

## CHAPTER 14: ADDRESSING COASTAL WATER POLLUTION

*Coastal waters are subject to cumulative impacts from a variety of pollutants—from near and far, and from point, nonpoint, and airborne sources. For this reason, any solution must be founded on an ecosystem-based and watershed management approach involving a broad range of agencies, programs, and individuals. Solutions will also require a substantial financial investment and will take time. Over the last few decades, great strides have been made in controlling water pollution from point sources, although further improvements could be realized through increased funding, strengthened enforcement, and promotion of innovative approaches such as market-based incentives. However, substantial enhancement of coastal water quality will require significant reductions in nonpoint source pollution—a technical and political challenge. Establishing measurable pollution reduction goals for coastal areas is needed, as is coordination of the many related agencies and programs to effectively target the various laws, programs, funds, training, technical assistance, incentives, disincentives, and other management tools to address nonpoint source pollution of coastal waters.*

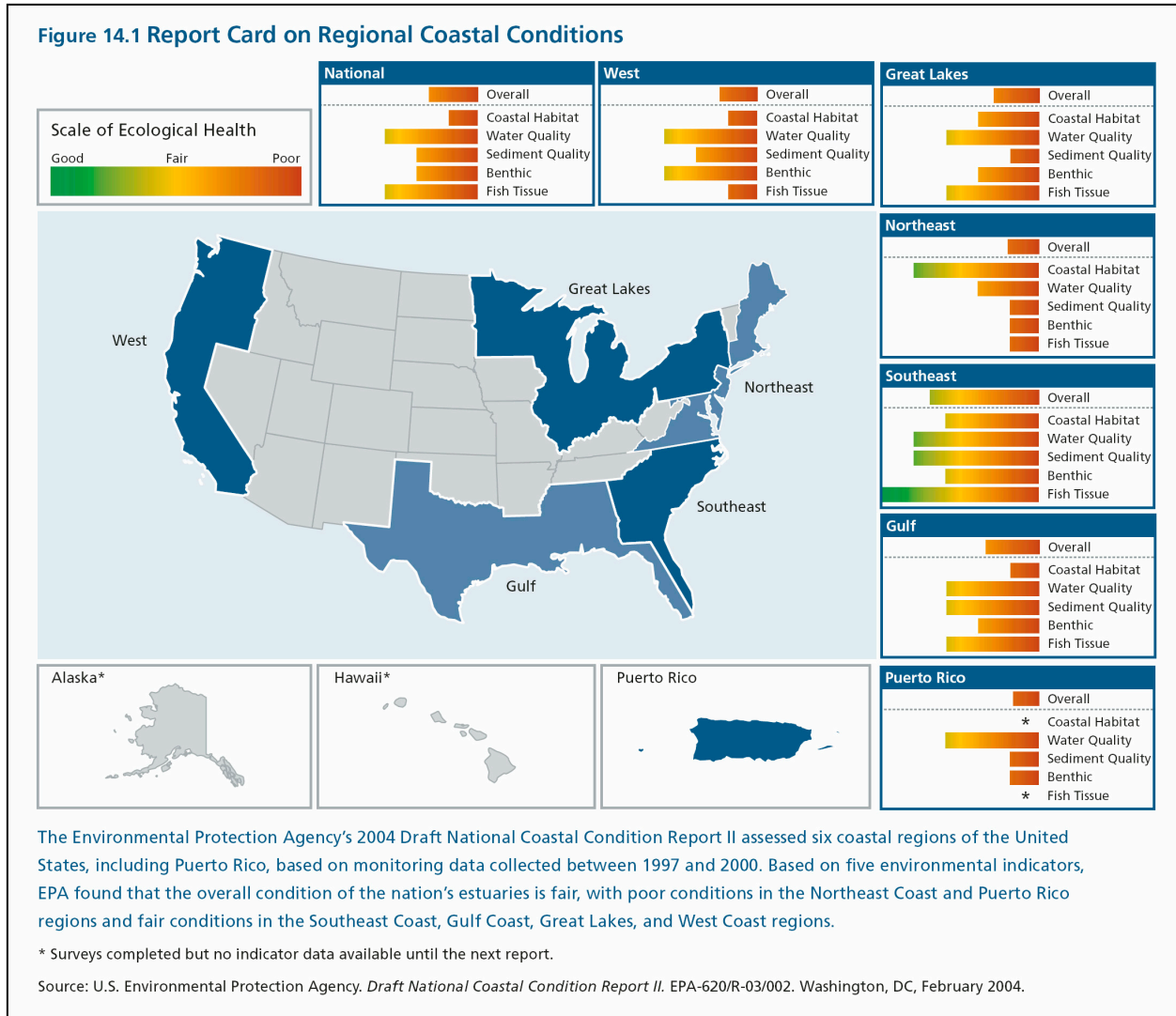
### STOPPING THE DEGRADATION OF COASTAL WATERS

Coastal waters are one of the nation's greatest assets, yet they are being bombarded with pollution from all directions. The heavy concentration of activity in coastal areas, combined with pollutants flowing from streams far inland and others carried through the air great distances from their source, are the primary causes of nutrient enrichment, hypoxia, harmful algal blooms, toxic contamination, sedimentation, and other problems that plague coastal waters. Not only do degraded waters cause significant ecological damage, they also lead to economic impacts due to beach closures, curtailed recreational activities, and additional health care costs. Reducing water pollution will result in cleaner coastal waters, healthy habitats that support aquatic life, and a suite of economic benefits.

The U.S. Environmental Protection Agency's (EPA's) 2002 *National Water Quality Inventory* found that just over half of the estuarine areas assessed were polluted to the extent that their use was compromised, either for aquatic life, drinking water, swimming, boating, or fish consumption. EPA's 2004 *Draft National Coastal Condition Report II* rated coastal waters along most of the continental United States as being in fair condition, with poor conditions in the Northeast and Puerto Rico regions (Figure 14.1).

The protection of coastal waters will require managers to address a range of human activities that generate pollution in many locations and a variety of pollutants following different pathways. Management that is ecosystem-based and that considers entire watersheds will help guide this daunting task.

Figure 14.1 Report Card on Regional Coastal Conditions



The complex array of laws, agencies, and programs that address water pollution, and the number of parties involved, will require greatly enhanced coordination among federal agencies, primarily EPA, the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Agriculture (USDA), and U.S. Army Corps of Engineers (USACE). Greater coordination is also needed between the federal government and managers at the state, territorial, tribal, and local levels, watershed groups, nongovernmental organizations, private stakeholders, and the academic and research communities. The case of nutrient pollution, detailed in the following box, illustrates many of the challenges involved in improving coastal water quality.

### Box 14.1 Nutrient Pollution in Coastal Waters

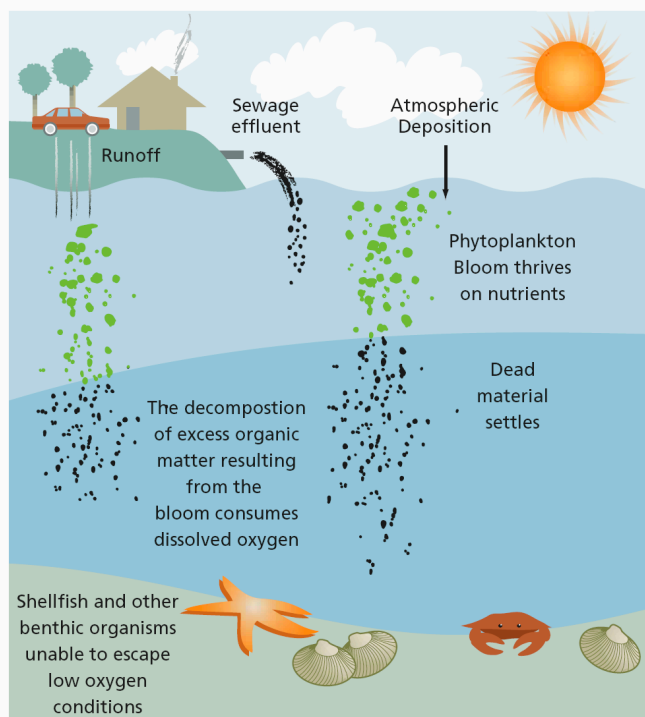
A 2000 National Research Council report called nutrient pollution the most pervasive and troubling pollution problem currently facing U.S. coastal waters.<sup>1</sup> Although nutrients such as nitrogen and phosphorus are necessary to marine ecosystems in small quantities, human activities on the coasts and inland areas have greatly increased the flow of nutrients, in some cases to harmful levels (Figure 14.2).

