United States
Environmental Protection
Agency

Office of Water
Washington DC 20460

EPA 440-4-90-003
April 1990

EPA

National Water Quality Inventory

1988 Report to Congress

Printed on Recycled Paper

This report was prepared pursuant to Section 305(b) of the Clean Water Act, which states: "(b)(1) Each State shall prepare and submit to the Administrator by April 1, 1975, and shall bring up to date by April 1, 1976, and biennially thereafter, a report which shall include—

"(A) a description of the water quality of all navigable waters in such State during the preceding year, with appropriate supplemental descriptions as shall be required to take into account seasonal, tidal, and other variations, correlated with the quality of water required by the objective of this Act (as identified by the Administrator pursuant to criteria published under section 304(a) of this Act) and the water quality described in subparagraph (B) of this paragraph;

"(B) an analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water;

"(C) an analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to additional action necessary to achieve such objectives and for what waters such additional action is necessary;

"(D) an estimate of (i) the environmental impact, (ii) the economic and social costs necessary to achieve the objective of this Act in such State, (iii) the economic and social benefits of such achievement; and (iv) an estimate of the date of such achievement; and

"(E) a description of the nature and extent of nonpoint souces of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the costs of implementing such programs.

"(2) The Administrator shall transimit such State reports, together with an analysis thereof, to Congress on or before October 1, 1975, and October 1, 1976, and biennially thereafter."

All photographs are courtesy of individual and or organization listed.
Cover photo by Steve Delaney

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE ADMINISTRATOR

Dear Mr. President:
Dear Mr. Speaker:

As required by Section 305(b) of the Federal Water Pollution Control Act, I am transmitting to the Congress the 1988 National Water Quality Inventory Report. This report is the seventh in a series of national water-quality assessments published since 1975. It is based primarily on reports submitted by the States in 1988; in some cases, State-reported information has been supplemented by data developed by the U.S. Environmental Protection Agency (EPA). Although EPA has analyzed and summarized the water quality information in the State reports, the views and recommendations presented are those of individual States, not those of EPA or the Administration. The individual 1988 State reports are being transmitted to the Congress in their entirety.

The message presented by the States in these reports is that many point source-related surface water-quality problems, such as bacteria and oxygen-demanding materials discharged by sewage treatment plants, appear to be diminishing as a result of pollution control programs. At the same time, the pollution problems that are most difficult to assess and control—e.g., sedimentation, nutrient enrichment, polluted runoff from farmlands, and toxic contamination of fish tissue and sediments—are becoming more evident.

About 30 percent of U.S. river miles, 40 percent of lake acres, and 70 percent of estuarine square miles were assessed by the States in 1988, a significant increase over previous years. Of these assessed waters, most are supporting the uses for which they have been designated by the States. These uses, such as drinking water supply, swimming, and the propagation of aquatic life, were found to be supported in 70 percent of assessed river miles, 74 percent of assessed lake acres, and 72 percent of assessed estuarine square miles.

A variety of pollution problems remain in the Nation's waters. The leading causes of pollution cited by the States in impaired rivers and lakes are siltation and nutrients; in impaired estuarine waters, nutrients and fecal coliform bacteria are most commonly cited. Agricultural activities are the most extensively reported source of pollution in rivers and lakes, and municipal discharges are cited as the leading source of pollution in estuaries. Wetland loss is also a significant problem reported by the States. Land development for residential or commercial uses is cited as the leading cause of loss of wetland acreage.

Major threats to ground-water quality, as reported by the States, include underground storage tanks, septic systems, agricultural activities, municipal landfills, surface impoundments, and abandoned hazardous waste sites. Nitrates, pesticides, volatile organic compounds, petroleum products, metals, and brine are cited as the leading contaminants of concern in ground water.

Nevertheless, as this report shows, the Nation's water pollution control programs have achieved significant results. Expenditures to construct and upgrade sewage treatment facilities have substantially increased the population served by higher levels of treatment. Municipal and industrial facilities are at a high rate of compliance with the conditions of their permit limits. A variety of State and Federal programs have led to progress in reducing the impacts of diffuse sources of pollution such as agricultural runoff. The States are engaged in a number of ground-water protection activities such as development of wellhead protection programs and ground-water mapping.

In addition, under the impetus provided by the Water Quality Act of 1987, the States have identified specific waters with impairments due to toxic contaminants and diffuse sources of pollution. EPA and the States are beginning to develop and implement control programs for these waters. In future editions of this report, EPA will be reporting on the progress achieved by these programs.

EPA is continuing to work with the States to improve the consistency and comprehensiveness of the Section 305(b) reporting process. A computerized data system has been developed to better manage State water-quality assessments and facilitate State reporting. EPA is developing guidance for the States to help them build effective, forward-looking monitoring programs. Future reports in this series should reflect these improvements.

Sincerely,

William K. Reilly

William K. Reilly

Honorable J. Danforth Quayle
President of the Senate
Washington, DC 20510

Honorable Thomas Foley
Speaker of the House of Representatives
Washington, DC 20515

Acknowledgments

This report is based primarily on water quality assessments submitted to EPA by the States, Territories, and Interstate Commissions of the United States. The Environmental Protection Agency (EPA) wishes to thank the authors of these assessments for the time and effort spent in preparing these reports and reviewing the draft of this national assessment. Additional thanks go to the water quality assessment coordinators from all ten EPA Regions who work with the States.

This document was written and edited by Alice Mayio of the Assessment and Watershed Protection Division, Office of Water Regulations and Standards (OWRS), under the direction of Bruce Newton, Chief, Monitoring Analysis Section. Key contributions were also made by the following individuals in other EPA program offices: Mary Lou Soscia, Office of Marine and Estuarine Protection; Caryle Miller, Office of Ground-Water Protection; John Maxted, Office of Wetlands Protection; Sandy Braswell, Office of Municipal Pollution Control; Brett Snyder, Office of Policy Planning and Evaluation; and Ed Bender and Kathryn Smith, Office of Water Enforcement and Permits.

Data analysis, technical assistance, graphics, and word processing were provided by Versar Incorporated under Contract No. 68-02-4254. Design, typesetting, illustration, and graphics were provided by Research Triangle Institute, Research Services Department, under Contract No. 68-C9-0013.

Contents

Page

Highlights iv
Figures v
Tables vii

Part One: Introduction

Executive Summary xi
Introduction xxi
Background xxi
Methodology xxii

Part Two: Surface Water Quality

1 Rivers and Streams 1
Support of Designated Uses 1
Causes of Impairment 3
Sources of Impairment 7
Attainment of the Clean Water Act Goals 11

2 Lakes and Reservoirs 17
Support of Designated Uses 17
Causes of Impairment 18
Sources of Impairment 22
Attainment of the Clean Water Act Goals 26
Trophic Status of Lakes 26
EPA's Clean Lakes Program 30

3 The Great Lakes 33
Support of Designated Uses 33
Causes and Sources of Impairment 34
Attainment of Clean Water Act Goals 35
The Great Lakes: A Narrative Assessment 38

4 Estuaries and Coastal Waters 49
Estuaries 50
Support of Designated Uses 50
Causes of Impairment 51

Page

Sources of Impairment 54
Attainment of the Clean Water Act Goals 57
Understanding Estuarine Water Quality: The Chesapeake Bay Perspective 59
Ocean Coastal Waters 68
Support of Designated Uses 68
Causes and Sources of Impairment 69
Attainment of the Clean Water Act Goals 69
New Initiatives for Estuarine and Coastal Waters 77

5 Wetlands 79
Types of Wetlands 79
Wetland Values 80
Overview of State Reporting 83
Wetland Resources 83
Wetlands Protection Programs 89

6 Public Health/Aquatic Life Concerns 101
Total Size of Waters Affected by Toxics 102
Fish Consumption Advisories and Bans 106
Sediment Contamination 110
Fish Kills Caused by Pollution 114
Bathing Area Closures 116

Part Three: Ground-Water Quality

Introduction 119

7 Ground-Water Quality 121
Current Ground-Water Use 121
Ground-Water Quality 122

8 Ground-Water Protection Programs 129
State Programs 129
Federal Ground-Water Protection Programs 136

Part Four: Water Pollution Control Programs

Introduction 143

9 Point Source Control Program 145
Toxics Control: Section 304(l) of the Clean Water Act 145
Treating Municipal Wastewater 148
Treating Industrial Wastewater 152
Permitting 155
Compliance and Enforcement 155
New Initiatives in Point Source Control 157

Page

10 Nonpoint Source Control Program 161
The Water Quality Act of 1987 164
The State Section 319 Reports 164
The NPS Agenda Task Force 165
New Directions 165

11 Surface Water Monitoring 167
Goals of the Water Monitoring Program 168
The Need for Change 169
New Water Monitoring Initiatives 171
Outlook for Water Quality Monitoring 172

12 Costs and Benefits of Pollution Control 177
Costs 177
Benefits 180

13 State Recommendations 185

References 189
Appendix – Excerpts from the State reports A-1

Highlights

Page

Sources of Pollution Reported by the States 10
Making Assessment Decisions 14-15
Green Bay/Fox River Mass Balance Study 42-44
The Potomac River: The Multidecade Recovery of a Chesapeake Bay Tributary 62-65
Coastal Protection in the Mid-Atlantic Bight 66-67
Port Townsend Bay 70-71
Red Tide in the Eastern Gulf of Mexico 74-76
National Wetlands Policy Forum 92-93
The National Wetlands Inventory 96-97
Citizen-Based Surface Water Monitoring 174-175
Washington's Centennial Clean Water Program 183

Figures

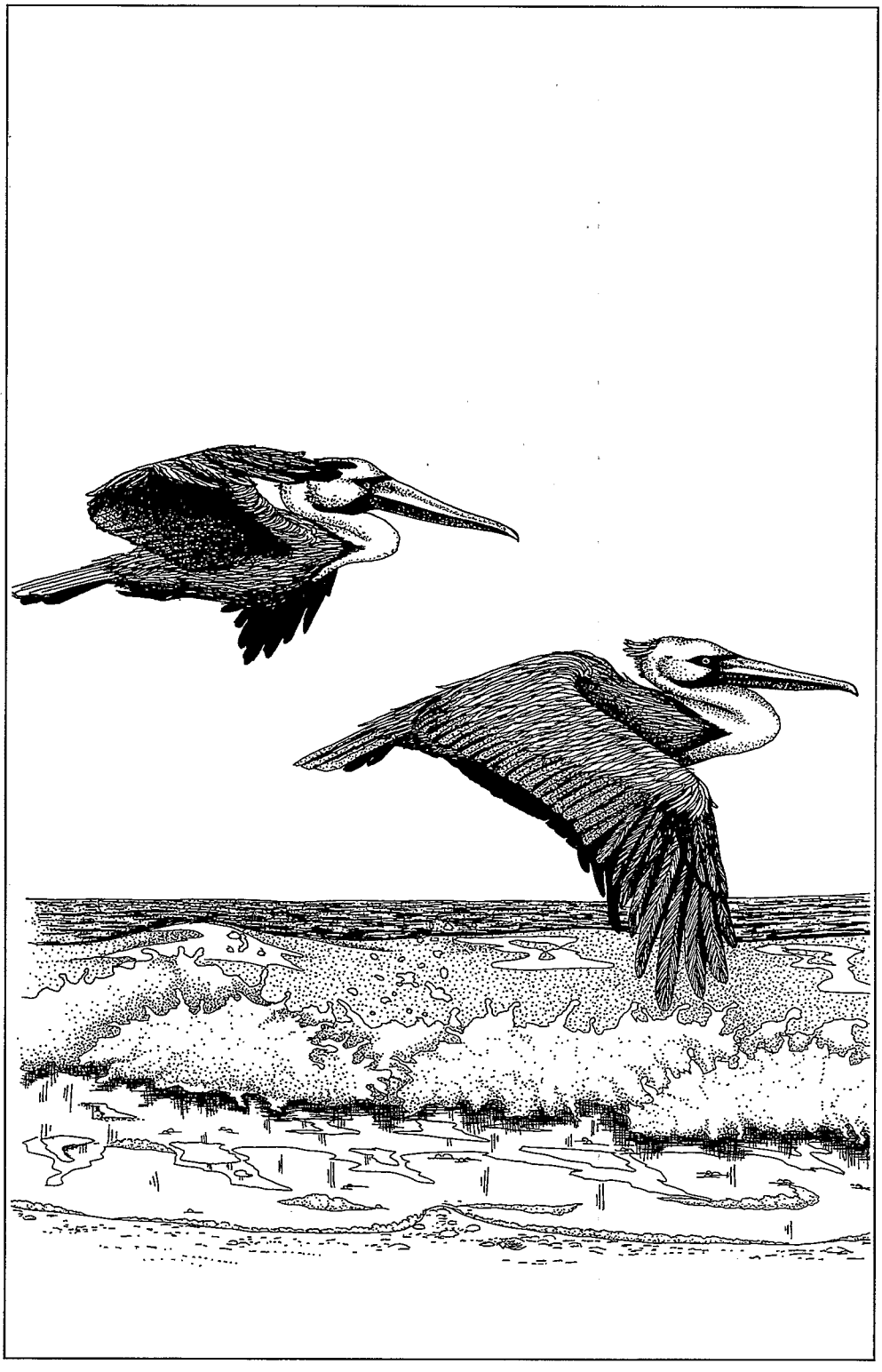
No.	Title	Page
1-1	Designated Use Support in Assessed Rivers and Streams	3
1-2	Percent of Impaired River Miles Affected by Each Pollution Cause	6
1-3	Percent of Impaired River Miles Affected by Each Pollution Source	7
1-4	Attainment of Clean Water Act Goals in Assessed Rivers and Streams	13
2-1	Designated Use Support in Assessed Lakes and Reservoirs	18
2-2	Percent of Impaired Lake Acres Affected by Each Pollution Cause	22
2-3	Percent of Impaired Lake Acres Affected by Each Pollution Source	23
2-4	Attainment of Clean Water Act Goals in Assessed Lakes and Reservoirs	26
3-1	Designated Use Support in Assessed Great Lakes	34
3-2	Attainment of Clean Water Act Goals in Assessed Great Lakes	36
4-1	Designated Use Support in Assessed Estuaries	51
4-2	Percent of Impaired Estuary Square Miles Affected by Each Pollution Cause	53
4-3	Percent of Impaired Estuary Square Miles Affected by Each Pollution Source	56
4-4	Attainment of Clean Water Act Goals in Assessed Estuary Square Miles	57
4-5	The Chesapeake Bay Watershed	59
4-6	Average Summer Dissolved Oxygen Concentrations in Chesapeake Bay: 1985-1986	60
4-7	Percent of Maryland Chesapeake Bay SAV Ground Survey Stations with Vegetation Present	61
4-8	Designated Use Support in Assessed Oceans	69
4-9	Attainment of Clean Water Act Goals in Assessed Oceans	72
5-1	Extent of Wetlands in the Lower 48 States	80
5-2	Original and Remaining Acreages of Wetlands in the Lower 48 States	83
5-3	Major Causes of Wetland Loss and Degradation	83
5-4	Wetlands Acreage Distribution Nationwide	96
6-1	Fishing Restrictions Nationwide	106
6-2	Fish Kills Distribution Nationwide	114
7-1	Percentage of State and Territory Populations Served by Ground Water for Domestic Supply	122

No.	Title	Page
7-2	National Breakdown of Ground-Water Withdrawals	122
7-3	National Use of Ground Water 1950-1985	123
7-4	Frequency of Reported State and Territory Concern with Ground-Water Contamination Source	126
7-5	Priority Ranking of Ground-Water Contamination Sources	127
7-6	Priority Ranking of "Other" Ground-Water Contamination Sources	127
7-7	Number of States and Territories Reporting Ground-Water Contaminant as a Concern	128
9-1	Status of Permit Compliance for Municipal Facilities	157
11-1	States with Citizen Monitoring Programs (CMPs)	174

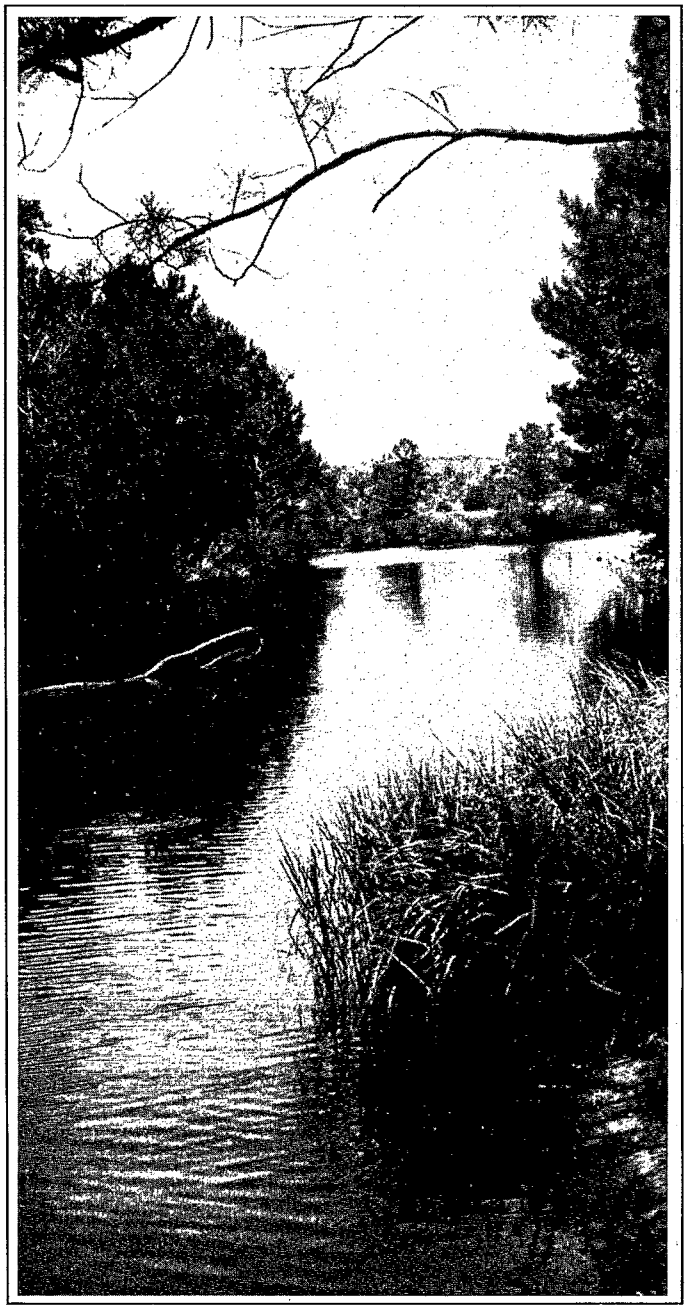
Tables

No.	Title	Page
1-1	Designated Use Support in Rivers and Streams	2
1-2	Impaired River Miles Affected by Causes of Pollution	4
1-3	Impaired River Miles Affected by Sources of Pollution	8
1-4	Attainment of Clean Water Act Goals in Rivers and Streams	12
1-5	EPA-Issued Guidelines on Making Use Support Decisions	15
2-1	Designated Use Support in Lakes and Reservoirs	19
2-2	Impaired Lake Acres Affected by Causes of Pollution	20
2-3	Impaired Lake Acres Affected by Sources of Pollution	24
2-4	Attainment of Clean Water Act Goals in Lakes and Reservoirs	27
2-5	General Characteristics of Traditional Lake Trophic Status Classifications	28
2-6	Trophic Status of the Nation's Lakes	29
3-1	Designated Use Support in Great Lakes	34
3-2	Impaired Great Lakes Shoreline Miles Affected by Causes of Pollution	34
3-3	Impaired Great Lakes Shoreline Miles Affected by Sources of Pollution	36
3-4	Attainment of Clean Water Act Goals in Great Lakes	37
4-1	Designated Use Support in Estuaries	50
4-2	Impaired Estuary Square Miles Affected by Causes of Pollution	52
4-3	Impaired Estuary Square Miles Affected by Sources of Pollution	54
4-4	Attainment of Clean Water Act Goals in Estuaries	58
4-5	Historical Record of Oyster Harvest from the Chesapeake Bay	65
4-6	Designated Use Support in Oceans	68
4-7	Impaired Ocean Coastal Miles Affected by Causes of Pollution	72
4-8	Impaired Ocean Coastal Miles Affected by Sources of Pollution	72
4-9	Attainment of Clean Water Act Goals in Oceans	73
5-1	Summary of State Permit and Other Selected Nonpermit Programs	91
5-2	Estimated Wetland Area by State	97
6-1	Size of Surface Waters Affected by Toxic Substances	104
6-2	Fishing Restrictions Reported by the States	107
6-3	Pollutants Associated with Fishing Restrictions	108
6-4	Sources Associated with Fishing Restrictions	108

No.	Title	Page
6-5	Fish Kills Caused by Pollution	115
6-6	Pollutants Associated with Fish Kills	116
6-7	Sources Associated with Fish Kills	116
9-1	Levels of Municipal Wastewater Treatment (1984-1988)	148
9-2	Needs for Publicly Owned Wastewater Treatment Facilities	150
9-3	Status of Permit Issuance	155
9-4	National Composite Rates of Facilities in Significant Noncompliance	156
12-1	Spending for Water Pollution Abatement and Control	178
12-2	Distribution of 1986 State Expenditures for Water Quantity/Quality Programs	179
12-3	Distribution of State Water Quality Program Expenditures 1988 and 1988-1990 Estimated Incremental Needs	181



Introduction



NC Dept. of Environment, Health, and Natural Resources

Executive Summary

The State Section 305(b) reports have become increasingly comprehensive water quality assessments. More and more information is becoming available on waters that were previously unassessed; on the specific causes of impairment and sources of pollution; on public health and aquatic life impacts such as fishing advisories; on ground-water conditions; and on efforts under way to evaluate and address water quality problems.

However, in reviewing the information presented, the reader should keep in mind that not all waterbodies have been assessed. Because governmental monitoring efforts tend to focus on problem areas, it is likely that unassessed waters are not as polluted as assessed waters. Many States are just beginning to study nonpoint source impacts that may affect areas that have been thought to have good water quality. The reader should also keep in mind that this 1988 report summarizes water quality data collected by the States in 1986 and 1987.

The information presented in this report reveals that many point source-related surface water quality problems—for example, conventional pollutants such as bacteria and oxygen-demanding materials discharged by sewage treatment plants—appear to be diminishing as a result of pollution control programs. On the other hand, problems that are harder to assess and control, such as sedimentation, nutrient enrichment, runoff from farmlands, and toxic contamination of fish tissue and sediments, are becoming more evident. Some of these problems may be on the rise. Others may just be more evident as point sources

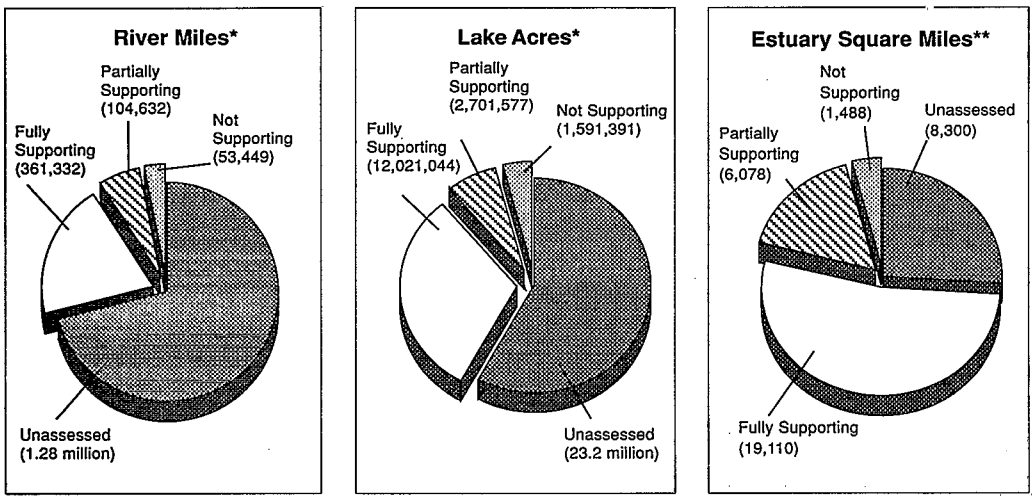
come under control and as we develop improved monitoring capabilities to identify them. To some extent, it is certainly true that the more we look, the more we find.

What Do the States Report on the Quality of Their Rivers?

Nearly 520,000 river miles were assessed by 48 States, Territories, and jurisdictions in 1988. This reflects 29 percent of the total river miles in the U.S., or 45 percent of the total river miles in the States that reported. This is an increase of nearly 150,000 miles over the number of river miles assessed in 1986. States used chemical/biological monitoring and other types of data such as surveys of fisheries biologists, predictive water quality models, and information from citizens to assess their waters.

The States designate their waterbodies for beneficial uses (such as drinking water supply, contact recreation, and warm and cold water fisheries) as part of their EPA-approved water quality standards. Among the States that reported on support of these beneficial uses, a combined total of about 360,000 river miles were found to support beneficial uses, or 70 percent of the river miles assessed in these States (see Figure ES-1). Including unassessed waters, it might alternatively be stated that 31 percent of the *total* river miles in these States were known to support uses, 14 percent were known to be impaired, and the remaining 55 percent were not assessed. These numbers should be interpreted with care and should not be compared to those of previous reporting cycles, as wide variations exist among States in methods used to determine support of beneficial uses.

The most extensive causes of impairment in the Nation's rivers are siltation (affecting 42 percent of impaired river miles), nutrients (affecting 27 percent), fecal coliform bacteria (affecting 19 percent), and organic enrichment/low dissolved oxygen (affecting 15 percent). Agricultural runoff is by far the most extensive source of pollution, affecting 55 percent of impaired river miles. Other sources include municipal discharges (affecting 16 percent of impaired waters), resource extraction and hydrological habitat modification (each affecting 13 percent), and storm sewers/runoff (affecting 9 percent) (see Table ES-1).



Source: 1988 State Section 305(b) reports.

*Total water based on State-reported information in America's Clean Water; The States' Nonpoint Source Assessment, ASIWPCA, 1985.
**Total US estuary square miles based on 1988 State-reported 305(b) data and excludes Alaska and Island Territories.

Figure ES-1. Degree of Designated Use Support in the Nation's Assessed Waters

What Do the States Report on the Quality of Their Lakes?

About 16 million lake acres (excluding the Great Lakes) were assessed by 40 States, Territories, and jurisdictions in 1988. This reflects 41 percent of the total lake acres in the U.S., or 73 percent of the total lake acres in the States reporting. This is an increase of about 3.8 million lake acres over the number assessed in 1986.

Among the States that reported on support of designated beneficial uses, a combined total of about 12 million lake acres were found to support those uses, or 74 percent of the assessed lake acres in those States (see Figure ES-1). Including unassessed waters, it might alternatively be stated that about 53 percent of the total lake acres in those States are known to support uses, 19 percent are known to be impaired, and the remaining 28 percent were not assessed.

The most extensive causes of use impairment in lakes are nutrients (affecting 49 percent of impaired acres), siltation (affecting 25 percent), and organic enrichment/low dissolved oxygen (also affecting 25 percent) (see Table ES-1). Nutrients such as phosphorus and nitrogen are the main cause of cultural eutrophication—a major alteration of lake ecology characterized by the excessive growth of aquatic weeds and algae. The States reported that about a third of all lakes assessed for trophic status are classified as eutrophic. The most extensive sources of pollution in lakes are agriculture (affecting 58 percent of impaired lake acres), hydrologic/habitat modification (affecting 33 percent), storm sewers/runoff (affecting 28 percent), land disposal (affecting 26 percent), and municipal discharges (affecting 15 percent) (see Table ES-1).

About 4,500 Great Lakes shoreline miles were assessed by six of the eight Great Lakes States in 1988. This reflects 87 percent of the total Great Lakes shoreline miles in the U.S. and all the shoreline miles in these six States. This is the first time sufficient use support information has been available for the Great Lakes. A combined total of about 370 Great Lakes shoreline miles were found to support designated beneficial uses, only 8 percent of assessed shoreline miles. This low rate of use support is attributed largely to fish consumption restrictions in place throughout nearshore waters of the lakes. The most extensive causes of nonsupport are synthetic organic chemicals, metals, and nutrients.

