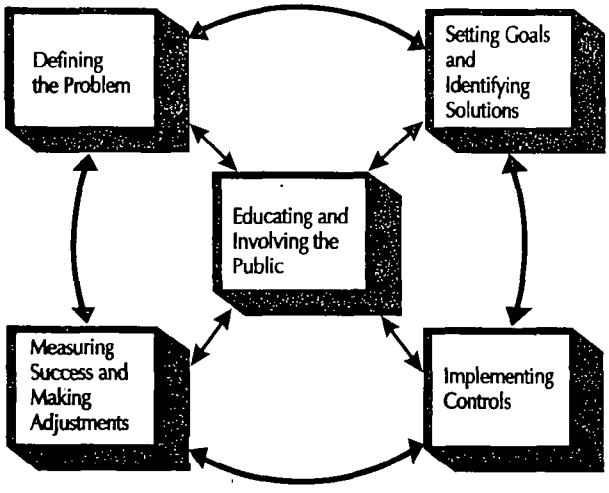


Figure 2.—Elements of a successful watershed project. ***Source: U.S. Environmental Protection Agency, The Watershed Protection Approach: A Project Focus, 1994.***

Step 4: Identify potential options.

Step 5: Evaluate options and alternative strategies.

Step 6: Set program goals.

Step 7: Select a final strategy.

Step 8: Develop a work plan.

Step 9: Adopt and implement the work plan.

Step 10: Monitor, evaluate, and revise the program.

A Nonpoint Source Management Program

Step 1: Define the current or potential problem.

Whether you are reacting to citizen complaints or planning ahead to prevent potential problems, you will need substantive, reliable data to define your community's current or future problems.

Enlist staff, interns, and/or volunteers to determine what information is needed, why it is important, and how to obtain it. Emphasize accuracy in collecting data and keep meticulous records on when, where, and how the data were collected.

Organize and store data for ease of use and accessibility, preferably in a computer database, complete with backup copies.

Your most important task is to first get to know your entire community to evaluate it for actual and potential nonpoint source pollution problems. All factors are important — from the people who live there to the community's physical position within its watershed.

Research and inventory your resource area and community to completely understand the community's strengths and weaknesses in relationship to the watershed. You'll find most of this information at your local soil and water conservation district or your state water quality authority. The U. S. Geological Survey, your regional planning commission, and local universities can also help. Table 2 lists further sources of various data.

Table 2.—Sources for natural resource assessment, inventories, and other data.

TYPE OF INFORMATION NEEDED	CONTACTS
Water Quality Data	U.S. Geological Survey, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service; state water quality agencies, fish and game departments, departments of health; and tribal environmental offices
Land Use Data	U.S. Department of Agriculture's Soil Conservation Service and Agricultural Stabilization and Conservation Service, U.S. Forest Service, Bureau of Indian Affairs, U.S. Bureau of Reclamation, U.S. Bureau of Land Management; state cooperative extension services, land office; tribal environmental or agricultural offices; local government offices such as city planners and county commissioners
Economic Data	County extension service, councils of government, economic research services, chambers of commerce; state department of commerce; tribal councils; real estate agents, private consultants
Demographic Data	Councils of governments, census reports, chambers of commerce, state statistics bureaus, almanacs

Source: Terrene Institute, Clean Water in Your Watershed: A Citizens Guide to Watershed Protection, 1993.

An important resource for community programs is section 319 of the Clean Water Act. This provision requires each state to assess and design a management program to control potential nonpoint source pollution problems. Contact the responsible state agency to pinpoint local problems and determine if resources have been allotted.

■ **Identify and map your watershed.** Include smaller watersheds within its jurisdiction and specific sites needing attention because of development or other special circumstances (see Fig. 3).

- Locate wetlands and other critical areas.
- Identify vegetation strips and other areas that can control pollution or urban runoff.
- Map your community's drainage pattern downstream and the location of groundwater aquifers and those used for drinking water (see Fig. 4).

■ **Identify the land uses within the watershed.** Map and calculate the number of acres within the watershed for each type of use. Check with your zoning commission first, and if you need more detail, go to

- land ownership and variance zoning records,
- site approvals,
- building permits, and even
- aerial photos.

You may not be able to obtain comprehensive, absolutely accurate and precise land use information — but the more details you gather now, the better your community will understand the land use in and around its watershed.

Categories can be defined broadly — residential, commercial, industrial, agricultural, and open space — and further subdivided as necessary.

For example, low-density residential has a different impact on water quality than high-density residential. Among industrial uses, a mining company may cause more nonpoint source pollution than a sugar processing plant. And forests differ from wetlands.

Some questions to ask:

- How much of the agriculture is dairy, soybeans, pasture, rangeland, or other?
- Are open spaces forest, meadow, or wetlands?

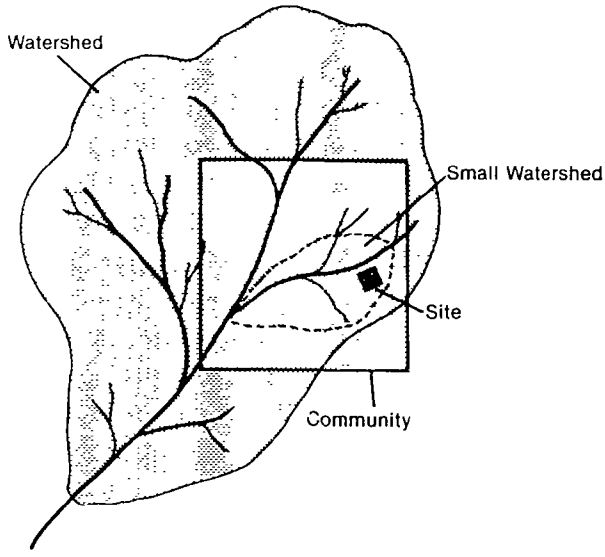


Figure 3.—Watersheds nest within each other; a site within a small watershed lies within the community and is part of the larger watershed.

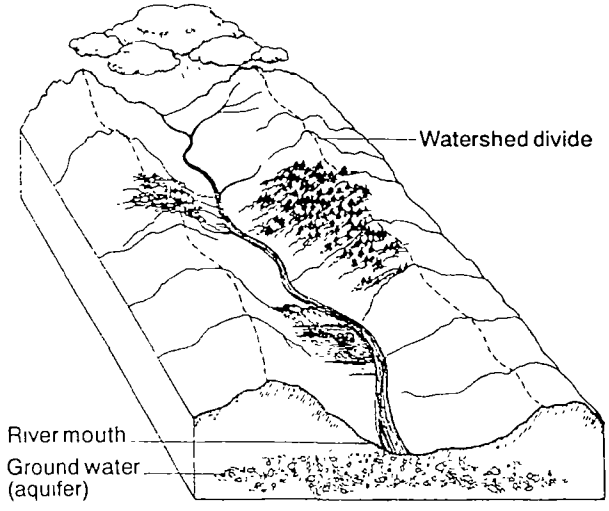


Figure 4.—A watershed graphically depicted. ***Source: Puget Sound Water Quality Authority.***

- How rapidly are the urban areas developing?
- How are urban areas divided for development (commercial, residential, industrial, other uses)?

■ **Investigate environmental factors.** Assess geology, topography, soil characteristics, vegetation, groundwater recharge areas, flood-prone sites, and hydrologic and biological characteristics.

Get help in determining what principles of geology, topography, soil, and vegetation are important in

understanding water quality. Study USDA Soil Conservation Service (SCS) soil maps, Federal Emergency Management Agency (FEMA) floodplain maps, and U.S. Geological Survey topographic maps. You can find assistance locally from the USDA Extension Service, soil and water conservation district, and university and high school science departments.

■ **Determine current waterbody quality.** Obtain basic information on your waterbodies — pollutant concentrations, vegetative cover, and aquatic life — and determine if the state has monitored or designated them by classes. Water quality standards specify the concentrations of various pollutants allowable according to how the waterbody is used. Water quality designated uses include fishing, boating, water supply, priority wetlands or floodplains, and productive or open shellfish beds.

The state water quality agency should be able to provide current data, including documentation of any known water quality problems. If the state has information for your waterbody, a baseline database on its water quality may exist. If not, determine how to establish baseline data; perhaps your local college or university can help.

Investigate ongoing efforts to collect data, such as those obtained from citizen monitoring groups (see Chapter 5).

■ **Determine actual threats to surface and groundwater.** Is an industrial park being developed with the potential for construction runoff and, later, operational discharges from high traffic parking and maintenance lots? Is land use changing significantly — or at a rapid rate? Is there a known trouble spot?

Threats to groundwater include high water tables, uncapped abandoned wellheads, discharges associated with industrial development, and failing and inappropriately located septic systems.

■ **Identify other problem areas.** Identify specific sites that need attention, using land use maps to define areas of greatest imperviousness. Additional actions can include

- researching water quality and biological resources;
- walking along streams to visually assess excessive erosion, lack of riparian cover, water quality conditions, and physical stream conditions;
- identifying point sources by obtaining copies of National Pollutant Discharge Elimination System (NPDES) permits for discharge levels;
- obtaining data related to flood control or stormwater best management practices;
- obtaining information from local resource managers familiar with water resources; and
- checking sections 319 and 314 (Clean Lakes) assessments and 305(b) reports made by your state water quality agency on impaired waterbodies (EPA requires these reports from each state).

■ **Research the local economy.** An accurate picture of the local economy is important to make growth projections and to assess what funds might be available to protect water quality.

- Determine what portion of the watershed's population is rural and what portion is urban.
- Describe factors specific to the area, such as a large plant opening or a long-time employer closing.
- Assess the growth trends in the community and in the watershed. Development is a major cause of both short- and long-term nonpoint source pollution. Understanding population and growth trends also helps determine the areas most vulnerable to water quality deterioration.
- Assess income levels compared to national and regional averages and calculate the local tax base and revenues available from government grants and other sources. Current and projected tax revenues and other income sources will determine the amount of resources available to manage water quality.

■ **Evaluate industry and infrastructure.** Are industrial plants and infrastructure, such as sewage and stormwater systems, potential nonpoint source polluters? Assess age, state of environmental technology and practices, and other features. Seek guidance from experts in this assessment.

Assess the condition of roads, bridges, airports, marinas, and other parts of the transportation network.

- Note needed or ongoing repairs or new construction, and specify possible nonpoint source pollution hazards.
- Observe current road and ditch maintenance practices and note opportunities for improvement.

DETERMINING FINANCING STRATEGIES

Communities must answer several questions before selecting the best financing option for the situation:

- *Are funds sustainable? Will they last over the long term or are they only a short-term band-aid approach?*
- *Are funds easy to obtain? Is the application complicated? Does it require multiple approvals?*
- *Are funds difficult to administer? Will you need additional staff to track and prepare reports or assess and collect fees?*
- *Does a correlation exist between the funding and the problem? Will those who pay for the benefits receive them?*
- *Will the funding be used appropriately? Will it be a quick fix or will it have secondary benefits?*
- *Have legal restrictions been placed on the use of the funds?*

Step 2: Evaluate existing programs and resources.

■ **Identify existing ordinances and enforcement authorities.** Identify state and local laws that authorize government to proceed with control methods. For example, zoning ordinances might authorize setbacks or buffer strips, limit development on impervious areas, or establish erosion and sediment controls. Existing programs and authorities should be used — and strengthened — to benefit water quality.

Determine if your governmental unit has the legal authority to protect its floodplains and enforce ordinances using fines, permits, inspections, stop work orders, or other methods to make a nonpoint source program work. Communities often set fines for septic violations, for example.

■ **Investigate funding options.** Review funding options and select those that best suit your community. For an overview of traditional and innovative funding mechanisms, refer to EPA's "A State and Local Government Guide to Environmental Program Funding Alternatives" (Appendix B).

STORMWATER UTILITY FINANCING

The stormwater utility is a creative approach to funding that also addresses political and institutional questions. One of the most important benefits of a stormwater utility is that it can provide a steady stream of funds to develop, operate, and maintain a comprehensive stormwater management system. This, in turn, permits the development of integrated, long-range planning from one source.

Establishing a stormwater utility can be complicated. It requires collecting water and analyzing its quality, assembling land use and economic information, and establishing an equitable billing system. Moreover, establishing the utility can prove expensive because of costs for engineering, legal, and financial studies; new staff; and information management systems. Local officials must educate citizens to overcome public resistance to a new utility charge.

Many cities have such programs, including Bellevue, Washington, and Billings, Montana (see Appendix C for contact information).

Federal sources

- Federal Construction Grants Program — States provide seed money loans to local governments for water quality projects to be repaid from local fees or taxes. This program, however, is being gradually replaced by the State Revolving Loan Fund.
- State Revolving Loan Fund — Administered by a state agency, loans can be used to fund projects to control nonpoint pollution and be repaid from local revenue.
- EPA Clean Lakes Program Grants — Publicly owned lakes may qualify for federal grants available through state environmental agencies.
- Section 319, Clean Water Act — EPA provides grants to specific nonpoint source projects that demonstrate progress in controlling and abating nonpoint source pollution.

State and local sources

- Special use taxes — State or community levies, fees, or taxes on cigarettes, boat licenses, hotel rooms, or permits.

CALIFORNIA NONPOINT SOURCE STATE REVOLVING FUND LOANS

California was one of the first states to use state revolving funds for nonpoint source projects. Projects included demonstration projects, retention/detention basins, wetlands for stormwater treatment, and a variety of best management practices. Eligible programs also include training, public education, technology transfer, and development of ordinance and management practices.

Loans can cover 100 percent of the project cost. Repayment, which can take as long as 20 years, begins one year after the program begins. Interest rates are determined by the state's general obligation bond rate.

The loan request begins with an eight-page application and background information. The local government passes a resolution establishing repayment arrangements. The State Water Board places the project in the SRF Intended Use Plan approved through a public hearing process.

- BMP tax credits — Used for installing best management practices or similar controls.
- Drainage fees — Used to compensate for excessive runoff from a site.
- Bonds — Paid for by fees from developers or users.
- Special assessments — Levied through utility districts established by communities.

Step 3: Build program infrastructure.

■ **Identify all participants and determine their objectives.** Participants with a vested interest might include state and local agencies, governing bodies such as legislatures and city/county councils, local or national public environmental groups, trade associations, citizens, and business leaders. Establishing a working relationship with the lead state nonpoint source pollution agency is particularly important for information, resources, and support.

■ **Match the resources with the problems.** Determine what governmental units fit into your proposed plan and which methods of funding will work best. You may not need a staff as much as you need the ability to coordinate the available resources.

TYPES OF NONPOINT SOURCE PROGRAM FINANCING

A number of creative strategies for financing water quality programs have been implemented in recent years. Examples of the most successful are

- **Real estate transfer fee:** *Nantucket, Massachusetts, has funded a land purchase program through a 2 percent transfer fee on all property sold on the island. From the land bank's beginning in 1984 until June 1993, the fee has collected nearly $27 million.*
- **License fees:** *In Iowa, the Groundwater Protection Fund includes revenue from increases in pesticide dealer license fees. Chemical manufacturers are also assessed a 75 cent per ton tax on nitrogen-based fertilizers.*
- **Impact fees:** *In Florida local governments can assess development impact fees when issuing permits to cover infrastructure costs associated with new development.*
- **Sales tax:** *Washington increased state sales tax on cigarettes by 8 cents a pack to finance water pollution control programs: 50 percent for marine, 10 percent for nonpoint source, 10 percent for freshwater, 10 percent for groundwater, and 10 percent for discretionary programs.*
- **Stormwater utility fees:** *Some governments have created a stormwater utility service to achieve multijurisdictional solutions. Charges are based on the amount of a property owners' impervious surface and generally range from $1 to $4 a month.*
- **Environmental trusts:** *Minnesota established a trust with proceeds from the state lottery; half of the net proceeds will remain in the fund for five years.*
- **State revolving funds (SRF):** *These funds were authorized by the Water Quality Act of 1987 specifically to improve water quality. The SRF money is loaned to local governments, who repay it with revenue raised from local fees or taxes. SRF funds recycle a set amount of money to finance numerous projects over an extended period.*

Local governments. Identify the units within your community with the authority, knowledge, and resources to coordinate a nonpoint source control program — for example, departments of public works, public health, or the environment. In small communities, the conservation commission, planning board, or code enforcement office might have the authority. Other relevant governmental units might include regional planning commissions or the departments of park maintenance, road maintenance, waste disposal, or health.

Existing municipal programs can be modified to address urban runoff concerns. For example, a pretreatment inspection program for a publicly owned treatment works (POTW) can be expanded to look at runoff at each industrial facility. Similarly, fire and safety programs can be expanded to inspect runoff collection points. This coordination should be high priority since it can be much more cost effective to use existing program resources than to start a new program.

Find out what actions neighboring cities and counties, particularly in your watershed, are taking to control nonpoint source pollution. While you cannot control other jurisdictions, even though their actions might affect your water quality, you should be well informed of their problems and methods of controlling them.

State agencies. Determine agencies responsible for nonpoint source management, groundwater, water quality standards, floodplains, wetlands, coastal zone management, land conservation, land planning, endangered or threatened species, and scenic and wild river protection.

Find out what help the lead nonpoint source agency can offer and fit this resource into your control strategy. State nonpoint source coordinators may not be able to help with all problems — they have their own agendas, determined by state and federal priorities. With the diversity of funding sources for nonpoint source control, the community may need to enlist the support of several different agencies.

Federal resources. U.S. EPA and USDA can provide technical advice and materials. In addition, the Army Corps of Engineers can provide technical guidance, information, and permits. The U.S. Fish and Wildlife Service is a source for biological information, and the National Park Service and U.S. Geological Survey can provide watershed information.

VIRGINIA STORMWATER MANAGEMENT

Virginia's stormwater management ordinance is an example of state-enabling legislation (Code of the Commonwealth of Virginia: Title 10.1, Chapter 6, Article 1.1). Municipal ordinances can be established by reference to the state law or tailored to local needs. Specifically, the components of Virginia's legislation are

- *statement of purpose;*
- *definition of terms;*
- *authorization for local programs;*
- *guidelines for developing technical criteria and administrative procedures;*
- *statement on the status of state projects and lands;*
- *specification of the state's oversight responsibilities;*
- *authorization for establishing more stringent local requirements;*
- *procedures for submitting plans and approving and exempting land uses;*
- *authorization for collecting performance sureties, recovering administrative costs, and assessing service charges;*
- *description of the appeals process;*
- *specification of civil penalties and enforcement options;*
- *authorization for cooperation with federal and state agencies; and*
- *statement exempting the legislation from limiting the authority of other agencies.*

The Virginia legislation includes all minimum critical elements and provides the legal authority for local governments to adopt their own stormwater management ordinances. The Virginia law places the primary burden on new development by defining existing runoff levels and the corresponding level of water quality effects, erosion, and flooding as a point of reference. Local governments can require performance bonds or escrow accounts for development. If proper stormwater controls are not installed, resources will be available to complete required activities without burdening taxpayers.