Nutrient pollution defies simple categorization and is difficult to control because it can come from point, nonpoint, and atmospheric sources, from near and far. The main sources include runoff from agricultural land, animal feeding operations, and urban areas, discharges from wastewater treatment plants, and atmospheric deposition of chemicals released during fossil fuel combustion. Human activities have approximately doubled the amount of reactive nitrogen cycling through the biosphere compared to pre-industrial conditions, with most of this increase occurring during the last thirty years.<sup>2</sup> The largest human additions of nitrogen result from an increased use of inorganic fertilizers.<sup>3</sup>

Nutrient pollution leads to a host of ecological and economic impacts including: fish kills due to oxygen depletion; loss of important and sensitive coastal habitats, such as seagrasses; excessive and sometimes toxic algal blooms; changes in marine biodiversity; increases in incidents of human illness; and reductions in tourism. The greatest impacts occur in estuaries and nearby coastal regions. Nutrient pollution has been particularly severe along the lower Atlantic Coast and in the Gulf of Mexico. The infamous “dead zone” in the Gulf of Mexico is an area of seasonal oxygen depletion caused by nutrients draining from the Mississippi River Basin.

Smaller dead zones are becoming increasingly frequent in other areas, including Lake Erie. The severity and extent of nutrient pollution are expected to worsen in more than half of the nation’s estuaries and coastal waters by 2020.<sup>4</sup> Without concerted, coordinated, and sustained action to reduce nitrogen sources, nutrient pollution will be a continuing problem in the nation’s coastal waters. Addressing such pollution will require prompt establishment by the U.S. Environmental Protection Agency (EPA) and the states of standards for nutrient loads, including both nitrogen and phosphorus.

**Figure 14.2 Land-based Nutrients Can Cause Death on the Seafloor**



When ocean water becomes enriched in dissolved nutrients, from such sources as agricultural runoff and sewage outflows, these nutrients can stimulate the growth of phytoplankton. As the phytoplankton die and sink to the bottom, their decomposition consumes the dissolved oxygen in the water and sediments that other benthic organisms need to survive.

Source: U.S. Environmental Protection Agency. *National Coastal Condition Report*. EPA620-R-01-005. Washington, DC, August 2001.

## REDUCING POINT SOURCES OF POLLUTION

With strong public support, government and private sector actions over the past three decades have made great strides in controlling water pollution from identifiable point sources, such as industrial facilities and wastewater treatment plants, whose discharges can be monitored as they emerge from the end of a pipe. Even so, opportunities remain to further reduce point source impacts on U.S. coastal waters and improve compliance with existing environmental requirements.

### Existing Management Tools

Point source pollution is primarily addressed through a few EPA programs, including the National Pollutant Discharge Elimination System (NPDES), the Total Maximum Daily Load (TMDL) Program, and the Clean Water State Revolving Fund.

#### *The National Pollutant Discharge Elimination System*

Over the past thirty years, the Clean Water Act, including its NPDES program, has led to dramatic reductions of polluted effluents. EPA typically delegates administration of this program to the states, and the state or EPA then regulates polluters by issuing permits that reflect federal standards for discharges. If the regulatory agency determines that a particular water body is not meeting water quality standards, permittees discharging to those waters may be required to implement more stringent controls.

#### *The Total Maximum Daily Load Program*

The TMDL program, which is carried out by states, territories, and authorized tribes with oversight and technical assistance from EPA, establishes the maximum amount of a pollutant, from point and nonpoint sources, that can be present in a water body while still meeting water quality standards. States must list waters that continue to exceed water quality standards even after application of required levels of pollution control technology, and then establish TMDLs for these listed water bodies. States are directed to develop a TMDL for each pollutant of concern and then implement plans to achieve and maintain those TMDLs by allocating reductions among all sources. EPA must review and approve state lists and TMDLs. To include a margin of safety, states are required to take seasonal variations into account.

#### *Clean Water State Revolving Funds*

Under the Clean Water Act, the federal government has provided significant financial support for water quality infrastructure improvement. From 1970 to 1995, funding was provided under the Federal Construction Grants Program to build wastewater treatment plants and collection systems, without any requirement for repayment. In 1987, in a major shift in policy, Congress established and began to target federal funding toward the State Revolving Funds, in which the federal government provides capitalization grants for a more self-sustaining, state-administered revolving loan fund (Figure 14.3). States are required to provide 20 percent in matching funds. States decide which projects are the highest priorities for funding, the borrowers repay the loans, and the program loans the money again to other borrowers. States provide below-market interest rates and other financial incentives to towns, counties, nonprofit organizations, farmers, and homeowners for water quality improvement projects. The funds finance capital construction costs—not operations and maintenance—and are mostly used to build or improve wastewater treatment plants and related sewer systems.

This program is widely considered a cost-effective, long-term mechanism for meeting infrastructure demands. From 1998 to 2002, the funds provided an average of \$3.8 billion per year for water quality improvement. Since the program's inception, a total of \$43.5 billion has been provided.<sup>5</sup> State Revolving Funds are crucial to restoring, maintaining, and improving the nation's water quality.

## Major Point Sources

The major point sources of pollution to the nation's waterways include wastewater treatment plants, sewer system overflows, septic systems, industrial facilities, and animal feeding operations.

Stormwater, which is formally classified as a point source, is grouped with nonpoint sources in this chapter. Stormwater differs considerably from most industrial or urban point sources and, like other nonpoint sources, is driven primarily by precipitation. Nevertheless, sewage and stormwater will need to be addressed together in making wastewater management decisions.

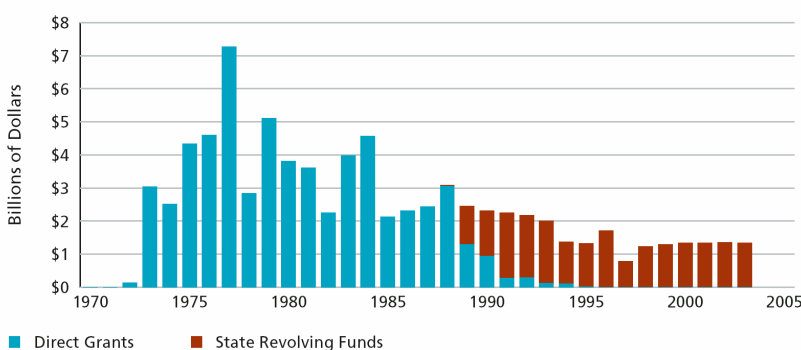
### *Wastewater Treatment Plants*

Municipal wastewater comes primarily from individual households and from manufacturing and commercial activities. Wastewater entering a treatment plant may contain organic pollutants, metals, nutrients, sediment, bacteria, viruses, and toxic substances. Wastewater treatment plants have substantially met their original goal of removing most pathogens, organic materials, and suspended solids; however, nutrients and many chemicals are not effectively removed through primary and secondary treatment processes. The effluent from treatment plants can be discharged directly into rivers, estuaries, coastal waters, or the ocean. Even discharges into waters far upstream can have serious impacts on the coast.

Nutrient pollution has had a major impact on coastal waters, contributing to toxic algal blooms, loss of seagrass habitat and coral reefs, and oxygen depletion. Unfortunately, primary and secondary wastewater treatment have not been effective in adequately removing nitrogen and phosphorus. In many heavily developed areas, wastewater treatment is unlikely to achieve nutrient-related standards and additional controls will be needed to meet water quality goals. Decisions to require additional controls on wastewater treatment plants will need to be linked to the TMDL analysis described above, with appropriate allocation of nutrient reductions among all point and nonpoint sources that contribute to nutrient loads in the water body.