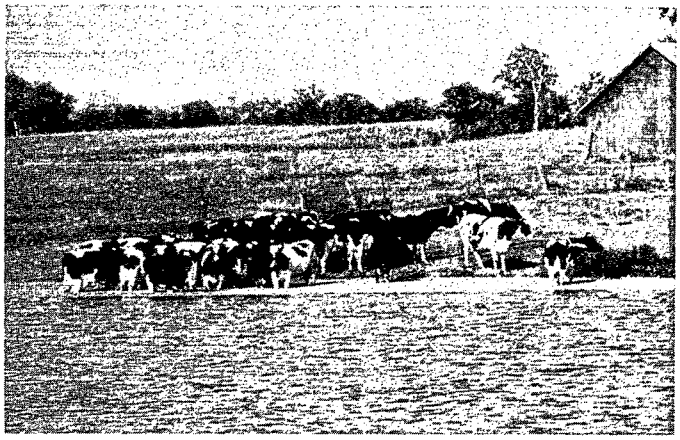
Table ES-1. Leading Causes and Sources of Impairment

Type of Waterbody	Leading Causes*	Leading Sources*
Rivers	Siltation Nutrients	Agriculture Municipal Discharges
Lakes	Nutrients Siltation	Agriculture Hydro/Habitat Mod.
Estuaries	Nutrients Pathogens	Municipal Discharges Resource Extraction

*Determined by size affected.

Source: 1988 State Section 305(b) reports.

Agricultural activities are the most extensive sources of pollution in lakes.



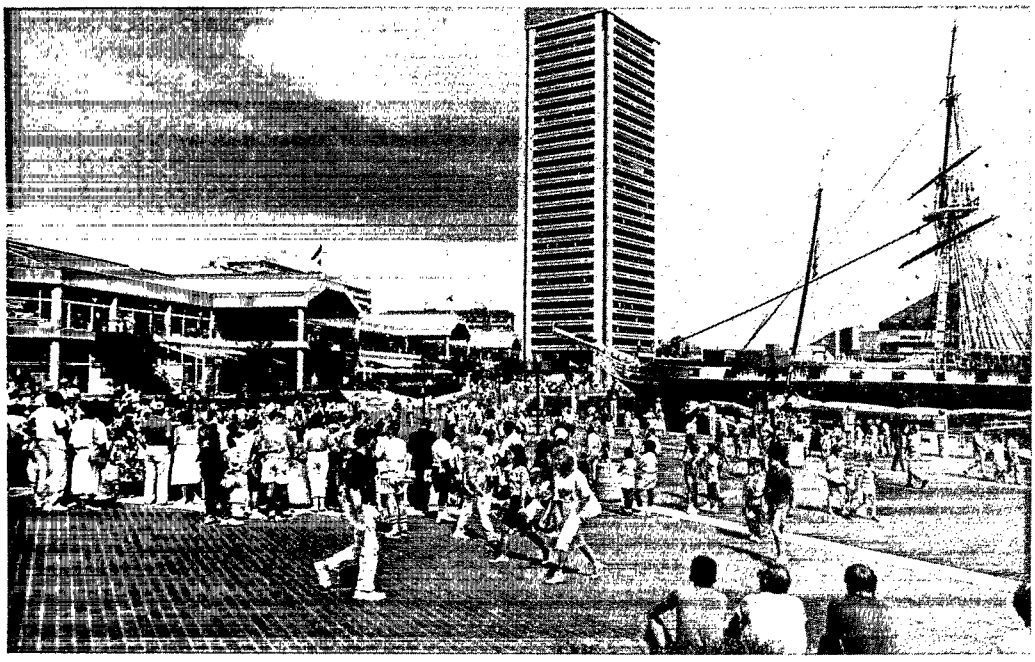
What Do States Report on the Quality of Their Estuaries and Coastal Waters?

About 26,700 square miles of estuaries were assessed by 23 States, Territories, and jurisdictions in 1988. This reflects about 76 percent of the estuarine area assessed in these States. Roughly 9,000 more estuarine square miles were assessed in 1988 than in 1986.

Among the States that reported on support of designated beneficial uses, a combined total of about 19,000 square miles were found to support uses, or 72 percent of estuarine square miles assessed in those States (see Figure ES-1). Including unassessed waters, it might alternatively be stated that 54 percent of *total* estuarine square miles in these States are known to meet designated uses, 21 percent are known to be impaired, and the remaining 25 percent were not assessed.

The most extensive causes of use impairment in estuaries are nutrients and pathogens (affecting 50 and 48 percent of impaired square miles, respectively) and organic enrichment/low dissolved oxygen (affecting 29 percent). The most extensive sources of pollution in estuaries, as cited by the States, are municipal discharges (affecting 53 percent of impaired estuarine square miles), resource extraction (affecting 34 percent), and storm sewers/runoff (affecting 28 percent) (see Table ES-1).

Coastal shoreline water quality is reported separately from estuarine water quality. Nearly 3,800 coastal shoreline miles were assessed by 12 States and Territories in 1988. This reflects only about 20 percent of the Nation's 19,200 miles of ocean coastline, and 73 percent of the coastline miles in these States. The 1988 reporting cycle is the first time sufficient use support information has been available for the Nation's coastal shoreline. Among the States that reported on support of beneficial uses, a combined total of about 3,300 miles were found to fully support uses, or 89 percent of coastline miles assessed in these States.



Steve Delaney

Baltimore's Inner Harbor.

What Do the States Report on the Status of Their Wetlands?

State reporting on their status in 1988 was sparse and uneven. Roughly one-quarter of the States and Territories provided information on wetland acreage, causes of loss, wetland legislation, and State programs. Furthermore, even where information was provided, it was often incomplete. States generally did not report on wetland quality (i.e., support of designated uses).

This incompleteness can be attributed to the complexity and expense of wetland monitoring, the lack of a complete data base on wetland acreage, the lack of State water quality standards for wetlands, and insufficient EPA guidance on wetland reporting. Future State 305(b) reporting on wetlands should be improved as activity increases in all these areas.

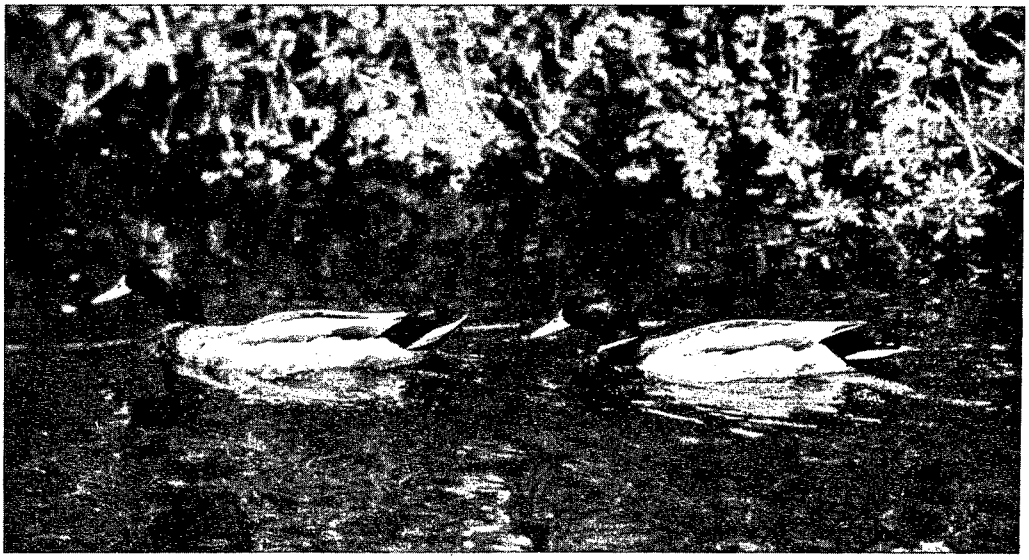
By far the most often cited cause of wetland loss reported by the States is land development for residential or commercial purposes. Second-home development and urban encroachment are commonly cited. Other reported causes include agricultural and resource extraction activities; agriculture is reported as a major historical cause of wetland loss but appears to be a lesser current threat.

A variety of State wetland protection legislation and programs are discussed by the States. In many cases, these State efforts appear to be effective in protecting wetlands and halting their destruction and degradation.

What Public Health/Aquatic Life Impacts Are Reported by the States?

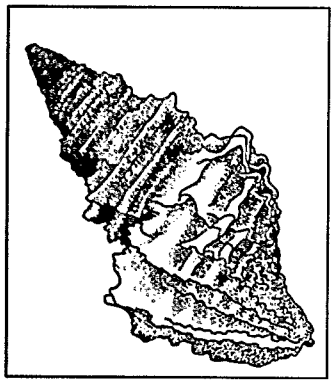
In general, the information reported by the States shows that toxic substances are somewhat less prevalent, in terms of areal extent, than other types of pollution problems such as siltation and nutrients. However, where they occur, toxic substances can cause or contribute to locally severe public health and aquatic life impacts.

Our understanding of the prevalence of toxic substances, exposure routes, and levels of concern is limited by the difficulty and expense of monitoring and conducting long-term health effect studies. Nevertheless, we have gained considerable experience over the last decade in monitoring for



Wetlands provide many benefits including food and habitat for fish and wildlife.

Al Peoples



toxic substances and in targeting monitoring to areas most likely to be contaminated. In 1988, the number of States providing data on toxic substances in their waters increased substantially compared to previous reporting cycles.

States provided specific information on toxic substances in their rivers, lakes, wetlands, estuaries, and coastal waters; in the bottom sediments of these waters; and in the tissue of fish and shellfish. Toxics-related impacts such as fish consumption advisories and other public health or aquatic life impacts (such as fish kills and beach closures) were also discussed by the States.

Where States monitored for toxic substances (usually a subset of waters most likely to have problems with toxics), they were asked to report on the extent to which elevated levels were found. These elevated levels are defined as exceedances of State water quality standards; criteria developed by EPA under Section 304(a) of the Clean Water Act; Water Quality Advisories developed by EPA; or "levels of State concern" where numeric criteria do not exist. The States reported elevated levels of toxics in one-third of monitored river miles, lake acres, and coastal waters. About a fourth of monitored estuarine waters and 90 percent of Great Lakes shoreline miles were reported as having elevated levels of toxics.

Forty-seven States and Territories reported on fishing advisories and bans; 586 fishing advisories and 135 bans were identified. PCBs, chlordane, mercury, dioxin, and DDT were the most commonly cited causes; industrial discharges and land disposal were the most common sources of contamination leading to fishing restrictions.

Sediment contamination by toxics was discussed by 37 States. Five hundred thirty-three incidents were reported, primarily caused by heavy metals, PCBs, and pesticides.

Nearly a thousand pollution-caused fish kills were reported by 35 States, with roughly 36 million fish killed. Biochemical oxygen demanding substances/low levels of dissolved oxygen, oil and gas, pesticides, temperature changes, ammonia, and chlorine were leading causes cited by the States. Commonly cited sources include agriculture, spills, and municipal and industrial discharges.

Information on the closure of swimming areas due to pollution is limited in the State reports. Over 200 beach closure incidents were reported, most of short-term duration and attributed to pathogen indicators such as fecal coliform bacteria from sewage treatment plants, combined sewer overflows, urban runoff, and spills.

Chesapeake Bay Foundation

What Do the States Report on Ground-Water Quality?

Ground water is a vital natural resource that is withdrawn for drinking water, irrigation, industrial use, and livestock watering. In many parts of the United States, ground water is the only reliable source of water. As result of a growing awareness of the important nature of this resource and its vulnerability, many States and Territories are developing and expanding legislation, regulations, and programs to protect ground water. Ground-water protection is especially important because of the difficulty and expense involved in cleaning up contaminated aquifers, providing alternative water supplies, or adding treatment to public water systems.

Many States and Territories are engaging in studies to better understand the quality of their ground water, identify and map their ground-water resources, identify potential sources of contamination, and determine the vulnerability of the resources to pollution. Many States have also begun developing more innovative approaches to ground-water protection, such as Wellhead Protection (WHP) Programs.

Over half of the States and Territories classified underground storage tanks, septic systems, agricultural activities, municipal landfills, surface impoundments, and abandoned hazardous waste sites as major threats to ground-water quality. With very minor differences, these are the same sources of concern reported in the 1986 State Section 305(b)reports. More than half of the States and Territories identified nitrates, pesticides, volatile organic compounds, petroleum products, metals, and brine as contaminants of concern (see Table ES-2). Other contaminants reported include bacteria, solvents, acids, and tanning wastes. These findings generally parallel the findings of the 1986 reports except for a reduction in the number of States reporting ground-water impacts from sewage.

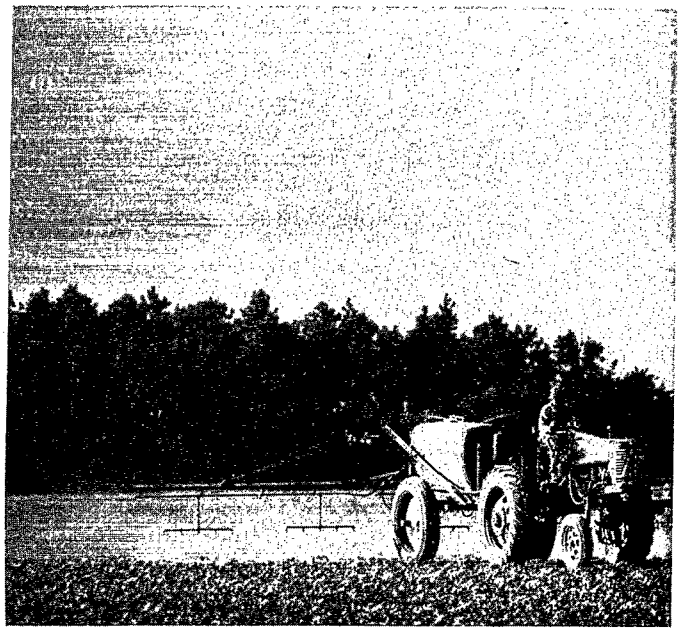
What Is the Status of Ground-Water Protection Programs?

The States and Territories are currently engaged in a number of ground-water protection activities to address identified contaminants and their sources. At least 49 States and Territories have developed or are in the

Table ES-2. Leading Sources and Contaminants Affecting Ground Water

Leading Sources of Ground-Water Contamination	Leading Ground-Water Contaminants of Concern
• Underground Storage Tanks • Septic Systems	• Nitrates • Pesticides
• Agricultural Activities • Municipal Landfills	• Volatile Organic Compounds • Petroleum Products
• Surface Impoundments • Abandoned Hazardous Waste Sites	• Metals • Brine

Source: 1988 State Section 305(b) reports.



NC Solid Waste Management Division

process of developing Ground-Water Protection Strategies. Many of these State Strategies have also been accompanied by changes in State laws or regulations to bolster ground-water protection activities. At least 31 States have adopted specific ground-water protection legislation. Other States rely on generic water or public health statutes. This legislation has led to the promulgation of regulations, which, in many States, stipulate controls for the management of specific sources of contamination and standards for ground-water quality protection. Sources of ground-water contamination have historically been regulated by many different agencies within the States. Coordinating the activities of these agencies to ensure an effective ground-water protection program is a priority in at least 12 States.

Since the reauthorization of the Safe Drinking Water Act in 1986, many State and local governments have been actively moving to develop and implement WHP Programs. Section 1428 of the Safe Drinking Water Act specifies that each State must prepare a WHP Program and submit it to EPA by June 19, 1989. Many of the States and local governments are already conducting specific WHP activities. Twenty-seven States submitted WHP programs by the deadline, and additional States are pursuing other wellhead protection initiatives.

Over 40 States and Territories report active programs to classify their ground waters and to map vulnerable sources of ground-water supply. Many of the State classification programs have been designed to support the application of ground-water quality standards.

In recent years, the Federal Government has joined the States in their efforts to protect the Nation's ground water through programs mandated by the Clean Water Act, the Safe Drinking Water Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act, and the Federal Insecticide, Fungicide, and Rodenticide Act. In 1984, EPA developed a Ground-Water Protection Strategy that provides an approach to integrating source-specific control and cleanup programs into a comprehensive policy and institutional framework for protecting the resource from unacceptable levels of contamination. EPA is also working to strengthen ground-water data management through activities such as developing a minimum set of data elements for ground water, thus facilitating entry and retrieval of ground-water data.

NC Solid Waste Management Division

Abandoned hazardous waste sites are among the many threats to ground-water quality.

Are the Nation's Surface Water Pollution Control Programs Working?

The Clean Water Act (CWA) of 1972 provided the basic framework for Federal and State programs to regulate point and nonpoint sources of pollution. Although revised by amendments in 1977, 1981, and 1987, the basic framework embodied in the original Act continues to guide the Nation's water pollution control programs.

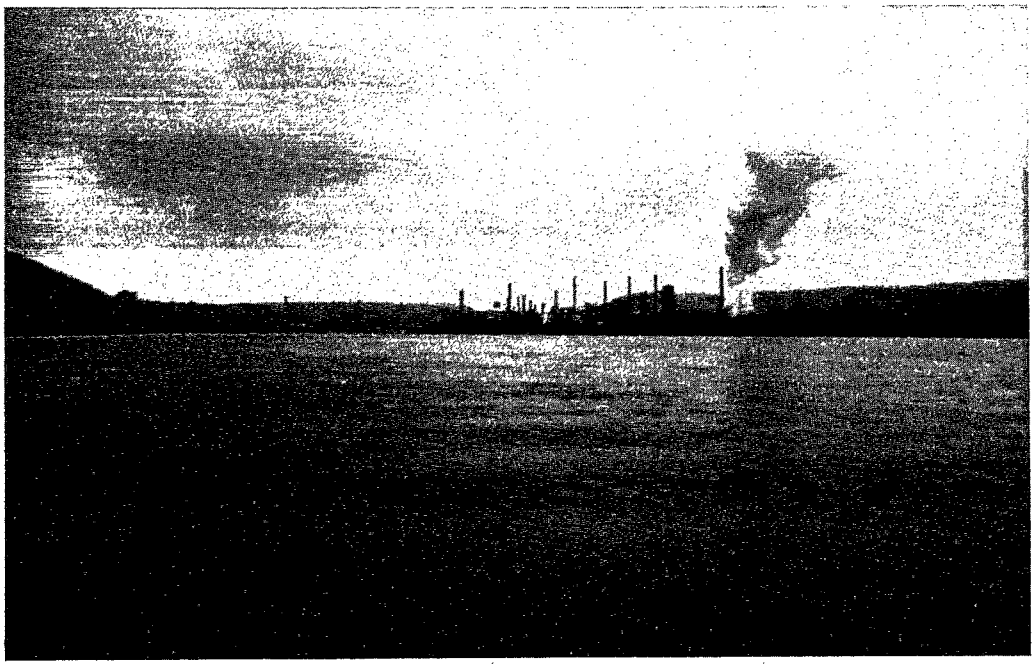
Point sources of pollution are regulated through permits issued by either EPA or the States. These permits contain limits on the amount and types of pollutants that may be discharged.

To control pollution from municipal dischargers, the CWA authorized EPA to provide grants and loans to the States. Expenditures under the construction grants program have produced significant gains for wastewater treatment. In 1972, 85 million people were served by secondary treatment or better; today, treatment facilities serving 144 million people have secondary or more advanced levels of treatment. According to EPA data, 87 percent of the Nation's municipal sewage treatment plants were in compliance with existing permit limits as of July 1, 1988. The States provide a number of examples of water quality improvements resulting from municipal construction and upgrading.

The Water Quality Act of 1987 includes a number of provisions to further improve municipal wastewater treatment. For example, control strategies must be developed for plants contributing to toxic problems in surface waters; EPA is directed to develop numerical limits for toxic pollutants of concern in sludge, the residual material from the wastewater treatment process; timetables were established for EPA to develop permits for storm water management; and a State Revolving Fund program was developed as a new financing mechanism for wastewater treatment.

In the early 1980s, significant backlogs of unissued permits for industrial dischargers had an adverse effect on water quality in the United States. EPA data reveal that efforts to remedy these backlogs have been largely successful; a 13 percent backlog currently exists for major sources. The data also show that industrial permittees have achieved a higher rate of compliance than municipal permittees: 93 percent of major industrial facilities were meeting their permit limits as of December 1988, compared to 87 percent of major municipal facilities.

Nonpoint sources of pollution are primarily addressed through programs at the State and local levels of government. Nonpoint source (NPS) management activities focus primarily on pollution prevention, as opposed to restoration. Approaches range from land use management to the implementation of structural and cultural practices designed to reduce the environmental impacts of human activities. Examples



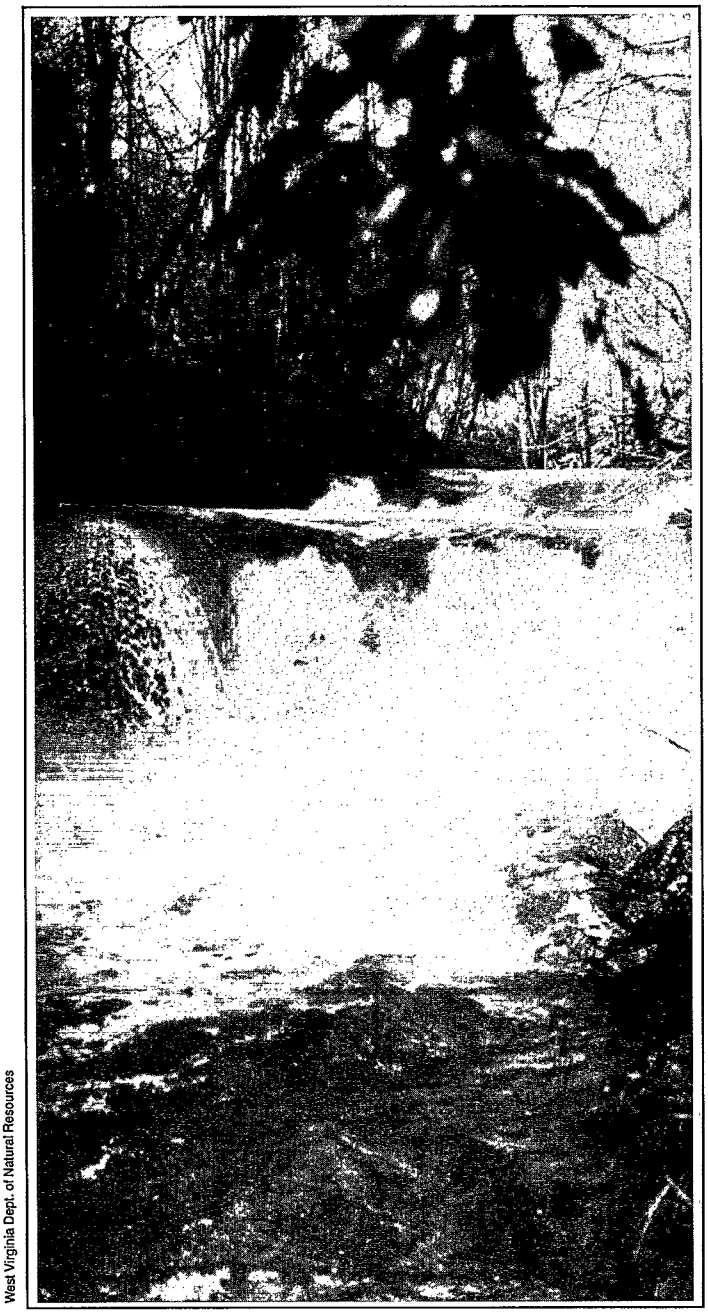
Mike McCarthy

of NPS management activities include preserving wetlands; managing nutrients and pesticides on farms; creating wet detention basins in urban areas; controlling stream acidification caused by abandoned coal mines; protecting salmonid fisheries from sediment entering streams from logging areas; and protecting and reestablishing riparian habitats. These activities may be imposed through regulatory or voluntary programs and are generally developed and applied on a site-specific basis.

Section 319 of the Water Quality Act of 1987 included provisions for the assessment and management of nonpoint sources. In its second NPS report to Congress entitled *A Report to The Congress: Activities and Programs Implemented Under Section 319 of the Clean Water Act—Fiscal Year 1988*, EPA reports that a variety of State and Federal activities have led to progress in reducing the impacts of NPS in specific waters. At the same time, several States have identified constraints affecting the implementation of NPS programs.

In January 1989, EPA completed a National NPS Agenda that will serve as the framework for the Agency NPS program over the next 5 years. The goal of the Agenda is to protect and restore the quality of U.S. waters through strong National leadership and by helping State and local governments overcome barriers to the successful implementation of NPS measures.

EPA has also initiated an NPS Agenda Task Force to explore new and creative approaches to achieving the goal of the Agenda. Likely approaches include raising public awareness of NPS; providing States and local governments with information on NPS solutions and incentives for their implementation; and developing water quality criteria and monitoring protocols specifically designed to assess NPS problems and evaluate NPS control activities.



West Virginia Dept. of Natural Resources

Introduction

Background

The Federal Water Pollution Control Act (commonly known as the Clean Water Act or CWA) has been the primary regulatory force protecting the Nation's water resources. A number of other statutes—for example, the Safe Drinking Water Act, the Marine and Estuarine Protection Act, and the Resource Conservation and Recovery Act—also directly address water quality issues. The objective of the Clean Water Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." An interim goal established to achieve this objective is that "wherever attainable . . . water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

In response to the Act, in the early 1970s the Federal government and the States developed new water pollution control programs and strengthened existing efforts to deal with the myriad sources adversely affecting water quality. The problems were daunting: industries and municipalities were discharging inadequately treated or raw wastes into rivers, lakes, and estuaries; the disposal of hazardous materials in landfills and dumpsites occurred without regulation or control; and little or no consideration was given to methods to control surface runoff of pesticides, fertilizers, and sediments.

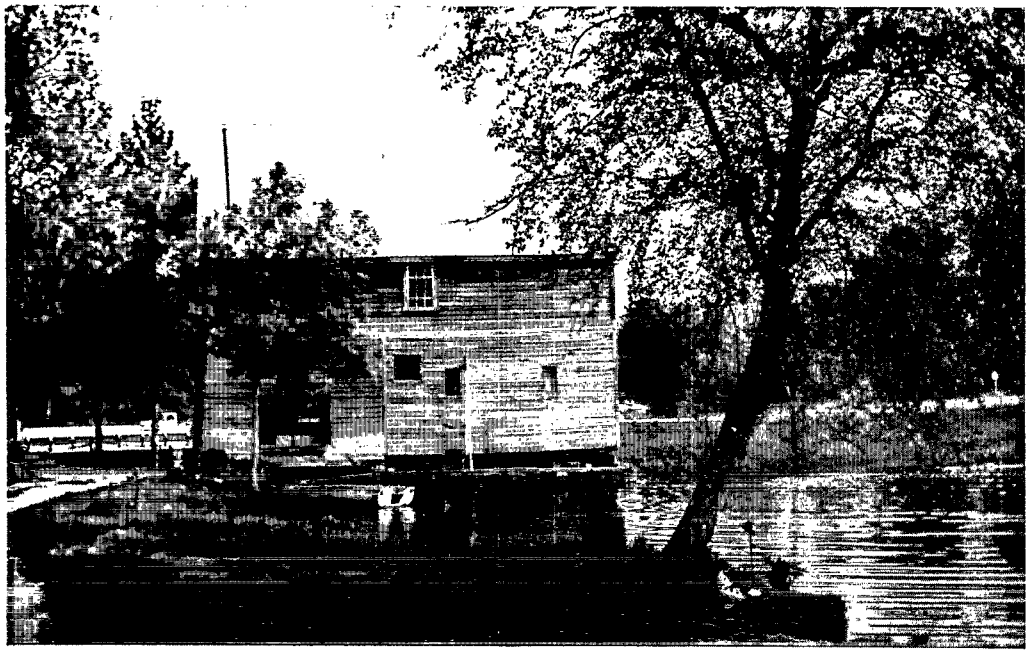
Significant progress was achieved under the CWA in the 1970s and 1980s in cleaning up the most pressing and obvious pollution problems. Industries and municipal sewage treatment plants were brought under regulation and achieved increasingly more stringent levels of control. State water pollution abatement and assessment programs grew more comprehensive. Yet along with the rising sophistication of these efforts came the realization that some problems were not being adequately addressed. Among these problems were sources of pollution that were difficult to identify and manage, such as runoff from agricultural lands and city streets; toxic contaminants for which methods of detection and control were highly expensive; and degradation of waters such as lakes, estuaries, and wetlands, which, because of their characteristics and uses, required unique approaches to pollution control.

Amendments to the Clean Water Act, passed in 1987, sought to address these problems. Among other things, the amendments require identification of specific degraded waters, development of strategies to control pollution in those waters, and application of additional resources to impaired estuaries and lakes. First-stage results of these new initiatives are included in this report.

Methodology

Section 305(b) of the Clean Water Act requires States to report to EPA on the extent to which their surface waters are meeting the goals of the Act and to recommend how the goals can be achieved. EPA, in turn, is to analyze these reports and transmit them and this national report to Congress. This report summarizes the States' 1988 reports, which contain data collected in 1986-1987.