Cognizant of EPA's municipal stormwater requirements, the Virginia law also authorizes local governments to cooperate with federal agencies.

Appendix C lists these and other information sources, including some interstate programs or compacts, such as the Chesapeake Bay Program, the Gulf of Mexico Program, EPA's National Estuary Program, FEMA's National Flood Insurance Program, and NOAA programs.

■ **Determine public attitudes and perceptions.** Alert citizens can be your best allies and informants. Use citizen complaints about water quality to spot current problems. Citizens often express such complaints in phone calls or letters to council members or the local newspaper editor. Look for newspaper articles on local lake or river problems.

If necessary, use a survey to assess public attitudes and perceptions regarding water quality issues and to determine the level of support and cooperation the program might elicit. Formal citizen monitoring projects are extremely successful components of many state and area water quality programs.

Step 4: Identify potential options.

The following chapters will help you think about your options for controlling urban runoff. Add to them the information you have garnered through your exploration of the agencies and organizations already working in the nonpoint source pollution arena. Your state nonpoint source coordinator can point to techniques that will work in your area.

- List each option to be considered for your plan (and your specific problems).
- For each option, list reasons favoring its use and those in opposition.
- Estimate the cost, including maintenance and longevity, for each option.

Step 5: Evaluate options and alternative strategies.

By now, you should have mechanisms in place to share information and thoughts about the process with many groups and individuals — both those knowledgeable in the field and interested citizens. At this point, you certainly need to know how your community is thinking. In addition to local stakeholders, make sure to include federal and state landowners and other groups such as the Department of Defense and the Conservation District.

Some jurisdictions use the consensus method, requiring support from all members, to make water policy decisions. Collecting information, airing viewpoints in group discussions, and analyzing the problems and solutions lead to acceptable compromises. The consensus process frequently produces a more creative and binding outcome, important when a community commits to a long-term project.

In exploring the merits of each option for controlling nonpoint source pollution, carefully consider the following issues:

- benefits and costs to the community;
- feasibility of implementation;
- public support and/or opposition;
- funding sources;
- staff to administer, enforce, and monitor;
- potential for problems and adverse reactions;
- technical support; and
- long-term maintenance ability.

■ **Models.** Computer models can be used as a design tool to project possible scenarios for pollution control programs, but they should be used with care and expertise. Modeling can be an expensive exercise that does not always relate to the real world. Models now in use include several versions of SWMM, a Stormwater Management Model developed by EPA, and its companion, RECEIV, and AGNPS, the Agricultural Nonpoint Source Model. Many states and regional governmental units are using GIS (Geographic Information System), another computerized tool, to predict erosion and other factors. Local governments can adapt GIS to their own needs.

Step 6: Set program goals.

After analyzing the information collected, determine the focus of your program. This step takes you back to the original premise: Does your community have an immediate problem, or has it simply recognized the wisdom of preventing future nonpoint source problems?

Thus, your program goals will be driven either by the need (1) to take immediate action, or (2) to achieve community support for a long-term preventive program. Of course, you may have to balance both concerns.

The basic steps in setting realistic goals, however, are based on setting priorities and matching them with available resources:

- Identify and list your community's most serious problems.
- List all other problems, both immediate and potential.
- Rank all problems for immediate, medium-range, and long-term action.
- Establish a series of objectives and a timeline for achieving each goal.

Visible progress is important to build community support. As you set program goals, try to identify at least one objective that can be accomplished quickly to assure your community that progress is being made.

Step 7: Select a final strategy.

The strategy selected should meet several objectives. At a minimum, it should

■ **Establish the legal, financial, and administrative framework for the nonpoint source management program.**

■ **Develop a comprehensive public education/participation program that ensures community buy-in to the nonpoint source management process.** Far from being an isolated element, public education, understanding, involvement, and support are vital elements in each stage of a project—from defining a problem, to developing workable solutions, to adjusting and monitoring the progress (see Fig. 5).

■ **Restrict construction/development in highly erodible areas — steep slopes and erodible soils.** Some slopes are not amenable to runoff control and some soils are impermeable — unable to absorb runoff. These areas should be identified and conventional ground-disturbing construction prohibited.

■ **Reproduce predevelopment hydrological conditions.** In addition to controlling runoff, a nonpoint source control program should, to the extent possible, diminish the hydrological changes brought about by development. Successful planning requires recognizing and addressing the serious implications of such changes.

■ **Reduce or remove pollutants.** Because control methods differ markedly in removal mechanisms, their performance in removing pollutants can vary significantly. Applying best management practices is one method of achieving goals (see Chapter 4 for discussion of BMPs). However, BMPs change with time and conditions and should be monitored and modified as necessary. Retrofitting includes constructing new BMPs or modifying existing practices in developed areas. Control practice effectiveness should constantly be reevaluated considering new technology, maintenance, repair, or upgrading needs.

■ **Use strategies appropriate to the watershed and the site.** Many control methods do not work because they are unsuited to the geographic area or site. Inappropriate methods can cause maintenance problems or nuisance conditions; in some cases, inappropriately located methods may not function at all. Decisionmakers need to understand a site's special characteristics. For example, plans may need to be modified after field reviews of the site's physical condition.

TARGETING

Implement a comprehensive management program by stages based on water quality problems — particularly when resources are limited. By ranking problems according to your specific area needs and targeting them for control, you can realize the greatest water quality benefits for resources expended. See Chapter 4 for discussion of best management control practices.

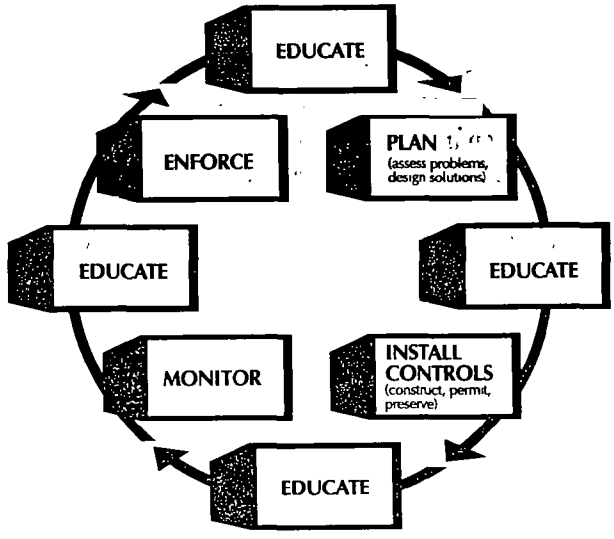


Figure 5.—Comprehensive public education/participation program. ***Source: Terrene Institute, Clean Water In Your Watershed: A Citizens Guide to Watershed Protection, 1993.***

■ **Protect and preserve vegetative treatment systems with nonpoint source benefits.** Buffers and natural systems filter out many pollutants in urban runoff before they become a problem. Communities should identify and preserve these natural vegetative treatment systems, because once they are altered, they cannot be easily replaced.

■ **Protect critical aquatic habitats and natural wetlands.** Determine the aquatic species most threatened by nonpoint source pollution in the watershed. What can be done to protect their habitats? Is the preferred technique compatible with other uses of the water? Should more than one control method be used?

■ **Be responsible for maintenance of controls.** Controls are effective only if regularly maintained, and maintenance costs can be significant. Over 20 years, structural BMPs can exceed their initial construction costs, passing on costs to future residents or taxpayers. While some effective BMPs require significant maintenance, others — particularly some nonstructural BMPs — are not expensive to maintain. Anticipate future maintenance needs and consider the cost factor compared to other needs and resources.

■ **Positively affect the environment.** Control methods significantly affect the natural environment and adjacent community, either positively or negatively. Small investments in design, landscaping, and maintenance can make a control method an attractive, or at least an unobtrusive, feature in a community. Without such effort, controls can become unsightly nuisances. If that occurs, public support for nonpoint source control is jeopardized.

Step 8: Develop a work plan.

After defining the goals and the strategy, develop a specific work plan. The work plan should express the community's goals in definitive terms, yet be broad and flexible in their execution. It should ultimately be a practical, easy-to-use guide to decisionmaking over the long term.

The work plan should also include specific measurable objectives to meet community goals (e.g., nitrogen concentration will drop 10 percent by 2000 from 1990 levels) and fit into the existing infrastructure. The plan should complement existing plans, translating local goals, priorities, and resources into action.

Consider other plans in developing a work plan for your community:

- comprehensive land use plan
- stormwater management plan
- roadway/transportation plan
- zoning map
- water and sewer network
- open space conservation plan
- preservation of critical areas

Also consider

- legal authorities
- local/state agencies
- existing land use patterns and zoning

The following is an outline for developing a nonpoint source pollution control work plan:

I. Formulate goals, objectives, assumptions.

II. Describe the size and scope of plan.

III. Identify legal authority.

IV. List the responsible agency or agencies.

V. Describe staff and training needs.

VI. Describe existing conditions and resources, using data relating to the community, including water quality problems and opportunities for improvement.

VII. Describe demand pattern for water. Analyze how water use patterns relate to demographic and economic groups; measure impact on residents, nonresidents, and tourists; assess impact of fees and other charges on demand patterns; analyze why existing opportunities (i.e., recreation, fishing) are not being used.

VIII. Provide needs analysis. Analyze supply and demand relationship; develop program standards; describe water quality needs, state need for a plan/program, and local government's ability to meet program needs.

IX. Analyze present policies and programs as they relate to program goals and outcomes. Recommend and justify the option selected.

X. Appendix. Include background studies (pertinent information collected), data and methods, bibliography (sources), and acknowledgments and credits.

Step 9. Adopt and implement the work plan.

The work plan must be adopted by the community's governing body. Information gained in developing the work plan should be used to further the effort to educate and involve the public and community decision-makers. Whether a public referendum is required to pass the plan and financing mechanism or a committee or city council will make the final decision, inevitable differences of opinion can be resolved through a continued program of public information, education, and political savvy.

■ **Implementation.** After local adoption, follow an implementation plan that describes the necessary actions and who is responsible. Schedule actions by time period, group, and responsible agency. Relate costs to the general budget. Describe needs for training, legislation, public participation, and state approval process, if necessary.

■ **Training.** A successful water quality program requires a high degree of staff involvement. A program must have technical staff to develop specific controls, administrative staff to oversee the project, clerical staff to maintain records, and volunteers to carry out citizen education and monitoring functions. Staff and volunteers should help develop the plan and begin training soon after its adoption.

Workshops sponsored by federal, state, regional, and county agencies and by private environmental groups are good ways to gain expertise. In addition, local university extension curricula may offer courses that relate to the program. On-the-job training can also be effective if supervised by professional water quality specialists (see Appendix C).

Step 10: Monitor, evaluate, and revise the program.

While some revisions will occur early in the planning process, evaluation and modification should continue indefinitely. Incorporate a monitoring and evaluation plan into the work plan and see that staff or volunteer programs are in place to carry out this ongoing process.

To make sure the control method is working, develop a monitoring program that relates results to initial goals set early in the planning process. The monitoring program must have clear goals, such as

- evaluating BMP efficiency;
- specifying problems with receiving water quality;
- identifying priority sources (for example, gas stations or malfunctioning septics);
- validating results against other studies or models; and
- complying with applicable regulations, including local requirements.

Compliance may be a good area in which to involve citizens. Citizens have made valuable contributions to local monitoring programs. However, volunteer monitors must be well trained, supervised, and motivated to ensure that the data is accurate and useful. The local government should carefully supervise program activities and conduct the analyses (see Chapter 5).

A monitoring program should consider, at a minimum, the following parameters:

- beneficial uses that need protection;
- expected impacts on water resources and assorted habitat; and
- an approach to measuring impacts.

Prepare an annual report of your progress for the county or city council and other governing bodies. This serves not only as a program evaluation tool but also keeps the community informed. In addition, the state government may be able to include the report as part of its annual report required by the Clean Water Act.

Chapter 3

Planning to Prevent Urban Runoff

A successful nonpoint source management plan begins by identifying general concepts and goals in the total community development or comprehensive plan. Specific controls (see Chapter 4) to prevent pollution should be part of each site plan.

Damage that occurs as part of the development process is, at worst, irreparable and, at best, costly to clean up. Therefore, urban runoff pollution prevention should be part of the overall plans for roads, parks, utilities, and other public facilities as well as for each site.

Such plans should consider the larger drainage basin, the immediate watershed, the municipality, and, finally, the specific site. Water quality plans must work in harmony with local legislation and programs of other political jurisdictions.

Developing a Land Use Plan

Land use planning begins with the local government, but it must also adhere to state mandates and comprehensive planning. A good nonpoint source program coordinates federal and state laws with local programs in a plan that improves and protects water quality according to community needs. Local government should provide the broad legal authority to develop comprehensive plans and programs.

Land use planning can prevent pollution problems by protecting water quality, open spaces, stream valleys, and floodplains. At the same time, planning should support local economic needs. Through comprehensive planning, communities can address water quality issues by setting development goals — for environmental quality, a sustainable economy, viable commercial areas, population density, housing patterns, recreational facilities, tourism, and property values — that work together to ensure the overall "quality of life."

Land use planning reduces pollutant loads in two ways:

- by controlling the type, size, and location of development in a given area, and
- by reducing pollution generated at specific levels of development.

While comprehensive planning provides general guidance in managing nonpoint source pollution, specific practices are put in place through zoning laws that regulate development.

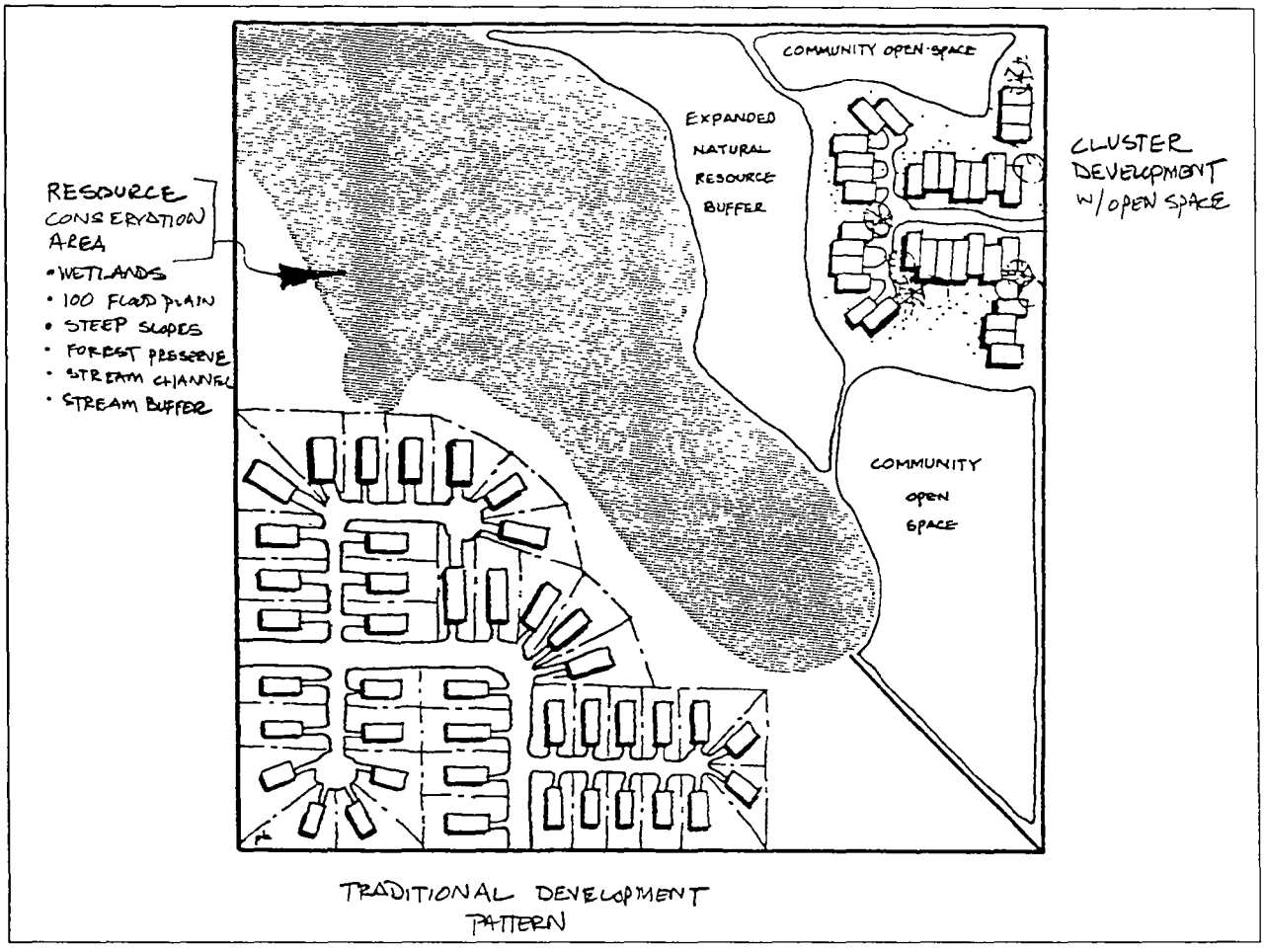


Figure 6.—Cluster versus traditional development preserves open space and reduces land disturbances.
Source: Metropolitan Washington Council of Governments, 1993.

■ **Zoning process.** Zoning specifies the density and type of land use that can occur in a given area. It is the working arm of a comprehensive plan that controls overall local development and considers water quality and other environmental goals along with a myriad of community concerns. Zoning ordinances apply only to uses that begin after the ordinance is enacted, and therefore affect only future practices.

Because zoning ordinances also regulate authorized uses (e.g., building, lot sizes, designs), they can be structured to control nonpoint source pollution. This control is particularly relevant on highly erodible steep slopes and shores or in high-density areas where developers must provide adequate drainage systems for their projects.