Advanced—or tertiary—treatment technologies, which can remove most nitrogen and phosphorus from wastewater treatment plant discharges, cost approximately 25 percent more than secondary treatment.<sup>6</sup> These advanced technologies are being implemented in regions where wastewater discharges are significant sources of nutrient pollution, such as Tampa Bay and Chesapeake Bay. One recent success in developing and applying advanced treatment was at a Stamford, Connecticut wastewater treatment plant where a novel biological nutrient process removed much of the nitrogen at very little cost.<sup>7</sup>

Figure 14.3 Changes in Funding for Water Pollution Controls



In the last thirty years, there has been a fundamental shift in the way the federal government funds the infrastructure for water pollution control in local communities. From 1970 to 1995, Congress, through EPA, provided \$61.1 billion in direct grants to help build or upgrade wastewater treatment facilities. However, since 1988, the federal government has increasingly provided financial support for these types of projects by making capitalization grants to the State Revolving Funds, which provide low interest loans that are paid back into the fund to finance future projects. As of fiscal year 2004, the federal capitalization grants total about \$22.4 billion, with state matching funds totaling about \$4.5 billion.

Source: U.S. Environmental Protection Agency, *Progress in Water Quality: An Evaluation of the National Investment in Municipal Wastewater Treatment*. EPA-832-R-00-008. Washington, DC, June 2000.



Ultimately, water conservation by users is the least expensive and most direct method of minimizing wastewater. In some locations, water quality impacts may also be avoided by re-using treated wastewater for beneficial purposes, such as maintaining landscaping or watering golf courses.

Primary and secondary wastewater treatment have been largely ineffective in removing many of the trace chemicals present in industrial and residential wastewater. These chemicals—including pharmaceuticals, antibiotics, hormones, insecticides, fire retardants, and detergents—are then discharged to surface waters. Although many of these substances may break down in the environment over time, continuous loading may maintain concentrations above levels at which biological effects occur. Designed to produce biological effects in humans, such compounds may also have unforeseen impacts on aquatic life. For example, the effluent from wastewater treatment plants has been shown to disrupt endocrine functions in some aquatic organisms.<sup>8</sup>

The U.S. Geological Survey’s Toxic Substances Hydrology Program has recently completed the first comprehensive study on the distribution of these compounds in surface waters of the United States. Significant concentrations of many commonly used chemicals, including prescription and over-the-counter pharmaceuticals, have been detected in some coastal and ocean waters.<sup>9</sup> The national monitoring network called for in Chapter 15 should track the presence of newly-detected wastewater contaminants such as residues from pharmaceuticals and antibiotics.

**Recommendation 14–1. The U.S. Environmental Protection Agency (EPA), working with states, should require advanced nutrient removal for wastewater treatment plant discharges that contribute to degradation of nutrient-impaired waters, as needed to attain water quality standards. EPA should also determine the extent of the impact of chemicals in wastewater from residential and industrial sources, including pharmaceuticals.**

*In particular, EPA should:*

- *support research and demonstration projects for biological nutrient removal and other innovative advanced treatment processes to eliminate nitrogen and phosphorus from wastewater discharges.*
- *ensure that information about innovative advanced treatment processes and technologies is widely disseminated.*
- *support development of technologies to reduce concentrations of pharmaceuticals, personal care product ingredients, and other biologically active contaminants in wastewater treatment plant discharges.*

### ***Sewer System Overflows***

Combined sewer systems were designed to collect domestic sewage, industrial wastewater, and rainwater runoff or snowmelt in the same pipes. While these systems provided human health benefits at the time they were constructed, they have a major drawback: when total water volumes exceed the system’s capacity, the overflow enters receiving waters without treatment. Sanitary sewer systems, which are designed to transport only domestic sewage and industrial wastewater, can also under some circumstances overflow, discharging untreated wastewater.

EPA estimates that at least 40,000 sewers overflow every year, discharging wastewater directly into rivers, estuaries, and oceans. In addition to causing human health problems and closures of beaches and shellfishing areas, human sewage may be a contributing factor in the decline of coral reefs.<sup>10</sup> Major new construction will be required to control sewer system overflows.

### ***Septic Systems***

About 25 percent of the U.S. population is served by residential septic systems and about 33 percent of new homes use these systems.<sup>11</sup> If not properly managed, septic systems can become a significant source of coastal pollution, particularly pathogens and nutrients. Septic systems can contaminate aquifers and coastal waters either by direct overflow from improperly operating systems or by migration of pollutants through groundwater to surface waters. The threat can be severe in places like Florida and Hawaii, especially if the ground is highly permeable and the water table close to the surface. Government policies and subtle socioeconomic factors may be encouraging new development that relies on septic systems rather than centralized wastewater treatment, even in locations where population density would support centralization. To protect coastal waters, it is important to ensure that existing and new septic systems are properly designed, located, constructed, maintained, and inspected.

**Recommendation 14–2.** The U.S. Environmental Protection Agency (EPA), working with states, should increase technical and financial assistance to help communities improve the permitting, design, installation, operation, and maintenance of septic systems and other on-site treatment facilities. State and local governments, with assistance from EPA, should adopt and enforce more effective building codes and zoning ordinances for septic systems and should improve public education about the benefits of regular maintenance.

### ***Industrial Facilities***

While some industrial plants are connected to wastewater treatment plants, others discharge directly into receiving waters. Discharges to wastewater treatment plants must comply with certain pretreatment requirements established by the facility operator. Direct discharges must have a NPDES permit which establishes limits on pollutants in the effluent. Initially, permits are based on the use of best available technology. However, in cases where the use of best available technology is insufficient to meet water quality standards, further action may be required.

Although the NPDES program and pretreatment requirements have made significant progress in abating industrial sources of pollution, these sources remain a significant cause of environmental degradation in some areas. Industrial discharges can contain nutrients, mercury, lead, sulfur, oils, corrosives, and other toxic chemicals. Another group of contaminants entering coastal waters from industrial sources is polychlorinated biphenyls (PCBs), used mainly for insulating heavy electrical equipment. Although these compounds are no longer manufactured and new uses are severely restricted, improper disposal and continued use of older PCB-containing products persist. In many cases, discharges from factories and power plants are also warmer than surrounding waters, resulting in thermal pollution that can disrupt local ecosystems. Industrial facilities also contribute to atmospheric deposition, discussed later in this chapter.

### ***Animal Feeding Operations***

Many animal feeding operations (for example, for beef cattle, hogs, or poultry) are located in coastal areas or in upstream areas that flow into coastal waters; these businesses have become major contributors to coastal water pollution. Along the East Coast, many feeding operations are concentrated in the coastal plain, which is home to an economically important and ecologically sensitive network of wetlands, rivers, estuaries, and coastline.

In the United States, there are approximately 238,000 confined animal feeding operations, which produce an estimated 500 million tons of manure every year—more than 3 times the amount of sewage produced by humans.<sup>12</sup> The animal manure generates discharges of solids and liquid effluent to groundwater and surface waters. Ammonia and other gases also volatilize from manure in storage facilities or on fields, resulting in

atmospheric transport and deposition of pollutants. Pollutants originating at animal feeding operations include nutrients, ammonia, pathogens, hydrogen sulfide, methane, hormones, pesticides, and antibiotics.

Although some discharges from animal feeding operations resemble dispersed nonpoint sources of pollution, the larger concentrated animal feeding operations (CAFOs) are defined and regulated as point sources under the NPDES program of the Clean Water Act. EPA issued new effluent guidelines and permitting regulations for CAFOs in December 2002. Under these new regulations, all CAFOs (about 18,500 nationwide) will be required to obtain NPDES permits from EPA or a state by 2006. These regulations are expected to greatly reduce the amount of nutrients and sediment entering coastal waters.<sup>13,14</sup> States that have appropriate legal authority may impose requirements in addition to those in the EPA CAFO regulations, such as regulating operations that are not large enough to be regulated under the EPA regulations, requiring increased monitoring and reporting, and requiring animal processors to be co-permittees along with their contractors who raise the animals.