A number of variables are involved in defining water quality, collecting monitoring data, and compiling and reporting on that information. EPA seeks to establish consistency among these variables by preparing guidelines for States' use in reporting water quality information. For example, these guidelines promote the use of a consistent measure of water quality based on the degree to which a waterbody is in compliance with the State water quality standards established for that waterbody. State water quality standards consist of the water quality objective, expressed as the "beneficial use," and numeric and narrative "criteria" designed to ensure maintenance of the beneficial use. EPA's Section 305(b) reporting guidelines require that States report on water quality in terms of the degree that beneficial uses are supported. Degree of use support is divided into four categories: fully supporting, fully supporting but threatened, partially supporting, and not supporting uses. Limited criteria for defining these categories have been developed, but States have considerable discretion in determining exactly how decisions about the degree of use support are made. Thus, the data reported by the States should be considered to represent State judgments about water quality.



AJ Peoples

Another method of defining water quality, as mentioned above, is by determining progress toward the goals of the CWA—that waters be of fishable and swimmable quality. EPA guidelines encourage reporting on this measure and seek to establish baseline definitions of fishability and swimmability.

Ideally, the State assessments should contain two types of water quality information: waterbody—specific and summary. This dual approach allows the State reports to serve various functions. The identification of specific problem areas and pollutants increases the usefulness of the reports in determining State management needs and pollution control priorities; summary data permit a "big picture" of State and national water quality to be drawn. In general, it is the State summary information that has been extracted and analyzed for this 1988 *National Water Quality Inventory*. In future 305(b) reporting cycles, considerably more emphasis will be placed on waterbody-specific information that will be managed using a computerized data system.

Some of the major data elements that were used in this report include the following:

- Total sizes of assessed waterbodies (in river miles, lake acres, estuarine square miles, coastal and Great Lake shoreline miles) per State that are fully, partially, or not supporting designated beneficial uses, and those that are threatened;

- Major causes of use impairment (i.e., pollutants or processes such as siltation causing degradation);

- Sources of pollution in those waters not fully supporting their uses; and

- Number of waters adversely affected by toxic pollutants.

Although many States have provided most or all of the summary data requested in the guidelines, others have not done so. For example, out of the 53 States, Territories, and jurisdictions that submitted water quality assessments in 1988 in time for their inclusion in this report:

- 48 provided information that could be used to derive the overall degree of designated use support for 519,412 stream miles, or 45 percent of the stream miles in these States;

- 40 provided information on designated use support for 16,313,962 acres of lakes and reservoirs, 73 percent of lake acres in these States;

- 23 out of 27 coastal States provided information on designated use support for 26,628 square miles of estuaries, 76 percent of the estuaries in these States;

- 15 States provided information on their existing wetland acreage and State wetland programs (no States assessed the quality of their wetlands);

- 38 reported on causes of nonsupport in impaired rivers, 33 reported on causes in impaired lakes, and 16 reported on causes in impaired estuarine waters;

- 37 reported usable information on sources of pollution in impaired rivers, 28 reported on sources in impaired lakes, and 14 reported on sources in impaired estuaries;

- 12 States reported on the extent of their wetland resources and the factors affecting those resources, 10 reported on their wetland protection programs; and

Ed Lui USEPA

The goal of the Clean Water Act is that the waters of the U.S. be fishable and swimmable.

■ 35 provided data on the total number of river miles affected by toxics; 28 reported on the number of lake acres affected by toxics, and 13 reported on the number of estuarine square miles affected by toxics.

However, despite incomplete reporting, the continuing effort to improve and better manage water quality data is succeeding. In 1988, the States provided more data on many topics of concern than in previous years. The number of waters assessed by the States has risen significantly. Current State and EPA initiatives to further improve water monitoring and reporting include implementing a computerized water quality data system to manage State information on the causes, sources, and magnitude of degradation in individual waterbodies, and developing more cost-effective monitoring techniques. EPA is also in the process of examining EPA and State monitoring efforts as part of planned revisions to program guidance for monitoring.

Nevertheless, the absence of data for some States limits EPA's ability to analyze the data over time and creates gaps in our understanding of water quality conditions nationwide. Another obstacle arises because of inconsistencies among States in how these data were generated. These inconsistencies are themselves the result of different State approaches to monitoring, different pollution problems and program needs, and the lack of generally accepted assessment methodologies.

For example, as mentioned previously, the standard measure for evaluating water quality is the degree to which designated uses are supported in a given waterbody. Determining the degree of use support involves a considerable amount of judgment, particularly for the aquatic life uses. It also may involve going beyond examination of the specific chemical criteria contained in State water quality standards. Such criteria are designed to support the use but are often incomplete compared to the range of potential pollutants and phenomena that adversely affect water quality and, ultimately, the degree of use support.

A wide degree of variation is evident among States in the number of river miles, lake acres, and estuarine square miles assessed for designated use support (see Table 1). Some States provided rather low estimates of their total number of waters; therefore, their percentages of total waters

NC NRCD

The number of waters assessed by the States has risen significantly.

Table 1. Percentage of Waters Assessed for Rivers, Lakes, and Estuaries*

State	Rivers		Lakes		Estuaries	
	Total Miles	Percent Assessed	Total Acres	Percent Assessed	Total Sq. Miles	Percent Assessed
Alabama	40,600	28	504,336	97	625	8
Arizona	6,671	34	—	—	NA	NA
Arkansas	11,508	36	—	—	NA	NA
California	26,970	37	1,417,540	76	1,598	69
Colorado	14,655	68	265,982	47	NA	NA
Connecticut	8,400	10	82,900	26	601	100
Delaware	500	93	—	—	—	—
Delaware River Basin	206	100	—	—	866	100
District of Columbia	36	72	377	36	6	100
Florida	12,659	63	2,085,120	45	4,298	62
Georgia	20,000	100	417,730	100	594	100
Hawaii	349	100	—	—	134	100
Illinois	14,080	92	247,188	74	NA	NA
Indiana	90,000	6	104,540	100	NA	NA
Iowa	18,300	45	81,400	99	NA	NA
Kansas	19,791	35	175,189	99	NA	NA
Kentucky	18,465	47	228,385	94	NA	NA
Louisiana	14,180	60	713,719	73	7,656	64
Maine	31,672	100	994,560	100	1,633	100
Maryland	9,300	100	17,448	100	1,981	100
Massachusetts	10,704	15	—	—	171	100
Michigan	36,350	100	840,960	50	NA	NA
Minnesota	91,944	5	3,411,200	42	NA	NA
Mississippi	15,623	100	500,000	100	133	100
Missouri	19,630	100	288,012	100	NA	NA
Montana	20,532	95	756,450	88	NA	NA
Nebraska	10,212	56	145,300	59	NA	NA
New Hampshire	14,544	9	151,000	99	27	63
New Jersey	—	—	—	—	420	62
New Mexico	3,500	33	126,500	95	NA	NA
New York	70,000	100	750,000	100	1,564	100
North Carolina	37,378	89	305,367	100	3,200	100
North Dakota	11,284	87	625,503	99	NA	NA
Ohio	43,917	16	117,323	77	NA	NA
Ohio River Valley	981	100	—	—	NA	NA
Oklahoma	19,791	47	—	—	NA	NA
Oregon	90,000	31	610,808	83	—	—
Pennsylvania	50,000	26	—	—	NA	NA
Puerto Rico	5,373	100	11,146	100	—	—
Rhode Island	724	80	16,520	97	192	100
South Carolina	9,900	38	525,000	78	2,155	29
South Dakota	9,937	38	1,598,285	41	NA	NA
Tennessee	19,124	49	538,657	100	NA	NA
Texas	80,000	17	1,410,240	100	1,990	100
Vermont	5,162	100	229,146	99	NA	NA
Virgin Islands	—	—	—	—	29	100
Virginia	27,240	13	161,562	100	2,382	76
Washington	40,492	11	613,582	26	2,943	72
West Virginia	28,361	50	19,171	100	NA	NA
Wisconsin	—	—	971,000	100	NA	NA
Wyoming	19,437	100	427,219	100	NA	NA
Totals	1,150,482	45	22,486,365	73	35,198	76

*Based on State estimates of total waters. — Not reported. Source: 1988 State Section 305(b) reports.

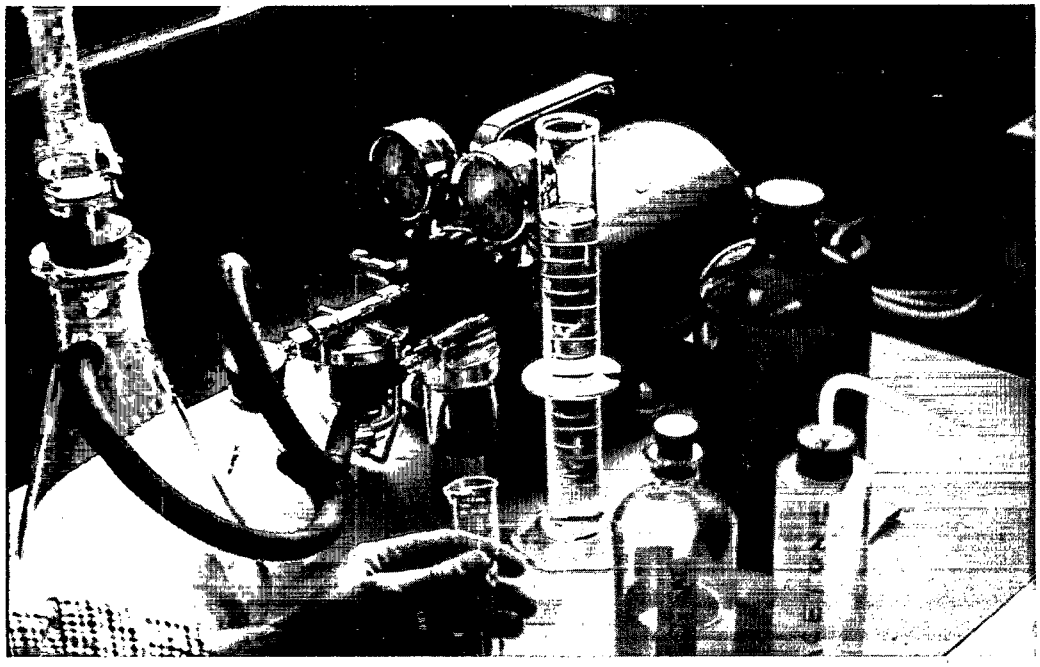
assessed may appear high by comparison with other States. Some States actually assessed a very high percentage of their waters because they used best professional judgment, information from citizens and other State agencies, and computer modeling to supplement actual chemical, biological, and physical monitoring data. Other States assessed a smaller percentage of their total stream miles because they preferred to rely almost exclusively on actual water quality monitoring data such as chemical and biological information from fixed stations and special surveys, and may have excluded supplemental sources of information.

Why do State monitoring strategies vary? Clearly, some States have more funds than others for these activities, just as some have more waters to deal with and some have more severe water quality problems. States heavily affected by diffuse and difficult-to-locate nonpoint sources may have to rely on other than traditional fixed station monitoring of chemical pollutants to determine water quality conditions.

On the other hand, States with high concentrations of industries and cities may find it more effective to rely on biological surveys and various chemical monitoring methods to assess water quality. Traditionally, then, each State weighs its needs and judges how it can best use its monitoring resources.

One drawback of this approach is that it results in a relatively small percentage of the Nation's waters being assessed. We assume that since States generally focus their monitoring resources on waters most likely to have problems—e.g., urban waters or those that are intensively used for recreational purposes—the remaining unassessed waters may be of better quality. EPA is encouraging increased water quality assessment in order to verify this and gain a more accurate picture of the Nation's waters as a whole. EPA has also asked States to identify which of their waterbodies were assessed using biological or chemical data (termed "monitored") and which were assessed using other types of data (termed "evaluated").

In addition to the problem of variations in the number of waters assessed, there are basic inconsistencies involving how support of designated uses is determined. Variability exists among States in defining the characteristics a waterbody must have to be fully, partially, or not supporting its uses and even what those uses should

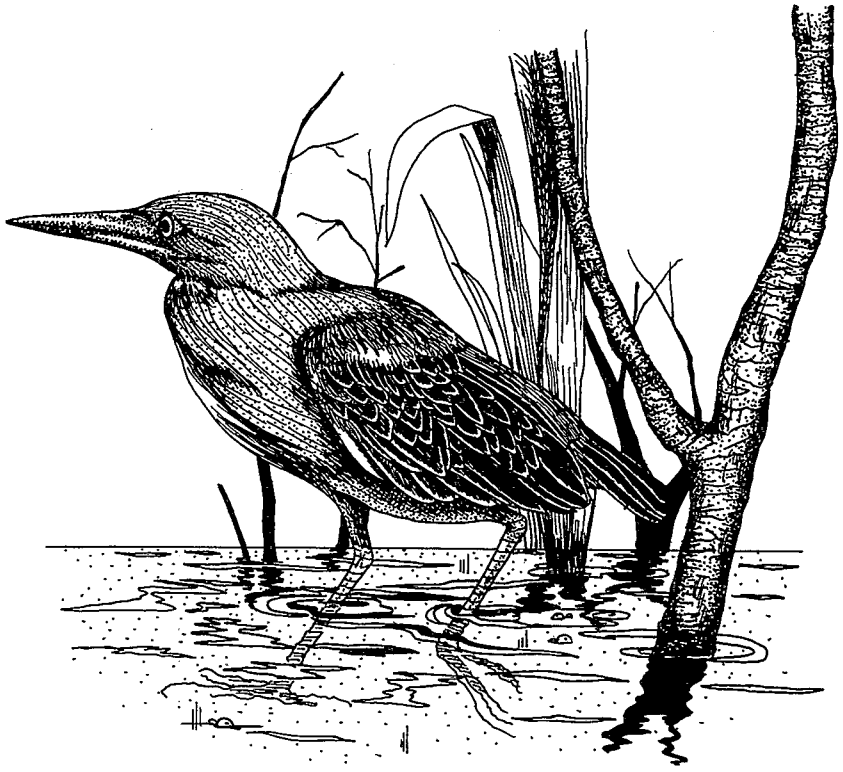


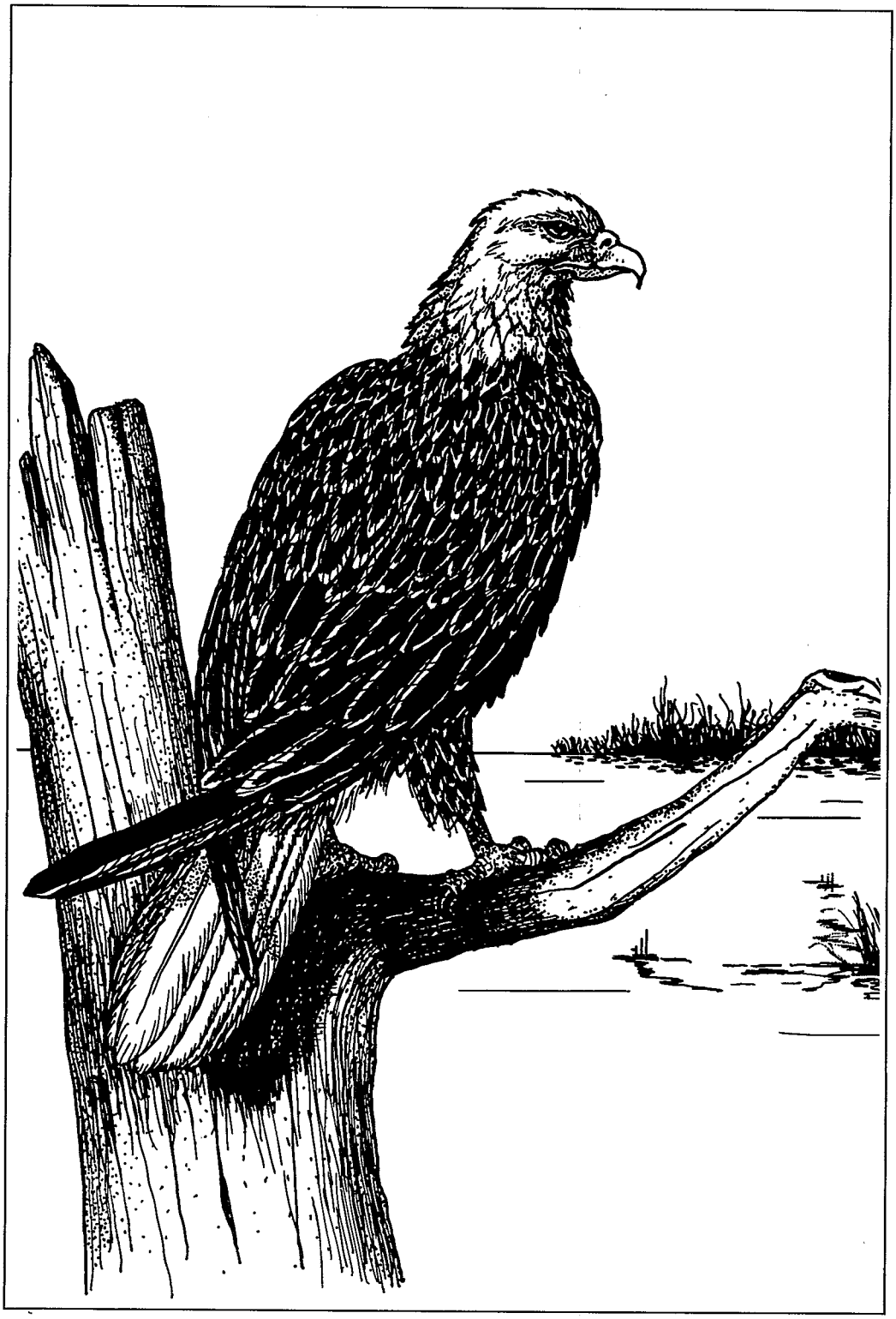
NALMS

States use a variety of methods to monitor their waters.

be. In part, this variability arises from the range of methods the States use to assess water quality. In many cases, biological, chemical, and evaluative data must all be weighed before a use support decision can be made. Other factors contributing to inconsistencies include widely divergent natural conditions among States and vast differences in the States' monitoring capabilities and resources. To address these problems, EPA is working with the States to develop improved guidance on making use support decisions. This guidance should greatly increase the consistency of State assessments of water quality. Other EPA activities include developing a consistent and accepted baseline of total State waters and encouraging the use of the Section 305(b) reporting process as a tool in managing toxicants, nonpoint sources, and lake/estuary/wetland protection programs.

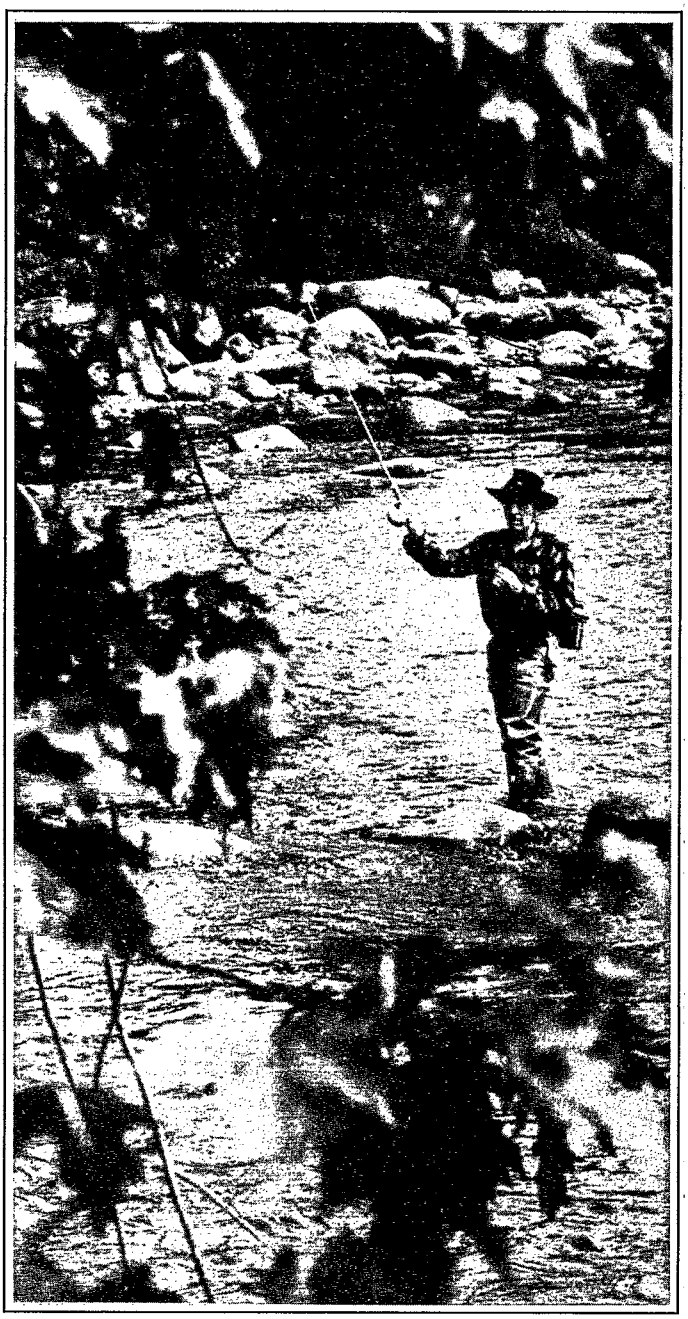
To further improve the Section 305(b) reporting process and to manage the various new assessments required by the Water Quality Act of 1987, EPA has developed a data system for managing water quality information for specific waterbodies. Design of the system—called the Section 305(b) Waterbody System (WBS)—began in 1986. The system was partially completed in late 1987, and eight States were able to use the WBS for their 1988 reports. Those States reported that the system was useful for organizing and analyzing their information and simplified the preparation of waterbody listings required by the Water Quality Act.





Surface Water Quality

1



Rivers and Streams

Support of Designated Uses

The standard measure of water quality reported by the States is the degree to which waters support the uses for which they have been designated, such as high-quality cold water fishery, contact recreation, or drinking water supply. In their 1988 State Section 305(b) reports, 48 States, Territories, jurisdictions, and Interstate Commissions (referred to, hereafter, as States) provided this information (see Table 1-1). These States assessed a total of 519,413 river miles—45 percent of the total stream miles estimated for these States and 29 percent of the Nation's estimated 1.8 million stream miles.*

Of those assessed waters, 361,332 miles, or 70 percent, were found to be fully supporting their designated uses. Ten percent of those fully supporting waters, or 36,038 stream miles, were identified as threatened waters that could soon become impaired if pollution control actions were not taken. Twenty percent of assessed waters, or 104,632 miles, were reported as partially supporting uses, and 10 percent, or 53,449 stream miles, were reported as not supporting uses (see Figure 1-1). Thirty-eight States specified the basis of their assessment decisions. In these States, 60 percent of assessed waters were evaluated using mathematical models, citizen complaints, questionnaires, etc., and

*Estimate from ASIWPCA, *America's Clean Water: The States' Nonpoint Source Assessment*, 1985.

Table 1-1. Designated Use Support in Rivers and Streams

State	Total River Miles	Miles Assessed			Miles Fully Supporting	Miles Threatened*	Miles Partially Supporting	Miles Not Supporting
		Total	Percent Evaluated	Percent Monitored				
Alabama	40,600	11,174	85	15	10,118	—	625	431
Arizona	6,671	2,279	—	—	1,583	400	207	489
Arkansas	11,508	4,107	46	54	1,714	—	29	2,364
California	26,970	9,885	—	—	6,578	—	2,219	1,088
Colorado	14,655	10,000	54	46	8,605	403	708	687
Connecticut	8,400	880	33	68	582	238	239	59
Delaware	500	467	0	100	280	—	156	31
Delaware River Basin	206	206	—	—	194	—	0	12
District of Columbia	36	26	0	100	0	0	0	26
Florida	12,659	7,943	27	73	5,287	—	2,021	635
Georgia	20,000	20,000	66	34	19,443	—	383	174
Hawaii	349	349	28	72	265	0	80	4
Illinois	14,080	12,970	23	77	5,783	172	7,001	186
Indiana	90,000	5,181	28	72	3,519	636	982	680
Iowa	18,300	8,235	75	25	69	69	6,503	1,663
Kansas	19,791	6,888	57	43	3,994	3,994	760	2,134
Kentucky	18,465	8,653	63	37	6,176	719	878	1,599
Louisiana	14,180	8,483	—	—	5,730	141	2,146	607
Maine	31,672	31,672	—	—	31,278	—	0	394
Maryland	9,300	9,300	84	16	8,635	—	504	161
Massachusetts	10,704	1,646	0	100	713	—	598	335
Michigan	36,350	36,350	—	—	35,567	—	0	783
Minnesota	91,944	4,443	0	100	1,553	—	564	2,326
Mississippi	15,623	15,623	87	13	13,850	359	1,331	442
Missouri	19,630	19,630	77	23	10,147	—	9,445	38
Montana	20,532	19,505	85	15	12,261	359	6,630	614
Nebraska	10,212	5,690	—	—	3,244	—	1,202	1,244
New Hampshire	14,544	1,331	77	23	950	—	210	171
New Mexico	3,500	1,152	—	—	576	—	554	22
New York	70,000	69,988	95	5	53,394	3,740	8,087	8,507
North Carolina	37,378	33,275	45	55	22,375	10,427	9,152	1,748
North Dakota	11,284	9,850	44	56	6,834	5,992	3,016	0
Ohio	43,917	7,045	0	100	2,256	—	1,501	3,288
Ohio River Valley	981	981	17	83	0	—	981	0
Oklahoma	19,791	9,248	36	64	3,306	2,442	3,512	2,430
Oregon	90,000	27,738	—	—	12,546	—	8,497	6,695
Pennsylvania	50,000	13,242	39	61	9,642	—	1,770	1,830
Puerto Rico	5,373	5,373	67	33	2,459	478	1,143	1,771
Rhode Island	724	581	43	57	489	271	14	78
South Carolina	9,900	3,795	0	100	2,824	—	395	576
South Dakota	9,937	3,750	18	82	1,387	484	1,260	1,103
Tennessee	19,124	9,428	—	—	5,976	1,598	2,484	968
Texas	80,000	13,998	0	100	12,169	0	0	1,829
Vermont	5,162	5,162	83	17	4,534	908	379	249
Virginia	27,240	3,532	0	100	1,210	—	1,401	921
Washington	40,492	4,621	22	78	2,295	1,269	1,608	718
West Virginia	28,361	14,301	46	54	2,862	128	10,107	1,332
Wyoming	19,437	19,437	67	33	16,080	811	3,350	7
Totals	1,150,482	519,413			361,332	36,038	104,632	53,449

*Miles Threatened is a subset of Miles Fully Supporting. — Not reported. Source: 1988 State Section 305(b) reports.

40 percent were monitored using ambient chemical and biological data (see *Making Assessment Decisions* for further discussion).

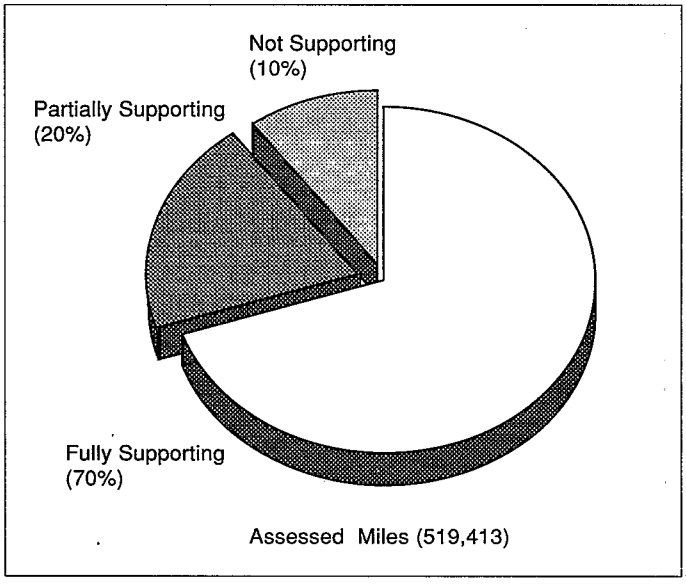
Table 1-1 illustrates some of the inconsistencies that hamper the Section 305(b) reporting and assessment process. First, ten States failed to provide usable information on support of designated uses. Second, of those States that provided data, variations exist in the percent of total State waters assessed and in the methods of assessing use support. For example, four States assessed 10 percent or less of their total waters, while ten States reported that they assessed all or nearly all of their waters. Similarly, miles fully supporting uses ranged from zero to 99 percent of assessed State waters, a variation more likely attributable to the portion of the State's waters assessed and different methodologies than to radically different water quality.

Caution should therefore be used in interpreting these numbers: they should not be compared to those of previous 305(b) reporting cycles, nor should they be used to draw comparisons among States. Differences in any given State's summary information from one year to the next may be due to the State's reporting on different waters or to changes in methods of assessing use support.