Several types of zoning apply to water quality issues:

Cluster development. Clustering preserves the existing topography and provides the community with more open green space by concentrating residential development on a limited portion of the site. This leaves substantial area for amenities such as playgrounds, parks, and woods (see Fig. 6).

Preserving open space and the existing tree canopy reduces impervious surfaces and the resulting runoff. Further, following the land's natural contours reduces disturbances that cause erosion, improves aesthetics, and preserves sensitive habitats.

Keeping the same population density, developers can save on necessary facilities such as roads and utility lines, since cluster development reduces the lengths of paved roadways and utilities needed.

Cluster development minimizes the need to convert agricultural land to residential use. It also allows development to match actual site capacity. Homeowners and the public can enjoy many of the amenities of rural living within an urban environment. Cluster development also helps maintain property values, one of zoning's basic goals.

Planned unit development (PUDs). Through comprehensive development planning, PUDs provide a mix of zoning classifications including compatible commercial, residential, and even light industrial development. PUDs, which sometimes include clustered development, range in size from a few acres to over 1,000.

PUDs harmoniously blend varying uses to create an attractive, interrelated unit that preserves both property values and aesthetics. As with cluster development, a PUD's goal is to maintain density while maximizing open space. The ideal PUD locates residences and offices within walking distance of each other, dramatically reducing traffic.

A PUD's main water quality benefit is large-scale urban runoff management planning. Local governments control PUDs through negotiations between the developer, the public, and the public review authority. PUDs must maintain open space to facilitate stormwater drainage and sometimes require developers to provide special structures to handle runoff.

Incentive or bonus zoning. This method is used to promote cluster development. It permits the developer higher density than normal in return for maximizing open and/or public use space or other amenities.

Downzoning. Downzoning changes an established zone to a lower density level or less intense use. Typically, industrial zoning permits the most intense land use, followed by light industrial, commercial, and residential.

Downzoning is used on strips of land adjacent to waterways to provide a buffer between industrial sites and the streambank or on a whole area surrounding a waterbody to reverse or prevent pollution.

Phase-in zoning. Phase-in zoning is used when present development is incompatible with water quality goals but abrupt change would be too disruptive to the economy and the community. For example, to protect a lake surrounded by heavy industrial development, the community might close and decontaminate plants when their useful life is finished, rather than allowing them to be sold or leased to another industry, and prohibit new plants from opening.

Large-lot zoning. Large-lot zoning applies to large residential developments, generally 5 to 20 acres. Regulations call for designs that take advantage of common management to achieve water quality goals. These may include reducing the quantity and impact of septic system leachate to a water supply, building stormwater detention basins, or preserving open land to facilitate aquifer recharge.

Conditional zoning. Conditional zoning can be used in a standard zone or where zones are not clearly delineated. It carefully monitors and limits potentially harmful activities by permitting certain activities only under special conditions. For example, a conditional zoning might allow multiunit apartments in a single-family housing zone only if no septic tanks were used.

Floating zone. A floating zone is defined by characteristics rather than geographical location. The proposed use must be compatible with the surrounding uses and conform to the zone's expressed purposes.

Under a floating zone, for example, multifamily dwellings that conform to specific code requirements regarding septic tanks, grading, and open space preservation could be acceptable in an area zoned for single-family dwellings. Alternatively, a floating zone might restrict certain development in a wetland or around a well or aquifer recharge zone. A developer would need to show that the project does not fall within the area subject to floating zones or take adequate steps to protect water quality within the zone.

Overlay zoning. An overlay zone is a mapped district that places restrictions or requirements in addition to those of the underlying zone. Overlay zones are used to meet a special public interest that is not met by the existing zone or by rezoning. For example, these zones can protect specific water sources such as ponds, wells, or wetlands lying within residential, commercial, or industrial zones. In Figure 7, the stream valley corridor buffer overlay zones provide special protection for water resources located within the existing zones, reducing the impact of uses on water and natural habitat.

In another example, Maryland counties use overlay zoning within the Chesapeake Bay Critical Area — a 1,000-foot land buffer surrounding the tidal portion of Maryland's bay tributaries — to protect land and water resources. The critical area overlay zone is designed to foster more sensitive development activity for shoreline areas while minimizing the adverse impacts of develop-

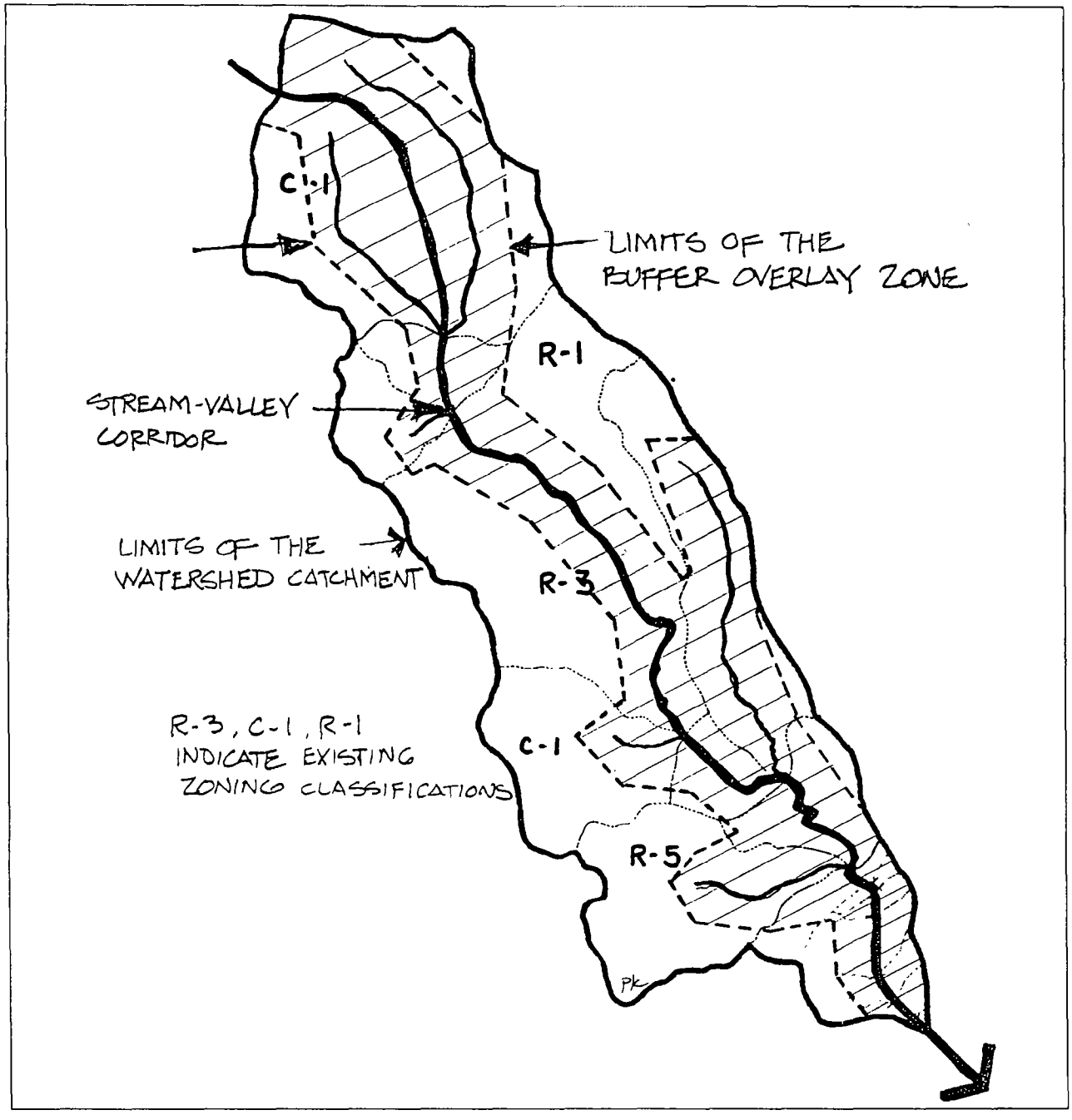


Figure 7.— Overlay zoning adds another measure of protection to critical resources. ***Source: Metropolitan Washington Council of Governments, 1993.***

ment on water quality and natural habitats. Zones are known as intensely developed areas (IDAs), limited development areas (LDAs), and resource conservation areas (RCAs).

Floodplain zoning. Building in floodplains — areas subject to periodic inundation by runoff — is considered unsafe. Except for roads or other transportation facilities, development is generally restricted. Local governments or FEMA can provide floodplain maps.

Open space preservation. This zoning protects community open spaces by creating public parks or undeveloped strips of land adjacent to waterbodies. This important zoning provides open space to allow urban runoff to seep into the ground and recharge the water table. Open space preservation also protects critical aquatic habitats such as wetlands, reduces flooding, and enhances aesthetics.

Not all open space uses benefit water quality. A zoo, for example, requires high maintenance to

dispose of manure, care for parking lots, and clean up litter. In addition, open space should be used differently depending on its location within the watershed.

Aesthetic zoning. Aesthetic zoning places design restrictions on new or historic buildings, preventing development or renovation from blighting the community or destroying its style or scale continuity. Aesthetic zoning can also protect water quality by requiring open space or limiting development size and the pressure it places on the watershed. For example, restrictions can protect attractive shores and swimming, boating, fishing, and other recreational uses.

Performance zoning. Performance zoning limits development to the resources of the specific property. While the overall intensity of use meets zoning requirements, the gross density can vary, depending on the property's characteristics. Performance zoning can set a maximum use intensity (density factor) on the buildable portion of the site. This avoids many small zoning districts providing different levels of protection. The environment is protected from disturbance of unstable or rare resources, but flexibility is allowed in less sensitive areas.

In using zoning as part of an environmental program, planners should consider all options to ensure that the zoning solution is appropriate and feasible. For example, downzoning a heavily developed area to protect a waterbody might not be economically feasible, but incentive zoning could be applied to future development or an overlay zone used to augment existing zoning.

Zoning regulations promote legal issues and challenges. Courts often strike down unnecessarily restrictive or discriminatory ordinances. In addition, zoning is a political issue, often requiring a referendum or other formal adoption mechanism. Therefore, zoning plans must be carefully structured to address a variety of needs and constituencies.

Subdivision review. Land use is regulated by many zoning categories. However, before separately owned parcels of land can actually be developed, they are subject to subdivision review.

The subdivision review process includes several stages in which various government entities and agencies review development plans to ensure that the developer has met all the standards and requirements placed on the land and has obtained all necessary permits and approvals.

ZONING + SITE PLAN REVIEW

A small, primarily rural Maryland community is devising a plan to protect the water supply of its rapidly growing town.

Subdivision regulations have been amended to give the town council authority to regulate the density of development based on anticipated demands and effects on the water supply and quality. Aquifer recharge areas have been identified and an overlay zoning district established.

A site plan for a development must be prepared by a professional hydrogeologist for review and approval by the town council and the planning commission. The plan must delineate the development within the recharge area and project water demand and its effect on aquifer recharge. If the council determines that the development does not lie within any recharge area, the development plan may proceed through normal processing.

The council or planning commission may reject any plans that

- *impose adverse effects upon the aquifer recharge rate or water quality (the developer may resubmit modified plans),*
- *would create a water demand on the site greater than the groundwater recharge rate, or*
- *cause more than a 10 percent decrease in a site's recharge rate (immediate rejection).*

Other economic and water quality considerations may also be grounds for rejection.

These requirements include building lots, streets, sewers, grading, and relationships to other properties and the comprehensive plan. The review can also include runoff control, drainage, and erosion control requirements, and provisions for parks, buffer areas, open spaces, and maintenance responsibility. These features are often phased in as the project progresses, with completion required by the time the lots are sold.

Before subdivision review was part of the normal planning process, developers often sold lots without such basic design features as roads, parks, and open spaces. The community had to pay for further improve-

ments. Reviews guarantee that developers meet requirements before construction can begin or proceed.

Subdivision review is a good time to review the design of permanent urban runoff management structures. This allows the entire parcel to be reviewed as a whole rather than in small separate parcels that may not individually require comprehensive treatment.

Site plan review is a stage in the subdivision process. It enables government to review the technical aspects of a proposed development. While not always required, site plan review ensures that new development or expanding current uses comply with zoning, environmental, health, and safety requirements. A site plan shows the proposed development in context and provides a good picture of how it will fit in with the surrounding areas. It shows existing topography, natural features, wetlands, and runoff facilities. The detailed project site includes internal roads and parking areas, building placement, recreational areas, and landscaping.

■ **Land acquisition.** To protect water quality and the environment, jurisdictions can purchase property uniquely valuable to the community. Land purchases protect wells, wetlands, and strips bordering waterways. Publicly owned land is used for parks and recreation and preserved as open space to recharge the groundwater.

While acquiring land to gain control of critical areas can be an effective technique, it is costly. Acquiring contiguous pieces of property often takes many years. Converting private lands to public ownership also removes them from the tax rolls — and requires ongoing management and maintenance expense.

In addition, land purchase is a divisive issue because of the cost and the frequent resistance to taking land out of development. Communities should prioritize potential land purchases and carefully evaluate each parcel's importance, such as ability to recharge groundwater, existing land uses, and development trends. Communities can then plan to fully purchase lands most critical to preserving water quality, and use partial purchase arrangements for less critical land.

Several types of purchase arrangements and financing mechanisms are possible.

Fee simple interest. The most expensive type of acquisition is outright purchase, where the jurisdiction gains full or "fee simple" title and the maximum measure of control over land uses. The community can benefit by establishing parks, recreation facilities, or a conservation district.

Partial interests. More limited interests can be tailored to specific public objectives, including environmental protection. Partial interests generally take several forms:

- *Conservation easements and restrictions.* The easement holder can prohibit actions on the property, such as restricting certain high-density development or prohibiting hazardous materials or septic tank systems. Easements apply to all subsequent landowners for the full term, which might be specified, or in perpetuity. Property owners gain benefits because easements take land off the tax roles or assess it at sharply reduced levels.

WISCONSIN STEWARDSHIP PROGRAM

The Stewardship Program, created in 1989, is part of Wisconsin's century-old history of acquiring and protecting environmentally sensitive lands.

Through the program's streambank protection category, the Wisconsin Department of Natural Resources (DNR) or nonprofit conservation organizations protect water quality and fisheries from urban and rural runoff through land purchases and easements along streams.

In 1992, for example, the department purchased a 43-acre corridor easement for $39,500. The corridor included a 7,000-foot frontage along the Milwaukee River and 27 acres of wetland and lowland woods. The easement protects water quality and fish habitat and assures public access to the shoreline.

While landowner resistance has resulted in only a modest number of easements, DNR has reported a renewed interest in the program, with some 40 landowners giving permission for easement appraisals. The addition of a fee acquisition authority by the legislature should also enhance landowner acceptance.

Source: Wisconsin Stewardship Program Progress Report, April 1993.

Conservation easements — such as the Maryland Environmental Trust, Eastern Shore Conservancy, Western Maryland Conservancy, and Wisconsin's Stewardship Program — are becoming more prevalent.

- *Purchase of development rights.* In this case, the right to develop the property is purchased, while ownership remains with the landowner. The landowner cannot develop the property, based on the restrictions in the deed.

- *Restrictive covenants.* A restrictive covenant attaches to the property and applies to future landowners. However, unlike an easement in which a local government can enforce restrictions, a restrictive covenant can be enforced only by other property owners similarly restricted.

  To protect water quality, a local planning board might require a restrictive covenant limiting paved surfaces as a condition to granting site plan approval for a proposed subdivision. Or, a government might purchase a parcel outright, place restrictive covenants on the title limiting future development rights, and sell the deed-restricted property back to a private party. Such restrictions can be used to prohibit specific land uses, densities, or activities that pose a threat to water quality.

While partial interests do not provide governments with total control, they have certain advantages:

- the community is not burdened with maintaining the property;
- the property remains on the tax rolls; and
- lower costs allow the community to obtain interests in more parcels.

Financing. Since full or partial purchase of land is costly, the community should carefully consider the alternatives. A number of strategies can be used to finance purchases, including those listed in Chapter 2.

- *Donations or "bargain sales."* Motivate individuals by allowing a charity or tax deduction to donate or take a loss on property sold to the local government.

FINANCING LAND ACQUISITION

Through a land bank program, Nantucket Island — off the coast of Massachusetts — has acquired 1,105 acres from purchase or gift as of June 1993. This represents 3.5 percent of the island's total acreage (see page 17, Nonpoint Source Program Financing). The land bank has targeted two coastal preserves with a large amount of shore frontage for acquisition as open space public lands. The program, funded by a 2 percent real estate transfer fee, receives favorable support from residents.

- *Purchase by conservation groups.* Encourage private conservation groups to purchase the land.

- *Increased water and sewer fees.* Dedicate "user fees" added to utility bills to land purchase.

- *Increased local property or property transfer taxes.* Levy fees on real estate transfers and trust funds set up to acquire land with the proceeds, placing the burden on developers.

- *Municipal bonds.* Issue bonds to raise money for land acquisition, depending on state law and federal limitations.

Protecting Critical Resources

Floodplains. Floodplains provide flood storage, runoff infiltration, vegetative filters, and protection for wildlife and streambanks. Naturally vegetated floodplains are a valuable habitat for plants and wildlife and allow streams to find their natural courses.

Generally, state and local governments work through FEMA's National Flood Insurance Program to preserve national floodplains. States have passed enabling legislation providing various levels of assistance and coordination to local governments, which adopt measures to reduce or eliminate flood damage in return for flood insurance. When enforced, these measures prevent and/or limit development in floodplains, allowing them to continue to provide flood storage, runoff infiltration, and erosion protection.

NATIONAL FLOOD INSURANCE PROGRAM

NFIP was created by Congress in 1968 to reduce the loss of life and property and the cost of rising disaster relief from flooding. These goals are achieved by

- *requiring that new and substantially improved buildings be constructed to resist flood damages;*
- *guiding future development away from flood hazard areas; and*
- *transferring the costs of flood losses from the taxpayer to floodplain property owners through flood insurance premiums.*

The courts have consistently upheld the land use management criteria of the NFIP and over 18,000 communities participate in the program.