**Recommendation 14–3.** The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Agriculture (USDA) should support research on the removal of nutrients from animal wastes that may pollute water bodies and on the impact of pharmaceuticals and other contaminants on water quality. EPA and USDA should also develop improved best management practices that retain nutrients and pathogens from animal waste on agricultural lands. Where necessary to meet water quality standards, states should issue regulatory controls on concentrated animal feeding operations in addition to those required by EPA.

### Improving the Control of Point Sources

To control point source pollution effectively, the nation will need to maintain a long-term commitment to investments in infrastructure, improve the enforcement of water pollution standards, and promote market-based incentives and other innovative approaches.

#### *The Need for Long-term Infrastructure Investments*

The gap between existing and needed funding for wastewater and drinking water improvements is large, and serious adverse human health and environmental effects are likely if the challenges presented by an aging public infrastructure are not addressed. Capital spending for public wastewater treatment infrastructure is currently about \$13 billion per year, and annual operations and maintenance costs are around \$17 billion. EPA estimates that, over the next twenty years, the total additional investment needed for wastewater treatment infrastructure could exceed \$270 billion, and for drinking water infrastructure could reach almost \$265 billion. Sewer system overflows will be particularly costly to correct.<sup>15</sup> These costs for infrastructure improvements are in addition to the \$700 to \$1 billion per year required to close the widening national funding gap between the resources states have and the funding they need to fully implement water quality programs under the Clean Water Act.<sup>16</sup>

Given expected shortfalls in funding for wastewater-related construction, dramatic increases will be needed in the State Revolving Funds. Improving coastal water quality will require long-term financial investments by federal, state, and local governments, as well as by ratepayers.

**Recommendation 14–4.** The U.S. Environmental Protection Agency (EPA), working with state and local governments and other stakeholders, should develop and periodically review a comprehensive long-term plan to maintain and upgrade the nation’s aging and inadequate wastewater and drinking water infrastructure, anticipating demands for increased capacity to serve growing populations, correction of sewer overflows, and more stringent treatment in the coming decades. To implement



this plan, Congress should significantly increase the Clean Water and Drinking Water State Revolving Funds.

### *Promoting Market-based Incentives*

One powerful incentive-based approach to reducing water pollution in many watersheds is EPA's water pollutant trading policy. Under this policy, a source can be reduced beyond required levels, creating a credit that can then be sold to another source discharging the same pollutant to the same body of water. EPA has had a water pollutant trading policy in place since the 1990s, primarily for use among wastewater treatment plants.

EPA's trading policy takes a very cautious approach to considering trades of any toxic pollutant. Also, EPA does not support any trading that would result in locally high concentrations of pollutants exceeding water quality standards. For example, any trading of credits for total nitrogen will need to be designed to avoid excessive concentrations of ammonia in any location.

**Recommendation 14–5. The U.S. Environmental Protection Agency, working with states, should experiment with tradable credits for nutrients and sediment as a water pollution management tool and evaluate the ongoing effectiveness of such programs in reducing water pollution.**

### *Improving Enforcement*

Many major point source facilities are exceeding water pollution permit limits. A significant number of serious offenders are exceeding pollution limits for toxic substances and many violators have been subject to only light penalties or no enforcement at all. In view of this, there is a strong need for improved oversight of states' permitting and enforcement programs and for more funds and personnel at the state level to properly implement and enforce the NPDES program.

**Recommendation 14–6. The U.S. Environmental Protection Agency, working with states, should modernize the National Pollutant Discharge Elimination System's monitoring and information management system and strengthen the program's enforcement to achieve greater compliance with permits.**

## **INCREASING THE FOCUS ON NONPOINT SOURCES OF POLLUTION**

While considerable progress has been made in reducing point sources of pollution, further progress toward improved coastal water quality will require significant reductions in nonpoint source pollution. This pollution arises when rainfall and snowmelt carry contaminants over land, into streams and groundwater, and down to coastal waters. Nonpoint source pollutants include: fertilizers and pesticides from rural farms and urban lawns; bacteria and viruses from livestock and pet waste; sediments from improperly managed construction sites and timber harvesting; oil and chemicals flowing over streets, parking lots, and industrial facilities; and a variety of pollutants being blown along airborne pathways. Ninety percent of impaired water bodies do not meet water quality standards at least in part because of nonpoint source pollution (Figure 14.4).

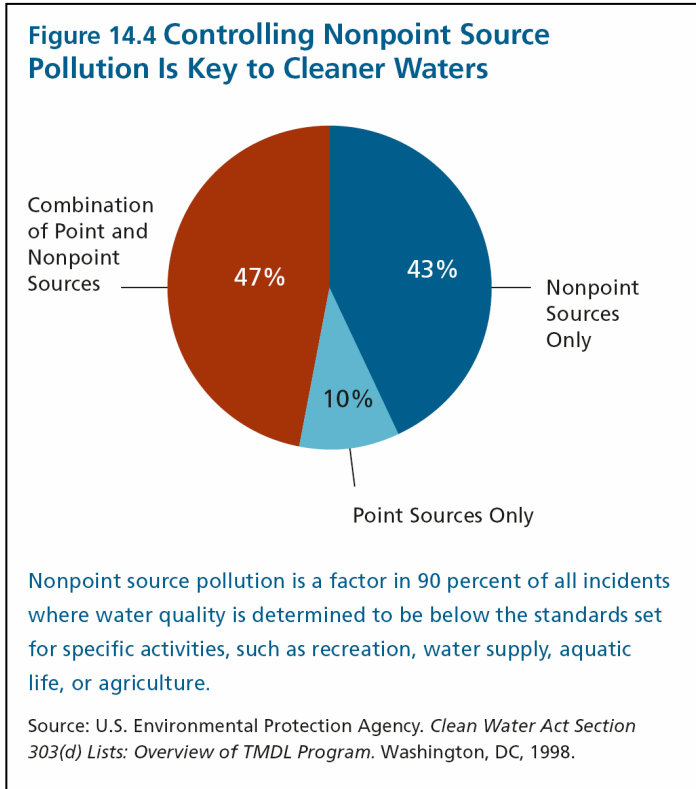
### **Existing Management Tools**

Decreasing polluted runoff from agricultural, urban, and construction sites will be a significant challenge. Numerous federal agency programs address nonpoint sources of pollution, and some of the most important programs are discussed briefly here. (Appendix D includes additional program information.)

### ***The Total Maximum Daily Load Program***

As discussed earlier in this chapter, the TMDL program establishes the maximum amount of a pollutant that can be present in a water body while still meeting the water quality standards. Because control of point sources has already received so much attention, the TMDL program is shifting its focus to controlling nonpoint sources. As a first step, the program requires states to identify water bodies that are not meeting water quality standards even after all point sources have installed their required pollution control technologies.

Although the TMDL program has been criticized as lacking effective compliance mechanisms for nonpoint source pollution, the program does provide valuable quantitative information on pollution amounts and impacts within a watershed. This information can be used to generate greater public awareness and support for water quality initiatives and to identify the most effective use of funds, such as those available through agricultural conservation programs, to address nonpoint sources within a particular watershed. While TMDLs specify limits for individual pollutants, EPA has been working with states and watershed managers to consider the impacts of multiple pollutants in a larger watershed management context, consistent with comprehensive ecosystem-based management initiatives.



### ***Beaches Environmental Assessment and Coastal Health Act***

Research two decades ago demonstrated a high correlation between swimming-related illnesses, such as gastroenteritis, and the presence of bacteria in the water. Congress enacted the Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act) to address this problem. The BEACH Act amended the Clean Water Act to require states to set appropriate water quality standards for coastal recreational waters and authorized EPA to award grants to eligible states, territories, tribes, and local governments in support of programs to test and monitor such waters. EPA awarded approximately \$10 million annually to eligible entities starting in 2002. However, compliance has not been uniform and not all affected states and territories have adopted the criteria for pathogens required by the BEACH Act. Full implementation of the statute will result in cleaner waters and better public awareness about coastal water quality.