Causes of Impairment

States were asked to identify the causes of nonsupport in waters not fully supporting uses. Causes of nonsupport are those pollutants (such as pesticides or nutrients) or pollution processes (such as habitat destruction) that are impairing the waterbodies. In 1988, 38 States provided data on the number of stream miles affected by the different causes of nonsupport (see Table 1-2).

Any given stream mile can be affected by many causes. Therefore, States were asked to include each stream mile under each of the cause categories that contributes to impairment, also assigning a degree of impact, reported here as major or moderate/minor. (Data from States that did not specify degree of impact are depicted in Figure 1-2 as "unspecified." In Table 1-2, they are included under the "Major" heading.) Therefore, a single river mile is counted under several categories if it is affected by multiple causes. The values reported are the total number of river miles affected by a particular cause of impairment, according to whether the cause is a major or moderate/minor contributor to impairment. The relative extent of each cause of nonsupport can be determined by dividing the



Source:1988 State Section 305(b) reports.

Figure 1-1. Designated Use Support in Assessed Rivers and Streams

Sediments and nutrients, both predominantly from diffuse sources such as agriculture, are leading causes of impairment in streams.

Table 1-2. Impaired River Miles Affected by Causes of Pollution

State	Total Impaired Waters*	Siltation		Nutrients		Pathogens		Organic Enrichment	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama**	1,056	57	—	879	—	—	—	931	—
Arkansas	2,393	—	—	—	—	1,759	199	56	—
Colorado	1,395	—	—	—	—	176	505	21	—
Connecticut	298	—	12	119	44	112	64	85	71
Delaware**	187	—	—	126	—	144	—	76	—
District of Columbia	26	—	—	—	—	7	18	—	—
Florida**	2,656	376	—	992	—	376	—	990	—
Georgia	557	—	—	—	—	9	183	163	192
Illinois	7,187	129	6,660	375	7,095	147	241	155	1,270
Indiana	1,662	14	167	82	173	413	375	192	320
Iowa	8,166	6,751	1,408	42	8,107	1,190	141	25	1,431
Kansas	2,894	—	35	—	49	1,238	741	81	406
Kentucky	2,477	724	126	100	4	969	—	300	114
Louisiana	2,753	—	22	513	808	405	1,451	514	1,086
Maryland	665	157	16	259	93	102	144	43	42
Minnesota**	2,890	1,870	—	1,567	—	2,196	—	1,999	—
Mississippi	1,773	415	181	595	911	—	28	78	423
Missouri	9,483	6	8,299	—	—	—	—	1	58
Montana	7,244	394	6,441	310	2,895	79	410	22	92
New Hampshire	381	—	—	—	—	136	232	69	62
New Mexico	576	108	313	31	193	11	71	—	—
New York	16,594	126	44	8	151	15	144	66	122
North Carolina**	10,900	6,299	—	—	—	77	—	115	—
North Dakota	3,016	1,396	748	1,286	1,725	289	1,110	210	156
Ohio River Valley	981	—	981	—	—	162	26	—	250
Oklahoma**	5,942	2,804	—	2,582	—	1,180	—	518	—
Oregon**	15,192	1,260	—	745	—	885	—	603	—
Pennsylvania**	3,600	—	—	368	—	194	—	278	—
Puerto Rico	2,914	224	151	91	368	383	228	34	283
Rhode Island	92	—	—	16	4	20	33	17	18
South Carolina**	971	—	—	—	—	618	—	321	—
South Dakota	2,363	110	275	—	232	150	1,003	—	161
Tennessee	3,452	1,426	952	245	969	546	831	504	1,224
Vermont	628	342	123	205	122	64	174	132	256
Virginia	2,322	—	—	—	—	820	1,016	20	90
Washington	2,326	425	376	238	251	805	865	184	364
West Virginia	11,439	846	4,405	383	1,602	57	363	627	2,948
Wyoming	3,357	—	2,623	—	—	—	273	—	—
Totals	142,808	26,259	34,358	12,157	25,796	15,734	10,869	9,430	11,439
Combined Totals			60,617		37,953		26,603		20,869
Percent of Impaired Waters			42.4%		26.6%		18.6%		14.6%

*The sum of partially and nonsupporting river miles (Table 1-1).

**These States did not specify the degree of impact (i.e., Major or Moderate/Minor); river miles were placed in the "Major" column for national reporting purposes.

Metals		Pesticides		Suspended Solids		Salinity		Flow Alteration		Habitat Modification		pH		Thermal Modification	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
51	—	—	—	—	—	—	—	155	—	—	—	21	—	—	—
—	—	—	—	—	—	—	15	—	—	—	—	56	62	—	—
527	767	—	—	—	—	—	—	—	—	—	—	—	—	—	—
69	29	—	—	—	11	—	—	—	—	10	101	—	—	—	—
24	—	19	—	—	—	—	—	—	—	—	—	16	—	—	—
24	3	—	—	—	—	—	—	—	—	—	—	—	7	—	—
280	—	—	—	—	—	259	—	—	—	—	—	—	—	—	—
—	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	908	—	131	—	—	—	18	—	701	371	1,242	14	141	—	—
66	194	68	232	—	—	—	—	4	13	14	—	44	113	—	6
2,358	213	545	7,603	—	—	—	—	—	—	3	86	92	—	—	—
114	—	—	—	—	—	800	141	89	294	—	—	22	30	—	—
370	125	28	—	—	—	158	50	—	—	111	20	185	—	—	—
26	5	—	103	339	646	18	323	—	22	—	—	—	—	—	20
—	—	—	13	—	—	—	—	—	7	—	—	49	67	—	—
—	—	—	—	—	—	—	—	—	—	—	—	354	—	—	—
83	306	162	628	—	—	11	5	—	—	—	—	—	172	—	—
—	24	—	883	—	—	—	—	—	—	—	180	15	40	—	—
284	606	—	—	—	—	140	2,981	231	2,312	—	1,510	614	97	213	1,441
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
82	35	—	—	—	—	56	—	72	30	275	108	27	60	—	—
11	88	5	47	—	—	9	13	56	95	—	—	60	—	103	10
246	—	—	—	—	—	—	—	—	—	—	—	48	—	—	—
255	321	31	—	1,041	363	426	459	234	100	—	—	—	—	—	—
981	—	—	981	—	—	—	—	—	—	—	—	—	—	—	—
684	—	2,381	—	1,969	—	1,154	—	22	—	—	—	22	—	—	—
—	—	52	—	—	—	—	—	1,355	—	1,480	—	455	—	1,320	—
834	—	175	—	544	—	—	—	—	—	—	—	730	—	16	—
12	33	14	86	—	—	1	—	300	1	43	—	—	—	—	—
70	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
11	—	—	—	772	964	—	—	—	—	—	—	—	656	5	4
87	548	60	205	848	706	8	11	144	250	113	172	150	336	14	39
10	17	—	—	—	—	—	—	168	89	259	150	16	3	116	358
—	—	—	—	—	—	—	—	—	—	—	—	81	256	—	39
187	632	120	43	224	469	—	58	201	65	289	26	135	136	248	874
1,308	1,544	—	2	—	—	80	648	356	538	135	724	1,031	866	94	665
7	—	—	130	—	—	—	811	—	347	—	741	—	—	—	—
9,084	6,410	3,660	11,087	5,737	3,159	3,120	5,533	3,387	4,864	3,103	5,060	4,239	3,042	2,129	3,456
	15,494		14,747		8,896		8,653		8,251		8,163		7,281		5,585
	10.8%		10.3%		6.2%		6.1%		5.8%		5.7%		5.1%		3.9%

— Zero or not reported.

Source: 1988 State Section 305(b) reports.

total number of miles affected by each cause category by the total miles impaired (see Figure 1-2).

Figure 1-2 illustrates that siltation, the smothering of stream beds by sediments (usually from accelerated soil erosion), is the most commonly reported cause of nonsupport in the Nation's rivers and streams, affecting 42 percent of impaired river miles. Nutrients, the second most commonly reported cause, affect 27 percent of impaired river miles and most often consist of phosphorus and nitrogen compounds such as those used in agricultural fertilizers. Both siltation and nutrients are predominantly from diffuse sources.

Fecal coliform bacteria are organisms commonly monitored as indicators of possible pathogen contamination of waters. Pathogen contamination (cited as the third leading cause of impairment nationwide) may impair drinking water supply and contact recreation uses. Such contamination may come from inadequately treated sewage or runoff from pastures, feedlots, and urban areas. These pathogen indicators were found to affect 19 percent of impaired waters.

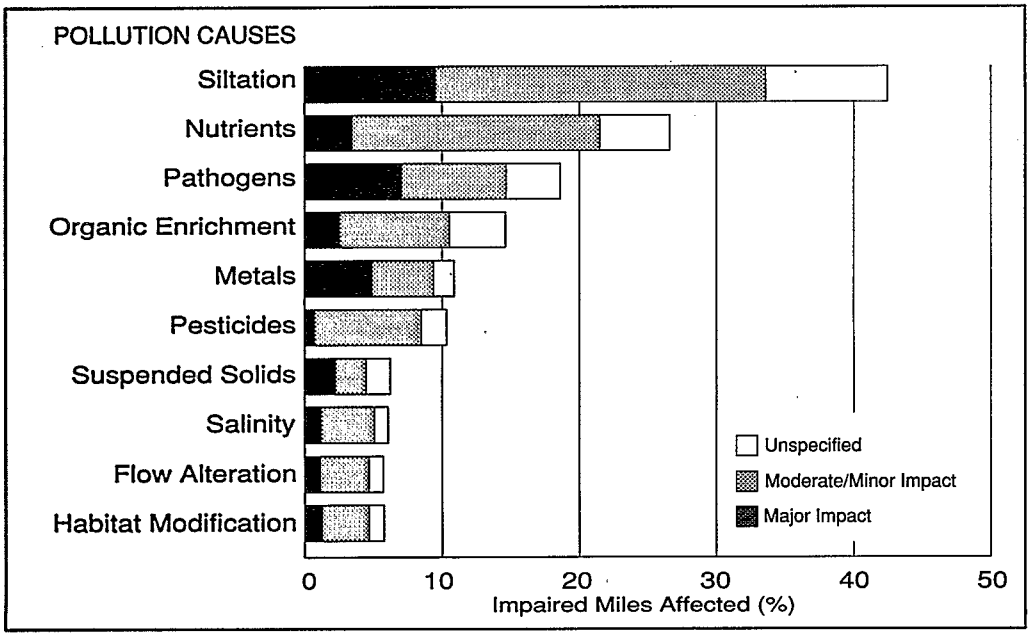
The next most common cause is organic enrichment/low dissolved oxygen, affecting 15 percent of impaired river miles. This cause may be closely linked to sewage treatment plants, feedlots, and nutrients. Nutrients can stimulate the growth of algae, which often leads to a drop in levels of dissolved oxygen.

The fifth and sixth most commonly reported causes of impairment are metals (such as lead, copper, and mercury) and pesticides (such as chlordane, dieldrin, and DDT), respectively. Other significant causes include suspended solids, salinity, flow alteration, other habitat modification, pH, and thermal modification.

These national summary figures should be interpreted with care, as a close look at Table 1-2 reveals that certain States are reporting a large proportion of the impact from these causes of impairment. For example, Iowa alone accounts for over half of the total river miles affected by pesticides, and Montana accounts for about a third of all stream miles affected by salinity and flow alteration. Reporting inconsistencies influence these findings.

Twenty-nine States specified the degree of impact (i.e., major or moderate/minor) of the causes affecting their rivers and streams. For most categories of causes, there were more waters in which the cause was a moderate/minor contributor to impairment than a major contributor. For only two categories of causes—metals and suspended solids—did major impacts outweigh moderate/minor impacts. In 52 percent of the waters affected by metals, the impact of metals was considered major, as was the impact of suspended solids in 51 percent of affected waters.

Other causes with a high percentage of major impact include pathogens (major impact in 48 percent of affected waters), pH (major impact in 46 percent), and siltation (major impact in 28 percent).



Source: 1988 State Section 305(b) Reports.

Figure 1-2. Percent of Impaired River Miles Affected by Each Pollution Cause

Sources of Impairment

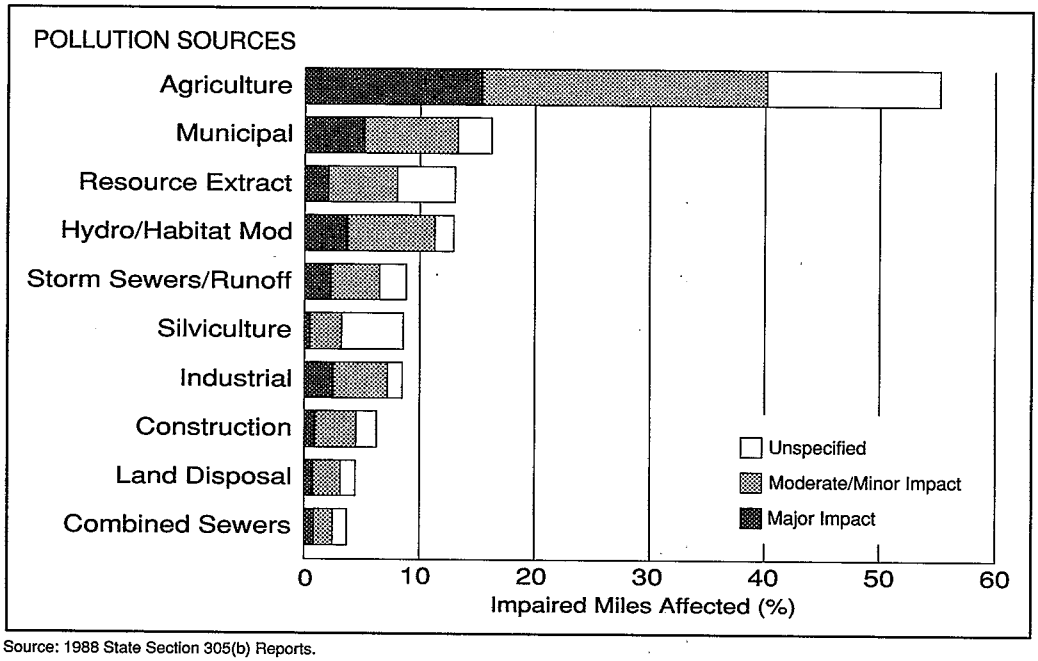
In their 1988 State Section 305(b) reports, 37 States provided information on the various sources of pollution contributing to use impairment in rivers, such as municipal discharges and agricultural runoff. Sources of impairment are those activities that contribute pollutants or result in harmful processes such as siltation (see *Highlight—Sources of Pollution Reported by the States).* Table 1-3 displays the categories of sources and the size of waters affected by each.

As with causes of impairment, any given stream mile can be affected by many sources. Therefore, States were asked to include each stream mile under each source category that contributes to impairment, also assigning a degree of impact, reported here as major or moderate/minor. (Data from States that did not specify degree of impact are depicted in Figure 1-3 as "unspecified." In Table 1-3, they are included under the "Major" column heading.) As a result, a single river mile will be counted under several categories if it is affected by multiple sources. The values reported are the total number of river miles affected by a particular source of impairment according to whether the source is a major or moderate/minor contributor to impairment. The relative extent of each source of nonsupport can be determined by dividing the total number of miles affected by each source category by the total miles impaired (see Figure 1-3.)

Some ambiguity occurs when defining the source categories used in Table 1-3. For example, States were asked to report separately on stream miles affected by storm sewers and miles affected by urban runoff (primarily surface runoff). Some States made this distinction, while others did not and chose to report only in the urban runoff category. Since separate storm sewers are designed to convey urban surface runoff, it is very difficult to distinguish between storm sewer discharges and urban runoff. Therefore, for purposes of analysis, these numbers were combined into one category reflecting waters affected by storm sewers/runoff. Entries in this category in Table 1-3 may also reflect additional information provided by some States subsequent to their 305(b) submission. This problem has been corrected for the next reporting cycle.

Table 1-3 reveals that the most extensive source of pollution reported for the Nation's rivers is agricultural runoff, which affects 55 percent of impaired river miles. Other extensive sources include municipal dischargers, affecting 16 percent; resource extraction and hydrologic/habitat modification, affecting 13 percent; and storm sewers/runoff, industrial dischargers, and silviculture, each affecting about 9 percent of impaired river miles.

As was the case with causes of impairment, this source information should be



Source: 1988 State Section 305(b) Reports.

Figure 1-3. Percent of Impaired River Miles Affected by Each Pollution Source

Table 1-3. Impaired River Miles Affected by Sources of Pollution

State	Total Impaired Waters*	Agriculture		Municipal		Resource Extraction		Hydrologic/ Habitat Modification	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama**	1,056	35	—	694	—	76	—	160	—
Arkansas	2,393	1,722	174	294	—	117	85	—	—
California**	3,307	395	—	51	—	301	—	—	—
Connecticut	298	—	102	212	52	—	44	10	69
Delaware**	187	146	—	35	—	—	—	—	—
District of Columbia	26	—	—	4	—	—	—	—	3
Florida**	2,656	1,711	—	785	—	464	—	880	—
Georgia	557	—	—	140	189	—	—	—	—
Illinois	7,187	144	6,964	371	2,405	14	1,211	223	3,526
Indiana	1,662	47	934	285	217	49	121	—	—
Iowa	8,166	7,395	753	524	828	—	103	—	86
Kansas	2,894	918	677	512	546	229	12	89	280
Maryland	665	172	133	33	94	49	84	—	5
Mississippi	1,773	933	288	135	345	—	—	19	—
Missouri	9,483	—	8,267	16	58	22	88	—	189
Montana	7,244	420	5,603	43	118	319	1,385	171	1,299
Nebraska**	2,446	1,394	—	441	—	—	—	196	—
New Hampshire	381	—	—	92	190	—	—	—	—
New Mexico	576	36	374	34	—	37	21	87	13
New York	16,594	33	22	153	130	1	16	97	41
North Carolina**	10,900	5,559	—	635	—	19	—	—	—
North Dakota	3,016	1,539	1,472	12	1,339	—	255	1,228	589
Ohio	4,789	917	1,724	2,831	929	649	328	931	1,203
Ohio River Valley	981	350	280	—	—	350	280	—	—
Oklahoma**	5,942	3,986	—	—	—	2,302	—	1,103	—
Oregon**	15,192	7,605	—	1,062	—	2,280	—	—	—
Pennsylvania**	3,600	464	—	378	—	1,775	—	31	—
Puerto Rico	2,914	294	684	79	34	—	—	49	—
Rhode Island	92	16	2	18	32	—	—	—	—
South Carolina**	971	364	—	170	—	—	—	2	—
South Dakota	2,363	1,187	1,022	11	43	—	62	—	—
Tennessee	3,452	1,289	1,269	628	924	360	700	847	1,102
Vermont	628	510	—	86	—	42	—	326	—
Virginia	2,322	453	801	229	145	—	—	—	—
Washington	2,326	1,049	564	143	694	27	54	522	581
West Virginia	11,439	517	2,748	535	2,281	645	2,953	220	1,501
Wyoming	3,357	2,192	734	6	110	54	770	569	378
Totals	143,835	43,792	35,591	11,677	11,703	10,181	8,572	7,760	10,865
Combined Totals			79,383		23,380		18,753		18,625
Percent of Impaired Waters			55.2%		16.3%		13.0%		12.9%

*The sum of partially and nonsupporting river miles (Table 1-1).

**These States did not specify the degree of impact (i.e., Major or Moderate/Minor); river miles were placed in the "Major" column for national reporting purposes.

Storm Sewers/ Runoff		Silviculture		Industrial		Construction		Land Disposal		Combined Sewers	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
69	—	—	—	406	—	6	—	—	—	—	—
—	—	—	—	115	39	—	—	—	—	—	—
—	—	—	—	8	—	—	—	—	—	—	—
—	148	—	—	69	48	—	16	13	111	126	11
99	—	—	—	37	—	4	—	—	—	69	—
—	26	—	—	1	—	—	1	—	13	—	26
1,786	—	63	—	578	—	792	—	947	—	—	—
9	183	—	—	24	11	—	—	—	—	—	—
38	112	—	—	14	1,201	—	470	14	16	113	692
145	112	—	—	165	225	26	56	12	1	386	130
680	1,234	—	—	219	221	—	16	3	165	—	—
37	13	—	—	124	92	—	—	—	—	—	—
15	108	—	—	2	—	—	—	22	—	—	12
46	97	—	—	103	214	—	—	—	—	—	—
—	154	—	—	—	10	—	—	—	1	—	—
27	61	44	806	—	233	5	762	22	154	—	—
24	—	—	—	49	—	—	—	—	—	—	—
—	—	—	—	38	36	—	—	—	92	10	78
—	—	3	76	—	—	3	87	3	15	—	—
1	98	—	32	28	90	—	32	62	133	36	70
274	—	48	—	159	—	79	—	59	—	—	—
12	31	—	—	—	91	—	—	—	—	—	—
503	883	9	29	1,061	629	9	85	243	977	10	26
150	—	—	—	—	—	—	—	—	—	—	—
853	—	20	—	—	—	271	—	666	—	—	—
—	—	7,580	—	368	—	1,420	—	—	—	1,675	—
49	—	—	—	201	—	—	—	169	—	39	—
302	223	—	—	58	126	—	—	208	466	—	1
62	9	—	—	1	69	16	—	16	2	15	3
157	—	4	—	55	—	4	—	—	—	—	—
47	215	—	—	11	—	—	26	—	26	—	—
252	796	76	64	191	386	110	822	14	155	78	22
55	—	23	—	16	—	142	—	32	—	—	—
87	69	—	—	48	13	—	—	—	—	—	4
354	103	100	138	113	246	239	89	201	228	12	31
489	1,133	426	2,728	856	2,674	446	1,769	224	878	428	1,233
10	282	58	65	334	169	362	858	—	—	—	—
6,632	6,090	8,454	3,938	5,452	6,823	3,934	5,089	2,930	3,433	2,997	2,339
	12,722		12,392		12,275		9,023		6,363		5,336
	8.8%		8.6%		8.5%		6.3%		4.4%		3.7%

— Zero or not reported.

Source: 1988 State Section 305(b) reports.

Sources of Pollution Reported by the States

Point and nonpoint source categories of pollution are not clearly defined in all cases. many source categories have significant point and nonpoint elements. For example, storm sewers/ runoff and resource extraction are sources that may be addressed both via point source control measures (i.e., permits) or nonpoint source best management plans. The following categories were used in the analysis of State data and are not intended as legal definitions.

Point Sources

- Discharge into waterways via a discrete "point" such as a pipe or ditch.
- Are subject to permits issued by the State or EPA that limit allowable amounts of pollutants.
- Are also subject to enforcement action if their permit limits are violated.

Nonpoint Sources

- Enter waterways generally as runoff from widespread (i.e., "nonpoint") areas.
- Are addressed via voluntary controls, best management practices, incentive programs, demonstration programs, and to some extent by regulatory programs at State or local level.

Source Categories Used in This Report

Industrial (e.g., pulp and paper mills, chemical manufacturers, steel plants, textile manufacturers, food processing plants, etc.);

Municipal (e.g., publicly owned sewage treatment plants which may receive indirect discharges from small factories or businesses);

Combined Sewers (storm and sanitary sewers combined, which may discharge untreated wastes during storms);

Storm sewers/runoff (runoff from streets, paved areas, lawns, etc., that enters a sewer, pipe, or ditch before discharge);

Agricultural (e.g., crop production, pastures, rangeland, feedlots);

Silvicultural (e.g., forest management, harvesting, road construction);

Construction (e.g., highway building, land development);

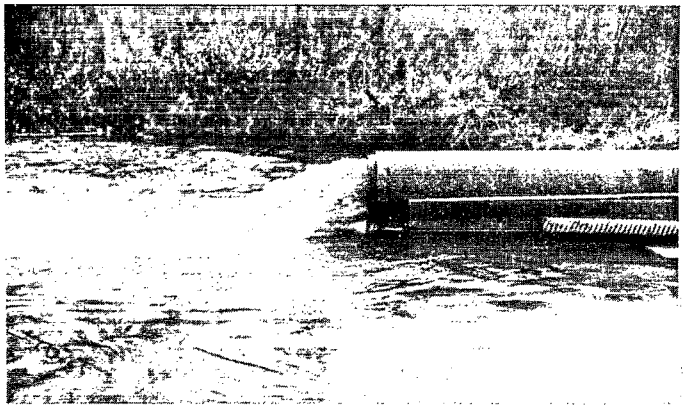
Resource extraction (e.g., mining, petroleum drilling, runoff from mine tailing sites);

Land disposal (e.g., leachate or discharge from septic tanks, landfills, hazardous waste disposal sites); and

Hydromodification (e.g., channelization, dredging, dam construction, streambank modification).

interpreted with care; a close look at Table 1-3 reveals that some States appear to predominate over others in the number of miles with impacts due to the various sources. For example, 61 percent of the river miles with silvicultural impacts are in Oregon alone.

Twenty-seven States specified the degree of impact (i.e., major or moderate/minor) of the pollution sources affecting their rivers. For no source category did major impacts outweigh moderate/minor impacts. The two sources that had the greatest percentage of miles with major impacts are municipal and agricultural sources, with 39 and 38 percent, respectively. In 35 percent of the miles with storm sewers/ runoff impacts, these impacts are considered major, as they are in 34 percent of the miles in the industrial category. Other sources with a high percentage of major impacts include combined sewer overflows and hydrologic/habitat modification, with major impacts in 34 percent and 33 percent of impaired river miles, respectively.



NC NRCD

Attainment of the Clean Water Act Goals

As stated at the beginning of the Clean Water Act, "It is the national goal that, wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 9, 1983." Most U.S. waters are classified to reflect these benchmarks, which are commonly referred to as the fishable and swimmable goals of the Clean Water Act (CWA). Support of CWA goals is considered a separate and independent criterion from the degree of designated use support.

Meeting the fishable goal is defined by EPA for the purpose of the 305(b) process as providing a level of water quality consistent with the goal of protection and propagation of a balanced population of shellfish, fish, and wildlife. Fishing advisories, consumption bans, and high incidences of fish abnormalities are indications that waters are not supporting healthy aquatic populations and do not support the fishable goal. Meeting the swimmable goal is defined by EPA as providing a level of water quality that allows for recreational activities *in and on* the water.

In some cases, the achievement of the CWA goals is precluded by physical constraints, irrevocable water quality impacts, and severe socioeconomic impacts. In these cases, State water quality standards may exclude the fishable or swimmable goal based on the results of a special study of use attainability. Thus, there are three possible outcomes for any waterbody when the question of CWA goal support is considered, as follows:

- Fishable and/or swimmable goals are supported;
- Fishable and/or swimmable goals are not supported but are attainable; and
- State water quality standards do not include fishable and/or swimmable uses (i.e., the CWA goals are not attainable).

In their 1988 water quality assessments, 44 States provided data on the attainment of the fishable and swimmable CWA goals in their rivers and streams (see Table 1-4). A total of 480,503 river miles were assessed for the fishable goal; 86 percent were found to be attaining the use, 11 percent were currently not attaining but could sometime in the future, and 3 percent were determined to be "not attainable" (see Figure 1-4).