The floodway, which maintains the flood-carrying capacity of rivers and streams, is the most important provision of the NFIP. The floodway is the area of the watercourse plus adjacent floodplain land that must be preserved to allow the base flood (100-year flood) discharge without increasing flood heights more than a designated amount. Communities must prohibit any development within a floodway that would increase flood heights.

A floodway — a de facto preservation tool — also protects critical riparian habitats, minimizes degradation of surface water quality, and provides for groundwater recharge.

A community that preserves and manages its floodplains also preserves a natural control for nonpoint source pollution and a no-cost alternative to detention basins and other structural controls (see Chapter 4). As an added benefit, homeowners may also enjoy lower flood insurance rates.

■ **Wetlands.** Once considered wastelands, wetlands are now highly valued for a multitude of benefits. In some cases, wetlands are even being constructed to control nonpoint source runoff. Wetlands support plants that remove suspended sediment and dissolved nutrients from runoff and provide a habitat for a variety of wildlife. They also store excess runoff and absorb destructive waves that can erode shorelines. Section 404 of the Clean Water Act protects the nation's wetlands by requiring permits to fill and dredge them.

Although wetland protection and use are critical to any comprehensive plan to reduce nonpoint source pollution, using wetlands to filter pollutants has drawbacks. Wetlands can easily become sinks, allowing trapped toxic pollutants to seep into groundwater. A nonpoint source management plan should, therefore, consider wetlands in the context of the entire drainage system.

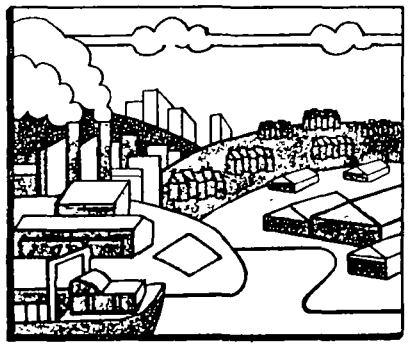
■ **Stream buffers.** These undeveloped zones at the edge of waterbodies preserve vegetation to reduce erosion and trap sediment, nutrients, and other pollutants before they reach the water. Buffers can also shade streams to reduce temperature, improving fish and wildlife habitat. Local jurisdictions usually pass laws to establish these buffers.

■ **Stabilized hillsides and steep slopes.** Vegetative or structural controls secure banks by retaining soil, holding back runoff, and maximizing infiltration. To protect slopes, local governments have purchased the land, used a site plan review process, or passed special ordinances.

■ **Aquifers or wellheads.** A valuable water resource, these structures require protection to preserve water quality. Sources as diverse as toxic wastes, manure, pesticides, road salt, and oil can cause contamination.

EPA has estimated, for example, that 20 percent of the one million underground petroleum storage tanks may be leaking and could contaminate water supplies. Since municipal pumping systems draw substances discharged toward the well, areas surrounding wells are particularly vulnerable. Toxins can easily enter an aquifer through an open, unsealed wellhead, making wellheads a chief source of groundwater contamination. Therefore, many county health departments are identifying abandoned wellheads without adequate caps or seals.

Many jurisdictions protect areas around wells, ranging from a few hundred feet to several miles, with special ordinances, permits, and prohibitions against specific types of development and activities. In some cases, communities have purchased the land surrounding a well to assure protection. The Wellhead Protection Program, part of the 1986 Safe Drinking Water Act Amendments, provides technical assistance to communities to protect wellheads.



Intensely Developed Area

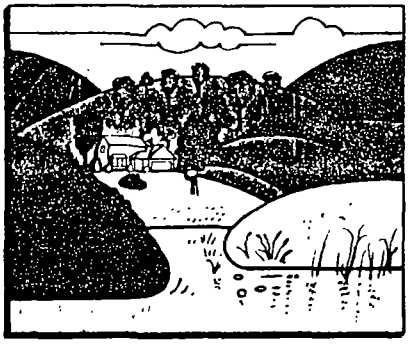
Characteristics
- Dense residential, institutional, commercial, or industrial uses
- 4 or more dwelling units per acre
- Public sewer and water serving 3 or more housing units per acre

Applicable Criteria
- Reduce pollutant loadings by at least 10% from predevelopment loads
- Reduce nonpoint impacts to streams and tidal waters from redevelopment
- Protect remaining wildlife and fish habitats

Limited Development Area

Characteristics
- 1 dwelling unit per 5 acres up to 4 per acre
- Areas with public sewer, or water, or both
- Mixture of land usage—not dominated by agriculture, wetlands, forest, or open space

Applicable Criteria
- Replace cleared forest land on an acre-for-acre basis
- Restrict removal of existing forest land to 20% when development occurs
- Restrict impervious areas to 15% of the land area being developed
- Encourage clustering of dwelling units to conserve natural habitats



Resource Conservation Area

Characteristics
- Housing density of less than 1 dwelling unit per five acres
- No public sewer or water
- Primarily open fields, wetlands, forest, and agriculture

Applicable Criteria
- Limit residential development to an overall density not to exceed 1 dwelling unit per 20 acres
- Encourage agriculture and forestry

Figure 8.—Characteristics of land classifications in Maryland's critical areas, and criteria for management.
Source: U.S. Environmental Protection Agency, Maryland's Critical Area Program.

Successful Land Use Programs

While land use controls vary according to location, a number of communities have successfully used these strategies to curtail nonpoint source pollution.

As mentioned earlier in this chapter, Maryland's Chesapeake Bay Critical Areas Program is one way local communities can implement state programs designed to protect water quality. The Critical Areas Commission, which established criteria to classify and protect lands in a 1,000-foot strip surrounding the tidal portions of the bay's tributaries, requires jurisdictions to write and adopt local programs. They must include both state and local comprehensive plan requirements for zoning, site planning, subdivision review, and other activities. The Critical Areas program addresses development, resource use, and resource protection.

Local jurisdictions must assign their lands in the critical area to one of the following development categories (see Fig. 8):

- intensely developed — four or more dwelling units per acre;
- limited development — one to four dwelling units per 5 acres; or
- resource conservation — less than one dwelling unit per 5 acres.

These definitions also include other characteristics, such as land usage and sewerage. Development requirements have been specified for all three categories. For example, only 5 percent of the land in a limited development or resource conservation area may be reclassified to more intense use.

Dade County, Florida, has developed a Wellfield Protection Ordinance that prohibits underground storage tanks and other potentially polluting activities in the recharge zone of public wells. The ordinance is based on a mathematical groundwater flow model that predicts the speed that groundwater travels in recharge areas. In Massachusetts, the Cape Cod

Planning and Economic Development Commission is using a similar principle to protect its well fields.

In 1988, Washington state developed a Local Planning and Management of Nonpoint Source Pollution administrative code (chapter 400-12) that outlines procedures for state watershed management. The state code was originally developed by the Puget Sound Water Quality Authority that monitors an environmentally sensitive area encompassing 12 watersheds.

The Washington program stipulates local watershed plan development, to be funded primarily through grants from the state Department of Ecology. Under the regulation, a watershed management committee prepares plans and addresses all major watershed nonpoint sources. Unlike traditional citizen advisory committees, these local bodies have significant decisionmaking responsibility. They operate under the general aegis of a lead agency — usually a county — responsible for convening the committee and overseeing plan development. The planning committee, government entities affected by the plan, and the Department of Ecology must approve each plan.

Chapter 4

Urban Nonpoint Source Control Methods

Construction and development activities can be one of the worst sources of urban nonpoint source pollution. Improper construction erosion and sediment control can cause large volumes of sediment to impair sewers, streams, lakes, and stormwater control devices. When this excessive sediment enters small streams, wetlands, and lakes, it can damage or destroy wildlife habitat by smothering stream and lake bottoms, filling impoundments with sediment, increasing dredging costs, and impeding navigation.

After construction is complete, many changes in land use and site drainage characteristics can cause a host of additional problems. Changes include increased impervious surfaces and pollutant loadings, as well as different runoff patterns and increased volumes and temperature. Cold water fisheries may be destroyed, streambank erosion and flooding may be increased, and beneficial uses of waterbodies — such as swimming, fishing, and boating — may be impaired. To avoid or reduce these problems, a dual focus on proper construction site erosion and sediment control and postdevelopment runoff control is necessary.

A number of control practices can be used to reduce the impact of development or redevelopment. Local conditions will determine what practices are appropriate for a given situation. In most cases, standard erosion and sediment control practices can be used, although they may need to be adjusted for areas with steep slopes, intense rainfall, or highly erosive soils. Management strategies for postconstruction runoff controls are generally site specific — they must be specifically designed to fit the individual development site and local conditions. Often a combination of techniques offers the most protection.

Practices used to control sediment and erosion during construction, when the soil is not stabilized, are different from practices used for long-term runoff control after construction. During the site development process — before construction begins — an erosion and sediment control plan should be developed for each activity during construction. This plan should be developed in conjunction with a stormwater management plan to address the runoff from the newly completed project or development.

Tools of the trade are usually referred to as best management practices (BMPs). The term BMP is used to describe the most effective practice or combi-

nation of practices to control runoff and nonpoint source pollution. A BMP may be a system that reduces the pollutants that enter urban runoff or a method that reduces the amount of pollutants in the runoff before it enters a waterbody. BMPs are generally grouped into categories — structural or nonstructural — depending on the operating principle or physical mechanism used to reduce nonpoint source pollution. Nonstructural controls decrease erosion potential, while structural controls prevent and mitigate erosion and sediment movement.

Nonstructural BMPs are a cost-effective way to manage stormwater runoff and prevent nonpoint source pollution. These controls take advantage of the land's natural features and use, relying on planning, design, maintenance, education, economic incentives, and even regulation to prevent runoff contamination (see Chapter 3).

A variety of urban BMPs can be used to mitigate some of the adverse impacts caused by development. More detailed information on selecting and using BMPs can be found in the resources listed in Appendix B.

Preconstruction Planning

■ **Basic development practices.** Land use strategies for local government to plan an overall nonpoint source control program were discussed in Chapter 3. But requirements for developers before construction begins, particularly at the site plan review stage, can help prevent problems from occurring on individual sites. A developer can be required to submit a detailed plan for managing runoff and for returning the site to a predetermined hydrological condition after completing construction.

Since few control methods can handle the large loads of sediment that erode during construction, a combination of control systems should be planned for and put in place. In some cases, the measures used during construction can be modified to control runoff over the long term.

Use the following check list, singly or in combinations, to develop an urban runoff management plan.

- Respect contours and natural features of the landscape — for example, avoid stream valleys and steep slopes.
- Use downzoning to restrain development.
- Specify minimum lot sizes.
- Limit development by soil type or proximity to waterbody.
- Restrict or prohibit development in sensitive areas identified in the comprehensive plan.
- Limit density of development.
- Limit percentage of lot that can be disturbed.
- Limit percent of impervious cover.
- Preserve natural 100-year floodplain (area that will receive a flood at least once within 100 years); allow no modification of the natural floodplain; and ensure that development is consistent with the comprehensive plan.
- Prohibit clearing or grading on steep slopes (more than 25 percent recommended) and limit road grades (equal to or less than 7 percent recommended).
- Prohibit development in nontidal wetlands and require a buffer zone for these areas.
- Retain upland and riparian trees as a certain percentage of predevelopment tree cover.
- Require waterway disturbance permits for structures such as roads and utilities so they do not restrict fish migration or riparian areas.
- Reserve a minimum percent of open space on each new development site.
- Designate the percent of the land that can be exposed at one time during construction; specify the duration of exposure and the developer's revegetation/stabilization responsibilities.
- Impose time restrictions on construction — e.g., prohibit disturbances during spawning season.
- Revegetate immediately or as soon as possible following construction.
- Provide for stormwater collection or treatment, such as use of sediment control basins, wetlands, or wet ponds, to accommodate large storms.
- Route clean water around the site.
- Maintain infiltration capacity, using natural drainage conditions where possible. This may mean limiting impervious area to a fixed percentage of lot size and limiting runoff to predevelopment rates and characteristics.
- Control erosion and sediment through the watershed protection ordinance.

- Limit the grade of constructed slopes.
- Stabilize existing steep slopes by sodding and pegging to establish grass cover, building retaining walls, and planting woody vegetation on the most extreme slope.
- Dispose of construction wastes such as oil, cement, and debris.
- Require inspection during and after construction.
- Require long-term maintenance and review of plans for adjacent parcels.
- Ensure that development plan meets all existing ordinances.

■ **Groundwater considerations.** When considering options for postdevelopment stormwater control, groundwater should be considered in choosing a BMP. Activities that have a significant impact on groundwater should be controlled by design standards. For example, a standard could require runoff collection systems for roads and parking lots to control at least the first flush — the first 1/2 inch of rainfall that typically contains most contaminants — during any storm.

Controlling Development

Local governments should consider the total environment in selecting a nonpoint source pollution strategy that will provide the maximum benefit to the environment and to consumers. These benefits usually depend not only on the method itself but also on its design, maintenance, and congruence with the surrounding landscape.

A community's success in preventing pollution depends largely on how well it has planned for controls during and after the development process (see Fig. 9).

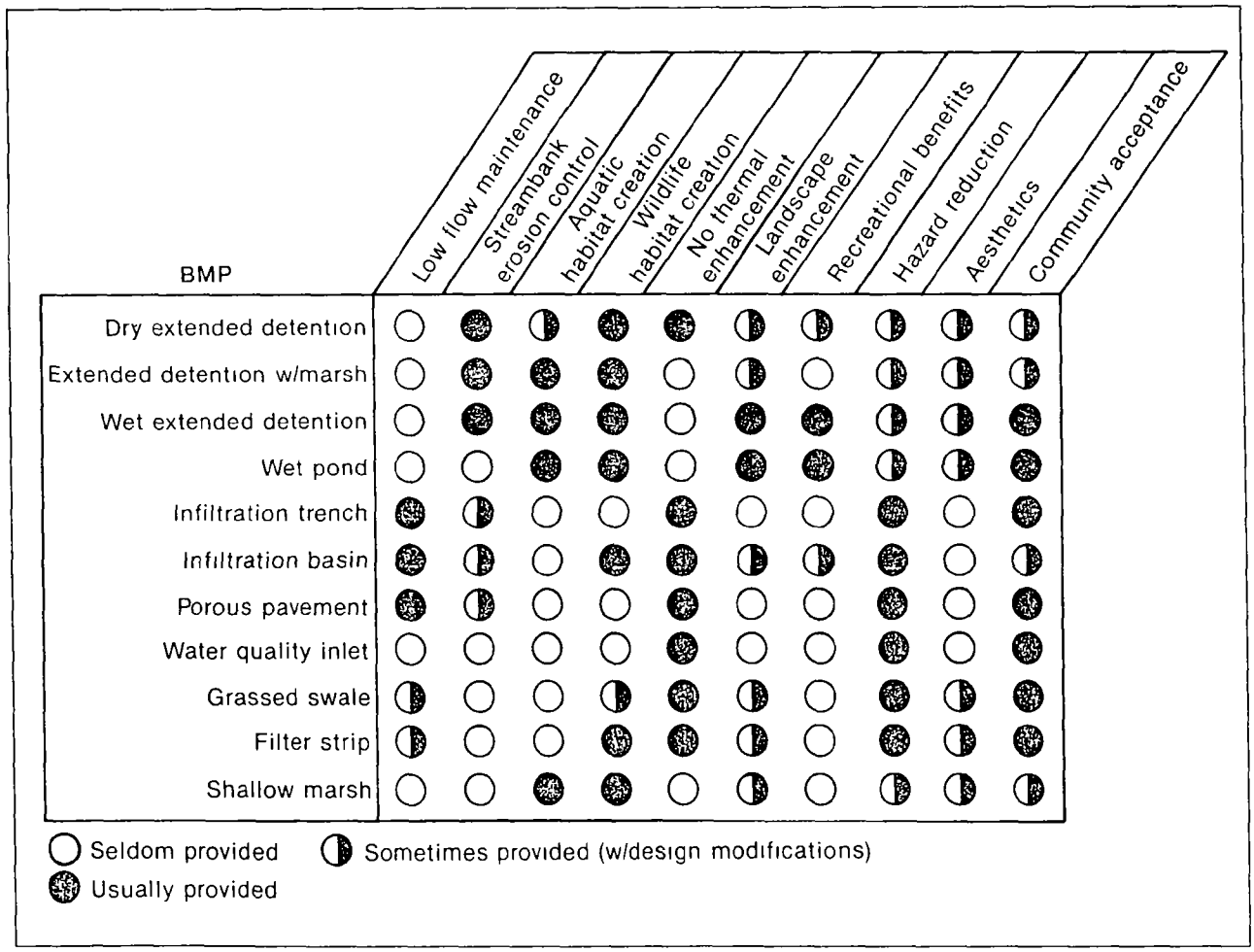


Figure 9.—Comparison of nonpoint source control methods in benefiting the surrounding environment and community. ***Source: Metropolitan Washington Council of Governments, 1993.***

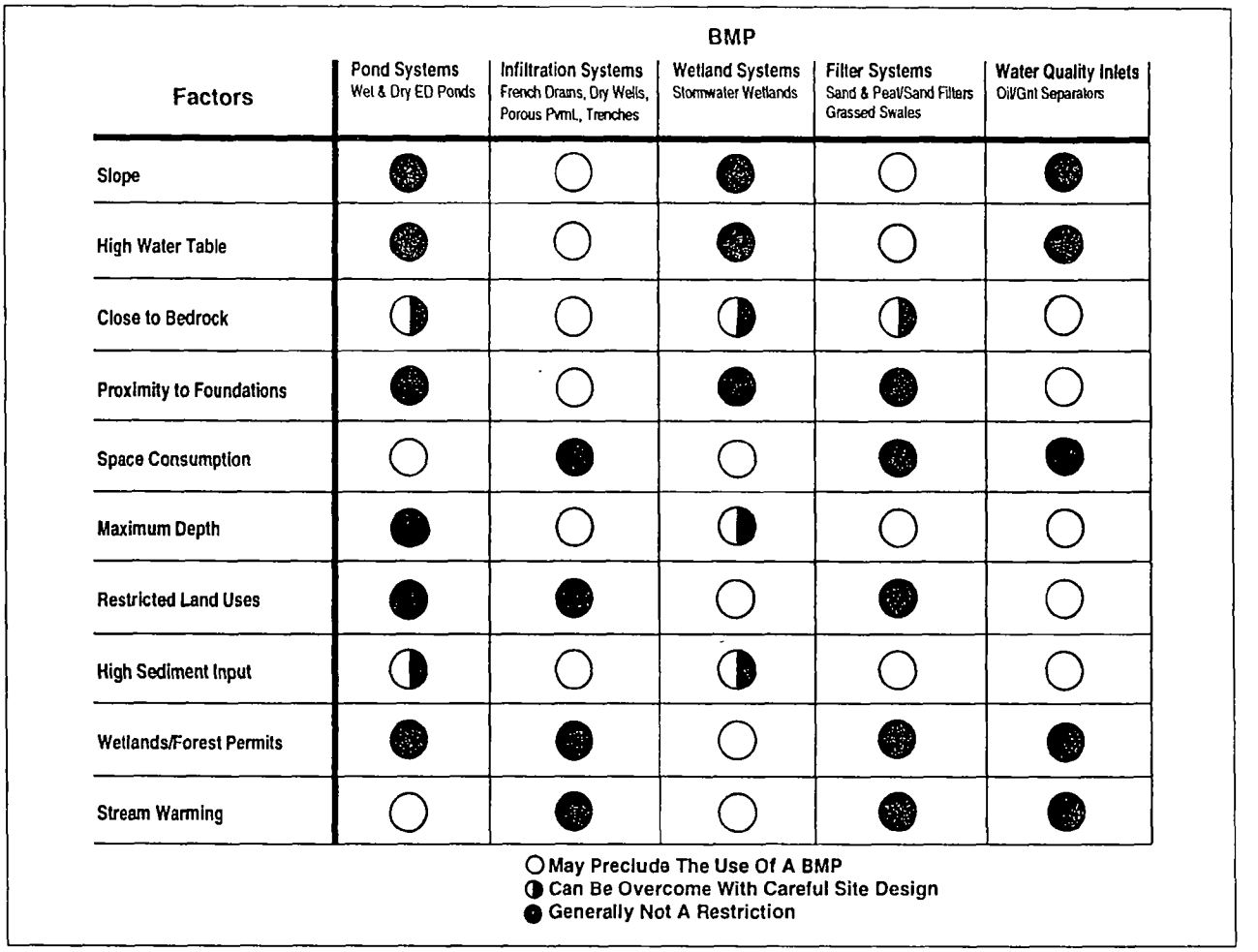


Figure 10.—Screening techniques for urban BMPs. ***Source: Metropolitan Washington Council of Governments, 1993.***

■ **Site conditions.** In developing a comprehensive nonpoint source water quality protection plan, the first step is to assess the site's geographic elements and morphology (see Fig. 10).