### ***National Nonpoint Source Pollution Program***

Under the National Nonpoint Source Pollution Program, established under Section 319 of the Clean Water Act, EPA provides matching grants to states to develop and implement statewide programs for managing

nonpoint sources. Grants may be used for a wide range of activities, including technical and financial assistance, education and training, monitoring, watershed planning, technology transfer, demonstration projects, and state and local regulatory programs. States must prepare an assessment of waters where the control of nonpoint source pollution is necessary to meet water quality standards, identify the significant sources, and specify control measures. States must also develop a program that sets forth the best management practices necessary to remedy the problems.

### ***Coastal Zone Management Act***

One of the hallmarks of the Coastal Zone Management Act (CZMA) is that it requires each participating coastal state to incorporate the requirements of the Clean Water Act into the state's coastal management program. This provision has proved to be very useful in coordinating these separate federal programs at the state level.

In addition, the 1990 amendments to the CZMA created a program specifically to address nonpoint sources of coastal pollution. Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) requires all states with a federally-approved coastal management program to develop a plan that includes enforceable management measures to control nonpoint sources affecting coastal waters. Administration of this program is assigned to both EPA and NOAA to combine their experiences with the Clean Water Act and Coastal Zone Management Act programs. The nonpoint source pollution control program created by Section 6217 relies on implementation of best management practices, compiled by EPA. Of the states eligible to participate in the coastal management program, approximately half have received final approval of their coastal nonpoint programs and half have received conditional approval.

### ***U.S. Department of Agriculture Conservation Programs***

Agricultural conservation programs have been growing in importance, scope, and funding. In 2002, Congress dramatically increased funding for these programs, dwarfing the resources of the EPA and NOAA nonpoint programs. The agricultural conservation programs generally involve cash payments to farmers to implement conservation and best management practices on productive farm and ranch lands, retirement of land through permanent or long-term easements, and conservation and restoration of wetlands and grasslands. These programs present an opportunity to decrease nonpoint source pollution and improve aquatic habitats and natural resources—the challenge will be to ensure that the programs are targeted to maximize their benefits.

The Environmental Quality Incentives Program—the largest agricultural conservation program—will receive approximately \$5.6 billion in funding through fiscal year 2007. This program offers financial and technical assistance to help eligible participants install or implement structural and management practices on eligible agricultural land. Farmers engaged in livestock or agricultural production on eligible land may participate in this program.

Another important USDA program is the Conservation Security Program, which will provide financial and technical assistance to implement stewardship measures. This program is anticipated to have its first signup in the summer of 2004 in eighteen high risk watersheds. It has the potential to improve water quality by encouraging conservation on land in active production and rewarding farmers who have been good stewards.

### **Major Nonpoint Sources**

The majority of the diffuse pollution entering rivers, estuaries, coastal waters, and ultimately the oceans is from agricultural and stormwater runoff. Stormwater discharges were mentioned in connection with municipal wastewater pollution because they are technically classified as point sources. However, they behave

quite differently from industrial or urban wastewater discharges, and like other nonpoint sources, are driven primarily by precipitation. Thus, they are discussed again here in conjunction with other nonpoint sources.

### ***Agricultural Sources***

There are more than 368 million acres of crop land in the United States.<sup>17</sup> Agricultural activities can be a significant source of nonpoint pollution in rivers, lakes, and estuaries and a major contributor to groundwater contamination and wetlands degradation. Soil disturbance, irrigation, and application of herbicides, pesticides, fertilizers, and animal wastes to crop fields can lead to excess sediment, nutrients, pathogens, and salts in coastal waters.

Excessive sedimentation decreases water clarity, smothers fish spawning areas and coral reefs, and carries pollutants into water bodies. (A more complete discussion of sediment management is provided in Chapter 12.) But arguably the most significant impact from agricultural activities is the transport of nutrients, primarily nitrogen and phosphorous, into coastal waters.

USDA is a very important participant in the nonpoint source management process because of the funding it can provide to address agricultural sources. The state conservationist in each state, an employee of USDA's Natural Resources Conservation Service, is a key player in allocating these funds. State- and county-level committees make recommendations to the state conservationist about best management practices to be rewarded and the appropriate level of cost sharing. There are concerns that funds may still go to farmers and ranchers who follow harmful practices, and that many deserving recipients do not receive adequate financial or technical assistance. The USDA Farm Service Agency, the USDA Cooperative State Research, Education, and Extension Service's Land Grant University System partnership, and farmers themselves also need to be more actively involved in broader watershed and coastal ecosystem-based management efforts so their actions can be coordinated with the many others that affect coastal water quality.

**Recommendation 14–7. The U.S. Department of Agriculture (USDA) should align its conservation programs and funding with other programs aimed at reducing nonpoint source pollution, such as those of the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration.**

*In particular, USDA's Natural Resources Conservation Service should:*

- *require that its state conservationists coordinate with representatives of federal and state water quality agencies and state coastal management agencies, and participate in watershed and coastal management planning processes, to ensure that funding for agricultural conservation programs complements and advances other federal and state management programs.*
- *provide enhanced technical assistance in the field to better support growing agricultural conservation programs.*

### ***Urban and Suburban Stormwater Runoff***

Stormwater runoff poses another serious threat to U.S. coastal waters. Housing developments, shopping centers, and roads have been built in areas once covered by natural vegetation and wetlands. These developments have increased impervious surfaces, decreased the land available to absorb rain and snow, accelerated runoff into streams, and altered the hydrology of coastal watersheds. Many areas have lost billions of gallons of drinking water due to reductions in groundwater recharge.<sup>18</sup>

### Box 14.2 The Impact of Farm Nutrients on the Marine Environment

Every year, an area in the Gulf of Mexico, covering up to 12,000 square miles at its largest extent, becomes a dead zone.<sup>19</sup> Nitrogen fertilizers from farms far inland wash into streams and other water bodies and ultimately flow into the Gulf. These nutrients cause excess algal growth, depleting oxygen in the Gulf's bottom waters to levels too low to support fish, crustaceans, and many other forms of marine life.

Between about 1960 and 1985, the use of nitrogen fertilizers within the Mississippi River Basin watershed increased exponentially. The main contributors to the Gulf's dead zone are located along the Mississippi and Ohio rivers, in southern Minnesota, Iowa, Illinois, Indiana, and Ohio (Figure 14.5). These states have the greatest acreage of artificially drained soil, the highest percentage of total land in agriculture (largely row crops of corn and soybeans), and the highest use of nitrogen fertilizers in the nation. The region has abundant precipitation in most years, but the soils have poor internal drainage. Because corn and soybeans require well-drained warm soil for optimum early season growth, many farmers have installed subsurface tile (now, usually perforated plastic pipe) drain systems to remove water from the soil. The tile drains short-circuit the natural drainage pattern and effectively flush nitrates out of the soil and into streams and rivers.<sup>20</sup> On average, streams draining from Iowa and Illinois contribute about 35 percent of the nitrogen discharged from the Mississippi River to the Gulf of Mexico.<sup>21</sup> Before humans converted the region to row crop agriculture, much of the nitrate would have been denitrified in wetlands and ponds or taken up by prairie grasses.

Figure 14.5 Thirty States Contribute to the "Dead Zone" in the Gulf of Mexico



The Mississippi River Basin is the largest in North America, draining an area of 1.24 million square miles, or about 41 percent of the continental United States. Polluted waters from the basin flow into the Gulf of Mexico, affecting coastal areas. Increased nutrients have resulted in a low-oxygen zone (known as the "dead zone") off the Louisiana coast.

Source: Committee on Environment and Natural Resources. *Integrated Assessment of Hypoxia in the Northern Gulf of Mexico*. Washington, DC: National Science and Technology Council, 2000.

Stormwater picks up a variety of substances on its way to coastal waters, including oil, chemicals, heavy metals, pesticides, trash, and pet waste. These pollutants alter the water chemistry and can harm ecosystems. As water runs across impervious surfaces, its temperature becomes elevated, accelerating the growth of algae and harming fish and other aquatic life that have specific water temperature tolerance limits. Larger volumes of water rushing into streams also erode streambanks, streambeds, and the surrounding land, transporting excess sediment that can damage coastal habitat, harm aquatic life, and reduce light penetration into the water column.