Progress toward the CWA swimmable goal was assessed in 414,923 stream miles. Eighty-five percent were found to be attaining the swimmable goal, 11 percent were currently not attaining

Table 1-4. Attainment of Clean Water Act Goals in Rivers and Streams

State	Fishable Goal (miles)				Swimmable Goal (miles)			
	Assessed	Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Not Meeting	Not Attainable
Alabama	11,174	9,925	801	448	11,174	9,925	801	448
Arkansas	10,820	10,581	239	—	10,099	8,107	1,992	—
Colorado	10,823	8,960	1,040	823	10,000	9,474	526	0
Connecticut	880	738	140	2	880	682	196	2
Delaware	467	349	118	—	467	309	158	—
Delaware River Basin	206	206	0	0	206	194	12	—
District of Columbia	26	0	26	0	26	0	26	0
Florida	7,943	7,308	600	35	7,943	7,308	600	35
Georgia	20,000	19,443	557	—	—	—	—	—
Hawaii	349	349	0	0	349	349	0	0
Illinois	12,970	12,488	482	0	2,994	730	2,189	75
Indiana	5,181	4,089	1,015	77	5,181	4,269	835	77
Iowa	8,235	6,714	1,497	24	8,235	1,638	580	6,017
Kansas	6,910	6,590	320	—	5,079	4,027	1,052	—
Kentucky	8,633	7,841	792	—	2,406	1,308	1,098	—
Louisiana	8,483	8,458	25	—	8,483	8,390	93	—
Maine	31,672	31,377	295	0	31,672	31,377	295	0
Maryland	9,300	8,660	640	—	9,300	9,286	14	—
Massachusetts	1,646	1,498	148	—	1,646	760	886	—
Mississippi	15,622	15,200	422	0	15,622	14,785	837	0
Missouri	19,630	10,147	1,037	8,446	19,630	10,147	1,037	8,446
Montana	19,505	18,891	614	0	19,505	19,505	0	0
Nebraska	5,690	4,476	1,214	—	2,264	810	1,454	—
New Hampshire	1,331	1,160	171	0	1,331	950	334	47
New Jersey	1,867	1,463	404	—	592	91	501	—
New Mexico	576	554	22	0	576	576	0	0
New York	70,000	53,700	15,000	1,300	70,000	69,200	800	0
North Carolina	33,275	22,375	10,900	—	33,275	22,375	10,900	—
North Dakota	9,851	9,389	462	0	9,851	9,287	564	0
Ohio River Valley	981	941	40	0	981	819	162	0
Oklahoma	19,791	18,834	436	521	19,791	17,663	2,128	0
Oregon	27,738	26,197	1,541	—	27,738	26,772	966	—
Pennsylvania	13,242	9,642	3,600	—	13,242	9,642	3,600	—
Puerto Rico	5,373	3,687	1,359	327	5,373	3,650	1,151	572
Rhode Island	581	465	27	89	581	465	27	89
South Carolina	3,795	3,477	318	—	3,795	2,199	1,596	—
South Dakota	3,750	2,840	910	0	939	659	280	0
Tennessee	11,081	10,857	224	—	11,081	10,420	661	—
Texas	13,998	13,843	155	—	13,998	12,616	1,382	—
Vermont	5,162	4,990	172	0	5,162	4,787	132	243
Virginia	3,532	1,210	2,322	—	3,532	1,210	2,322	—
Washington	4,637	3,168	1,469	0	4,637	2,898	1,739	0
West Virginia	14,340	13,005	1,335	0	14,340	13,005	1,335	0
Wyoming	19,437	19,430	7	0	947	947	0	0
Totals	480,503	415,515	52,896	12,092	414,923	353,611	45,261	16,051

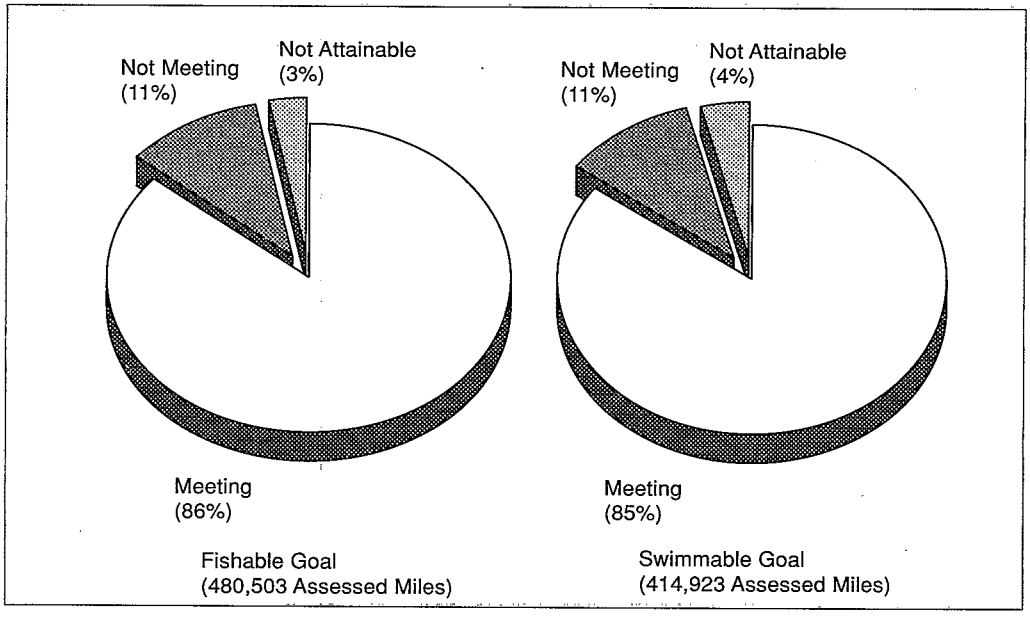
— Not reported.

Source: 1988 State Section 305(b) reports.

the swimmable goal but could sometime in the future, and 4 percent were categorized as "not attainable" (see Figure 1-4). Fewer waters were assessed for the swimmable goal than for the fishable goal, at least in part because some States do not include swimming uses in their standards.

From these figures, it appears that proportionately more waters meet each Clean Water Act goal than fully support their designated uses. This may be because some States are reluctant to indicate that a waterbody is not fishable or swimmable when impacts in that waterbody are slight or moderate. Clearly, definitions of CWA goal attainment vary among States as widely as do definitions of use support: the percent of waters meeting goals varies from zero to 100 percent. For example, some States do not adhere to EPA's definition of fishability and consider waters fishable if they support aquatic life (thereby excluding fish consumption considerations). EPA is working to better define attainment of the CWA goals for future reporting.

Eleven States reported that the fishable goal was not attainable in 12,092 stream miles, and 11 States found the swimmable goal not attainable in 16,051 miles. Reasons cited include naturally occurring physical limitations and extensive land uses such as row crop agriculture that would be prohibitively expensive to control.



Source: 1988 State Section 305(b) reports.

Figure 1-4. Attainment of Clean Water Act Goals in Assessed Rivers and Streams

Making Assessment Decisions

How do we know what it means for a waterbody to support or not support its designated uses? What kinds of data are used? How are these data interpreted? Do all States use the same methods?

The answers to these questions are key to understanding the water quality findings reported by the States and summarized in this document. In many cases, the answers are not simple: State methodologies vary widely and may not be clearly documented. However, EPA is engaged in efforts to catalog State methodologies and develop recommended guidelines which, if followed, should result in more uniform water quality assessments among States.

States collect a broad range of information on conditions in their rivers, lakes, and estuaries. EPA asks the States to report based on two categories of assessment data. **Monitoring data** can be provided by networks of chemical or biological sampling stations located near dischargers or at other strategic points along waterbodies, and by short-term or one-time intensive or special surveys designed to provide water quality "snapshots" for discrete areas or to answer questions about specific problem sources or conditions. The data collected may be chemical (e.g., the concentration of a given pollutant in water, sediment, or fish/shellfish tissue) or biological (e.g., counts of the number of certain indicator species in a given sample or testing the toxicity of river or wastewater samples). Their common elements are that they are scientifically collected by the State pollution control agency, local governments, or Federal authorities using quality control procedures and involve actual observations and water/sediment/tissue/organism samples from aquatic sites.

Evaluative data, on the other hand, are collected from a variety of sources that may not use quality control procedures or involve site-specific sampling. Examples of this type of data include information provided by citizens, reports of pollution-caused fish kills, predictive modeling based on knowledge of sources, land use types, etc., surveys of fisheries personnel, and certain kinds of volunteer monitoring.

The degree to which States use these different types of data varies greatly. Some States rely almost exclusively on fixed station monitoring data or a combination of fixed station and intensive survey data. Other States may use rotating basin surveys in which a limited number of basins are studied intensively. Others with limited monitoring resources may find that their evaluative data provide a more realistic picture of water quality conditions than does a small network of infrequently sampled stations. Most States use a combination of data types to reach their assessment decisions.

Designated use support information for rivers shows that in the 38 States that specified data types, 386,530 stream miles were assessed, 40 percent using monitoring data and 60 percent using evaluative approaches. Of the 258,060 miles supporting uses in these States, 67 percent were evaluated and

33 percent were monitored. However, nearly the reverse of this applies in the 41,147 miles not supporting uses: 32 percent of waters were evaluated and 68 percent were monitored. Two different conclusions could be drawn from these findings: that States concentrate their monitoring efforts in their most degraded waters or that where States monitor they tend to find problems. Many States have indicated that the former argument is true. Faced with diminishing resources for monitoring, States have traditionally focused monitoring stations and intensive surveys on those areas most likely to have problems. Nevertheless, perhaps a combination of the two may apply, since reliance on models, questionnaires, and citizen complaints may fail to reveal certain types of water quality problems. In any case, EPA continues to support both types of assessment activities as the best available and most practical way to expand coverage of the Nation's waters.

Once data are collected by the States, they must be analyzed using established criteria in order for decisions to be made on support of designated uses. In an attempt to encourage consistency among States in how these decisions are made, EPA has issued general guidelines on criteria States might use to determine degree of use support. Table 1-5 illustrates key elements of these guidelines, which were developed jointly with the Association of State and Interstate Water Pollution Control Administrators for a 1984 assessment of trends in water quality.

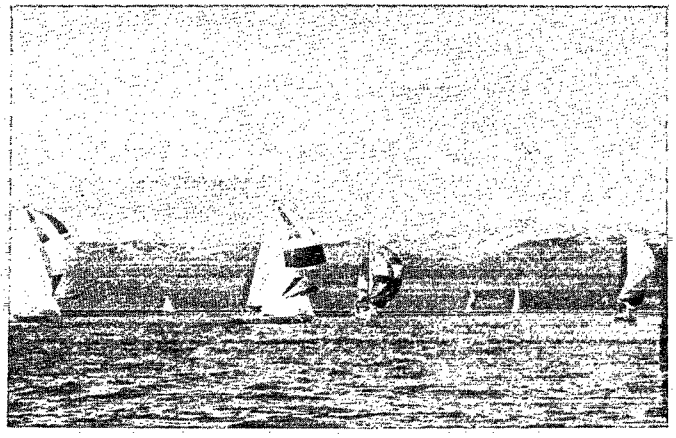
State adoption of these guidelines has been limited. A preliminary survey of the 1988 State Section 305(b) reports shows that about 15 States used these guidelines, numerous States used variants of these guidelines, and a handful did not specify which criteria they used in making their use support decisions. Many States feel that these criteria are too rigid and do not lead to accurate overall judgments about water quality conditions. Clearly, the EPA guidelines do not allow for much flexibility in making determinations where chemical data alone are used; do not address the issue of how to weigh contradictory evidence (e.g., results of biological studies that disagree with the results of chemical analyses); and do not address how many data points are actually required before a decision can be made. Until more widely acceptable and comprehensible guidelines are developed and adopted by the States, State-to-State inconsistencies in use support determinations will doubtless continue to hamper national analyses.

EPA is taking steps to develop assessment guidance that will provide a basis for greater consistency. Several new developments have occurred that need to be considered, such as toxicological specifications for the duration and frequency of concentrations of chemicals; the increased use of toxicity testing and biological monitoring; and a greater awareness of the prevalence of impacts caused by habitat alterations.

Table 1-5. EPA-Issued Guidelines on Making Use Support Decisions*

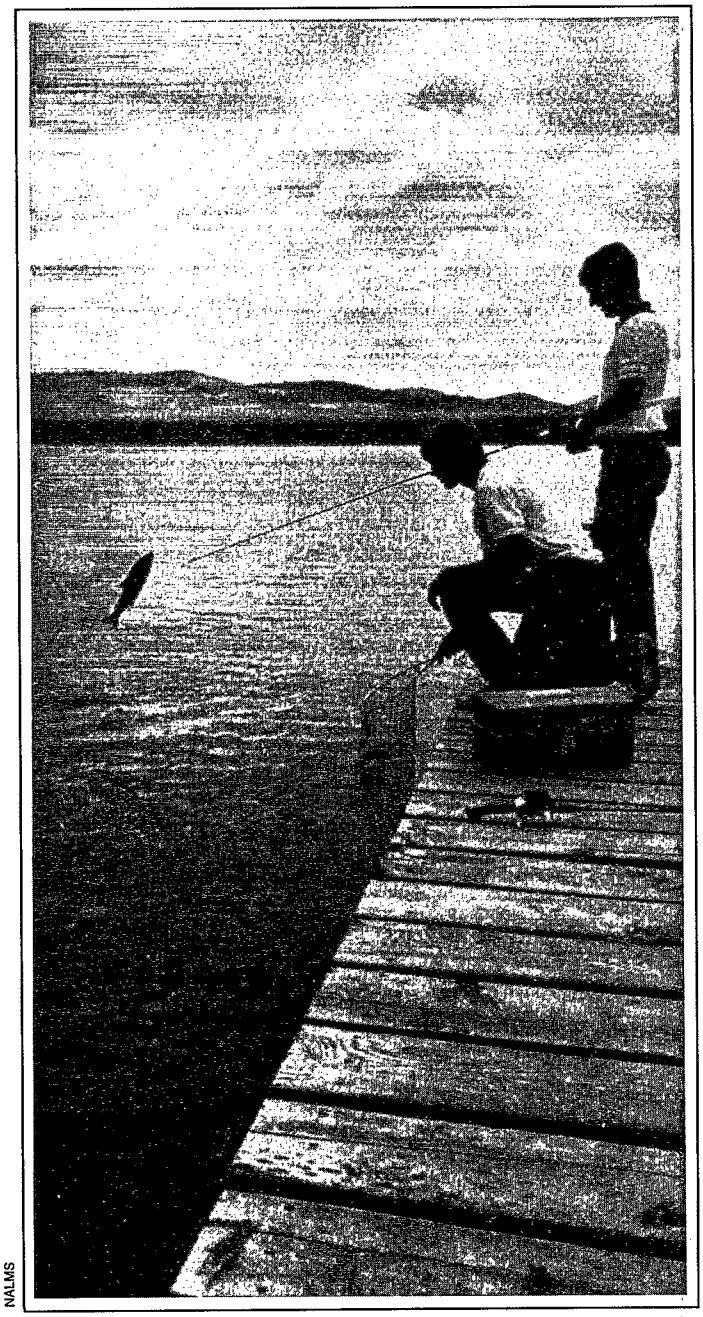
Basis for Assessment	Full, Partial, or Nonsupport of Uses Determined by:
Evaluative Data	Presence of sources and predictions, based on professional judgment, as to whether sources impair uses.
Chemical Monitoring Data	Percentage of criteria exceedances and the mean of the measurements (i.e., whether or not the mean is less than or greater than the criteria).
Biological Monitoring Data	Whether or not evidence exists that the biological community in a waterbody has suffered slight or substantial modification.

*Derived from 1986, 1988, and 1990 guidelines.



Lake Tahoe Visitors Authority

2



NALMS

Lakes and Reservoirs

Support of Designated Uses

In their 1988 State Section 305(b) reports, 40 States, Territories, and jurisdictions (referred to hereafter as States) provided information on support of designated uses in their lakes and reservoirs (see Table 2-1). A total of 16,314,012 acres were assessed, 73 percent of the lake acres estimated for these States and 41 percent of the Nation's total 39,400,000 acres.

Of those assessed lake acres, 12,021,044 acres, or 74 percent, were found to be fully supporting their designated uses. Of these, 2,897,711 acres are threatened and may not fully support uses in the future if action is not taken to control pollution sources. Seventeen percent of assessed lake acres, or 2,701,577 acres, partially support uses, and 10 percent, or 1,591,391 acres, do not support uses (see Figure 2-1).

Thirty-two States specified the basis of their assessment decisions. In these States, 11,844,582 acres were assessed. Sixty-eight percent were monitored; the remaining 32 percent were evaluated. (See *Making Assessment Decisions* for further discussion.)

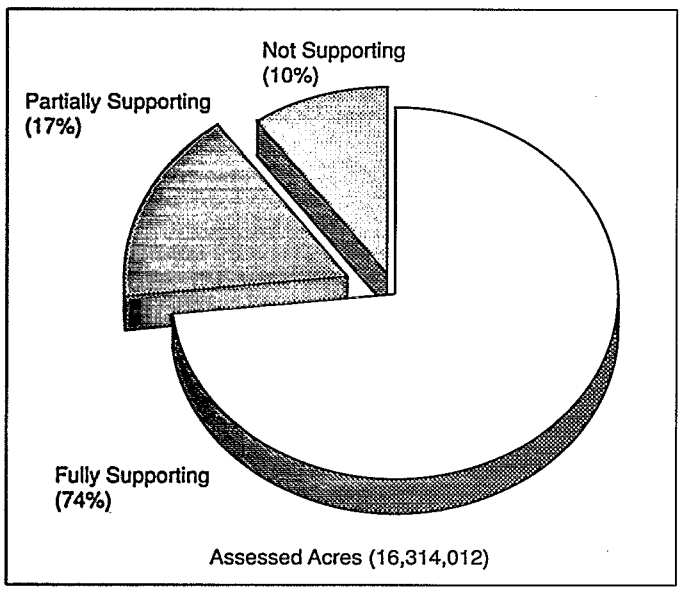
As for rivers and streams, these data should be interpreted with caution because of inconsistencies in data analysis and reporting. First, a number of States did not provide usable summary information on designated use support in lakes. Second, the percentage of total lake acres assessed varies widely among States, from a quarter of total acreage to all State acreage. Third, the percent of assessed lake acres supporting designated uses also shows wide variations

among States, ranging from zero to nearly 100 percent. These variations should probably be attributed more to different State methodologies than to wide differences in lake water quality.

Causes of Impairment

In 1988, 33 States provided data on the causes of nonsupport in their lakes (see Table 2-2). As described in Chapter 1 for rivers, any given acre of lake can be affected by many causes (i.e., specific pollutants or pollutant processes). Therefore, States were asked to include any given lake acre under each of the cause categories that contribute to impairment. This allows a single lake acre to be counted multiple times if it is affected by multiple causes. The values reported are the total number of lake acres affected by a particular cause of impairment, according to whether the cause is a major or moderate/minor contributor to impairment. (Data from States that did not specify this degree of impact are included under the "major" column heading in Table 2-2.) The relative extent of each cause of nonsupport can be determined by dividing the total number of acres affected by each cause category by the total acres impaired (see Figure 2-2).

The most commonly reported cause of use impairment in lakes is nutrients, which affect 49 percent of impaired lake acres. Nutrients, in turn, can lead to organic enrichment and low levels of dissolved oxygen, which were identified as affecting 25 percent of impaired lake acres. Siltation also affects 25 percent, and salinity, the fourth most commonly reported cause, affects 14 percent. Habitat modification, pathogens, and priority organics affect approximately 11, 9, and 8 percent of impaired lake acres, respectively.



Source: 1988 State Section 305(b) reports.

Figure 2-1. Designated Use Support in Assessed Lakes and Reservoirs

Table 2-1. Designated Use Support in Lakes and Reservoirs

State	Number of Lakes	Acres of Lakes	Acres Assessed			Acres Fully Supporting	Acres Threatened*	Acres Partially Supporting	Acres Not Supporting
			Total	Percent Evaluated	Percent Monitored				
Alabama	43	504,336	491,566	2	98	405,486	—	0	86,080
California	4,955	1,417,540	1,076,891	—	—	568,739	—	95,505	412,647
Colorado	4,069	265,982	124,973	91	9	123,300	7,172	1,673	0
Connecticut	6,000	82,900	21,701	39	61	9,312	8,176	12,389	0
District of Columbia	8	377	136	0	100	0	0	0	136
Florida	7,712	2,085,120	947,200	13	87	309,760	—	536,320	101,120
Georgia	175	417,730	417,730	0	100	412,357	140	5,347	26
Illinois	2,940	247,188	183,572	41	59	22,931	22,455	100,591	60,050
Indiana	560	104,540	104,540	39	61	104,361	—	63	116
Iowa	282	81,400	80,249	81	19	26,801	18,902	52,058	1,390
Kansas	232	175,189	173,911	8	92	116,655	116,655	48,141	9,115
Kentucky	92	228,385	214,483	0	100	179,335	152,544	31,471	3,677
Louisiana	101	713,719	517,476	93	7	376,335	87,034	141,141	0
Maine	5,779	994,560	994,560	—	—	958,080	—	36,480	0
Maryland	59	17,448	17,448	45	55	14,838	4,606	2,603	7
Michigan	35,000	840,960	424,021	—	—	304,185	161,894	62,834	57,002
Minnesota	12,034	3,411,200	1,435,554	54	46	1,198,709	—	67,622	169,223
Mississippi	—	500,000	500,000	51	49	481,740	—	18,260	0
Missouri	362	288,012	288,012	—	—	285,701	—	2,311	0
Montana	4,018	756,450	663,363	81	19	345,367	129,500	305,396	12,600
Nebraska	412	145,300	85,518	—	—	82,304	—	2,779	435
New Hampshire	1,300	151,000	149,854	0	100	130,708	4,603	18,756	390
New Mexico	—	126,500	119,666	52	48	72,358	—	47,308	0
New York	7,500	750,000	750,000	11	89	454,668	29,942	267,343	27,989
North Carolina	1,500	305,367	305,367	12	88	293,470	50,330	2,075	9,822
North Dakota	216	625,503	619,333	5	95	571,208	570,170	48,125	0
Ohio	2,500	117,323	90,771	—	—	30,936	25,733	50,988	8,847
Oregon	6,095	610,808	504,928	85	15	374,303	—	58,918	71,707
Puerto Rico	38	11,146	11,146	52	48	3,801	1,745	4,240	3,105
Rhode Island	113	16,520	16,089	29	71	14,688	11,425	787	614
South Carolina	1,418	525,000	410,407	0	100	409,242	—	840	325
South Dakota	789	1,598,285	662,532	17	83	567,812	548,000	17,984	76,736
Tennessee	117	538,657	538,657	—	—	452,009	75,828	50,830	35,818
Texas	5,700	1,410,240	1,410,240	0	100	1,225,629	332,145	0	184,611
Vermont	719	229,146	227,121	3	97	177,915	153,319	37,713	11,493
Virginia	248	161,562	161,089	64	36	147,352	—	13,737	0
Washington	808	613,582	156,518	2	98	122,834	116,210	33,104	580
West Virginia	94	19,171	19,171	0	100	0	0	17,441	1,730
Wisconsin	14,998	971,000	971,000	—	—	249,000	179,300	478,000	244,000
Wyoming	2,629	427,219	427,219	85	15	396,815	89,883	30,404	0
Totals	131,615	22,486,365	16,314,012			12,021,044	2,897,711	2,701,577	1,591,391

*Acres Threatened is a subset of Acres Fully Supporting.

— Not reported.

Source: 1988 State Section 305(b) reports.

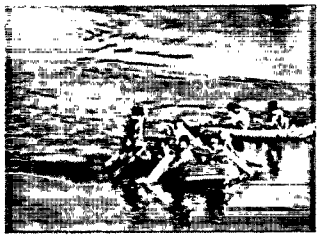


Table 2-2. Impaired Lake Acres Affected by Causes of Pollution

State	Total Impaired Waters*	Nutrients		Siltation		Organic Enrichment		Salinity	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama**	86,080	—	—	—	—	—	—	—	—
Colorado	1,672	—	500	—	—	—	650	—	—
Connecticut	12,389	9,612	2,777	812	7,914	1,462	8,930	—	—
District of Columbia	136	—	—	—	—	—	—	—	—
Florida**	637,440	75,520	—	171,520	—	175,360	—	272,000	—
Georgia	5,373	5,373	—	—	—	—	—	—	—
Illinois	160,641	44,552	108,699	69,364	90,500	56,645	90,484	—	—
Indiana	179	122	12	—	—	82	52	—	—
Iowa	53,448	19,048	34,278	46,112	2,268	44	16,815	—	—
Kansas	57,256	7	3,491	10	34,736	—	—	9,230	13,167
Kentucky**	35,148	6,707	—	4,517	—	—	—	—	—
Louisiana	141,141	—	121,262	—	986	—	42,548	—	46,394
Maryland	2,610	2,610	—	15	—	—	—	—	—
Minnesota**	236,845	236,845	—	—	—	—	—	—	—
Mississippi	18,260	—	18,260	724	17,060	—	—	—	1,200
Missouri	2,311	—	—	—	—	—	—	—	—
Montana	317,996	5,750	17,449	19,022	5,600	—	—	13,250	14,509
New Hampshire	19,146	95	4,281	—	—	—	—	—	—
New Mexico	47,308	2,338	40,346	1,178	8,665	—	—	—	—
New York	295,332	101,663	27,928	—	3,507	306	61,103	—	2,944
North Carolina**	11,897	2,015	—	707	—	1,900	—	—	—
North Dakota	48,125	37,467	10,555	6,288	12,800	11,984	30,663	5,000	1,750
Oregon**	130,625	115,965	—	15,594	—	69,147	—	—	—
Puerto Rico	7,345	1,448	447	135	—	891	581	348	—
Rhode Island	1,401	246	—	60	—	—	—	—	—
South Carolina**	1,165	—	—	—	—	50	—	—	—
South Dakota	94,720	75,190	13,574	55,629	5,287	130	28	—	—
Tennessee	86,648	35,383	35,647	21,123	30,445	34,655	43,575	—	—
Vermont	49,206	2,953	9,089	1,102	16,184	684	13,878	—	—
Virginia	13,737	—	12,518	—	2,698	—	8,001	—	—
Washington	33,684	—	33,104	—	—	—	580	—	580
West Virginia	19,171	1,236	2,933	2,047	9,136	—	642	—	—
Wyoming	30,404	—	17,749	—	12,919	—	53	—	459
Totals	2,658,839	782,145	514,899	415,959	260,705	353,340	318,583	299,828	81,003
Combined Totals			1,297,044		676,664		671,923		380,831
Percent of Impaired Waters			48.8%		25.4%		25.3%		14.3%

*The sum of partially and nonsupporting lake acres (Table 2-1).

**These States did not specify the degree of impact (i.e., Major or Moderate/Minor); lake acres were placed in the "Major" column

Habitat Mod		Pathogens		Priority Organics		Suspended Solids		Metals		Pesticides		pH		Flow Alteration	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	84,230	—	—	—	1,850	—	—	—	1,850	—	—	—
—	—	—	—	105	—	—	—	102	410	160	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	136	—	—	—	—	—	—	—	—	—	136	—	—
—	—	640	—	—	—	—	—	41,600	—	—	—	11,520	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	2,437	4,845	2,937	2,228	74,401	83,665	5,196	17,355	13,395	1,070	—	—	—	—
—	—	45	89	27	—	—	—	15	45	12	—	30	—	—	—
222	—	15,300	—	—	—	—	—	—	—	—	49,400	1	—	10	—
—	—	—	—	—	—	—	—	9,040	757	—	—	—	—	3	5,694
—	—	—	—	—	—	—	—	23,584	—	—	—	—	—	—	—
—	—	—	100,352	—	—	—	22,490	—	—	—	1,229	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	17,060	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	561	—	20	—	—
—	284,000	1,423	1,300	—	—	—	—	—	9,750	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	296	5,135	—	—
10	200	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	3,355	22,939	102,060	434	—	—	326	7,597	24,716	—	16,569	—	33,877	600
—	—	—	—	—	—	—	—	9,680	—	—	—	—	—	40	—
67	—	—	—	—	—	220	—	—	—	—	—	—	—	—	5,469
—	—	13,248	—	—	—	—	—	—	—	—	—	81,365	—	—	—
300	16	354	137	—	—	836	251	47	—	—	350	141	10	—	—
—	—	966	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	865	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	359	593	—	—	—	—	—	—	—	79
16	—	—	25,130	18,508	6,149	383	17,041	69	29,257	—	—	69	11,924	—	24,905
7,205	9,318	741	131	—	—	—	—	—	—	—	—	44	69	1,887	4,173
—	—	—	129	—	—	—	—	—	1,034	—	79	—	2,810	—	—
—	—	580	33,104	580	—	—	—	580	33,104	—	33,104	—	—	580	—
—	—	—	—	—	—	—	—	2,930	3,475	—	—	2,973	1,761	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9,420
7,820	293,534	39,954	188,292	208,447	8,811	76,199	124,040	95,019	102,784	38,283	102,853	114,858	21,865	36,397	50,340
	301,354		228,246		217,258		200,239		197,803		141,136		136,723		86,737
	11.3%		8.6%		8.2%		7.5%		7.4%		5.3%		5.1%		3.3%

— Zero or not reported.

for national reporting purposes.

Source: 1988 State Section 305(b) reports.