Soil. Permeability — the ability of the soil to absorb runoff — is crucial in selecting an appropriate control method. This characteristic particularly affects infiltration methods, which can affect groundwater quality (see Fig. 11).

Slopes. Steep slopes preclude the use of several types of control methods and certain types of development. For example, porous pavement and grassed swales must be situated on sites with slopes of 5 percent or less, whereas infiltration trenches are not practical when slopes exceed 20 percent.

Size of the watershed area. The success of some control methods depends on the watershed size. For example, detention ponds normally do not work unless the watershed area is greater than 10 acres. Alternately, infiltration and vegetative controls are most successful in areas less than 10 acres (see Fig. 12).

Water table. A high water table can reduce the effectiveness of an infiltration basin. If a seasonally high water table extends to within 4 feet of the bottom of an infiltration basin, the site generally is not considered suitable. The depth of infiltration and pond controls are limited by their proximity to the water table.

Distance to bedrock. As with a high water table, a bedrock layer too close to the surface (2 to 4 feet from the bottom of an infiltration basin) will prevent the infiltration basin from draining properly. Similarly, controls that use ponds generally will not work if the bedrock lies within an area that must be excavated to provide stormwater storage.

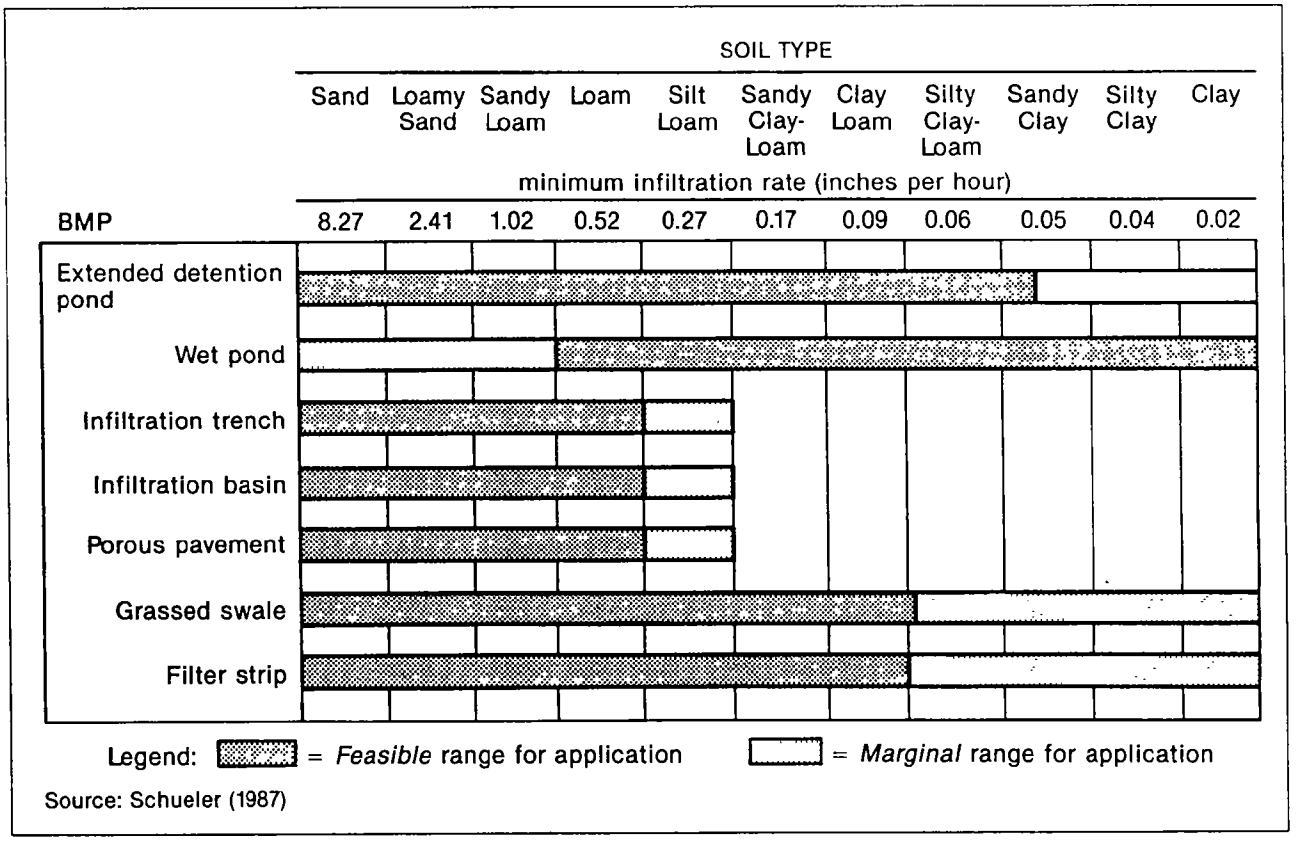


Figure 11.—Restrictions for BMP application based on soil permeability. ***Source: Schueler, 1987.***

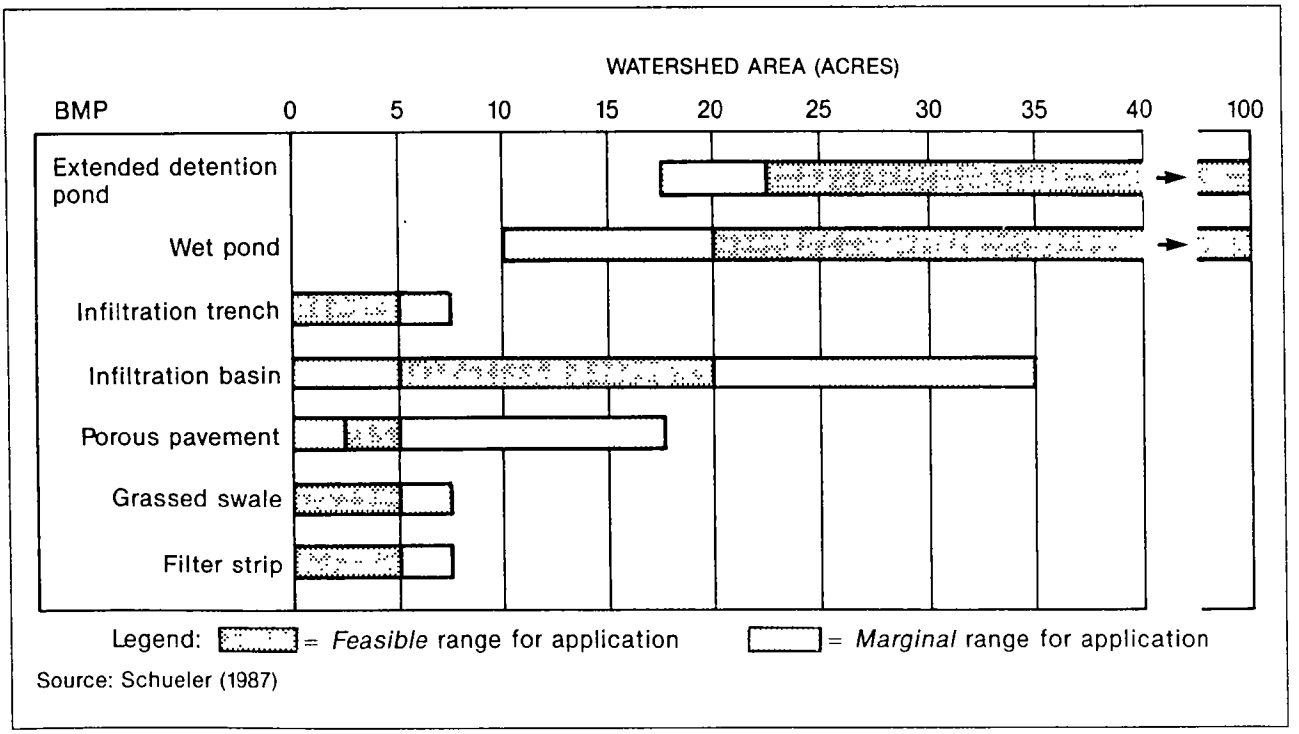


Figure 12.—Feasible BMPs for different watershed sizes. ***Source: Schueler, 1987.***

Proximity to foundations and wells. Infiltration basins should be at least 100 feet away from drinking water wells to prevent groundwater contamination. Wellhead protection areas may require even greater distances to properly protect public water supplies. To prevent seepage, they should be installed at a reasonable distance (100 feet) from a building foundation.

Land use. A very small or intensively developed site may preclude the use of space-consuming controls such as detention ponds and porous pavement. In addition, some controls are appropriate only to particular types of land uses. For example, sand filters are suitable for parking lots, while grassed swales are effective only in low density residential areas.

Effects of temperature. Shallow marshes and wet ponds heat up rapidly during the summer, and their runoff into colder streams can harm aquatic life.

■ **Predevelopment status.** The second step in selecting a control method is to determine which option comes closest to duplicating the site's hydrology prior to development. Consideration involves a number of factors:

Control of peak flows. Some local regulations require that a nonpoint source control method be able to control the peak flow from a two-year storm — a storm expected to produce a flood every two years. Some jurisdictions require control of even larger storms. Ponds are an excellent method for achieving this goal; infiltration basins are somewhat less effective.

Control of first flush. First flush is the disproportionately large amount of pollutants usually found in runoff during the early part of a high intensity or large volume storm, caused by the rapid runoff of accumulated pollutants. First-flush control — the first 1/2 inch of rainfall — can also be required for a runoff area. However, if storms in an area are frequent, the first flush may not be significant and further monitoring may be needed.

Volume control. Infiltration basins can reduce the runoff volumes of smaller storms by diverting much of the runoff back into the soil.

Groundwater replenishment. Infiltration basins provide an excellent way to replenish groundwater lost because of development; however, this benefit must be weighed against the potential for groundwater contamination.

Streambank erosion control. While some nonpoint source pollution methods control streambank erosion to some extent during a two-year storm if properly designed, installed, and maintained, more severe storms require large extended detention ponds and infiltration controls to prevent downstream erosion.

■ **Pollutant removal.** The third step is to determine which control method will remove the greatest volume of pollutants. Important interrelated factors are the removal mechanisms, types and percentage of runoff to be treated (first flush versus total runoff), and the type of pollutant being removed.

The nature of the pollutant is the most important factor in a control method's effectiveness. For example, most control methods are extremely effective in removing sediment and trace metals, which are usually adsorbed into sediment surfaces. However, vegetative systems are more effective in removing soluble pollutants such as phosphorus, nitrogen, and chloride. Systems that combine nonvegetative and vegetative features are generally highly effective.

■ **Cost.** A final step in selecting a control method is estimating the cost by taking into account all factors associated with the method. Construction and both short- and long-term maintenance are, of course, the major cost components. Costs may include

- labor,
- materials,
- land purchase,
- loss of tax revenue on acquired lands, and
- downstream mitigation.

Flood Control and Retrofitting

In the past, flood control efforts have focused primarily on decreasing the volume of water that abruptly enters waterbodies. Traditional methods to reduce flooding include using dry detention basins that temporarily store excess runoff, constructing channels, streambank hardening, and floodplain restrictions that limit development along or in flood-prone stream areas.

These flood control measures were not originally designed to control pollution caused by increased urbanization. The historical focus was on quantity control — not quality control. Urban planners and water quality professionals now recognize that these issues must be incorporated into an overall strategy that assesses both flooding and pollutant removal. Existing flood control BMPs are now being redesigned or retrofitted to protect water quality. New flood control BMPs are almost universally being built with this dual focus.

A comprehensive watershed protection strategy, which uses nonstructural and structural BMPs, will reduce the long-term costs of both controlling floods and protecting water quality.

Identifying and preserving buffers and natural systems is an important component of a watershed management plan. These areas serve as nonstructural controls, filtering out many pollutants in urban runoff that might reach the waterbodies. However, in existing developments, they have often been altered. When nonstructural controls are impossible or impractical because of existing development, a community may turn to structural practices — constructing new runoff treatment structures or retrofitting existing runoff management systems.

Retrofitting requires modifying runoff control structures or conveyance systems, originally designed to control flooding, to also control water quality. Modifications might include enlarging structures, changing the inflow and outflow patterns, and increasing detention times.

Retrofitting costs are a major hindrance in improving water quality in developed areas. Therefore, communities may need to identify the most insidious pollutants and then select the most cost-efficient and effective solutions to deal with them, thus improving water quality in urban runoff.

URBAN RUNOFF CONTROL PROGRAMS

Several states and localities have made significant advances in developing and implementing runoff controls. Two particularly noteworthy examples are in Maryland and Florida.

- **Maryland** *began its stormwater management program with the passage of a 1982 state law requiring each county and municipality to adopt a stormwater management ordinance based on state criteria. Criteria call for maintaining predevelopment hydrological conditions and reducing erosion and pollution.*

  The state Sediment and Stormwater Administration reviews and approves local ordinances and develops stormwater management programs for state and federal construction projects. The ordinances must include an approved stormwater management plan, criteria and procedures for stormwater management, proper implementation of the plan (including design criteria for specific proposed controls), maintenance and inspection procedures, and penalties for noncompliance. The ordinances are required for any new construction projects, with a few exceptions for single-family homes on small parcels of land.

- **Florida's** *stormwater management program applies to all new development. Administered through a stormwater rule that serves as a performance standard, Florida's program ensures that runoff volume, speed, timing, and pollutant loads are close to predevelopment levels.*

  The standard requires that a stormwater management system remove at least 80 to 95 percent of the annual pollutant load of sediments, nutrients, and many heavy metals. If permit applicants show that they can meet the standard, the state assumes that water quality requirements will not be violated. But if violations occur, the state can impose more stringent requirements, even if the basic performance standard has been met.

Urban Best Management Practices

BMPs should be selected as part of an erosion and sediment control plan during the site development process, with long-term runoff management part of the objective. The best system of practices to control nonpoint source pollution after construction is completed may be a modification of the practices used during the construction process.

Selecting the proper BMP system is critical in achieving the ultimate goal — reducing the pollutants in urban runoff. In selecting the most appropriate BMPs for a specific site, consider the following:

- the site's physical condition and development status;
- runoff control benefits provided by each BMP option;
- the pollutant removal capability of each BMP option under several design scenarios;

- the environmental and human advantages of each BMP option; and
- the long-term maintenance cost of the BMP.

Table 3 compares the effectiveness of a number of currently used urban best management practices. Urban BMPs are generally grouped into four categories based on the operating principle or physical mechanism used to reduce the amount of runoff pollutants — detention basins, retention/infiltration devices, vegetative controls, and source controls.

■ **Detention basins.** Detention basins are most popular and effective in reducing suspended solids and particles by temporarily holding the runoff and allowing the sediment to settle.

In addition to reducing the pollution in runoff, detention basins also delay the amount of runoff released into receiving waters, thus reducing flooding and streambank erosion and lessening the stress on the physical habitat. The slow release also dilutes the runoff, thereby reducing the concentration of pollutants entering the stream.

With proven success in controlling runoff, detention basins can reduce suspended solid concentrations by 50 to 95 percent. These basins can be used for large drainage areas, be incorporated into new development site plans, and enhance the value of the surrounding property.

Often, however, finding suitable land for a detention basin is difficult and constructing basins in developed areas may not be possible. One solution may be to convert dry ponds previously installed for flow control; they can usually be economically retrofitted to detention basins.

Routine maintenance is required for detention basins. Solids should be removed regularly, because removing accumulated solids after 10 to 20 years can be expensive.

Detention basins are generally of three types:

Dry ponds. Used for flood and erosion control, dry ponds remain dry and available to catch water following large storms. While intended to control water quantity, they can be retrofitted to improve water quality.

Wet ponds. Designed to hold water permanently, wet ponds can be highly efficient in removing sediment and in reducing nutrients through biological activity such as algal growth if properly constructed.