It is estimated that aquatic ecosystem health becomes seriously impaired when more than 10 percent of the watershed is covered by impervious surfaces.<sup>22</sup> Impervious surfaces cover 25–60 percent of the area in medium-density residential areas, and can exceed 90 percent at strip malls or other commercial sites.<sup>23</sup> An inch of rain on a 1-acre natural meadow would typically produce 218 cubic feet of runoff. The same



rainstorm over a 1-acre paved parking lot would produce 3,450 cubic feet of runoff, 16 times more than the natural meadow.<sup>24</sup>



As natural vegetation and wetlands are paved over to create parking lots, sidewalks, and housing developments, stormwater runoff is greatly increased. Unlike natural terrain, water flows quickly off these impervious surfaces into rivers, estuaries, and coastal waters, bringing with it higher concentrations of environmental contaminants.

Stormwater-related problems impose measurable economic costs. Drinking water sources can become polluted and excess sediment can increase dredging costs for navigational purposes. Poor stormwater management may increase flooding, causing property damage from flash floods and leading to higher insurance rates. Stormwater is also a source of bacterial contamination, leading to increased disease incidence, thousands of beach closures in the United States each year, and loss of revenues from coastal tourism and sport fishing.<sup>25</sup> Millions of dollars are spent on treating the symptoms of stormwater pollution but much less is spent on efforts to control its causes.

### **Improving the Control of Nonpoint Sources**

The nation has a number of opportunities to reduce the impacts of nonpoint sources of pollution on coastal waters. These include coordination of federal nonpoint programs so they are mutually supportive, more targeted and aggressive use of the state revolving funds, broader implementation of incentives and disincentives, and improved monitoring to assess compliance and overall progress. (Improved monitoring is described in Chapter 15.) State and local governments also have important roles to play in land use planning and stormwater management decisions.

In addition to these mechanisms to address nonpoint source pollution, regulatory controls such as the TMDL program have made progress in meeting state water quality standards. State water quality agencies have a major role in establishing water quality standards and in developing TMDLs where necessary to address impaired water bodies and allocate necessary reductions among point and nonpoint sources. EPA reports that there are 28,739 impaired water bodies in the United States. Within those bodies, there are 53,049 distinct impairments (e.g., pathogens, metals, nutrients) for which 10,313 TMDLs have been developed and approved.<sup>26</sup> States have made significant progress in developing TMDLs during the last several years although much work remains to be done.

### ***Aligning Federal Nonpoint Programs and Goals***

The management of nonpoint source pollution in coastal areas includes a mix of planning requirements, state actions, direct funding incentives, and grant programs to encourage standard setting and implementation. Some programs are directed by EPA; one is jointly directed by NOAA and EPA; USDA and USACE both

have programs with substantial impacts; and state and local governments play major roles. Currently, there is no mechanism to ensure that the diverse programs are effective, are being adequately coordinated, and are working toward common goals. Addressing nonpoint source pollution will require mechanisms at both the national and regional levels to develop goals and coordinate efforts in both coastal and inland watersheds to meet those goals. These goals should build on water quality standards developed by states under the Clean Water Act.

**Recommendation 14–8. The National Ocean Council (NOC), working with states, should establish reduction of nonpoint source pollution in coastal watersheds as a national goal, with a particular focus on impaired watersheds. The NOC should then set specific, measurable objectives to meet human health- and ecosystem-based water quality standards. The NOC should ensure that all federal nonpoint source pollution programs are coordinated to attain those objectives.**

Coordination among agencies, however, will not be enough. Some combination of incentives and enforcement techniques will be needed to ensure progress. States must have enforceable policies, similar to those called for in the CZARA Section 6217 nonpoint source pollution control program. However, states also need funding and incentives to reward those that adopt proactive nonpoint source control programs, such as are provided under the Clean Water Act Section 319 program. Both programs have positive attributes that, if strengthened and perhaps combined, could more effectively address nonpoint source pollution.

For example, under Section 319 of the Clean Water Act, states that make satisfactory progress toward fulfilling their plans to implement nonpoint source controls are eligible for federal grants—an effective incentive. However, Section 319 does not direct states to actually require or enforce best management practices or any other mandatory controls in their management plans.

In the CZARA Section 6217 nonpoint source pollution control program, the emphasis to date has been on developing approvable, enforceable state programs, with less focus on implementation. If a state fails to submit an adequate CZARA plan to EPA and NOAA, or fails to implement an approved plan, the only recourse for EPA and NOAA is to withhold Clean Water Act and CZMA grant funds, including the very funds that could help address nonpoint pollution problems. To avoid this counterproductive result—and encourage states to continue to participate in the CZMA program, of which CZARA is one part—EPA and NOAA have postponed deadlines for submission of an approvable CZARA plan. Another significant limitation to the CZARA program has been inadequate federal assistance to states in preparing and implementing their plans.

**Recommendation 14–9. The National Ocean Council should strengthen efforts to address nonpoint source pollution by evaluating the nonpoint source pollution control programs established under Section 6217 of the Coastal Zone Act Reauthorization Amendments and under Section 319 of the Clean Water Act and making recommendations to Congress for improvements to these programs, including their possible consolidation.**

*Improvements to the programs should:*

- *require enforceable best management practices and other management measures throughout the United States, with increased federal support for states to develop and implement those practices and measures.*
- *eliminate counterproductive financial disincentives.*
- *enhance cooperation and coordination between federal and state water quality and coastal management agencies.*

### ***Expanding Uses of State Revolving Funds***

Currently, the State Revolving Funds are primarily used for addressing municipal point source pollution, but they can also be tapped to address nonpoint sources by funding watershed-based activities, including control

of agricultural and urban runoff. However, because of the already large gap between existing wastewater infrastructure needs and available funds, State Revolving Funds would need to be substantially supplemented (as called for in Recommendation 14-4) to meet additional nonpoint source demands.

### ***Creating Incentives to Reduce Agricultural Runoff***

Because of the many individuals involved, and their geographic and socioeconomic diversity, an incentive-based strategy may be a good approach for reducing pollution from agricultural sources. A number of agricultural conservation programs (some of which are described above) provide incentives to farmers and ranchers to set aside areas of land, purchase better equipment, and employ best management practices.

Several additional forms of incentives could encourage farmers and ranchers to follow practices that would reduce nonpoint source pollution. Some examples include the following:

- Congress and USDA could develop incentives to reward farmers and ranchers by providing special services or technology for good performers.
- Congress could enact tax incentives for farmers and ranchers who implement best management practices that reduce nutrient and soil runoff, as specified by EPA, USDA or others.
- Congress and USDA could establish insurance programs for agricultural producers who apply fertilizer at or below the agronomic rates recommended by the local Land Grant University to compensate the producers if crop yields decrease as a result.
- Federal farm aid could be tied to implementation of best management practices to reduce nonpoint source pollution.

Efforts to reduce nonpoint source pollution through incentives are already underway. For example, the Sand County Foundation launched a pilot program to test market-based incentives for reducing nitrogen discharges from agricultural lands in targeted watersheds in the Upper Midwest and to gauge farmers' receptiveness to such incentives.

Other kinds of market-based programs would allow farmers to create nutrient credits by changing cropping practices or implementing best management practices, as specified by EPA, USDA, or others. These credits could then be sold to a wastewater treatment plant or other nutrient source discharging to the same water body to offset some of its own nutrient outflow and help meet water quality limits.

### ***Authorizing Federal Agencies to Impose Disincentives***

While the use of incentives has many benefits, there are times when the federal government has an obligation to take action if a state is failing to protect water quality. Existing nonpoint source programs do not include the necessary federal authority to do so. In the end, if a state continues to fail in controlling nonpoint source pollution, the federal government should be able to step in to protect the public resource. In addition to invoking regulatory authority, the federal government may also have to apply appropriate financial disincentives. Reasonable disincentives might include withholding federal funds for programs that contribute to degradation of water quality, such as federal highway construction, agricultural subsidy programs, or USACE development projects in watersheds that are already impaired. Funding for federal programs that promote water quality should be maintained to encourage continued progress, including the CZARA Section 6217 and EPA Section 319 programs.