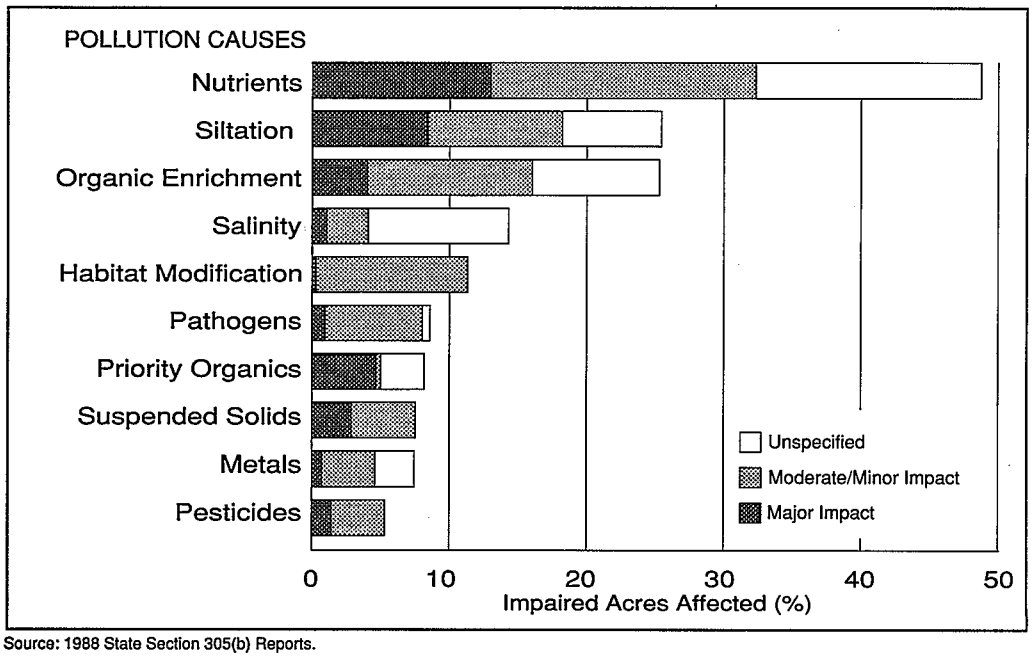
Care should be taken in interpreting these figures, as a close look at Table 2-2 reveals that certain States report a large proportion of the impacts from these causes of impairment. For example, Florida alone accounts for 71 percent of the lake acres affected by salinity; New York accounts for 47 percent of the acres affected by priority organics and 40 percent of the lake acres affected by flow alteration; and Louisiana accounts for 44 percent of the lake acres affected by pathogens. Reporting inconsistencies influence these findings.

Twenty-six States specified the degree of impact of the various causes of nonsupport in their lakes and reservoirs. As in rivers, for most cause categories there were more lake acres in which the cause was a moderate/minor contributor to impairment than a major contributor. Of the leading causes, only the priority organics category showed more major than minor impacts: in 93 percent of the lake acres affected by priority organics, their impact was considered major. Among the other causes of use impairment, those with the greatest percentage of major impacts include pH (major impact in 48 percent of affected acres), siltation (major impact in 46 percent), flow alteration (major impact in 42 percent), and nutrients (major impact in 40 percent).

Sources of Impairment

Information on the various sources of pollution contributing to use impairment in lakes and reservoirs was provided by 28 States. Table 2-3 displays the categories of sources and the size of waters affected by each.

Since an acre of lake can be affected by many sources of pollution, States were asked to include any given lake acre under each of the source categories that contribute to impairment. This allows a single lake acre to be counted multiple times if it is affected by multiple sources. The values reported are the total number of lake



Source: 1988 State Section 305(b) Reports.

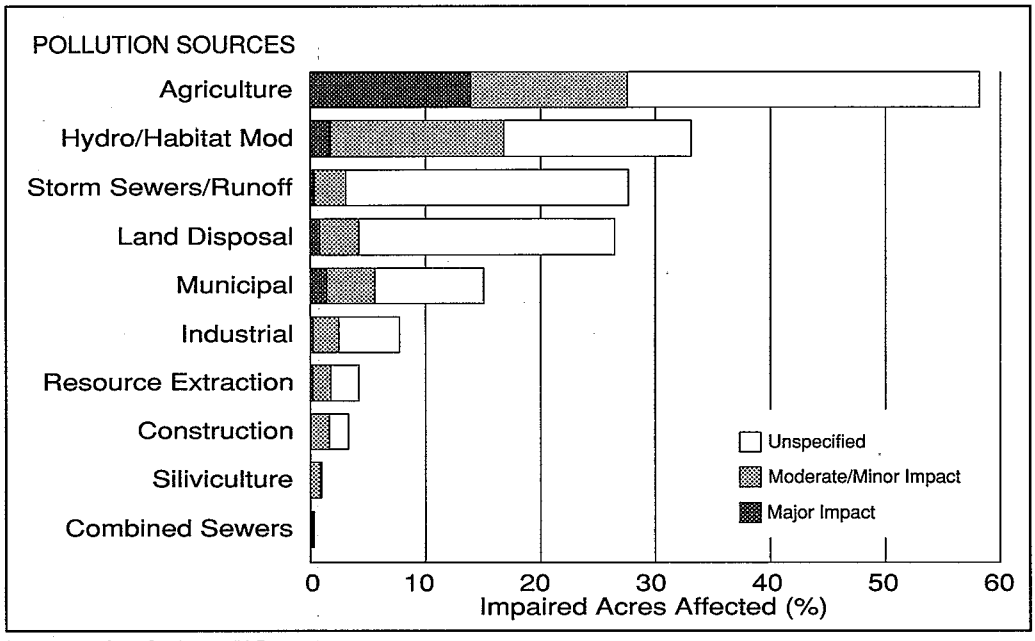
Figure 2-2. Percent of Impaired Lake Acres Affected by Each Pollution Cause

acres affected by a particular source of impairment, according to whether the source is a major or moderate/minor contributor to impairment. The relative extent of each source of nonsupport can be determined by dividing the total number of acres affected by each source category by the total acres impaired (see Figure 2-3).

As with rivers, certain ambiguities apply to the "definitions" of sources of pollution in lakes (see discussion on p. 7). Table 2-3 shows that agricultural runoff is reported as the most extensive source of pollution, affecting 58 percent of impaired lake acres. Other leading sources in lakes include hydrologic/habitat modification (affecting 33 percent of impaired lake acres), storm sewers/runoff (affecting 28 percent), land disposal (affecting about 26 percent), and municipal dischargers (affecting 15 percent).

These numbers should be interpreted with care, as a close look at Table 2-3 reveals that certain States predominate in the number of lake acres they report as affected by the various sources of pollution. For example, Florida alone accounts for 85 percent of the total number of lake acres affected by storm sewers/runoff and 82 percent of the lake acres affected by land disposal.

Twenty-two States specified the degree of impact (i.e., major or moderate/minor) of pollution sources in their lakes. Only in the agricultural category did the number of acres with major impacts exceed those with moderate/minor impacts (major impact in 51 percent of impaired lake acres). Other source categories with a high percentage of major impact include combined sewers (major impact in 45 percent of affected lake acres) and municipal dischargers (major impact in 25 percent).



Source: 1988 State Section 305(b) Reports.

Figure 2-3. Percent of Impaired Lake Acres Affected by Each Pollution Source

Table 2-3. Impaired Lake Acres Affected by Sources of Pollution

State	Total Impaired Waters*	Agriculture		Hydro/ Habitat Mod		Storm Sewers/Runoff		Land Disposal	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama**	86,080	—	—	—	—	15,930	—	—	—
California**	508,152	107,922	—	—	—	—	—	—	—
Colorado	1,672	—	148	—	—	—	1,000	325	—
District of Columbia	136	—	—	—	—	—	27	—	—
Florida**	637,440	616,320	—	437,760	—	631,680	—	582,400	—
Illinois	160,641	115,534	43,791	1,329	40,388	—	—	6,056	19,629
Indiana	179	12	85	40	—	35	67	—	—
Iowa	53,448	48,264	3,774	229	—	4,822	12,529	7	—
Kansas	57,256	10	34,769	3	5,734	—	16	—	—
Maryland	2,610	1,162	—	—	—	415	—	—	—
Mississippi	18,260	2,979	14,081	—	—	—	—	—	—
Missouri	2,311	—	—	—	1,730	—	561	—	—
Montana	317,996	12,600	18,322	—	284,000	—	—	150	5,420
New Hampshire	19,146	20	—	—	—	34	68	—	—
New Mexico	47,308	—	47,058	—	60	—	—	—	—
New York	295,332	28,205	93,991	33,877	—	1,314	3,720	2,844	48,829
North Carolina**	11,897	2,056	—	—	—	2,055	—	1,900	—
North Dakota	48,125	37,729	6,677	665	6,453	22	5,951	—	—
Oregon**	130,625	98,145	—	—	—	10,866	—	13,129	—
Puerto Rico	7,345	948	870	—	—	1,505	782	25	378
Rhode Island	1,401	—	103	—	50	111	566	—	103
South Carolina**	1,165	—	—	—	—	25	—	—	—
South Dakota	94,720	83,628	1,516	1,209	7,868	99	—	12,731	9,272
Tennessee	86,648	15,520	45,813	9,221	31,559	33	41,481	—	7,800
Virginia	13,737	—	7,925	—	—	—	7,856	—	—
Washington	33,684	—	33,104	580	—	580	—	—	—
West Virginia	19,171	76	5,047	—	—	12	27	—	—
Wyoming	30,404	28,513	7,665	—	27,005	—	25	—	—
Totals	2,686,889	1,199,643	364,739	484,913	404,847	669,538	74,676	619,567	91,431
Combined Totals			1,564,382		889,760		744,214		710,998
Percent of Impaired Waters			58.2%		33.1%		27.7%		26.5%

*The sum of partially and nonsupporting lake acres (Table 2-1).

**These States did not specify the degree of impact (i.e., Major or Moderate/Minor); lake acres were placed in the "Major" column for national reporting purposes.

Municipal		Industrial		Resource Extraction		Construction		Silviculture		Combined Sewers	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	68,300	—	1,850	—	—	—	—	—	—	—
160	—	—	—	31,082	—	—	—	—	—	—	—
—	500	160	—	105	410	—	125	43	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
252,160	—	62,720	—	32,000	—	42,240	—	—	—	—	—
6,046	62,403	2,631	10,972	43	22,831	1,352	14,273	—	—	—	—
99	—	15	—	30	—	—	—	—	—	45	12
—	10,400	—	—	—	—	12	—	—	—	—	—
—	—	—	—	190	—	—	—	—	—	—	—
35	360	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1,200	—	—	—	—	—	—
—	—	—	—	—	20	—	—	—	—	—	—
—	—	—	—	—	2,100	—	—	—	3,200	—	—
—	142	—	15	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	590	—	879	—	—
15,468	8,203	—	7,800	—	—	—	35	—	3,180	2,944	—
1,900	—	9,680	—	—	—	2,042	—	450	—	—	—
—	9,299	—	—	—	172	—	—	—	2,986	—	—
485	—	895	—	—	—	—	—	2,755	—	—	—
62	—	—	112	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	250	—	—	—	—	—	—	—	—	—
1,870	—	—	—	—	—	—	—	162	463	—	—
14,600	9,556	—	40,391	1,993	—	49	15,500	—	4,550	—	4,400
—	102	—	137	—	—	—	—	—	130	—	—
—	—	580	—	—	—	—	—	—	—	580	—
12	2,684	2,930	3	3,111	6,320	114	41	137	6,099	—	—
—	8,300	—	—	—	9,520	—	11,506	—	—	—	—
292,897	111,949	148,161	59,430	70,404	42,573	45,809	42,070	3,547	21,487	3,569	4,412
	404,846		207,591		112,977		87,879		25,034		7,981
	15.1%		7.7%		4.2%		3.3%		0.9%		0.3%

— Zero or not reported.

Source: 1988 State Section 305(b) reports.

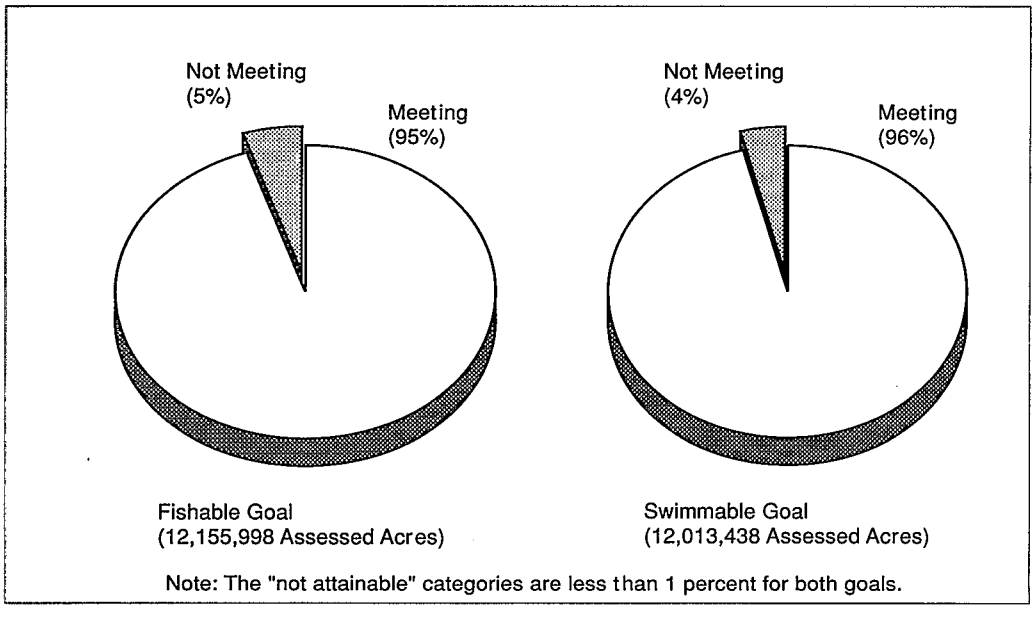
Attainment of the Clean Water Act Goals

The Nation's lakes and reservoirs, like its flowing waters, are also traditionally measured in terms of their ability to support fishing and swimming, basic goals of the Clean Water Act. In 1988, 35 States reported this information for lakes (see Table 2-4).

A total of 12,155,998 lake acres were assessed for fishability; of these, 95 percent fully attained the fishable goal, 5 percent did not currently attain it but might in the future, and less than 1 percent (3,886 acres) were determined to be "not attainable" (i.e., suffering from irrevocable impacts and/or not designated for the use). Approximately the same number of lake acres (12,013,438) were assessed for swimmability. Similar proportions were found to apply to swimmability as to fishability: 96 percent of assessed acres fully attained the swimmable goal, 4 percent were not currently attaining it, and less than 1 percent (3,703 acres) were categorized as "not attainable" (see Figure 2-4). As with rivers, the States reported higher levels of attainment of the CWA goals than designated uses. This difference may be the result of State reluctance to declare moderately or slightly impaired lakes as not fishable or swimmable.

Trophic Status of Lakes

Lakes naturally change over time, filling with sediments and organic matter that alter many basic characteristics such as average depth, biological productivity, oxygen levels, and water transparency. This natural aging process is known as eutrophication. Human activities can accelerate eutrophication by increasing the loadings of nutrients and organic substances through runoff, sewage discharges, septic tank leachate, and similar sources. These substances can overstimulate algae, plant, and weed growth, creating choked conditions that adversely affect swimming, boating, and the health and diversity of indigenous fish populations. This major change in lake ecology due to human activities is known as cultural eutrophication.



Source: 1988 State Section 305(b) reports.

Figure 2-4. Attainment of Clean Water Act Goals in Assessed Lakes and Reservoirs

Table 2-4. Attainment of Clean Water Act Goals in Lakes and Reservoirs

State	Fishable Goal (miles)				Swimmable Goal (miles)			
	Assessed	Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Not Meeting	Not Attainable
Alabama	491,566	405,486	86,080	—	491,566	405,486	86,080	—
Colorado	124,973	123,111	1,862	0	124,973	124,973	0	0
Connecticut	21,701	18,826	2,875	0	21,701	21,701	0	0
District of Columbia	136	0	136	0	136	0	136	0
Florida	947,200	846,080	101,120	0	947,200	846,080	101,120	0
Georgia	417,730	412,357	5,373	—	417,730	412,357	5,373	—
Illinois	183,572	166,248	17,324	0	183,572	77,176	106,396	0
Indiana	104,540	104,424	116	0	104,540	104,361	179	0
Iowa	80,249	79,534	712	3	80,249	77,350	686	2,213
Kansas	173,884	173,809	75	—	173,884	173,809	75	—
Kentucky	214,483	214,483	0	0	214,483	214,483	0	0
Louisiana	517,476	517,390	86	—	517,476	517,390	86	—
Maine	994,560	979,558	15,002	0	994,560	958,080	36,480	0
Maryland	17,448	17,442	6	—	17,448	17,446	2	—
Mississippi	500,000	500,000	0	0	500,000	500,000	0	0
Missouri	288,012	285,701	2,311	0	288,012	288,012	0	0
Montana	663,363	650,763	12,600	0	663,363	663,363	0	0
New Hampshire	149,854	149,854	0	0	149,854	149,854	0	0
New Mexico	47,308	47,308	0	0	47,308	47,308	0	0
New York	750,000	537,000	213,000	0	750,000	670,000	80,000	0
North Carolina	305,367	295,687	9,680	—	305,367	303,180	2,187	—
North Dakota	619,334	608,657	9,792	885	619,334	614,067	5,267	0
Ohio	—	—	—	—	100,259	21,799	78,460	—
Oregon	504,928	504,928	0	—	504,928	504,928	0	—
Puerto Rico	11,146	6,395	2,581	2,170	11,146	6,395	3,915	836
Rhode Island	16,089	14,443	1,122	524	16,089	14,443	1,122	524
South Carolina	410,407	410,107	300	—	410,407	408,742	1,665	—
South Dakota	662,532	662,532	0	0	662,532	662,532	0	0
Tennessee	538,657	496,337	42,320	—	538,657	521,235	17,422	—
Texas	1,410,240	1,410,240	0	—	1,410,240	1,408,585	1,655	—
Vermont	225,350	222,772	2,274	304	203,647	202,808	838	1
Virginia	160,985	147,248	13,737	0	121,777	121,648	0	129
Washington	156,518	122,834	33,684	0	156,518	155,938	580	0
West Virginia	19,171	17,441	1,730	0	19,171	19,171	0	0
Wyoming	427,219	427,219	0	0	245,311	245,311	0	0
Totals	12,155,998	11,576,214	575,898	3,886	12,013,438	11,480,011	529,724	3,703

— Not reported.

Source: 1988 State Section 305(b) reports.

The eutrophication progression can be described by a series of trophic states:

- **Oligotrophic**—clear waters with little organic matter or sediment and minimal biological activity;
- **Mesotrophic**—waters containing more nutrients and therefore exhibiting more biological productivity;
- **Eutrophic**—waters extremely rich in nutrients, with high biological productivity; and
- **Hypereutrophic**—murky, highly productive waters, closest to the wetland status.

Dystrophic is also a lake classification but not necessarily a part of the eutrophication progression. Dystrophic systems are often low in nutrients yet are highly colored with dissolved humic organic matter. Sphagnum bogs are examples of such dystrophic systems.

Table 2-5 displays the general characteristics of lakes in the various trophic classifications.

Although changes in lake water quality may be tracked by monitoring for trophic state, experience has shown that the trophic state of a lake does not always define its use. Some States believe that advanced eutrophication does not necessarily eliminate a lake's designated recreational uses, nor is an oligotrophic lake always best for recreational activities. These States have recognized this apparent disparity between positive recreational uses and the negative connotations associated with eutrophic conditions, adjusting the ways they determine trophic status to reflect desired use (such as warmwater fishing) and public perceptions in addition to measurable physical, chemical, and biological parameters. In addition, many lakes (particularly in the Midwest and Southeast) are naturally eutrophic. Trophic status by itself is not an indication of water quality but must be evaluated against the natural status of the lake.

Section 314 of the Water Quality Act of 1987 required States, in their Section 305(b) reports, to identify their lakes by trophic status. As with other results reported by the States, there is probable sampling bias in the lakes represented by the data on trophic status. If the lakes were assessed in response to a problem or public complaint or because of their easy accessibility, there is probable bias in the reported information. It is therefore likely that the more remote and/or pristine lakes are underrepresented in some State assessments.

Table 2-6 displays the results of the State evaluations of trophic status. States reported that 30 percent of all lakes assessed for trophic status were either eutrophic or hypereutrophic; 23 percent were mesotrophic; 14 percent, oligotrophic; and less than 2 percent, dystrophic. Trophic status for the remaining 30 percent assessed was unknown.

Table 2-5. General Characteristics of Traditional Lake Trophic Status Classifications

Characteristics	Oligotrophic	Mesotrophic	Eutrophic
Nutrient Level	Low	Medium	High
Organic Matter Content	Low	Medium	High
Biological Productivity	Low	Medium	High
Lake Age	Young	Medium	Old
Water Transparency	High	Medium	Low
Oxygen Depletion Hypolimnion	No	Yes	Yes
Average Depth	Deep	Moderate	Shallow

Source: *Report to Congress: Water Quality of the Nation's Lakes,* 1989. Nonpoint Sources Branch, OWRS.

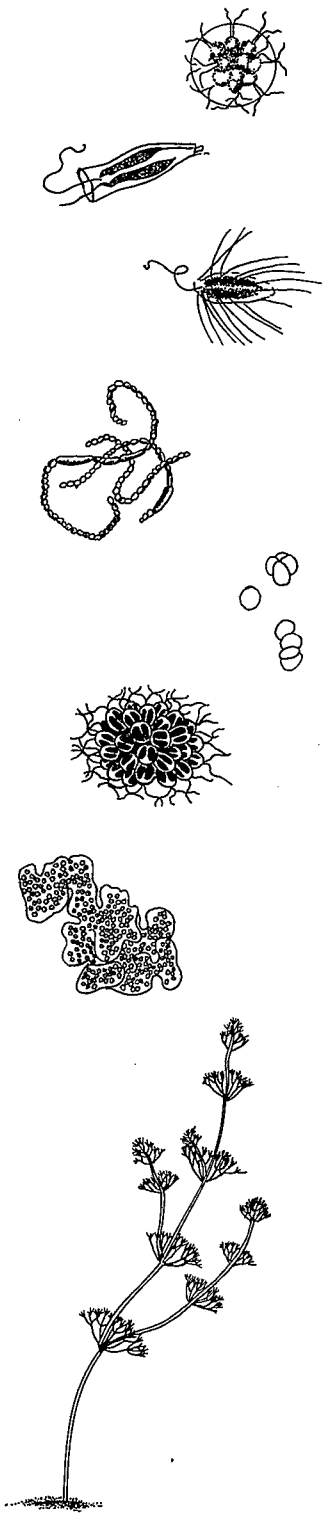


Table 2-6. Trophic Status of the Nation's Lakes

State*	Lakes Assessed	Oligo-trophic	Meso-trophic	Eutrophic	Hyper-eutrophic	Dys-trophic	Unknown
Alabama	34	4	15	11	0	0	4
Arkansas	71	0	59	4	0	0	8
California	459	114	39	12	2	0	292
Colorado	82	9	35	38	0	0	0
Connecticut	160	34	78	17	0	0	31
Delaware	31	0	0	31	0	0	0
District of Columbia	2	0	1	0	0	0	1
Florida	91	57	19	13	0	0	2
Idaho	554	0	55	499	0	0	0
Illinois	412	2	25	239	146	0	0
Indiana	404	75	144	67	0	118	0
Iowa	114	0	0	114	0	0	0
Kansas	193	0	68	125	0	0	0
Kentucky	92	14	27	51	0	0	0
Louisiana	101	0	0	101	0	0	0
Maryland	59	2	13	44	0	0	0
Massachusetts	478	133	289	56	0	0	0
Michigan	682	98	367	217	0	0	0
Minnesota	1,409	167	439	536	267	0	0
Mississippi	127	0	0	33	0	0	94
Montana	1,880	452	428	371	0	127	502
Nebraska	23	0	1	12	10	0	0
Nevada	9	1	4	4	0	0	0
New Hampshire	415	161	172	82	0	0	0
New York	3,340	85	132	84	0	0	3,039
North Carolina	144	11	21	25	9	8	70
North Dakota	216	0	0	216	0	0	0
Oklahoma	74	5	49	8	12	0	0
Oregon	204	46	78	69	11	0	0
Pennsylvania	37	1	29	7	0	0	0
Puerto Rico	17	0	3	14	0	0	0
Rhode Island	54	4	41	9	0	0	0
South Carolina	40	0	0	39	1	0	0
Tennessee	119	21	33	55	10	0	0
Utah	127	33	44	50	0	0	0
Vermont	719	19	72	28	0	11	589
Virginia	248	20	49	120	0	1	58
Washington	140	58	24	45	0	0	13
Wisconsin	2,153	605	746	802	0	0	0
Totals	15,514	2,231	3,599	4,248	468	265	4,703

*States not listed in the table either did not report the information or reported in a way that was inconsistent with the format of the table.

EPA's Clean Lakes Program

History of the Program

Widespread public support for preserving and protecting the Nation's lakes gave rise to the Clean Lakes Program in 1972. Initiated under the Federal Water Pollution Control Act, the Clean Lakes Program set ambitious goals for defining the causes and extent of pollution problems in the lakes of each State and for developing and implementing effective techniques to restore and protect lake resources. The Clean Lakes Program provided financial assistance to the States to carry out the provisions and objectives of the Act.

Promulgation of the Clean Lakes Regulations in 1980 focused the program by establishing a comprehensive grant assistance program that included grants to the States for the preparation of Classification Surveys, as well as for Phase I diagnostic/feasibility studies and Phase II implementation projects. The purpose of the State lake classification survey was to identify and classify the publicly owned lakes within each State according to trophic conditions. This activity set the stage for the award of Phase I grants by defining a universe of potential lake water quality projects in each State and by serving to assist in setting priorities for potential funding assistance.

Phase I studies were intended to determine the causes and extent of pollution in particular lakes of each State, to evaluate possible pollution control mechanisms for them, and to recommend the most feasible and cost-effective methods for restoring and protecting lake water quality. Up to 70 percent of the total cost of the project could be awarded by the Federal government, with a maximum of $100,000 awarded to any one study.

The award of Phase II Federal assistance grants translated Phase I lake restoration and protection recommendations into action. Funds provided for Phase II projects were intended for actual implementation of in-lake restoration practices and best management practices in the lake watersheds. Phase II projects required at least a 50 percent non-Federal match. Since 1976, EPA has funded over 350 projects at a total cost of $102 million.

In the last 2 years, these Clean Lakes projects have produced environmental results. For example, in Panguitch Lake, Utah, stream banks have been resloped and revegetated, 3,000 feet of juniper tree revetments have been installed in highly eroded areas, seven check dams and a sedimentation pond have been built, and fences have been installed to keep out cattle. The result has been a significant decrease in sediment and phosphorus loadings and a marked recovery of the lake. Another example is the Baton Rouge University Lakes in Louisiana. Hydraulic and mechanical dredging, sewer rehabilitation, runoff diversion, and shoreline stabilization have significantly improved water quality and thereby reduced fish kills in the lakes.

With the passage of the Water Quality Act of 1987, new directions for the Clean Lakes Program were established within the broader context of State water quality management.

HALLS

Scooping algae from a eutrophic lake.

The Water Quality Act of 1987

Section 314 of the Water Quality Act of 1987 reauthorized the Clean Lakes Program and mandated a number of new initiatives and requirements. First, in order to remain eligible for Clean Lakes Program grant funds, each State is required

to submit biennially to EPA the following:

- A revised Lake Classification Report;
- A list of lakes that do not meet water quality standards or will require controls to maintain standards;
- Lake pollution control procedures;
- A restoration plan for degraded lakes;
- Methods and procedures to mitigate the harmful effects of acidity in lakes;
- An assessment of the status and trends of lake water quality; and
- A list of threatened and impaired lakes.

As required by the Act, the State Section 305(b) report will be the mechanism for reporting this information.

Second, under the new Act, EPA was authorized to establish a Clean Lakes demonstration program to enhance current scientific understanding of the causes of lake degradation and the effectiveness of various lake restoration techniques. This includes a study of the causes and extent of lake acidification nationwide and should result in the development of mitigation techniques for affected lakes.

Third, EPA was required to develop a lake restoration guidance manual and distribute it to the States and others interested in lake management, restoration, and protection. The manual has been completed, and nearly 10,000 copies have been distributed nationwide.

Finally, in accordance with Section 518(e) of the Water Quality Act of 1987, EPA's Administrator is authorized to treat qualified Indian tribes as States.

In implementing the CWA reauthorization, States are encouraged to develop integrated water quality strategies that include lake and reservoir management, restoration, and protection activities. EPA will develop technical support materials to strengthen State programs. These materials focus on developing closer ties between lake management interests and other water quality programs. As part of this technical support effort, EPA will continue to encourage national and international lake management conferences as well as regional and State lake management workshops.