Extended detention dry ponds. These ponds catch stormwater and retain it for 24 to 40 hours, remaining dry at other times. They remove pollutants by trapping sediment particles and allowing them to settle.

■ **Retention/infiltration devices.** Retention or infiltration devices allow runoff to percolate into the ground, reducing the amount of pollutants released into the receiving water. The filtration and adsorption mechanism traps many pollutants — particularly suspended solids, bacteria, heavy metals, and phosphorus — in the upper soil layers and prevents them from reaching the groundwater.

Infiltration devices can remove up to 99 percent of runoff pollutants, depending on the percolation rate and area, soil type, pollutants present, and available storage volume. Success also depends on the rainfall. Not only do infiltration devices have high pollution removal rates, but they can also be built in developed areas and effectively reduce the volume of runoff.

However, poor site conditions such as impermeable soils, a high water table, and bedrock can lessen the effectiveness or cause failure of retention/infiltration devices. These devices must also be installed carefully to prevent soil compaction from heavy machinery, and they require such pretreatment devices as grass filter strips to remove coarse sediment from the infiltration surface. Operation and maintenance are also critical. Many infiltration BMPs have failed from lack of maintenance. Devices must be designed for ease of access, maintenance, and operation.

Retention devices fall into the following categories:

Infiltration basins. An infiltration basin is a natural or excavated large open depression. It temporarily stores runoff until the water percolates through the bottom or sides. Excess runoff can overflow through elevated outlets to maximize the storage volume. Because runoff usually percolates in a day or two, these basins can be dry.

Infiltration trenches and dry wells. Similar in design, infiltration trenches and dry wells are excavated holes filled with coarse stones and then covered. Dry wells are used primarily for roof drainage; trenches are used on larger areas such as streets and commercial parking lots. In both designs, runoff infiltrates the surrounding soil or is collected by perforated underdrain pipes and routed to an outflow. Infiltration trenches preserve the natural hydrology of an area and can fit on small sites. However, they require considerable maintenance and can contaminate groundwater under certain conditions.

Table 3—A comparative assessment of the effectiveness of current urban best management practices.

URBAN BMP OPTIONS*	RELIABILITY FOR POLLUTANT REMOVAL	LONGEVITY*	APPLICABLE TO MOST DEVELOPMENTS	WILDLIFE HABITAT POTENTIAL	ENVIRONMENTAL CONCERNS	COMPARATIVE COST	SPECIAL CONSIDERATIONS
STORMWATER WETLANDS	Moderate to high, depending on design	20+ years	Applicable to most sites if land is available	High	Stream warming; natural wetland alteration	Marginally higher than wet ponds	Recommended with design improvements and the use of micropools and wetlands
EXTENDED DETENTION PONDS	Moderate, but not always reliable	20+ years, but frequent clogging and short detention common	Widely applicable, but requires at least 10 acres of drainage area	Moderate	Possible stream warming and habitat destruction	Lowest cost alternative in size range	Recommended with design improvements and the use of micropools and wetlands
WET PONDS	Moderate to high	20+ years	Widely applicable, but requires drainage area of greater than 2 acres	Moderate to high	Possible stream warming, trophic shifts, habitat	Moderate to high compared to conventional	Recommended, with careful site evaluation
MULTIPLE POND SYSTEMS	Moderate to high; redundancy increases reliability	20+ years	Widely applicable	Moderate to high	Selection of appropriate pond option minimizes overall environmental impact	Most expensive pond option	Recommended
INFILTRATION TRENCHES	Presumed moderate	50% failure rate within five years	Highly restricted (soils, groundwater, slope, area, sediment input)	Low	Slight risk of groundwater contamination	Cost-effective on smaller sites; rehab costs can be considerable	Recommended with pretreatment and geotechnical evaluation
INFILTRATION BASINS	Presumed moderate, if working	60 – 100% failure within 5 years	Highly restricted (see infiltration trench)	Low to moderate	Slight risk of groundwater contamination	Construction cost moderate, but rehab cost high	Not widely recommended until longevity is improved
POROUS PAVEMENT	High (if working)	75% failure within 5 years	Extremely restricted (traffic, soils, groundwater, slope, area, sediment input)	Low	Possible groundwater contamination	Cost-effective compared to conventional asphalt when working properly	Recommended in highly restricted applications with careful construction and effective maintenance
SAND FILTERS	Moderate to high	20+ years	Applicable for smaller developments	Low	Minor	Comparatively high construction costs and frequent maintenance	Recommended, with local demonstration
GRASSED SWALES	Low to moderate, but unreliable	20+ years	Low-density development and roads	Low	Minor	Low compared to curb and gutter	Recommended, with checkdams as one element of a BMP system
FILTER STRIPS	Unreliable in urban settings	Unknown, but may be limited	Restricted to low-density areas	Moderate if forested	Minor	Low	Recommended as one element of a BMP system
WATER QUALITY INLETS	Presumed low	20+ years	Small, highly impervious catchments (<2 acres)	Low	Resuspension of hydrocarbon loadings; disposal of hydrocarbon and toxic residuals	High, compared to trenches and sand filters	Not currently recommended as a primary BMP option

*** Based on current designs and prevailing maintenance practices.** ***Source: Metropolitan Washington Council of Governments, 1992.***

Sand filter. Sand filters, used to pretreat runoff before it enters another stormwater structure, are suitable for small sites in highly impervious areas and can be retrofitted into existing urban areas. To use sand filters, drainage areas must be stabilized against erosion. Designed mainly to enhance water quality, sand filters are also used to control first-flush water quantity in smaller drainage areas.

Porous pavement. Most practically used for parking lots, porous pavements increase infiltration of water into the soil, maintaining the water balance at nearly the same level as before the land was paved. Runoff rapidly permeates the pores of several layers of different permeable materials and filters the pollutants into the underlying subsoil or perforated drain pipes. The rate of pollutant removal depends on the amount of filtered runoff and underlying soil type.

A study by the Metropolitan Washington Council of Governments found that porous pavement removes as much or more suspended sediment and other pollutants — phosphorus, nitrogen, bacteria, lead, and zinc — as detention/retention basins. Porous pavements can also moderate runoff rate and volume so that drainage patterns and surrounding vegetation remain normal, improving erosion control and enhancing water quality.

Operation and maintenance must be considered in the use of porous pavements, however. They do eventually clog and should be routinely vacuumed.

Oil/grit separators. Also known as water quality inlets, oil/grit separators are designed to remove sediment and hydrocarbons from runoff before it is released to the storm drain network or infiltration system. Runoff passes through long, rectangular concrete chambers — modified to remove sediment, grit, and oil — before exiting through a storm drain pipe.

Oil/grit separators are used infrequently because of their limited ability to remove pollutants caused by low average detention times and the possibility that pollutants removed during one storm could reenter runoff from later storms. However, oil/grit separators can remove coarse-grained sediments from urban runoff and treat runoff before it enters underground filtration systems. They are unobtrusive, compatible with storm drain networks, and easily accessed.

OPERATION AND MAINTENANCE OF URBAN BMPS

Proper operation and maintenance of urban BMPs are critical to their success. A 1990 study of four Maryland counties showed that in 434 wet and dry detention ponds, 70 percent were not operating properly. Poor maintenance was the most frequently cited reason.

To ensure that stormwater management facilities are an asset to the community, not a liability, maintenance must include

- *periodic inspections;*
- *debris and sediment removal from basins and channels;*
- *pipes, pumps, and structure maintenance;*
- *general housekeeping, such as grass cutting and repairs;*
- *mosquito control;*
- *fish stocking; and*
- *vegetation control.*

Before adopting a nonpoint source program using urban BMPs, include sufficient funding for regular maintenance to ensure proper functioning.

Maintenance can be performed by private corporations, individuals, or local government staff. While homeowners' associations and individual property owners can do some maintenance, depending on private citizens to maintain urban BMPs is risky. Legal maintenance and monitoring agreements can be negotiated between a developer and the local public works department. When maintenance is clearly its responsibility, local government may choose to contract with a private company.

A realistic cost estimate is vital to making the community aware of its responsibility for nonpoint source pollution. Maintenance requires staff time to record and assess routine maintenance checks and on-site visits to perform the routine checks.

■ **Vegetative controls.** Vegetative BMPs decrease the velocity of stormwater runoff, promoting infiltration and settling of suspended solids and preventing erosion (see Fig. 13). For maximum effectiveness,

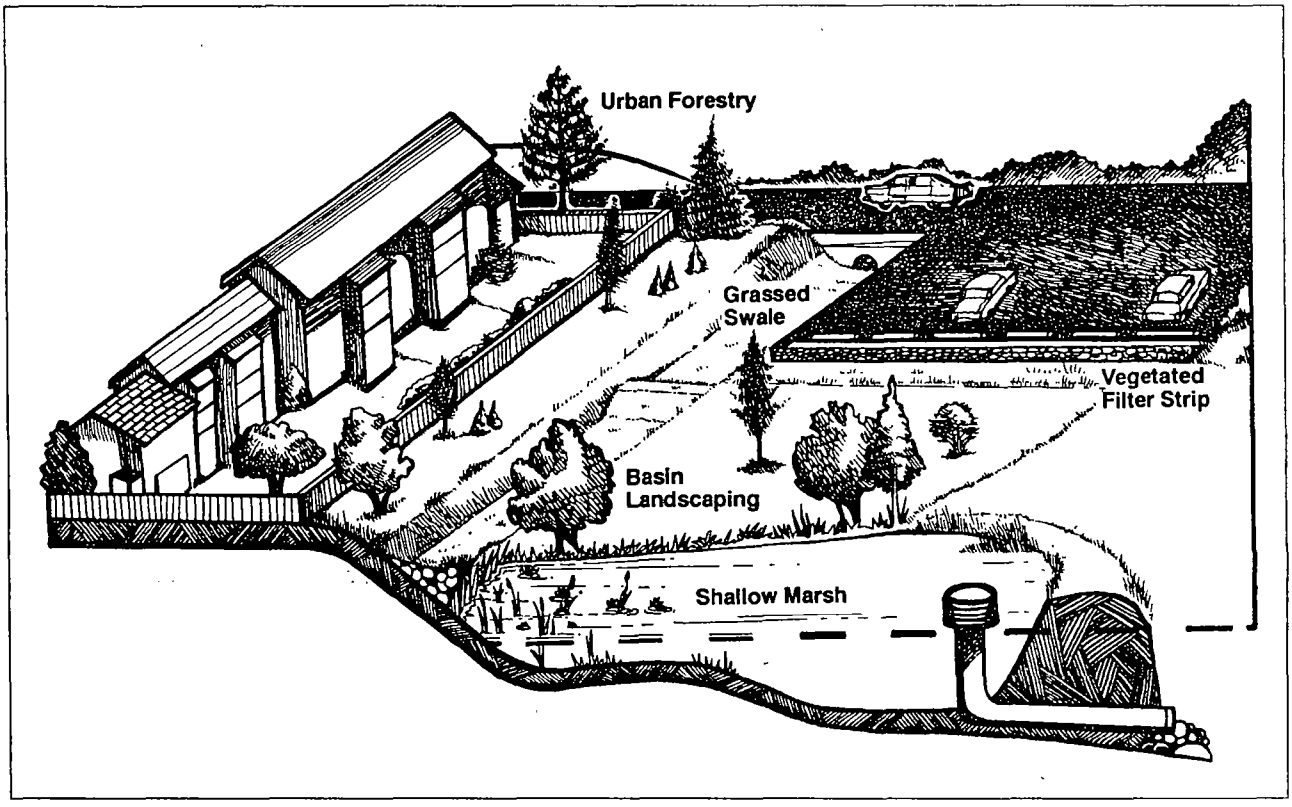


Figure 13.—Vegetative BMPs take many forms and are used for various purposes. ***Adapted from Schueler, 1987.***

vegetative controls must be used in combination with other BMPs as a first line of defense in removing suspended solids before more intensive treatments take over. Vegetative BMPs also remove organic material, nutrients, and trace metals.

Less costly than other control practices, vegetative controls enhance the attractiveness and value of sites. Using vegetative controls to pretreat runoff improves the operation and maintenance of other BMPs.

The ultimate performance and practicality of vegetative controls depend on the site's physical features. Plant material must be selected carefully and regularly maintained. Because they have limited ability to control runoff, and effectiveness varies according to the season, vegetative controls should not be a site's only control practice.

Several types of vegetative controls are as follows:

Basin landscaping. Landscaping can improve a stormwater basin's effectiveness in removing pollutants. Landscaping around a basin reduces the amount of impervious surface area, provides an attractive, green buffer along streambanks, and protects and enhances the use of existing wetlands. Proper landscaping can route stormwater runoff through green areas and away from erosion-prone steep slopes and other areas.

Grassed swales. Grassed swales are depressions, such as gullies, that infiltrate and transport runoff water. They are often used in residential developments and on highway medians as an alternative to curb and gutter drainage systems.

Swales control peak discharges by reducing runoff velocity. The swale allows some runoff to infiltrate the soil, thus diminishing the volume of water passing downstream. Swales are easy to construct, attractive, and a potential habitat for wildlife. However, effectiveness varies considerably from site to site; swales may encourage mosquitos, ragweed, dumping, and erosion.

Filter strips. While similar to grass swales, filter strips are shallower and distribute runoff across a wider area. Their efficiency depends on strip length, slope, and size; soil porosity; normal runoff velocity; and vegetation type. Grassy strips supplemented with shrubs and small trees increase the ability to absorb and retain nutrients.

Riparian reforestation. Trees planted near streambanks can stabilize soil, cool water, and benefit many forms of aquatic life.

■ **Pollution prevention.** Local governments should establish ongoing programs to reduce the generation and exposure of pollutants that accumulate on streets and other surfaces, and eventually wash into lakes and streams. These source reduction programs are usually called pollution prevention programs.

In most cases, pollution prevention is more cost effective than structural BMPs in reducing pollutant loadings. However, a combination of source reduction efforts and structural BMPs is generally needed to fully control the effects of urbanization.

Pollution prevention controls — also known as nonstructural controls — include land use planning and zoning strategies, as well as public education efforts. Storm drain painting, recycling, and household hazardous waste collection offer high value for the initial investment. Incentives to use public transportation or otherwise lower emissions that generate pollutants are also considered source controls. (See *Clean Water in Your Watershed: A Citizens Guide to Watershed Protection* for more information on source reduction controls and areas to target for community participation.)

Pollution prevention controls can generate a sense of community; in addition, they have aesthetic or economic benefits. To be effective, source reduction practices require a combination of education, regulation, and guidance. Chapter 5 more fully discusses these issues relating to citizen involvement and education.

Listed below are common pollution prevention controls communities can consider. Local governments can

- collect and recycle crankcase oil;
- begin leaf and other yard waste collection programs;
- establish catch basin drainage programs;
- redesign road salting programs to minimize the salt quantity and, where feasible, use an alternative deicer;
- educate the public about the hazards of fertilizers and pesticides used in commercial lawn care and grounds maintenance operations and the alternative organic treatments;
- start remedial erosion control programs;
- educate the public on how to reduce litter and properly dispose of pet wastes and household pollutants;
- remove illegal and improper industrial and commercial connections to storm drains that discharge directly into receiving waters without prior treatment; and
- plug or seal abandoned wells and cisterns that are conduits for nonpoint source groundwater pollution.

Other administrative strategies may include hazardous waste restrictions or contingency plans. Source prohibitions — barring storage or use of dangerous materials in a defined area — are common ways to protect health and the environment. Many jurisdictions, for example, now prohibit handling or storing toxic chemicals where a spill could threaten groundwater supplies. Jurisdictions also offer hazardous waste amnesty days, which provide residents the opportunity to properly dispose of hazardous waste.

Many commercial and industrial users produce hazardous wastes that threaten water quality. They include dry cleaners, auto service stations, industrial plants, trucking and railroad facilities, and airports. Other activities — such as agriculture, junk yards, machine shops, landfills, and septic systems — also use hazardous materials.

Most of these activities are controlled by NPDES industrial or municipal stormwater permits, but local governments should check with their permitting authorities to determine the degree to which permit requirements are being met and controls inspected.

Chapter 5

Community Education and Citizen Involvement

Even the best planned nonpoint source pollution program cannot succeed without community participation and cooperation. Citizen monitoring groups and solid public information and education programs are invaluable tools to be planned for and nurtured.

Because nonpoint source pollution is a continuing issue related to development and individual life styles, a water quality program must be established and embraced to succeed. Organization and ordinances mean nothing without community support. The community must buy in and accept the program, just as it does a sewage treatment system.

To gain support, you must understand your community. Is your community small or large? Are residents primarily retired or parents with young children? Are residents commuters or do they earn their living in the community? Do most residents stay in the community all year or seasonally? How much do residents know about nonpoint source pollution? How will they be affected by a nonpoint source management plan? How can they be expected to react to the proposed plan?

A public opinion survey or series of well-publicized public hearings throughout the watershed and in your immediate community will help you get to know the community and give you a basis for measuring public opinion.

■ **Public awareness.** Public information and education are important ways to curb nonpoint source pollution, since the solution lies largely in changing individual behaviors and lifestyles. An informational program must educate citizens about the problem and make citizen involvement part of the solution.

■ **Framing the message.** An initial step in developing a public awareness program is to frame your message. Determine what information about nonpoint source pollution you wish to convey, and stress this message at every opportunity. The tone and level of complexity of your message depend on the community's composition and sophistication. The program should include concrete information about using and disposing of toxic substances in homes, yards, farms, and work places.

■ **Targeting the audience.** Nonpoint source pollution affects everyone in the community. On the issue of control, business people, developers, and home-

owners each have an individual agenda. Make sure your public awareness program considers these individual needs and interest.

Tailor your messages and presentations to specific groups — for example, college faculty, city employees, developers, civic organizations, or youth groups. Involve environmental groups such as the Izaak Walton League, state associations of conservation districts, and other public or private organizations.

■ **Reaching your audience.** A targeted public awareness campaign uses a variety of tools to convey your message and attain your goals. Some of the tools include

- *Media.* Techniques include press releases, articles, photos with captions, talk shows, news programs, public service announcements, newsletters, and public notices to publicize your message.
- *Community events.* River/lake festivals, county/city fairs, and other special events are educational and public awareness opportunities to make your message known to a variety of audiences.
- *Awards.* Broaden your visibility, recognize good work, and gain a variety of advocates for your program through conservation awards for young people, public service awards, and participation and sponsorship awards.
- *Meetings.* Use public gatherings, club meetings, special conferences, and workshops to explain your program; customize your message to the needs and interests of your audience.
- *Speakers' bureau.* Face-to-face communication to a specialized audience provides a powerful opportunity to deliver your message, answer questions, and clarify ambiguities.
- *Educational materials.* Brochures and posters obtained from EPA, the state water authority, or other groups can be distributed to schools, civic groups, and businesses to further support your message.