Federal regulatory action and financial disincentives to protect water quality should only be invoked if a state chronically fails to make meaningful progress toward controlling nonpoint sources, similar to the precedent established for similar situations under the Clean Air Act. In other words, the federal government should only

assume the lead to address nonpoint source pollution when all else fails. It is important for federal regulatory authority and financial disincentives to be phased in over time and be predictable and clearly communicated. Additionally, the standards for triggering federal financial disincentives or regulatory involvement need to be designed with care and consider mitigating circumstances, such as whether the failure to attain water quality standards in a state is due to water quality problems that originate in upstream states.

**Recommendation 14–10. To ensure protection of coastal resources nationwide, Congress should provide authority under the Clean Water Act and other applicable laws for federal agencies to establish enforceable management measures for nonpoint sources of pollution and impose financial disincentives related to programs that result in water quality degradation if a state persistently fails to make meaningful progress toward meeting water quality standards on its own.**

### *Monitoring to Assess Compliance*

After best management practices are employed and incentive programs are underway, ongoing monitoring will be essential to determine whether these efforts have been effective. (A detailed discussion of monitoring is provided in Chapter 15.)

### *Thinking about Land Use*

Land use decisions dramatically affect the health of coastal waters. When the siting and design of new development considers such impacts and balances them with socioeconomic factors, measurable improvements can be made. In addition to its positive impacts on water quality, low-impact development can bring economic advantages. For example, developers are often able to realize additional profits and quicker sales on units that are adjacent to a landscaped stormwater control structure such as a constructed wetland.

Unfortunately, local zoning ordinances and building codes can also pose significant barriers to low-impact development. For example, ordinances that control the design of curbs, gutters, and streets can significantly affect stormwater runoff—for better or for worse. Not only do some local zoning ordinances and building codes erect barriers to low-impact development, but some states and local governments do not even have codes and ordinances to require land use planning and decision making.

Greater public awareness of the connection between land use and water quality will help move decision makers in the right direction. One program that provides education on the effects of planning, zoning, and land use on water quality is Project NEMO—Nonpoint Education for Municipal Officials. Project NEMO is a University of Connecticut program supported by many different partners including EPA, NOAA, USDA, the National Aeronautics and Space Administration, and the U.S. Fish and Wildlife Service, as well as a myriad of state and local governments and organizations. The national NEMO network, adapted from the Connecticut original, now numbers 34 projects in 32 states. While this program has had successes, it reaches only a small fraction of the tens of thousands of relevant decision makers across the nation.

Another program that provides education and training to coastal managers and decision makers is the National Estuarine Research Reserve System (NERRS) Coastal Training Program, a partnership between NERRS, Sea Grant, NOAA Coastal Management, and many other federal, state, and local organizations. This program provides scientific information and skill-building opportunities to individuals who are responsible for making decisions that affect coastal resources. It targets a range of audiences, including land use planners, elected officials, and regulators, and focuses on a number of issues, including water quality.

**Recommendation 14–11. The U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and other appropriate entities should increase assistance and outreach to provide decision makers with the knowledge and tools needed to make sound land use decisions**



that protect coastal water quality. State and local governments should adopt or revise existing codes and ordinances to require land use planning and decision making to carefully consider the individual and cumulative impacts of development on water quality, including effects on stormwater runoff.

### *Managing Stormwater Runoff*

EPA regulates three types of stormwater discharge sites under the Clean Water Act NPDES program: municipal separate storm-sewer systems; industrial facilities; and construction sites. These discharges require permits and require that the discharger develop a stormwater pollution prevention plan specifying which best management practices will be used.

Since 1990, Clean Water Act regulations, known as the Phase I rule, have required cities and municipalities of 100,000 or more residents, ten categories of industrial activity, and construction projects disturbing five acres or more to obtain NPDES stormwater permits. In 1999, EPA released the Phase II rule, under which NPDES permits will be needed by communities with a population greater than 10,000 or a density higher than 1,000 people per square mile, and by construction sites that disrupt one to five acres of land. The Phase II rule became effective in March 2003.

The primary method for controlling stormwater runoff is the application of best management practices. Structural best management practices are measures—such as constructing detention basins, wet ponds, or wetlands—that help control the quantity and quality of stormwater. Nonstructural best management practices are generally preventive actions that rely on behavioral changes, such as modifying the use of fertilizers, sweeping streets, and educating the public. EPA and the American Society of Civil Engineers have jointly developed a national database of stormwater best management practices as a tool for local stormwater designers and planners.

While best management practices can be effective, these tools may not be sufficient on their own. In urban areas, construction activities still contribute significantly to sediment loadings and, where impervious surfaces are prevalent, stormwater flows directly into surface waters and sewer systems. A comprehensive approach will be required to minimize disturbance to the natural hydrology, minimize water flow over surfaces, and maintain water quality. Rigorous monitoring will also be needed to determine whether water quality standards are being achieved and to allow management approaches to be modified as needed to reach desired water quality goals. Effective implementation of EPA’s NPDES Phase II stormwater control program will require additional personnel to carry out the needed oversight and enforcement.

**Recommendation 14–12. The U.S. Environmental Protection Agency (EPA), working with state and local governments, should strengthen implementation of the National Pollutant Discharge Elimination System Phase I and II stormwater programs.**

*Improvements should include:*

- *local codes or ordinances that are designed to achieve the management goals for a particular watershed and require use of EPA-approved best management practices.*
- *monitoring to determine whether goals and state water quality standards are being met and to identify ongoing problems.*
- *an adaptive management approach to ensure that efforts are effective and that best management practices are modified as needed.*
- *improved public education.*
- *increased enforcement of legal requirements and personnel sufficient to implement stormwater management programs.*



## Collaboration at the Watershed Scale

As discussed in Chapter 9, watersheds are often the appropriate geographic unit for addressing water-related problems because they acknowledge upstream and downstream connections and consider the cumulative impacts of activities taking place in the watershed. These features are particularly important in addressing nonpoint source pollution.

Collaborative watershed groups have had significant successes in addressing nonpoint source pollution. These groups bring together stakeholders reflecting the diverse interests that may be represented in a watershed: agriculture, timber, and industry; sport and commercial fishing interests; recreational users and tourism-related businesses; environmental and citizen groups; and local, state, tribal, and federal governments. While such public/private sector collaborations can complement more traditional water pollution control strategies, they are often hampered by limited financial resources, institutional instability, and lack of technical expertise. Another limitation is that, because watersheds cross political boundaries, controlling authorities and programs may be different in different parts of the watershed.

Addressing nonpoint source pollution on a watershed basis makes good sense for environmental, financial, social, and administrative reasons. In addition, regional ocean councils can play an important role in helping to support the collaborative efforts of watershed groups. Collaborative watershed approaches can build a sense of community, reduce conflicts, increase commitment to the actions necessary to meet common goals and ultimately improve the likelihood of sustaining long-term water quality improvements.

As recommended in Chapter 9, Congress should amend appropriate legislation to provide better support for watershed management initiatives. The National Ocean Council can play a role in improving the effectiveness of federal support for watershed initiatives by coordinating agency management and technical assistance for watershed groups, overseeing development of an accessible clearinghouse of information on watershed best management practices, and coordinating the distribution of federal grants and program funds in support of coastal watershed initiatives.

## International Efforts

Nonpoint source pollution is an important, and increasingly visible, international issue. The health, well-being and, in some cases, the very survival of coastal populations around the world depend upon the viability of coastal and marine systems. Nonpoint source pollution threatens the health of these systems and the important economic activities, such as fishing and tourism that they support. Public health is also adversely affected through contamination of seafood, direct contact, such as through bathing, and the use of seawater in desalination and food-processing plants.