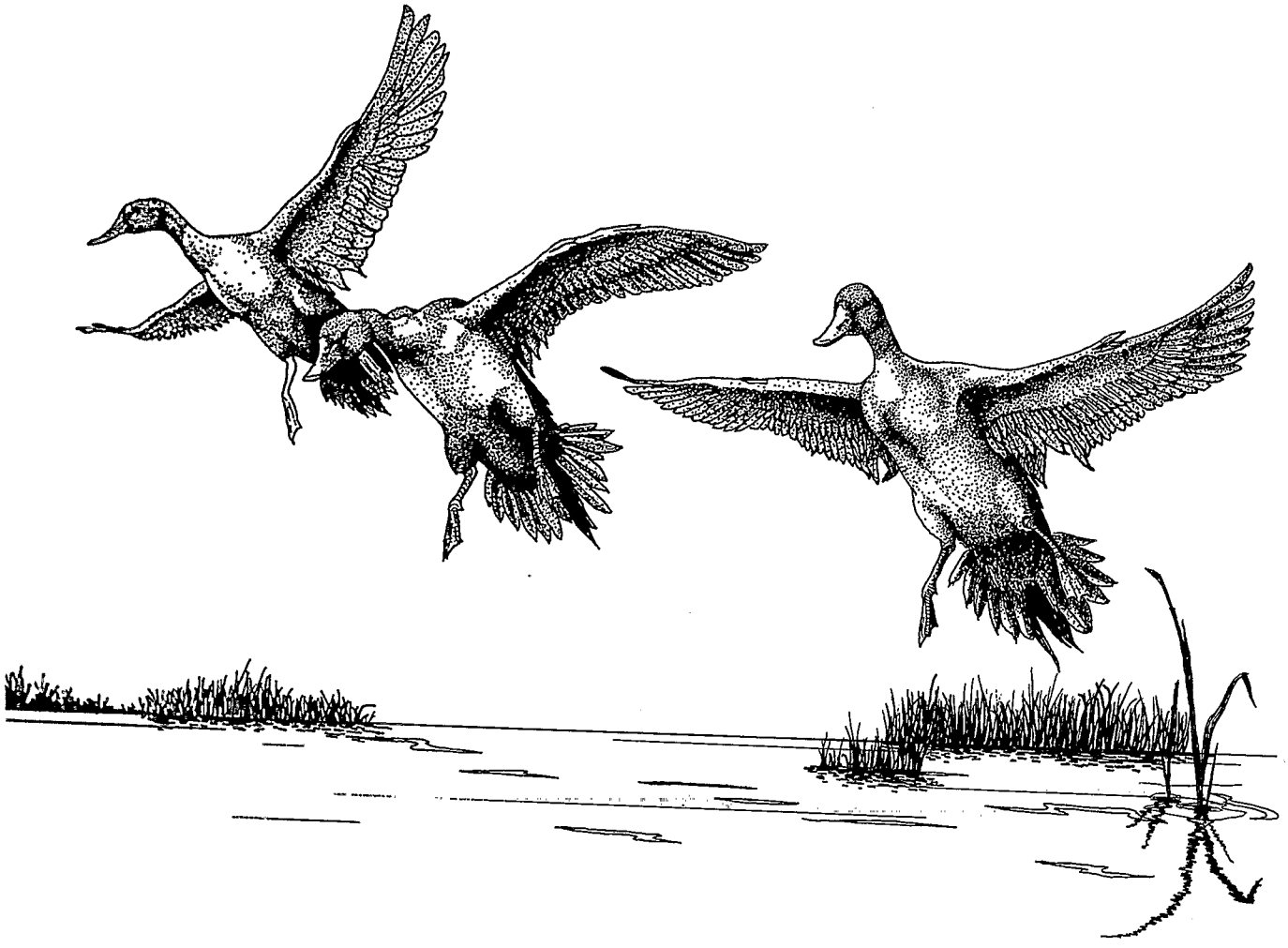
California Regional Water Quality Control Board

NALMS

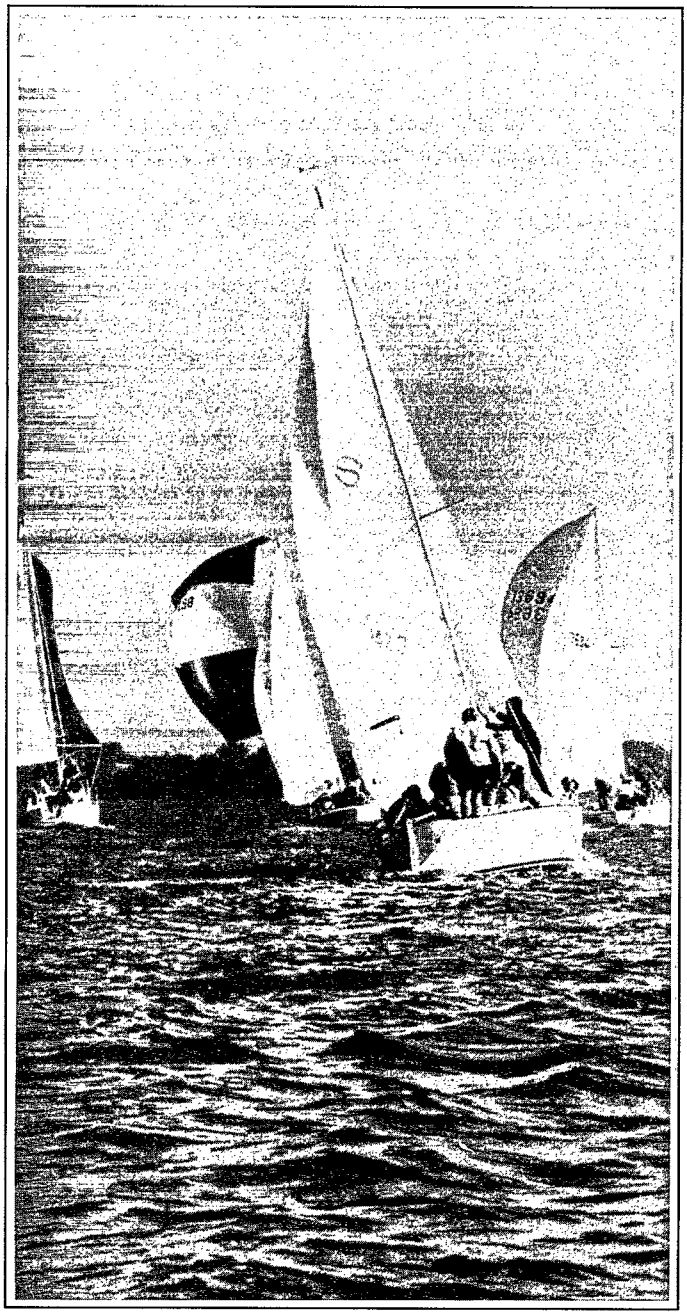
Section 314 of the Water Quality Act of 1987 mandated a number of new initiatives to study, protect, and restore the Nation's lakes.

In addition, in 1987-1988, EPA worked to improve coordination with other Federal agencies such as the U.S. Department of Agriculture; prepared a Report to Congress on the status of water quality in lakes; and initiated a long-term citizen's information and education program.

Also, in 1988-1989, the Agency awarded over 100 new Clean Lakes Program grants to States and eligible Indian tribes for the study and restoration/protection of lakes. Forty States and 12 Indian tribes received grants to assess lake water quality. In addition, 43 Phase I Diagnostic/Feasibility Study grants were awarded to determine the causes and sources of pollution to specific lakes and to develop feasible restoration plans. Ten Phase II Restoration Implementation grants were awarded to implement approved restoration plans, and Phase III Post-Restoration Monitoring grants were awarded to determine the longevity and effectiveness of previously completed restoration activities.



3



The Great Lakes

Support of Designated Uses

The Great Lakes hold one-fifth of the world's fresh water and are so large that in many ways they might better be considered as freshwater inland seas. Major urban and industrial centers such as Chicago, Detroit, Gary, Toledo, Toronto, and Buffalo are located along their shores. They serve as receiving waters for the municipal and industrial dischargers in many of these urban areas and are also affected by a myriad of other sources including urban and agricultural runoff, hazardous waste sites, pollution brought by tributaries, and atmospheric deposition. Despite these influences, the Great Lakes have immense recreational and commercial value and are unique, vital natural resources.

In their 1988 State Section 305(b) reports, six of the eight Great Lakes States provided information on the extent to which their Great Lakes shoreline miles attain the uses for which they have been designated (see Table 3-1). A total of 4,479 miles were assessed—all of the shoreline miles in these States and 87 percent of the total number of Great Lakes shoreline miles in the U.S. Eight percent of assessed miles, or 372 miles, were found to be fully supporting uses, and 4 percent of these were determined to be supporting but threatened. Eighteen percent of assessed miles (819 miles) were reported to be partially supporting uses, and 73 percent (3,288 miles) were reported as not supporting uses (see Figure 3-1).

Table 3-1 gives further evidence of the variability of State reporting and assess-

Table 3-1. Designated Use Support in Great Lakes

State	Total Shoreline Miles	Shoreline Miles Assessed			Miles Fully Supporting	Miles Threatened*	Miles Partially Supporting	Miles Not Supporting
		Total	Percent Evaluated	Percent Monitored				
Illinois	63	63	0	100	0	0	63	0
Indiana	43	43	0	100	0	0	43	0
Michigan	3,288	3,288	0	100	0	0	0	3,288
Minnesota	272	272	0	100	272	—	0	0
New York	577	577	0	100	100	15	477	0
Ohio	236	236	—	—	0	—	236	0
Totals	4,479	4,479			372	15	819	3,288

*Miles Threatened is a subset of Miles Fully Supporting.

— Not reported.

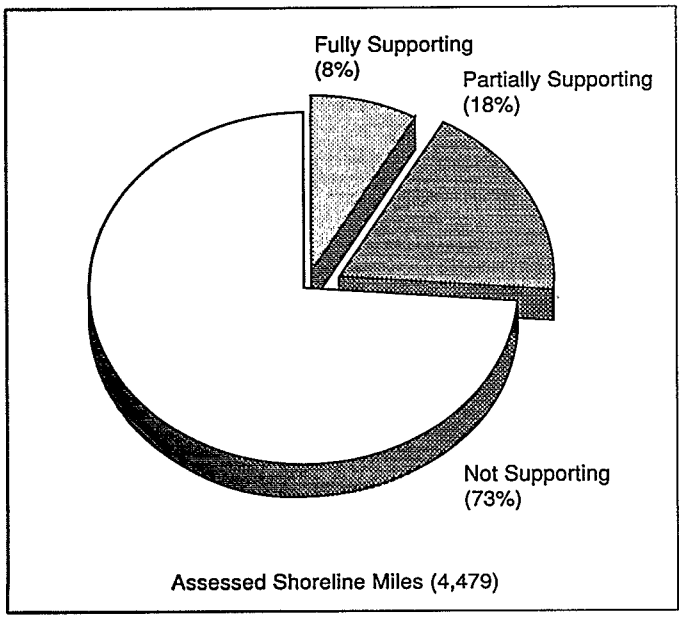
Source: 1988 State Section 305(b) reports.

ment methodologies. Fish consumption restrictions are in place for one or more species throughout near-shore waters of the Great Lakes; as a result, Michigan, which has portions of four Great Lakes in its jurisdiction totaling 3,288 shoreline miles, reported all of its lake shore miles as not supporting uses. Other States have classified waters with restrictions as partially (or even fully) supporting designated uses.

It should also be noted that it is the nearshore waters of the Great Lakes that are most likely to be degraded; Table 3-1 does not address water quality conditions in the deeper, cleaner, less stressed central waters of the Lakes.

Causes and Sources of Impairment

Priority organics are by far the most extensive cause (i.e., specific pollutant or process) responsible for use impairment in the Great Lakes, according to the four States reporting (see Table 3-2). While all States reported Great Lakes waters affected by priority organics, New York alone accounts for over 60 percent of those waters. Metals are also



Source: 1988 State Section 305(b) reports.

Figure 3-1. Designated Use Support in Assessed Great Lakes

Table 3-2. Impaired Great Lakes Shoreline Miles Affected by

State	Total Impaired Waters*	Priority Organics		Metals	
		Major	Mod/Min	Major	Mod/Min
Illinois	63	63	—	—	—
Indiana	43	—	43	—	—
New York	477	463	—	—	—
Ohio	236	4	188	86	129
Totals	819	530	231	86	129
Combined Totals			761		215

commonly reported, with nutrients, organic enrichment/low dissolved oxygen, and pesticides also cited as contributors to use impairment.

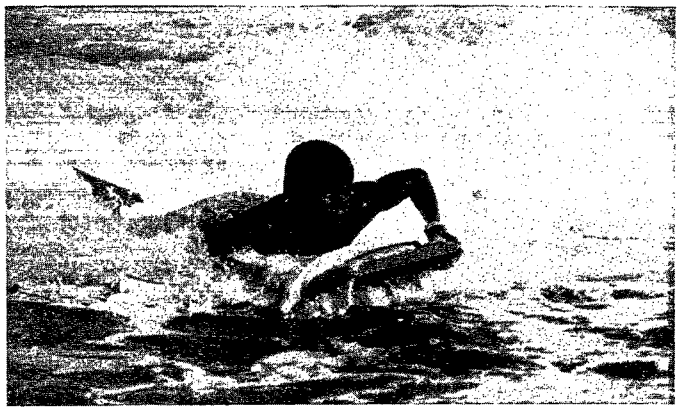
Three States provided information on the various sources of pollution in their Great Lakes shoreline miles (see Table 3-3). Land disposal is cited as the leading source of impairment; however, all waters reportedly affected by land disposal are in one State (New York). Source and cause data on the Great Lakes are limited and are probably not indicative of the lake system as a whole.

Attainment of Clean Water Act Goals

Five States provided information on the degree to which their Great Lakes shoreline waters meet the fishable and swimmable goals of the Clean Water Act (see Table 3-4).

A total of 1,191 shoreline miles were assessed for fishability. Largely because of fish consumption advisories and bans, only 32 percent of these assessed waters are meeting the fishable goal. The main reason for these fishing restrictions is contamination of sediments by toxic chemicals such as priority organics that are, in turn, passed along to macroinvertebrates and fish. In none of the assessed Great Lakes shoreline miles is the fishable goal considered not attainable by State standards (see Figure 3-2). Variations in State definitions of fishable goal attainment clearly account for inconsistencies in these statistics.

Somewhat fewer shoreline miles (919) were assessed for the swimmable goal. A striking reversal is evident for the swimmable goal: 98 percent of assessed shoreline miles meet the goal, and only 2 percent do not. Again, in none of the assessed miles is the swimmable goal of the Clean Water Act considered not attainable.



Causes of Pollution

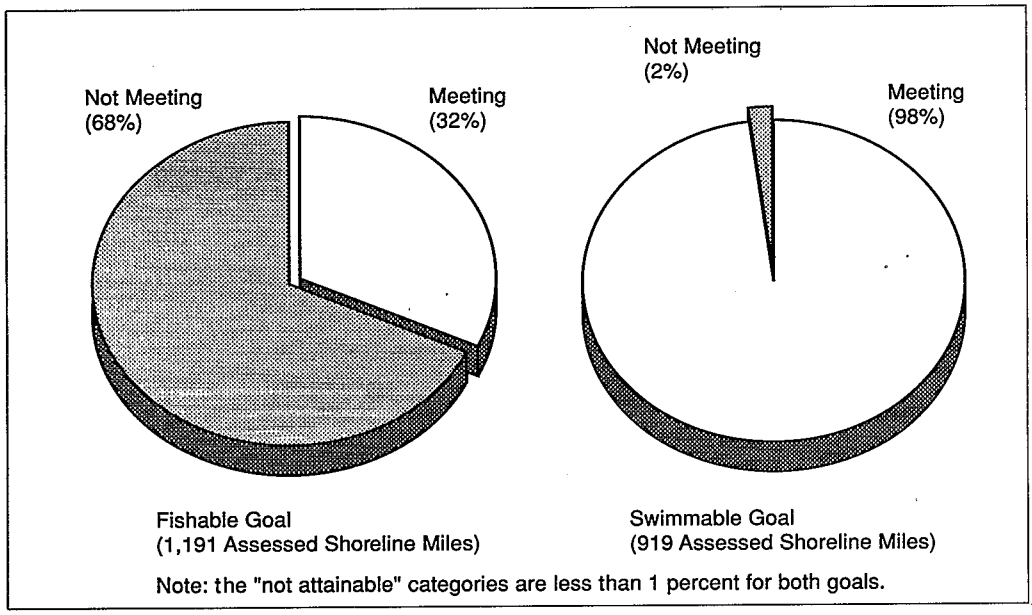
Nutrients		Organic Enrichment		Pesticides		pH		Pathogens		Siltation	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
17	26	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	43	—	—	—	—	—	—
29	—	—	15	—	—	—	—	—	15	—	14
—	4	—	46	—	—	—	35	—	—	—	—
46	30	0	61	0	43	0	35	0	15	0	14
	76		61		43		35		15		14

Table 3-3. Impaired Great Lakes Shoreline Miles Affected by Sources of Pollution

State	Total Impaired Waters*	Land Disposal		Agriculture		Combined Sewers		Storm Sewers/Runoff	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Illinois	63	—	—	—	—	—	6	45	—
Indiana	43	—	—	—	43	—	43	—	—
New York	477	—	477	14	15	—	14	—	14
Totals	583	0	477	14	58	0	63	45	14
Combined Totals			477		72		63		59

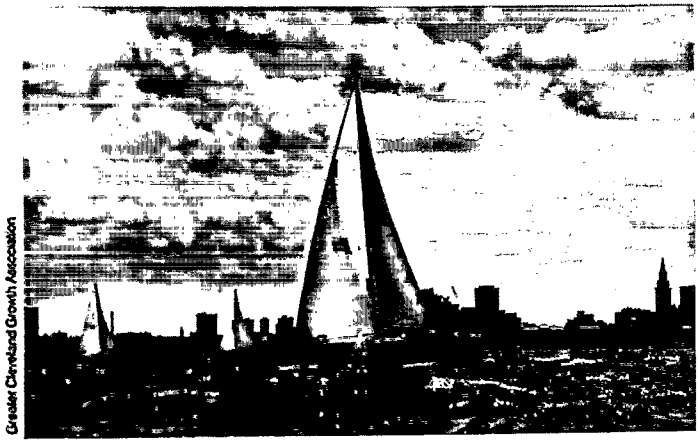
*The sum of partially and nonsupporting Great Lakes shoreline miles (Table 3-1). — Zero or not reported.

Source: 1988 State Section 305(b) reports.



Source: 1988 State Section 305(b) reports.

Figure 3-2. Attainment of Clean Water Act Goals in Assessed Great Lakes



The Cleveland lakefront.

Industrial		Municipal		Construction		Silviculture		Resource Extraction		Hydro/ Habitat Mod	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	—	—	—	—	—	—	—	—
—	43	—	43	—	—	—	—	—	—	—	—
—	—	—	—	—	14	—	—	—	—	—	—
0	43	0	43	0	14	0	0	0	0	0	0
	43		43		14		0		0		0

Table 3-4. Attainment of Clean Water Act Goals in Great Lakes

	Fishable Goal (shoreline miles)				Swimmable Goal (shoreline miles)			
State	Assessed	Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Not Meeting	Not Attainable
Illinois	63	0	63	0	63	63	0	0
Indiana	43	0	43	0	43	43	0	0
Minnesota	272	272	0	—	—	—	—	—
New York	577	114	463	0	577	563	14	0
Ohio	236	0	236	—	236	231	5	—
Totals	1,191	386	805	0	919	900	19	0

— Not reported.

Source: 1988 State Section 305(b) reports.

Sediment contamination is the main reason for fishing restrictions in the Great Lakes. Contaminants may be passed along to some fish species.

The Great Lakes: A Narrative Assessment

The Great Lakes are cooperatively protected by the U.S. and Canada under the Great Lakes Water Quality Agreement of 1978 as amended in 1987. The Clean Water Act also applies to the U.S. waters of the Great Lakes, incorporating the Great Lakes Water Quality Agreement by reference and providing special Great Lakes programs under Section 118(c). The International Joint Commission (IJC), which was established under the 1909 Boundary Water Treaty with Canada, is responsible for identifying actions needed to maintain the integrity of the Great Lakes ecosystems. The Commission's two boards—the Great Lakes Water Quality Board and the Science Advisory Board—include members from a variety of State and Federal agencies and universities who work together to identify problem areas, plan programs to reduce pollution, and publish reports on issues and findings.

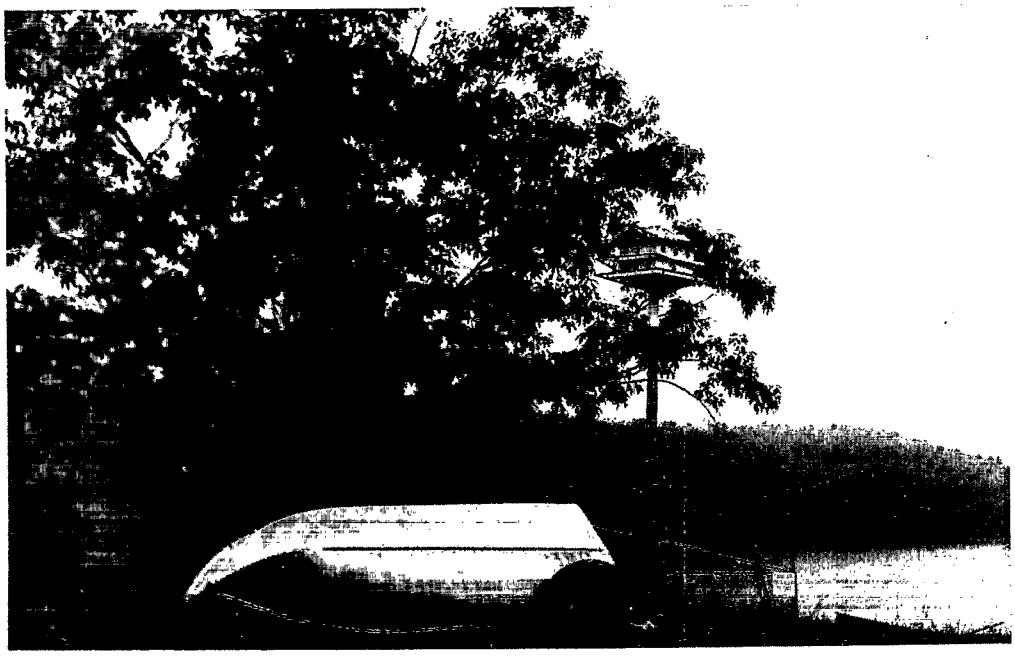
The IJC has identified 42 Areas of Concern in the Great Lakes basin. These are defined as waterways where environmental quality is degraded and beneficial uses are impaired. The IJC has developed a system to classify the Areas of Concern in terms of the information available on each and the stage of development and implementation of remedial actions. The IJC's main focus, in its listing of these problem areas, has shifted away from eutrophication and toward toxic contamination of fish tissue and sediments. Remedial action plans are required for waters identified as Areas of Concern.

Several of these IJC Areas of Concern are discussed below: the Niagara River, the Grand Calumet River-Indiana Harbor Ship Canal, Waukegan Harbor, and Saginaw Bay. Other Areas of Concern are discussed in detail in the 1988 State Section 305(b) reports.

In their 1988 Section 305(b) reports, seven States—Illinois, Indiana, Michigan, Minnesota, New York, Ohio, and Wisconsin—provided narrative information on the quality of the Great Lakes within their jurisdictions. Some overall conclusions can be drawn about conditions in the Great Lakes based on these assessments:

- Contamination of fish tissue and sediments by toxic substances such as mercury, PCBs, DDT, and other pesticides continues to be widespread. Fish advisories and bans are in place in many areas of the Great Lakes. However, declines are noted in toxics in fish tissue—particularly in levels of DDT and mercury. All the Great Lakes States appear to be pursuing aggressive, long-term monitoring for toxic substances in fish tissue.

- No improvement is noted for toxic contamination of sediments, a major problem in Great Lakes harbors and bays. Sediment contamination, in turn, can affect aquatic life and serve as a continuing source of toxics to the larger lake system.



USGS (Carol Spencer)

■ Phosphorus control programs such as bans on phosphorus-containing detergents and improvements to municipal treatment facilities—along with industrial and nonpoint source controls, reductions in combined sewer overflows, and resource management actions—have been successful in reducing the levels of this nutrient in the Great Lakes. Improvements in the eutrophic conditions of nearshore waters are noted by several States. Nitrogen levels, however, appear to be increasing.

■ Nearshore waters—particularly harbors and river outlets—seem to have the greatest problems with sediment contamination, industrial and municipal pollution, combined sewer overflows, and tributary inputs.

Information from the 1988 State Section 305(b) reports is summarized below for each of the Great Lakes.

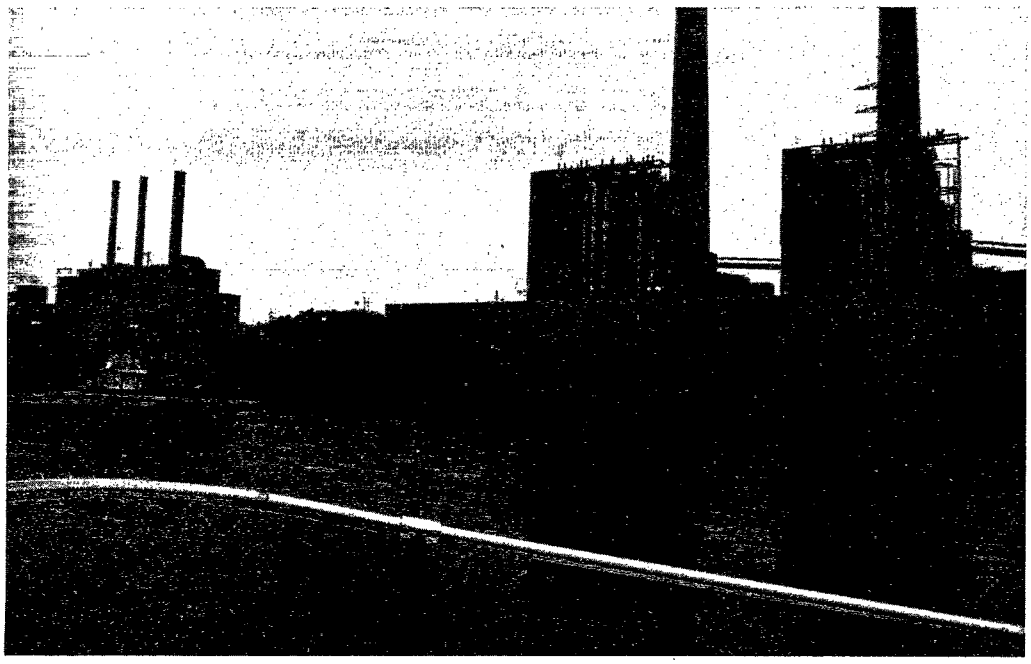
Lake Superior

Lake Superior, the northernmost of the Great Lakes, discharges to the southeast through the St. Mary's River into Lake Huron. In surface area, Lake Superior is the largest body of fresh water in the world; it is also the deepest (1,330 feet) of the Great Lakes.

Lake Superior is classified as oligotrophic. Water quality is generally good, with only a few localized problem areas along the shoreline. Michigan reports that atmospheric deposition appears to be an important source of pollutants because of Lake Superior's large surface area and the relatively low amount of input from other sources. Wet atmospheric deposition may be responsible for as much as 22 percent of the total sulfate loads and 55 percent of the total nitrogen loads to the lake.

In May 1986, the Minnesota Department of Health, in conjunction with the Wisconsin Department of Health, issued a lakewide advisory for lake trout over 30 inches. The advisory is most probably the result of new data rather than worsening water quality conditions.

Lake Superior's St. Louis Bay has been identified as an Area of Concern by the IJC because of toxic contamination of sediments that, in turn, affect aquatic life. A remedial action plan is being developed by Minnesota and Wisconsin.



Mike McCarthy

Lake Michigan

Lake Michigan drains eastward through the Straits of Mackinac into Lake Huron. Its open waters are oligotrophic. Nearshore areas in Green Bay and along the southern portion of the lake are more mesotrophic because of nutrient inputs from industrial activities and urbanization.

Of the Great Lakes surveyed under Michigan's fish contaminant survey program, Lake Michigan has been the most heavily affected, particularly by organochlorine compounds. However, levels of most contaminants in fish are declining. Mercury levels have been declining in the lake since 1972. The 1984 data showed that contaminants in coho salmon, steelhead, and lake trout less than 20 inches long decreased to the point where 90 percent or more of the fish tested did not exceed action levels issued by the U.S. Food and Drug Administration (FDA). However, contaminant levels remain high in lake trout over 25 inches long and in carp and brown trout. Levels of DDT, dieldrin, and PCBs are consistently higher in fish taken from the southern end of the lake. These higher levels in fish correspond closely with higher levels of these contaminants in the sediments at the lake's south end.

Water quality in the Indiana portion of Lake Michigan varies widely. Indiana reports that water column sampling reveals few violations of standards. However, concentrations of mercury and phenols in the near shore zone reflect the effects of wastewater and tributary contributions from the watershed. The highest values consistently appear near the Indiana Harbor Ship Canal. High levels of chlorides in the contiguous harbor, as well as low dissolved oxygen and high un-ionized ammonia values in Trail Creek, may also be responsible for some of the chemical variability in the Lake.