■ **Using a variety of information/education tools.** The numerous techniques available to make your community aware of the nonpoint source problem and its solutions are limited only by your imagination and budget. See the following list and Table 4 for ideas to ensure support from your community:

- Publicize your program in all possible ways — use fact sheets inserted into utility statements, flyers, radio, TV, newspapers, public hearings, group meetings; develop personal contacts with reporters — offer story and photo opportunities.
- Tailor your message to various levels of knowledge — from those who understand the concept of nonpoint source pollution to those who have never heard of it.
- Form committees to work on specific aspects of the program; include representatives from all interest groups.
- Offer field trips to groups. Seeing the watershed's problem has much more impact than reading about it.
- Distribute drafts of the plan to interested groups for review.
- Set up meetings using existing organizations such as 4-H or Extension Service and organize community informational watershed workshops.
- Involve schools — make presentations to classes or conduct field trips.
- Set up nonpoint source pollution displays at every opportunity — county fairs, local Earth Day events, conferences, school events.

■ **Citizen monitoring.** Environmentally conscious citizens have made great contributions to local programs nationwide. Groups such as the Chesapeake Bay Watch and the Streamwalk Committee in Seattle, Washington, have become integral parts of the water quality program. Citizen groups can collect valuable information on basic parameters — they can monitor and identify problems, collect surface water samples, and measure turbidity.

Table 4.—Community education and citizen involvement methods.

METHOD	MOST EFFECTIVE USE	RESULTS
Newsletters	Announce meeting time and dates, update information on actions already taken, list issues to be discussed at upcoming meeting	Public awareness
Newspaper articles	Same as newsletter — provide additional detail about local success stories, photos of citizen activities; feature articles provide information about problems and solutions	Public awareness
Demonstration sites	Exhibit innovative technology — should be accompanied by signs, brochures, or permanent on-site interpretive staff	Public awareness, knowledge, understanding
Printed and taped material (e.g., factsheets, videos)	Explain new technology, describe case studies, provide training information for new employees, outline facts to stakeholders	Public awareness, knowledge, understanding
Signs	Mark watershed boundaries, identify critical areas, promote specific behaviors in specific places, identify cooperators in project, explain adjacent project and its BMPs, provide interpretive natural resources information	Public awareness, knowledge, understanding
Meetings	Share information, plan actions, evaluate progress	Public awareness, knowledge, understanding, desire/ability to act
Field trips	Observe resources to be protected, view installed BMPs, learn how BMPs operate, monitor (assessment or compliance type) BMPs	Public awareness, knowledge, understanding, desire/ability to act
On-site inspections	Identify problems, recommend corrective actions, evaluate effectiveness of pollution controls, identify noncompliant stakeholders, educate individuals	Action
Training	Provide new skills to stakeholders	Action
Technical assistance	Identify problems, recommend solutions, assist with installation of BMPs, educate individuals, evaluate effectiveness of solutions	Understanding, desire/ability to act, action

Source: Terrene Institute, Clean Water In Your Watershed: A Citizens Guide to Watershed Protection, 1993.

Local officials see two advantages to citizen monitoring. First, these activities are an economical way to gather high quality data. Second, citizen monitoring is a valuable tool to build grassroots interest in water quality issues. In addition to helping officials identify and avert potential water problems, citizen groups build public support for nonpoint source programs and remedial actions, when necessary.

Despite these benefits, a volunteer program needs careful handling. Everyone is not suited to be a volunteer monitor. Groups and individuals may have difficulty staying motivated throughout an entire sampling project. Inappropriate training or procedures can result in useless data. Sampling also involves a slight risk of injury; local governments must have sufficient liability insurance to cover such situations.

Consider the following recommendations concerning volunteer monitoring programs:

- Citizen monitoring projects should not stand alone but should be integrated into a total water quality management program.
- A qualified water quality specialist should develop the sampling design, analyze the data, and prepare the final report.
- A qualified water quality specialist should train and supervise volunteers in the field, review data frequently, and work closely with the state water quality agency.

TVA RESERVOIR LANDS PLANNING PROGRAM*

The Tennessee Valley Authority manages some 300,000 acres of public reservoir lands, spanning seven states and including 23 multipurpose reservoirs with more than 11,000 miles of shoreline.

When he established TVA in 1933, President Franklin D. Roosevelt charged it with "the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin."

TVA uses the land for activities ranging from generating electrical power to managing recreation, forestry, and wildlife areas. Communities and the public use TVA's reservoir lands for industrial and navigation facilities, agriculture, community parks, and recreation.

Since it receives more than 1,500 requests for land use each year, TVA considers planning a land management priority. To accommodate the growing demand for development on its lands, TVA initiated a planning process to balance competing demands for public and private uses with environmental needs and national, regional, and local values.

TVA uses planning teams to determine how the land should be used. The team considers public comment, compatibility with existing and adjacent land uses, and legal requirements in making its decision. Plans approved by the TVA Board are continually revised to keep up with growth pressures, economic trends, public needs, environmental conditions, and changing laws. A Geographic Information System (GIS) keeps track of an endless amount of resource data on which the team bases and updates its recommendations.

As part of its planning process, TVA developed a three-step public participation plan. First, TVA identified why and how the public should be involved; next, it identified its audience; and finally, it planned how to involve the public. During public meetings, for example, private citizens and local, state, and federal agencies identify regional concerns and local land use issues. This information is incorporated into the GIS data and used to make social, cultural, and environmental planning decisions.

TVA's land planning process provides a continuing opportunity for local governments and citizens to offer their views on how public reservoir lands should be used, with public acceptance an added benefit. This objective assessment of regional needs guides TVA in handling a multitude of land use request.

Constant public involvement and reevaluation give TVA an insight into early problems, avoiding later crisis management. In addition, local governments and interest groups have a clear understanding of TVA's land use and development intentions. Finally, this process provides warnings of potential detrimental impacts to water quality from proposed uses.

**Adapted from TVA Reservoir Lands Planning and Land Management Planning Applications of a Geographic Information System fact sheets.*

- The sample design should be relatively simple and not dependent on precise measurement.
- Volunteers should be carefully recruited and trained; periodic training may be necessary to replace drop-outs and refresh monitoring skills of current volunteers.
- The water quality specialist should encourage frequent reports, personal presentations at group meetings, and media coverage to keep the group motivated.

The Missing Link — Community Partnership

The optimum situation — informed watershed planning to identify and correct existing problems and prevent future problems — will achieve the best environment possible. But all planning, no matter how complete, must be done *with* your community, not *for* it.

The advantages of the prevention/restoration ethic are impressive and would tempt any community — clean, usable waterbodies attract business and recreational dollars and measurably improve the economic health of the community. Remedial measures, designed to address current environmental conditions, can return water resources to an acceptable purity level.

However, billions of dollars are lost on public works projects, declining property values, and missed revenues from tourism, recreation, and other uses because of the missing link — community partnerships. Without community buy-ins by educated citizens who understand their individual responsibility and the community's needs, remediation will need to be repeated in each generation, if not more often.

Planning and prevention within the total community and watershed area comprise a vital permanent solution to water quality issues. In some cases, eliminating the cause of pollution may not be enough — the waterbody will still need rehabilitation. In other cases, communities must restore the quality of a waterbody even as they prevent further harm.

So plan for the optimum, seeking guidance and cooperation from your community along the way. When the community agrees to implement the plan you know will work, you will have served them — and the environment — well.

Appendix A

Federal Water Quality Program Summary

Coastal Zone Management Act of 1972 (CZMA)

This act established a program to encourage states and territories to develop comprehensive programs to protect and manage coastal resources, including the Great Lakes. To receive federal approval and implementation funding, states and territories had to demonstrate programs and enforceable policies sufficiently comprehensive and specific to regulate land and water uses and coastal development and to resolve conflicts between competing uses. They also needed authority to implement the enforceable policies.

Under federally approved state and territorial programs, the program must protect and manage important coastal resources, including wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitats. Resource management and protection are accomplished through state laws, regulations, permits, and local plans and zoning ordinances.

Water quality protection was not specifically cited as a purpose or policy of the original statutes. The Coastal Zone Act Reauthorization Amendments of 1990 specifically charged state coastal programs, and state nonpoint source programs, to address nonpoint source pollution affecting coastal water quality.

Coastal Zone Act Reauthorization Amendments of 1990 (CZARA)

In these amendments, Congress recognized that nonpoint pollution is a key factor in the continuing degradation of many coastal waters and established a new program to address this pollution. Congress further recognized that the solution to nonpoint pollution lies in state and local action. In enacting CZARA, Congress called upon states to develop and implement state coastal nonpoint pollution control programs.

EPA developed the technical guidance to help states develop control programs. The guidance specifies management measures for sources of nonpoint pollution in coastal waters — agriculture, silviculture, urban, marinas, and hydromodification. Management measures are economically achievable measures to control the addition of pollutants to coastal waters; that is, they reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives.

National Pollutant Discharge Elimination System (NPDES)

Traditional point sources of water pollution are regulated by EPA and the individual states under the NPDES permit program established by section 402 of the Clean Water Act, which establishes permit requirements for certain municipal and industrial stormwater discharges.

Under Phase I, NPDES permits are required for municipal separate storm sewers serving large or medium-sized populations (greater than 250,000 or 100,000 people, respectively) and for stormwater discharges associated with industrial activity. Permits are also issued, case by case, if EPA or a state determines that a stormwater discharge contributes to a violation of a water quality standard or significantly contributes pollutants to U. S. waters.

Under Phase II, EPA is to prepare two reports to Congress that (1) assess the remaining stormwater discharges, (2) determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges, and (3) establish procedures and methods to control stormwater discharges to the extent necessary to mitigate impacts on water quality. Then EPA is to designate stormwater discharges in addition to those addressed in Phase I that must be regulated to protect water quality and establish a comprehensive program to regulate those designated sources.

Section 319 of the Clean Water Act

This statute establishes a national program to control nonpoint sources of water pollution and to protect groundwater. Under section 319, states address nonpoint pollution by assessing the problems and causes within the state, adopting management programs to control the pollution, and implementing the management programs.

States are required to submit an assessment of state waters not expected to meet water quality standards because of nonpoint source pollution and a management program for controlling nonpoint source pollution. Section 319 authorizes EPA to issue grants to states to assist them in implementing management programs or portions of management programs that have been approved by EPA.

National Estuary Program

Administered by EPA under section 320 of the Clean Water Act, this program focuses on point and nonpoint pollution in geographically targeted, high-priority estuarine waters. In this program, EPA assists state, regional, and local governments in developing comprehensive conservation and management plans that recommend priority corrective actions to restore estuarine water quality, fish populations, and other designated uses of the waters.

Section 320 authorizes EPA, on its own or at the request of a state, to convene a management conference to address water pollution problems in estuaries. This conference must identify the causes of environmental problems within the estuarine zone and develop a comprehensive conservation and management plan for the estuary that recommends corrective actions and compliance schedules for controlling point and nonpoint sources of pollution.

Pesticides Program

Administered by EPA, this program controls some forms of nonpoint pollution under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). It authorizes EPA to control pesticides that may threaten groundwater and surface water. FIFRA provides for the registration of pesticides and enforceable label requirements, which may include maximum rates of application, restrictions on use practices, and classification of pesticides as "restricted use" pesticides, which would limit their use to certified applicators trained to handle toxic chemicals.

Source: Adapted from U.S. Environmental Protection Agency, Guidance Specifying Management Measures from Sources of Nonpoint Pollution in Coastal Waters, 1993.

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Appendix C

Contacts

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ARKANSAS

SOIL AND WATER CONSERVATION COMMISSION
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Little Rock, AR 72201
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DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY
Permits Section
8001 National Drive
P.O. Box 8913
Little Rock, AR 72219-8913
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CALIFORNIA

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Sacramento, CA 95812-0100
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COLORADO

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DELAWARE

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
P.O. Box 1401
Dover, DE 19903
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DIVISION OF WATER RESOURCES/POLLUTION CONTROL BRANCH
89 Kings Highway
Dover, DE 19903
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DISTRICT OF COLUMBIA

DEPARTMENT OF CONSUMER & REGULATORY AFFAIRS
5010 Overlook Ave., SW
Washington, DC 20032
Tel: (202) 404-1120

* WATER RESOURCE MANAGEMENT DIVISION
2100 Martin Luther King, Jr. Avenue, SE
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FLORIDA

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WATER QUALITY MANAGEMENT PROGRAM
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DEPARTMENT OF HEALTH
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ENVIRONMENTAL PROTECTION AGENCY
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IOWA

DEPARTMENT OF NATURAL RESOURCES
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ENVIRONMENTAL PROTECTION DIVISION
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** Indicates states that do not have delegated NPDES programs.*

KANSAS

DEPARTMENT OF HEALTH AND ENVIRONMENT
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Topeka, KS 66620
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INDUSTRIAL PERMITS
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KENTUCKY

DIVISION OF WATER — NONPOINT SOURCE
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Baltimore, MD 21224
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PROGRAM REVIEW DIVISION
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DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Lansing, MI 48909
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STORMWATER PERMITS UNIT
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MINNESOTA

POLLUTION CONTROL AGENCY
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DEPARTMENT OF ENVIRONMENTAL QUALITY
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** Indicates states that do not have delegated NPDES programs.*

NEBRASKA

DEPARTMENT OF ENVIRONMENTAL CONTROL
P.O. Box 98922
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NEVADA

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Capitol Complex
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DEPARTMENT OF ENVIRONMENTAL SERVICES
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BUREAU OF WATER QUALITY PLANNING
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WASTEWATER PLANNING AND STORMWATER PERMITTING
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NEW MEXICO

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DEPARTMENT OF HEALTH AND NATURAL RESOURCES
Division of Environmental Management
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Raleigh, NC 27626-0535
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1800 Watermark Drive
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STORMWATER UNIT
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OKLAHOMA

CONSERVATION COMMISSION
Water Quality Division
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Oklahoma City, OK 73117-1212
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** Indicates states that do not have delegated NPDES programs.*

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DEPARTMENT OF ENVIRONMENTAL RESOURCES
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Point Source Control Division
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** Indicates states that do not have delegated NPDES programs.*

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WASHINGTON

STATE DEPARTMENT OF ECOLOGY
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U.S. EPA REGION 9 *AS, AZ, CA, GU, HI, MP, NV, TT*
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Office of Ocean Resources Conservation and Assessment
Pollution Sources Characterization Branch
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Office of Wastewater Enforcement and Compliance
Permits Division
Water Quality and Industrial Permits Branch
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Office of Wetlands, Oceans and Watersheds
Assessment and Watershed Protection Division
Nonpoint Source Control Branch
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Office of Wetlands, Oceans and Watersheds
Assessment and Watershed Protection Division
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U.S. DEPARTMENT OF AGRICULTURE
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Appendix D