Ongoing efforts to reduce nonpoint source pollution internationally include the United Nations Environment Program's (UNEP's) establishment of fourteen regional seas programs worldwide as part of the 1995 Global Program of Action for the Protection of the Marine Environment from Land-Based Sources (GPA). Many nations, including the United States, are moving forward with initiatives to implement the GPA. However, broader application of GPA measures will depend on increased foreign technical assistance and funding. The U.S. Agency for International Development, NOAA, and EPA provide limited technical and training assistance through UNEP for nations where sewage treatment, monitoring, research, and law enforcement capacity are insufficient. (For a listing of ocean-related international agreements, see Table 29.1.)

As part of the GPA, UNEP launched the Hilltops to Oceans initiative (H2O) at the 2002 World Summit on Sustainable Development. Overall objectives of H2O include facilitating international recognition of the links between fresh-water and marine environments, and assisting in the implementation of actions needed to reduce, remediate, and prevent pollution and degradation of the coastal and marine environment.

The United States is particularly involved in the coordination, integration, and management of marine pollution programs in the wider Caribbean region, including programs for addressing upstream sources and protecting wetlands, mangrove swamps, coral reefs, and offshore areas. At the 2002 Summit, the United States launched the White Water to Blue Water initiative with a coalition of partners that includes the United Kingdom, France, Canada, the Netherlands, Caribbean island governments, nongovernmental organizations, and the private sector. The ultimate goal of the initiative is to improve the capabilities of all coastal nations to manage watershed and coastal ecosystems for sustainable development. Participants hope that success in implementing the pilot phase in the Caribbean will encourage other regions in Africa and the South Pacific to follow suit.

## ADDRESSING ATMOSPHERIC SOURCES OF POLLUTION

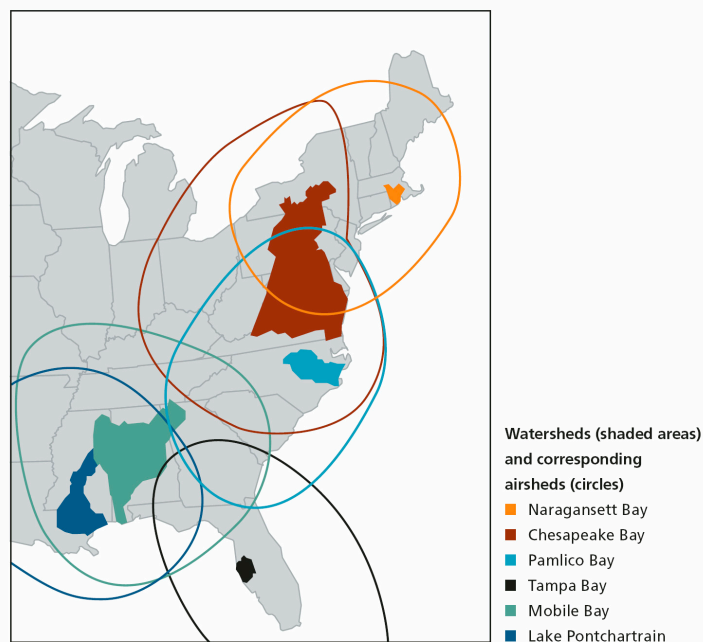
Atmospheric deposition of pollutants can also harm water quality, aquatic resources, and human health. Atmospheric deposition accounts for between 10 and 50 percent of the nitrogen entering estuaries along the East Coast and the Gulf of Mexico.<sup>27, 28</sup> Major atmospheric pollutants include nutrients, metals such as lead and mercury, pesticides, polycyclic aromatic hydrocarbons, dioxins, furans, and persistent toxic substances. Certain persistent toxins, such as DDT and PCBs, have even been measured in remote locations, such as the Arctic and Antarctic, demonstrating the extent of dispersal of pollutants by the atmosphere. Atmospheric deposition is also a significant source of pollution in the Great Lakes; as much as 90 percent of some toxic chemicals entering the Great Lakes are believed to be the result of atmospheric deposition.<sup>29</sup> Sources of atmospheric deposition are quite varied and include agriculture, incineration, coal-fired power plants, industrial facilities, and motor vehicles, as well as natural sources such as forest fires, lightning, and volcanoes.

### Improving Control of Atmospheric Sources

Addressing atmospheric deposition requires controlling multiple sources within a particular water body's airshed, defined as the geographic area responsible for 75 percent of the air pollutants that reach that body of water (Figure 14.6). The airshed can be ten, twenty, or even several hundred times larger than the area of the watershed. To add to the complexity, different pollutants exhibit different physical and chemical behaviors in the atmosphere, so the airshed of a particular body of water may vary depending on the pollutant of interest.

The federal government is taking some positive steps to address atmospheric deposition. For example, in 2001, EPA developed the Air-Water Interface Work Plan, which identifies over 20

Figure 14.6 Looking Skyward: Accounting for Airshed Deposition



The atmospheric area affecting water quality within a watershed may be ten to several hundred times larger than the watershed itself. As shown here for oxidized nitrogen contributions along the East Coast, the extent of the calculated airsheds illustrates the states, regions, and nations that must coordinate in order to effectively manage atmospheric contributions to water quality.

Source: U.S. Environmental Protection Agency. <<http://www.epa.gov/owow/oceans/airdep/air1.html>> (Accessed January 2004).

actions that EPA will take over the next several years to reduce atmospheric deposition of pollutants—including nitrogen compounds and toxics—into water bodies nationally, using the authorities of both the Clean Air Act and the Clean Water Act.<sup>30</sup> The plan is based in large part on a number of existing Clean Air Act regulatory programs that have not been fully implemented, including, for example: the maximum achievable control technology (MACT) standards for emissions of toxic pollutants from sources, such as industrial facilities and coal-fired power plants; the nitrogen oxides (NO<sub>x</sub>) reductions under the Acid Rain program for power plants; a separate program to reduce NO<sub>x</sub> emissions to meet the National Ambient Air Quality Standards; and controls on automobiles, trucks, vessels, and other mobile sources that will reduce emissions of both NO<sub>x</sub> and toxics.

**Recommendation 14–13. The U.S. Environmental Protection Agency, working with states, should develop and implement national and regional strategies to reduce the sources and impacts of atmospheric deposition to water bodies, building upon plans such as the EPA Air-Water Interface Work Plan.**

Control of atmospheric deposition is currently hampered by relatively poor data on sources, atmospheric transport routes, and sites where pollutants are ultimately deposited. While several monitoring programs exist, relatively few are in coastal areas. Reducing atmospheric deposition would be greatly aided by better data, analysis, and information on emission sources, fate and transport, and related environmental and human health consequences. (A further discussion of monitoring needs is provided in Chapter 15.)

Because of the potential range of atmospheric transport of pollutants, widespread international cooperation will also be needed.<sup>31</sup> For example, atmospheric deposition of mercury will require concerted international action in addition to domestic measures. Mercury contamination in fish is a human health concern because of potential neurotoxic effects, particularly for pregnant women and children, and depending on the location, it can come from a wide variety of sources.

Recent studies have demonstrated that air pollution from human activities in Asia can be carried across the Pacific Ocean by prevailing mid-latitude winds, with potentially significant impacts on the concentration and number of air pollutants in North American coastal areas. This impact is likely to increase along with the growth of Asian economies. EPA, in conjunction with a number of research organizations, is currently conducting a modeling study of intercontinental pollution transport from Asia and its potential effects on regional air quality. In the Caribbean, studies are also underway to assess impacts in a number of areas, from human health to coral reef health, caused by hundreds of millions of tons of dust carried through the air from Africa each year.<sup>32</sup>

International action to control contamination by persistent organic compounds and other pollutants is carried out under multilateral treaties such as the Stockholm Convention on Persistent Organic Pollutants and the Convention on Long-Range Transboundary Air Pollution, as well as bilateral agreements between the United States and Canada and Mexico. Additional international agreements may be needed to address specific issues, such as mercury.

**Recommendation 14–14. The United States should work with other nations to develop and implement international solutions to better address the sources and impacts of transboundary atmospheric deposition, and to initiate needed research programs.**

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