Watershed Restoration and Pollution Control Programs

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Environmental Protection Agency (EPA)	Administers educational and regulatory programs designed to protect the environment (prevent and control pollution). Provides environmental assessments, water quality monitoring, regulations and regulatory oversight, education, planning, technical assistance, grants, and loans for pollution control. Works mainly with state, federal, regional, and local agencies on pollution control efforts.	Staff, information and data, laboratories and research facilities, grants and loans for pollution control, educational materials, monitoring equipment. Offices located in 10 regional centers and Washington, DC.
EPA Water Quality	Overall water quality planning and management: • Nonpoint Source Control program oversees and approves state development of water quality assessments and implementation of management programs designed to control nonpoint source pollution; directs funds to high priority watersheds or projects. • Clean Lakes program provides funds to restore or enhance publicly owned lakes. • Water Quality Standards Program provides technical assistance in developing numeric, narrative, and biological limits (standards) to protect water quality and its use. • Coastal programs oversee a number of different programs and initiatives designed to assess coastal resources and study ways to protect coastal waters. Includes the National Estuary program; administers new CZARA.	Staff for technical assistance to state and local agencies; review and approval of state programs, research, and special studies. Provides grants to states for most water quality protection activities, educational materials, and programs; funds for special studies or projects.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Environmental Protection Agency (continued)		
EPA Permits	NPDES permits for industries, cities, and confined animal feeding operations; provides enforcement for noncompliance.	Staff for technical assistance with modeling and permit drafting, site inspections, and compliance monitoring; funds for special studies or projects.
EPA Pesticides	Regulates pesticide labeling and registration, including application rates, allowable crops and pests, environmental and human health cautions, disposal procedures; licenses restricted-use pesticide applicators.	Staff to review research results, assist with strategic planning, education and training, oversee enforcement procedures of states; funds for special projects and studies.
EPA Groundwater	Administers the Sole Source Aquifer Protection Program; provides technical and programmatic assistance to state wellhead protection programs.	Staff for technical assistance; funds for special studies.
EPA Wetlands	Cooperatively administers wetlands dredge and fill permits with the Corps of Engineers; enforces actions for illegal wetlands filling; technical support for wetlands delineations; research and education about wetland values and function.	Staff to oversee and enforce activities, monitoring wetland status, health, and trends; funds for special studies, educational materials, and programs; data.
EPA Monitoring and Surveillance	Provides environmental assessment, data analysis, oversight of state monitoring programs, special studies and agency research, EPA lab and Office of Research and Development coordination.	Staff for technical assistance to states and citizens on monitoring programs and projects; special studies and data analysis upon request; water quality monitoring at select locations.
EPA Drinking Water	Regulates public drinking water supplies and suppliers; special studies on human health and risk; develops drinking water criteria and maximum contaminant levels (MCLs). Administers special program for watershed treatment to decrease pollution loads to drinking water supplies if installation of BMPs is cheaper than the water treatment method needed.	Staff for technical assistance to set drinking water standards. Special studies, oversight, and compliance monitoring of public water supplies and suppliers.
EPA National Environmental Policy Act (NEPA)	Reviews and comments on other federal agencies' environmental impact statements (EISs); prepares EISs for EPA-sponsored projects.	Staff for technical assistance to prepare NEPA documents and review pollution control techniques required as part of federal action.
EPA Office of Research and Development (ORD)	Conducts basic and applied research to support EPA's mission, including biological and physical studies on fate and transport of environmental contaminants; studies ecosystems at large.	Provides reports, data, maps, monitoring equipment, study, and demonstration sites; staff for technical assistance in interpreting research results. Laboratories and research stations located throughout the country.
U.S. Department of Agriculture (USDA)	Stabilizes and supports efficient production, marketing, and distribution of food and fiber. In addition to commodity and public welfare programs, administers a number of conservation programs to assist private and federal land owners or managers in natural resource conservation and multiple-use management. Works mainly with private individuals on improving resource management.	Staff, technical assistance, information and data, educational materials, cost-share funds, engineering equipment. Field offices located in nearly every county, state, and Washington, DC.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of Agriculture (continued)		
USDA — Multiple agency administration of the 1985 and 1990 Farm Bill programs:		
Conservation Reserve Program	Conserves and protects highly erodible or other environmentally sensitive land from production with permanent vegetative cover through 10-year easements and annual rental payments.	In most cases, responsibilities within programs are divided between various USDA departments: **SCS** — Technical assistance in planning, designing, and implementing BMPs. **ASCS** — Administrative oversight of program and cost-share funding disbursement. **CES** — Education and information about the variety of conservation and economic choices available. **CSRS** — Research, data, and the results of demonstration field trials of new technologies.
Wetlands Reserve Program	Available only in pilot states to return drained wetlands to wetland status and protect existing wetlands. Uses same easement/payment method as CRP.	
Sustainable Agricultural Research and Education Program	A practical research and education and grant program to promote lower input methods of farming.	
Conservation Cross Compliance (Sodbuster and Swampbuster)	A quasi-regulatory program that denies subsidy payments to farmers who plow highly erodible land or drain wetlands.	
Water Quality Incentives Program	A watershed treatment program designed to improve or protect soil and water resources in watersheds impacted or threatened by NPS pollution.	
USDA Soil Conservation Service (SCS)	Technical assistance on planning, site-specific design, and installation and management of soil and range conservation, animal waste, and water quality management systems; special land and water resource assessments and inventories. Cost-share funds to install BMPs on private lands available from some programs.	Staff and equipment in field offices for technical assistance including engineering designs, survey work, and planning for water resource protection.
USDA SCS — Small Watershed Program (PL-566)	Evaluates and treats small agricultural watersheds with multiple resources to protect. Targets resources for both technical and financial assistance and educational programs.	Staff for technical assistance to landowners and decisionmakers in the watershed; funds for demonstration projects.
USDA SCS — Great Plains Conservation Program (GPCP)	Intensive conservation treatment for individual farms located within the Great Plains ecoregion through long-term agreements (3 to 10-year contracts) with farmers.	Technical assistance and cost-share funds up to 75 percent of the average cost of selected high priority conservation practices.
USDA SCS — Resource Conservation & Development Program (RC&D)	Helps local governments in authorized areas plan and use natural resources and solve local problems.	Planning assistance for small communities for resource protection; financial assistance up to 25 percent of a project — not to exceed $50,000.
USDA SCS — River Basin Program	Assists state and local governments identify water and related land resource problems, evaluate alternative solutions, and develop their implementation program.	Staff for technical assistance to decisionmakers for inventory and planning activities.
USDA SCS — Natural Resource Assessment Programs: Soil Survey, Natural Resources Inventory	Various programs to map and assess the condition of natural resources (soil, water, vegetation, and wildlife) and conservation treatments.	Maps, reports, data information, statistical analysis.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of Agriculture (continued)		
USDA Agricultural Stabilization and Conservation Service (ASCS)	Provides administrative oversight and cost-sharing programs for approved conservation practices from ASCS and other USDA administered programs; tracks crop production and other statistics; distributes crop subsidy and deficiency payments.	Financial assistance (i.e., cost sharing); map and conservation practice information.
USDA ASCS — Agricultural Conservation Program (ACP)	Annual cost-sharing for a number of soil conserving, production improving, and water quality practices.	Funding for cost-share programs generally limited to $3,500 per farm per year.
USDA ASCS — Emergency Conservation Program (ECP)	Annual cost-sharing to replace conservation treatments (mainly structural) destroyed in areas designated as natural disaster areas.	Cost-share funds for high priority conservation practices.
USDA ASCS — Water Bank Program	Designed to improve and restore wetland areas through financial compensation for 10-year easements on private property.	Funding for easement compensation on eligible lands in participating states.
USDA ASCS — Colorado River Salinity Control Program (CRSCP)	Financial assistance on farm projects that seek to control salinity levels delivered to the basin, primarily irrigation water management.	Funds, reports, data on level of conservation treatment and demonstration sites; cost-sharing, monitoring, and education.
USDA ASCS — Forestry Incentives Program (FIP)	Cost-share to revegetate and improve timber stands on private lands.	Cost-share funds.
USDA Cooperative Extension Service (CES)	Educational programs and information to aid individuals in selecting, operating, and maintaining the most beneficial conservation treatments. Economic analysis and data for each farm or ranch; technical assistance in integrated pest management and landscape issues. Programs generally carried out in cooperation with state land-grant universities.	Staff to offer educational programs and technical assistance and personalized economic analysis; coordinates small-scale demonstrations on local farms; educational materials.
USDA Cooperative State Research Service (CSRS)	Applied research, usually at state experiment stations, on agricultural production and soil and water conservation, generally using demonstration plots. Conducts the Sustainable Agriculture Research and Education (SARE) program. Many projects in cooperation with state land grant universities.	Provides reports, data, equipment; occasionally has funds for joint or special projects outside the normal research agenda; grants for Agriculture in Concert with the Environment (ACE) program.
USDA Forest Service (FS) — National Forest System (NFS)	Manages national forests and grasslands for sustained production and multiple use. Works with individuals, industries, and other agencies.	Staff, maps, reports, equipment for construction and monitoring, educational materials; occasionally funds for special projects. Field offices located in each national forest; regional offices located in 9 areas and Washington, DC.
USDA NFS — Permit Program	Oversees timber sales and harvest contracts, grazing leases, and minerals developed on FS property; provides technical assistance to permittee in proper resource use.	Staff for technical assistance and compliance monitoring.
USDA NFS Air and Watershed Programs	Overall environmental planning and technical support for forest management decisions; special studies and watershed demonstration projects in certain areas.	Funds for special studies and watershed demonstration projects; natural resource inventories and reports, water quality or habitat monitoring; environmental analysis of resource trends and conditions.
USDA NFS — Research	Basic and applied research on range and forest lands.	Technical papers on effects of management on water quality.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of Agriculture (continued)		
USDA NFS — State and Private Forestry —Forest Stewardship Initiative	Technical assistance and cost share to inholding or privately owned lands adjacent to national forest lands for installing BMPs.	Funds for and technical assistance to individuals.
USDA Farmers Home Administration (FmHA)	Loans and loan guarantees to eligible producers for operating expenses, land purchase, and conservation measures.	Funds and loans for property improvement and conservation, treatment installation, and water conservation practices. Located in counties, states, and national offices.
USDA Agricultural Research Service (ARS)	Basic and applied research on agricultural production and conservation measures, including fertilizers, pesticides, and BMP effectiveness.	Reports on BMP effectiveness and environmental fate and transport data; demonstration sites; occasionally provides funds for joint sponsored projects. Research stations, located throughout each state, specialize in particular types of investigations.
U.S. Department of Commerce — National Oceanic and Atmospheric Administration (NOAA)	Administers programs in cooperation with states to inventory and manage coastal resources; funds and performs basic research and assessments relating to coastal eutrophication; maintains database for agricultural pesticides and nutrient loadings.	Funds to state coastal programs; staff for technical assistance; data, reports, and educational materials; occasionally administers funds for special demonstration projects.
NOAA — Coastal Zone Management Act Programs (CZMA)	Administers a quasi-regulatory coastal protection program, in cooperation with EPA, that sets performance-based management measures for control and prevention of nonpoint source pollution in coastal areas for all land use activities.	Staff for technical assistance; funds for plan development.
U.S. Department of Defense (DOD) Army Corps of Engineers (COE)	Oversees construction and operation of large flood control and public water supply reservoirs; conducts water quality monitoring on lakes within its jurisdiction; regulates in-lake activities and shoreline development. Cooperatively administers wetlands dredge and fill permit program with EPA and Fish and Wildlife Services; can enforce permit requirements for wetland BMPs or other mitigation measures.	Maps, special studies, water quality monitoring data; staff and funds for improvement of existing projects; staff to review and oversee 404 (wetlands) permits. Field offices located in various districts throughout states and Washington, DC.
U.S. Department of the Interior (DOI)	Oversees, manages, or monitors national natural resources, including land, water, and wildlife.	Staff, maps, reports, demonstration sites, educational materials, monitoring equipment. Offices located in regional centers, management areas, and Washington, DC.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
U.S. Department of the Interior (continued)		
DOI Fish and Wildlife Service	Oversees and regulates the nation's wildlife resources; manages national wildlife reserves; enforces federal game and fish laws; cooperatively administers national wetlands program with the Corps of Engineers and EPA. Cooperative projects to enhance wildlife habitat; special studies, especially fisheries investigations.	Staff to enforce Endangered Species Act and other laws on public and private land; research reports and data on habitat, populations, and management of wildlife. Funds for cooperative projects. Educational materials, teacher training, curricula, and maps.
DOI Bureau of Land Management (BLM)	Administers and manages federal lands; oversees grazing leases, mineral exploration, and extraction bids and leases on BLM lands; technical assistance to permittees on BLM land in proper resource use; oversees recreational users of BLM land.	Staff for environmental analysis and trend evaluation on BLM land, technical assistance, and oversight. Funds for special studies and cost-share for permittees for certain conservation practices (generally grazing/range management); funds for range improvement, riparian area management, and recreational area development projects. Maps.
DOI Bureau of Indian Affairs (BIA)	Technical assistance to tribes on tribal lands mainly for social services; some assistance for conservation work and educational programs; natural resource inventories and monitoring surface and groundwater.	Maps; natural resource inventories of Indian and tribal lands; funds for special projects; staff for technical assistance to tribes.
DOI Bureau of Reclamation	Administers, constructs, and oversees water supply facilities in western states; regulates discharges from these facilities; jointly administers the Colorado River Salinity Control Program with many agencies to set consistent salinity standards and manage public and private lands within the basin; new initiative to reclaim lands damaged by federal irrigation projects.	Staff to oversee projects and manage federal property and facilities; assesses water quality around reservoirs as part of the national irrigation water quality program; maps, reports, and some data.
DOI National Park Service	Administers and manages national parks for preservation of natural resources.	Staff to oversee and administer; funds for special studies and occasional cooperative projects on land adjoining park boundaries.
DOI Office of Surface Mines (OSM)	Regulates the removal and reclamation of surface mined minerals, mostly coal on private lands.	Staff to oversee and provide technical assistance in mining operations, reclamation efforts, and engineering studies; vegetative site inspections and monitoring resources; educational materials, data, and reports.
DOI U.S. Geological Survey (USGS)	Long-term baseline monitoring of water resources (quantity, flow, and quality), hydrologic and geologic investigations and data, special intensive short-term studies.	Maps, data, and information on hydrology and water quality status and trends; staff for technical assistance in designing a monitoring plan.
State Water Quality Agencies	Administer many programs (similar to EPA) to protect water quality in surface and groundwaters, including the NPDES permit program, water quality standards regulations, the nonpoint source program, and ambient statewide monitoring programs.	Staff for technical assistance to local governments and individuals implementing BMPs; water quality monitoring, data, and reports; funds for pollution control projects, educational materials, and programs.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
State Agencies (continued)		
State Natural Resource Agencies	Administer programs for wetlands and coastal protection.	Staff for technical assistance to local governments; monitor natural resource trends, reports, and data; educational materials and programs.
State Departments of Agriculture	Regulate pesticide registration and use and administer marketing and rural development programs; sometimes issue permits for fertilizer or feedlots.	Staff to oversee pesticide applicators and other regulatory functions.
State Forestry Commissions or Departments	Oversee activities on state forest lands; administer forest practice laws or BMP regulations.	Staff for site inspections, technical assistance, and education for private landowners and state forests; information on forest resources.
State Cooperative Extension Services	Natural resource, family health, and agricultural production education and training programs for citizens.	Staff, reports, educational materials, technical assistance. Field offices located in each county or state office connected with land-grant universities.
State Parks and Tourism Departments or Bureaus	Administer programs to promote tourism and the use of state parks for recreation.	Maps, signs, educational materials; occasional small grants for historic preservation or local development.
State Natural Heritage Commissions or Boards	Administer programs to educate people and preserve historic and cultural resources.	Maps, signs, educational materials.
State Highway or Transportation Departments	Oversee design, construction, and maintenance of state and federal highways; provide assistance to local governments on road-related issues; responsible for erosion and pollution control along highway right-of-ways and during construction and maintenance activities.	Maps, signs, educational materials, maintenance equipment, and flower and grass seeds; technical assistance for local governments; sometimes provide funds for special studies or beautification projects.
State Public Lands Commissions or Boards	Oversee administration of state lands; generate revenues for state treasury.	Natural resource information and maps.
State Natural and Scenic Rivers Commissions	Oversee use and protection of state designated scenic rivers, may levy taxes and take enforcement actions to protect the river.	Staff for river protection and (sometimes) assessments; occasionally provide funds for special protection or improvement projects.
State Livestock and Poultry Boards or Commissions	Regulate health, welfare, and safety of livestock, poultry production, and products.	Staff for site inspections, technical assistance, and enforcement actions; sometimes special studies and reports.
State Water Well Boards	Regulate the drilling of new wells and the sealing of old ones	Staff for site inspections, technical assistance, and enforcement; educational materials and training for drillers.
State Oil, Gas, and Minerals Departments or Commissions	Oversee the leasing, production, and administration of state and privately owned natural resources; responsible for spills and environmental programs related to petroleum.	Staff for oversight and inspection including site-specific environmental audits and spill prevention and clean-up.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
State Agencies (continued)		
State Plant Boards	Administer programs that evaluate mainly agricultural plants and conservation plantings.	Staff for technical assistance; special studies and reports.
State Health Departments	Administer septic tank and public drinking water regulatory programs; monitor water supplies; provide technical assistance to local governments.	Staff for technical assistance to local governments, monitoring, and educational programs; data, reports, and educational materials.
State Soil and Water Conservation Commissions	Administer cooperative programs with the USDA/SCS to conserve soil and water resources on private lands; provide technical assistance to individuals.	Staff for technical assistance to individuals; engineering or construction equipment, services, and supplies that support BMP implementation. Some states have cost-share funds for BMPs.
State Fish and Game Agencies	Regulate the harvest of fish and wildlife resources by individuals and commercial operations; responsible for state cost recovery of lost fish and wildlife affected by environmental contamination.	Staff for enforcement of state fish and game laws and for technical assistance in wildlife and fisheries management for private individuals; educational materials; natural resource inventory data.
State Water Rights Agencies	Allocate water rights (mostly in western states); regulate consumptive use of water resources.	Staff for permit writing and oversight; data and reports on water flow.
Local Planning and Zoning Boards, City Planning Commissions, County Planning Boards	Specify land use zoning and boundary determinations; general community planning; oversee program operation.	Maps, long-range plans, inventory of local resources, special reports, budget information; staff for technical assistance.
Local County Judges, Commissioners Court, or Parish Police Jury	Manage, construct, and maintain county roads and bridges; oversee and approve county budgets for all county programs. Taxing authority.	Information on county conditions; equipment for construction and maintenance; budget reports; occasional funds for special projects.
Local SWCDs	Local field office of state agency.	See State Soil and Water Conservation Commission.
Local Erosion and Sediment Control Districts	Oversee activities that could cause erosion and sedimentation.	Staff for on-site inspections, technical assistance, and sometimes enforcement actions.
Local Irrigation or Acequia Districts	Regulate local water use and maintain public or jointly owned irrigation projects; responsible for controlling pollution and erosion from projects.	Maintenance workers.
Local Flood Control, Water Management, or Subsidence Districts	Regulate water and land use and management to prevent subsidence or flooding.	Staff for on-site assessments and inspections; maps, reports, land use data; zoning information.
Local School Boards and School Administrations	Oversee public education within jurisdictional boundaries; can set local curricula requirements and priorities. Taxing and bond issuing authority.	Information on status of current educational programs; assistance in developing new initiatives.
Local Municipal Utilities Districts	Oversee construction and maintenance of public works projects for water, sewer, and occasionally energy. Taxing and bond issuing authority.	Information and special reports on water issues; funds for special projects to enhance system operation and reduce costs.

AGENCY AND PROGRAM	PROGRAM DESCRIPTIONS AND AGENCY RESPONSIBILITIES	RESOURCES AVAILABLE AND POSSIBLE ROLES
Regional River Authorities	Manage and coordinate activities within their basin for flood control, water quality protection, energy development. Taxing authority.	Data, reports, maps, water quality monitoring; staff for technical assistance to local government and other agencies or groups. Funds for special projects.
Regional Planning Commissions and Councils of Government	Assist in coordinating activities of all governments within the area; provide technical assistance and information; promote special projects of benefit to all.	Staff for technical assistance to local governments; occasional water quality monitoring, reports, and data about local conditions; funds for special projects.
Others — Commodity Groups	Various groups usually formed to improve marketing and lobbying capabilities for specific crops or livestock interests. Nearly every major crop has at least one such group.	Staff for data gathering and analysis, public education campaigns, technical support to growers, legislative and market analysis; funds from members for special projects.
Environmental Organizations	Various groups formed to protect, conserve, or preserve the environment in general or to address a specific issue; lobby for environmental laws and programs as well as funding. Many perform volunteer services such as water quality monitoring, natural resource rehabilitation work, cost-share, or provide other funds for special projects.	Staff and volunteers assist with local projects; educational materials and programs; reports and data on environmental conditions and trends; occasional funding for cooperative work.
Social and Service Clubs	Formed for reasons other than resource protection, most have local projects that enhance or beautify community. Provide labor, supplies, and equipment on mutually beneficial projects as well as insight into the community.	Volunteers for special projects.

Source: Adapted from Terrene Institute, Clean Water In Your Watershed: A Citizens Guide to Watershed Protection, 1993.