Since testing began in the early 1970s, PCBs, chlordane, DDT, and dieldrin have been found in fish tissue in Lake Michigan at levels exceeding FDA action levels. Indiana issues a revised fish consumption advisory for fishermen and consumers of these fish each spring.

The two branches of the Grand Calumet River meet to form the Indiana Harbor Ship Canal, which empties into Lake Michigan. The Grand Calumet River-Indiana

Michigan Dept. of Natural Resources

Harbor Ship Canal has been designated as an Area of Concern by the IJC. Standards for dissolved oxygen, chlorides, ammonia, and fecal coliform are commonly violated. However, the number and severity of violations have been reduced because of recent upgrades to area municipal sewage treatment facilities.

In 1985, EPA prepared a "Master Plan for Improving Water Quality in the Grand Calumet River and Indiana Harbor Canal." The Master Plan calls for programs that will focus EPA and State water quality control efforts on problems in these waters. Programs include tightening discharger permit limits, developing pretreatment programs, and taking compliance actions (both municipal and industrial) to ensure that permit limits are met. Longer term investigations to evaluate the effectiveness of existing and new control programs will be conducted.

Indiana is also preparing a remedial action plan to define activities needed to improve water quality in the Grand Calumet River-Indiana Harbor Ship Canal so that designated uses for Lake Michigan are maintained or restored.

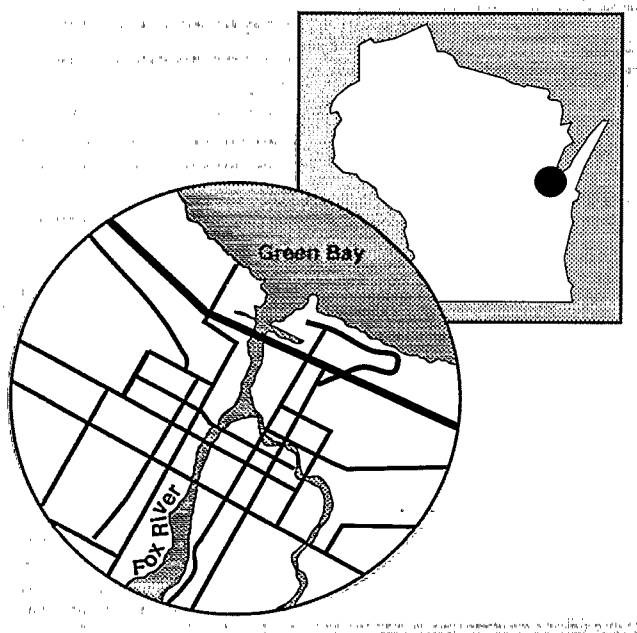
Illinois reports that priority organics are considered a major problem along its Lake Michigan shoreline. PCBs, chlordane, and dieldrin were found to exceed FDA action levels in fish tissue in 1986. PCBs are also a problem in sediments of various Lake Michigan harbors. Improvements are noted for phosphorus due to municipal sewage treatment improvements and a ban on phosphate detergents in Indiana.

Major sources of pollutants along the Illinois shore of Lake Michigan include atmospheric deposition, urban runoff, and in-place contaminants (sediment contamination). Waukegan Harbor, identified as an Area of Concern by the IJC, is one of several areas severely affected by sediment contamination. PCBs in the harbor prevent its use for fish consumption and swimming, and restrict dredging for navigation channels. A Superfund Consent Decree has recently been entered for the Outboard Marine Corporation site at Waukegan Harbor. While it includes a remedial action plan specific to the site, the settlement does not address the harbor as a whole and should be considered as a probable component of the Area of Concern remedial action plan. Now that the Superfund issue is settled, Illinois will be able to prepare a remedial action plan for the Area of Concern under the terms of the Great Lakes Water Quality Agreement.

Green Bay/Fox River Mass Balance Study

Description of Geographical Area

Green Bay can be characterized as a long, relatively shallow extension of northwestern Lake Michigan. The Green Bay watershed drains land surfaces in both Wisconsin and Michigan and contains about one-third of the total Lake Michigan drainage basin. It drains the Fox River Valley, which supports extensive agriculture and is heavily industrialized, containing the largest concentration of pulp and paper plants in the world.



Water Quality Problems

At present, conditions in Green Bay range from hypereutrophic in the southern portion to mesotrophic-oligotrophic near the Lake Michigan interface. The extreme productivity in the southern portion results in deposition of organic material which, in turn, causes hypolimnetic oxygen depletion in the central bay.

The presence of toxic organic materials in the water, sediment, and biota has adversely affected both the use and management of the bay's fisheries. The commercial fisheries in the bay, with the exception of yellow perch, are closed because of PCB contamination. Consumption advisories have been issued to sport fishermen. Reproductive failure and increased deformities have been observed in some fish-eating birds and are apparently related to toxic contamination.

Problems with toxic contamination observed in Green Bay are similar to those in other polluted areas of the Great Lakes and are representative of the problem of bioaccumulation of toxic contaminants in fish in the Great Lakes at large. The lower bay and Fox River have been recognized as a polluted water system and have been designated by the International Joint Commission as one of the 42 Great Lakes Areas of Concern.

The Green Bay/Fox River Mass Balance Study

EPA's Great Lakes National Program Office (GLNPO) is coordinating and providing major funding for a mass balance study of the toxic contaminants in the Green Bay ecosystem.

The concept of total load management in the Great Lakes Basin is a fundamental element of the Water Quality Agreement between Canada and the United States, of GLNPO's Five-Year Strategy, and of the Lake Michigan Toxicant Control Strategy. Great Lakes managers have recognized that addressing toxic contaminants in the Great Lakes system requires a comprehensive multimedia evaluation of the point and nonpoint source loadings to the lakes, including less easily measured sources such as air, precipitation, soil, sediments, and ground water. The mass balance approach, based on the law of conservation of mass, assumes that inputs of toxic contaminants (less quantities stored, transformed, or degraded within the system) must equal

outputs. This concept serves as the framework around which data are being gathered to provide a comprehensive picture—an ecosystem model—of contaminant dynamics in Green Bay.

The overall goal of the Green Bay/Fox River Study is to develop a modeling framework to improve our understanding of the sources, transport, and fate of toxic compounds, to evaluate the technological capability to measure multimedia loadings to the system, and ultimately to guide and support regulatory activity.

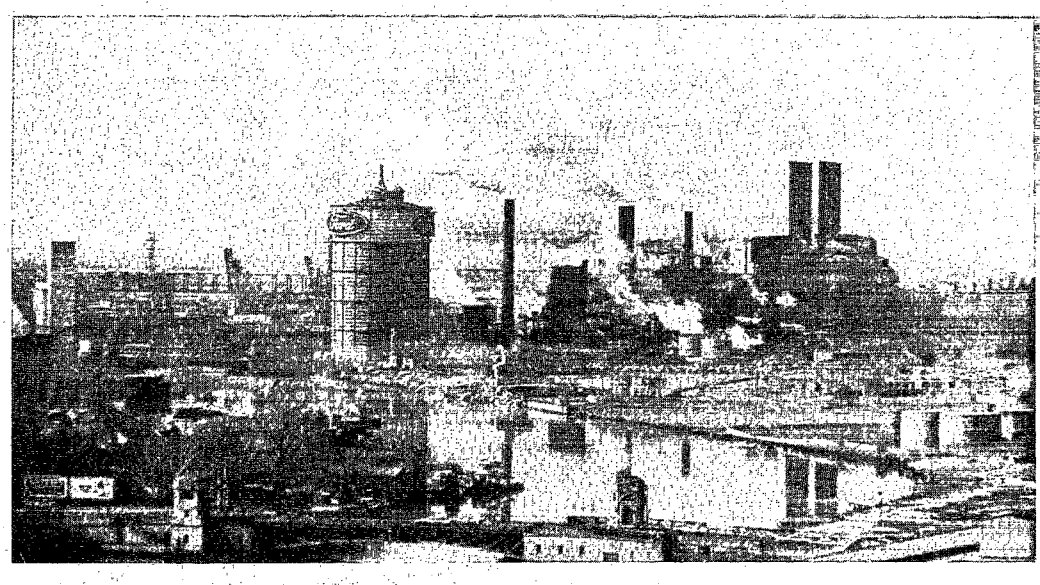
Study Scope and Activities

For the Green Bay/Fox River Mass Balance Study, models will be applied to toxicants of interest. These include PCBs, dieldrin, cadmium, and lead. Physical/chemical models will be coupled with a food chain model to allow estimation of the body burdens in the target species (carp, brown trout, and walleye). The integrated model will then be used to predict concentrations in the water, sediment, and biota in response to differing regulatory and remedial action scenarios. The predictions will include long-term extrapolation from the short-term calibration.

The study is concentrating research efforts on Green Bay in order to gather the data needed to construct and drive the mass balance model. Research vessels are traveling the bay to measure contaminant levels in water, sediments, and biota. Projects to quantify sources of toxic contaminants include:

- A first-of-its-kind network of air monitors to measure the introduction of airborne toxicants to Green Bay;
- Sampling programs to measure toxic input from major rivers that enter Green Bay, including the mouth of the Fox River; and
- An in-depth study of the distribution and movement of contaminants from polluted sediments.

These activities will tap the expertise of a number of State and Federal agencies. Aside from EPA's GLNPO, participants include the Wisconsin Department of Natural Resources; the Wisconsin Sea Grant; the National Oceanic and Atmospheric Administration (NOAA); the U.S. Fish and Wildlife Service; the U.S. Geological Survey; the Michigan Department of Natural Resources; the Green Bay Remedial Action Plan Implementation Committee; EPA laboratories at Duluth, Minnesota, and Grosse Isle; and EPA Region V's Divisions of Water and Waste Management.

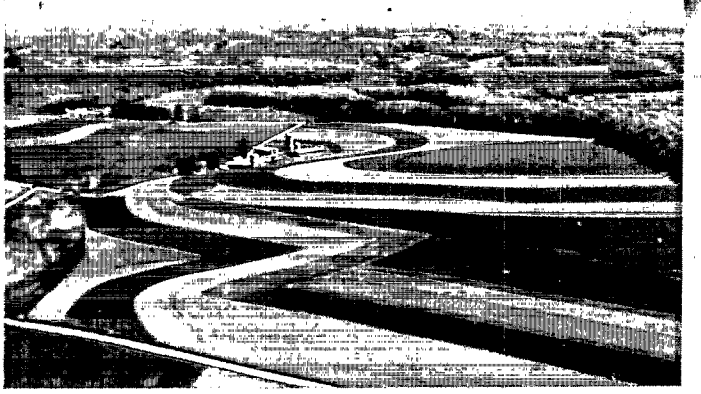


Study Schedule and 1988 Status

The study activities are being conducted during a 4-year period beginning in 1986 and continuing until the end of 1990.

During 1986-1987, a monitoring plan was developed, along with a quality assurance program to be used in evaluating analytical and field methods for the project. Also during this time, modeling tasks were scoped out and assigned to appropriate investigators, and some field reconnaissance was accomplished.

During 1988, the three atmospheric deposition monitoring stations were operating. The 1988 field season saw the first shakedown surveys in the bay. EPA's research vessel, the R/V Roger Simons, was outfitted with the necessary sampling and laboratory equipment. During the August, October, and November surveys, methods for sampling toxics in bay and tributary waters were tested in preparation for the main field work year of 1989.



NOAA deployed wave rider buoys and current meters at strategic locations in the bay.

Field work will peak during the 1989 field season, when investigators will concentrate their efforts to provide a comprehensive and coordinated data set for describing contaminant dynamics in the Green Bay ecosystem. Sample analysis and data evaluation will proceed through 1990. Modeling results and a final report are expected in 1991.

Significance of the Study to Great Lakes Water Quality Management

As recommended by the International Joint Commission for all of the Areas of Concern, Wisconsin's Department of Natural Resources has prepared a remedial action plan for Green Bay and the Lower Fox River. This plan outlines actions the State intends to carry out to restore the bay's beneficial uses, such as swimming and fishing. The plan also points out that the relative importance of some sources of toxic contaminants, such as acid deposition, is not well understood. The results of the Mass Balance Study will aid the State in refining its plans to enhance water quality in the bay.

The methods and findings of the study could also have a much wider application. Mass balance modeling has successfully been applied to the regulation of nutrient loads in the Great Lakes. However, the sources, pathways, and sinks for toxic substances are less well understood. Under the Water Quality Agreement, the U.S. EPA and the Great Lakes States have a mandate to manage toxic contamination in the Great Lakes on a lakewide basis by taking all inputs into account.

The Green Bay/Fox River Mass Balance Study will test the use of a modeling framework to improve our understanding of the sources, transport, and fate of toxic compounds. It will ultimately guide and support regulatory activity. The study is also designed to develop and test methods, such as sampling for airborne toxics, that can later be used for lakewide investigations of toxic contaminants. In this way, it serves as a pilot for future modeling studies of Great Lakes ecosystems.

Lake Huron

Lake Huron receives the outflow of both Lake Superior and Lake Michigan and in turn discharges to the south through the St. Clair River, Lake St. Clair, and the Detroit River, into Lake Erie. Although Lake Huron is classified as oligotrophic, Michigan reports that one area of the Lake—Saginaw Bay—is considered eutrophic. Saginaw Bay has also been identified by the IJC as an Area of Concern. Water quality problems in the bay include elevated levels of heavy metals, toxic organics, conventional pollutants, and contaminated sediments. A fish consumption advisory is also in effect in the bay. Michigan reports that Saginaw Bay's water quality has improved considerably in recent years.

Lake Erie

Michigan reports that Lake Erie's shallowness and warm temperatures make it susceptible to nutrient enrichment problems. According to the International Joint Commission, remedial programs for reducing phosphorus loadings have led to a 56 percent decrease in rates of loading over the last 15 years. This has contributed to a 44 percent decline in mean total phosphorus concentrations in the central basin's upper water column over the same period. In recent years, oxygen depletion rates in the central basin's lower water column have decreased and are less variable, suggesting an improvement in eutrophic conditions. On the other hand, documented increases in nitrate concentrations are cause for concern.

Other indicators of water quality including water clarity, measurements of phytoplankton biomass, and counts of certain fish species also suggest that Lake Erie water quality is improving. In addition, recent evidence from municipal water intakes indicates that concentrations of ions, such as chlorides and sulfates, have decreased since 1970.

Michigan also reports that, in general, concentrations of total PCB and other organochlorine contaminants monitored in walleye since 1977 have exhibited year-to-year variability and no obvious trend. Levels of mercury in walleye have decreased since 1977, remaining below FDA action levels, and concentrations of other contaminants have also remained relatively low.

Ohio reports that although phosphorus loadings and concentrations have been decreasing, Lake Erie is still eutrophic, particularly throughout the western basin and in nearshore areas. The nearshore area at the eastern end of the Ohio shoreline is the only area of the State's nearshore waters in the lake approaching or attaining mesotrophic status. Maumee Bay and Sandusky Bay, the most eutrophic areas in Lake Erie, are fed by rivers whose drainage basins are used intensively for agriculture. Although nutrient levels are elevated throughout the nearshore and particularly near river mouths, water quality standards are rarely exceeded. However, violations of metals standards are common throughout the nearshore area, particularly for cadmium and copper. Metals violations are the primary reason that the Lake Erie nearshore is classified as only partially supporting its designated uses.

An exchange of fish monitoring data among New York, Pennsylvania, Ohio, Michigan, and the Province of Ontario revealed concentrations of PCBs in excess of acceptable FDA levels. This information led to the 1987 issuance of a whole-lake advisory warning against consuming channel catfish and carp. (New York later withdrew its lakewide advisory after determining that levels of PCBs in its Lake Erie waters did not exceed acceptable FDA levels. However, a statewide fish consumption limit based on more protective State criteria does apply to all fresh waters in New York.) Fish consumption advisories are also in effect in the lower Black and Ashtabula Rivers because of elevated concentrations of PCBs and polycyclic aromatic hydrocarbons (PAHs). Although Lake Erie supports the most productive fishery in the Great Lakes, the issuance of the advisory classifies the whole lake as not supporting the CWA fishable goal.

Ohio reports that Lake Erie harbor areas are much more eutrophic and contain higher levels of contaminants than any nearshore areas. The harbors act as natural sinks for sediments and associated pollutants delivered by tributaries. Four of the harbor areas in Ohio (the lower Maumee, Black, Cuyahoga, and Ashtabula Rivers) have been designated as IJC Areas of Concern, and remedial action plans are being developed to return these areas to conditions supporting beneficial uses.

Lake Ontario

The bioaccumulation of toxic substances is one of Lake Ontario's major problems. New York reports that tributaries to Lake Ontario—the Niagara, Oswego, and Genessee Rivers—are often the major source of these pollution problems. Atmospheric deposition is believed to be a significant contributor of several volatile organic contaminants, including PCBs.

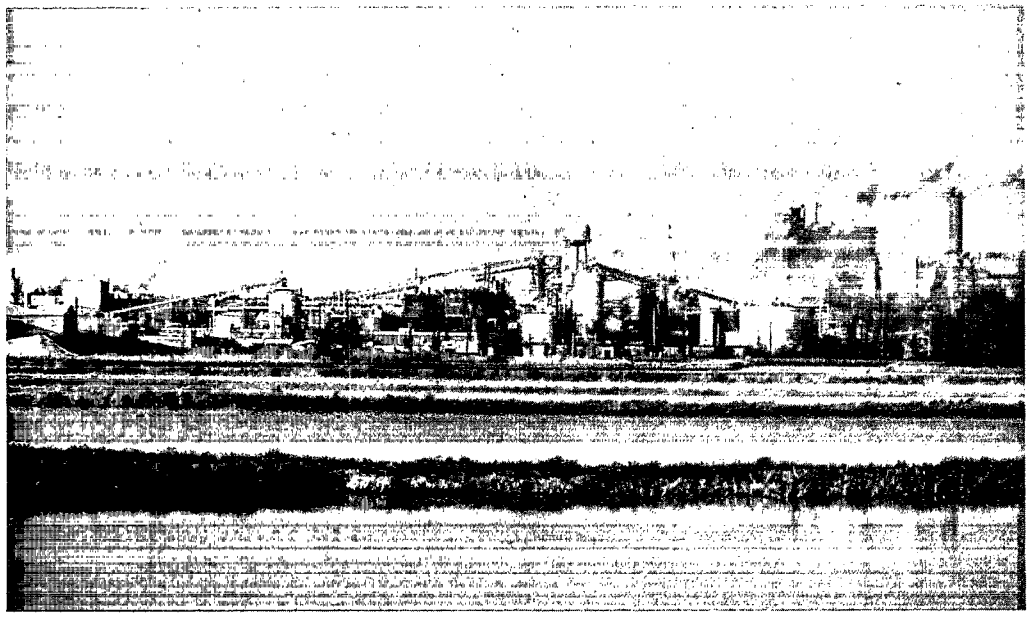
Fishing advisories are in effect in Lake Ontario for a number of species including channel catfish, lake trout, chinook and coho salmon, rainbow and brown trout, and white perch. PCBs, mirex, dioxin, and chlordane in tissue at levels exceeding FDA action limits are cited as the causes of the fishing advisories.

Toxic substances in the water column off the major tributaries are also found at levels violating standards. Those that are measured most frequently in excess of standards are heavy metals, specifically cadmium and zinc.

A steady decrease in phosphorus loadings to Lake Ontario has been observed since 1972. Improving conditions in the lake are indicated by a shift of the open lake phytoplankton community from one containing mesotrophic forms to one with species more indicative of oligotrophic conditions.

However, the concentration of nitrogen continues to increase in the lake. The reasons for this increase require further investigation. Environment Canada compared the rate of increase in Lakes Ontario and Huron and concluded that both lakes are responding in a similar manner to a common loading source.

Eutrophication is also a problem in two major embayments along the lake, Irondequoit Bay and Sodus Bay. The problem is attributed to local inputs of nutrients from point and nonpoint sources.



Weyer Plywood

Niagara River

The Niagara River drains the entire Great Lakes system and all of the municipal and industrial discharges entering the lakes from one of the most highly industrialized regions of the United States and Canada. Because of the huge volume of flow in the Niagara, conventional wastes are readily assimilated and dissolved oxygen levels are consistently above minimum required standards. However, toxic chemicals in water, sediments, and fish tissue pose a persistent problem in the Niagara River, difficult to quantify and remedy. A number of tributaries of the Niagara River have also been identified as having water quality problems related to toxic substances. These include Two Mile Creek, the Black Rock Canal, Black Creek, Smokes Creek, Bloody Run Creek, Gill Creek, Bergholtz Creek, and Scajaquada Creek. A fishing advisory has been issued for several species in the Niagara River below the Falls because of PCB, mirex, and dioxin contamination, and for all fish species in Cayuga Creek because of dioxin contamination.

The International Joint Commission has identified the Niagara River as an Area of Concern. A remedial action plan to address water quality problems is being prepared. The Niagara River Toxics Committee, a joint U.S.-Canada work group, found that data for sediments and for some sport fish from the western basin of Lake Ontario indicated declines in the uptake of PCBs, DDT, mirex, and chlorinated benzenes between the early to mid-1970s and 1980. This was confirmed by the significant declines in PCBs and DDT residues since 1975 in spottail shiners collected at the outlet of the Niagara River. Mirex levels in these fish declined since 1978, but no trends are evident for chlordane and hexachlorocyclo-hexane isomers. Since 1980, levels of PCBs and DDT in spottails are no longer declining, but fluctuations make it difficult to determine any new trends.

A study completed in 1987 by the New York Department of Environmental Conservation found that the total daily loadings of priority pollutants from 29 significant discharges into the Niagara River had decreased from 2,740 pounds per day to 540 pounds per day since a 1981-1982 baseline study. The majority of the total daily loadings are heavy metals and cyanide, and the remainder are organic pollutants.

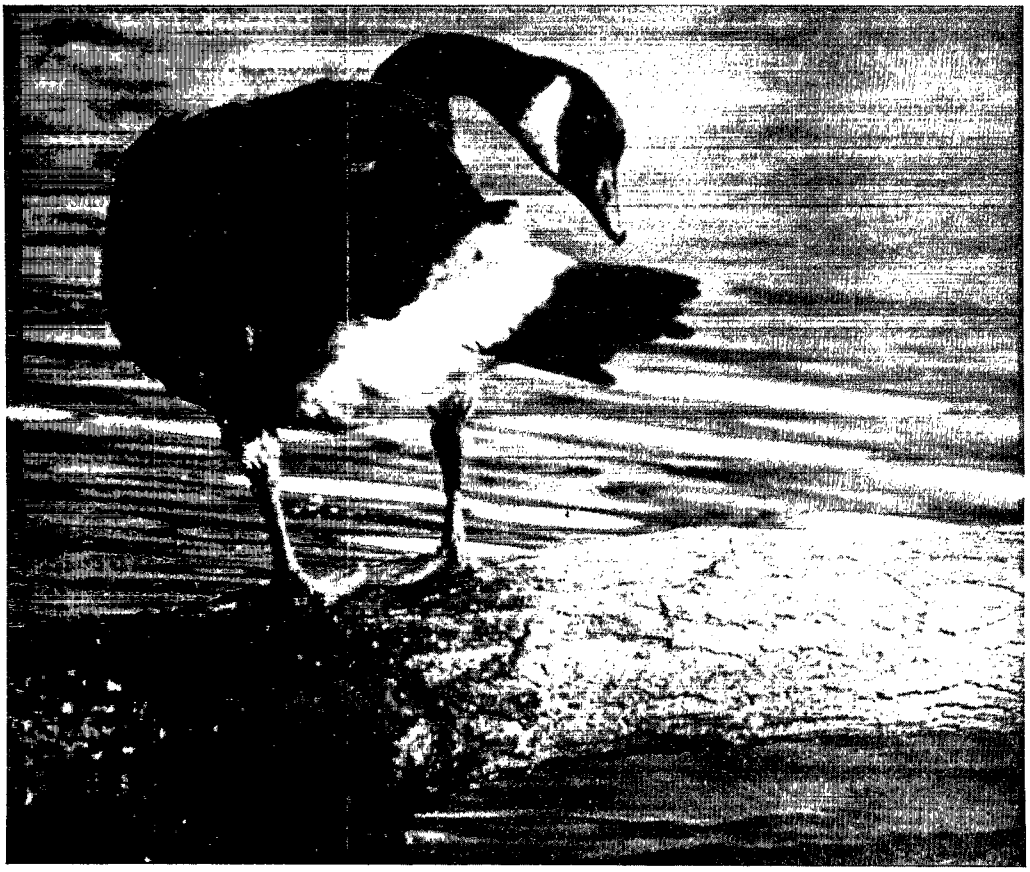
International Joint Commission, Great Lakes Regional Office

A view of Niagara Falls.

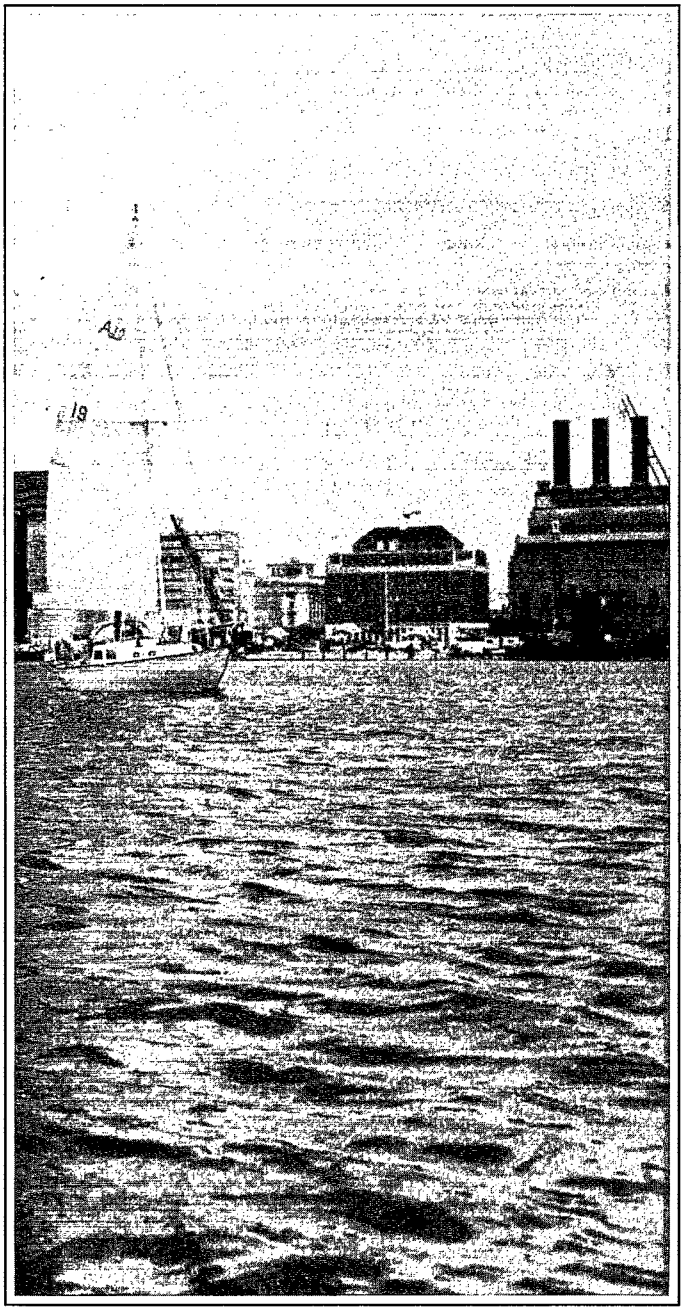
A report released in 1986 by the Niagara River Data Interpretation Group concluded that ambient loadings of a number of substances were considerably higher at the mouth of the river, at Niagara-on-the-Lake, than at the beginning of the river at Fort Erie. This report summarizes data collected by Environment Canada at Fort Erie and Niagara-on-the-Lake in 1984-1986.

The Group released its second report in early 1988 covering the period of April 1986 to March 1987. Among the findings were that eight organic contaminants and six trace metals showed statistically significant increases in loadings or in concentrations in water or sediment at Niagara-on-the-Lake. Twenty-five of the 59 contaminants analyzed were higher at Niagara-on-the-Lake than at Fort Erie.

A recent study of organochlorine contaminants in ducks wintering on the Upper Niagara River found that concentrations of PCBs, dieldrin, hexachlorobenzene, and heptachlor epoxide increased in adults between their late fall arrival and early spring departure. These contaminants were present at levels high enough to be considered a potential health risk to humans who might consume the birds.



4



Steve Delaney

Estuaries and Coastal Waters

The States provided far more information on water quality conditions in their estuaries and bays than in their ocean coastal waters. In part, this may be because degradation is more likely to occur in embayments and estuaries where polluted rivers join the sea and human population has concentrated for economic and recreational reasons. Another reason is that States generally lack reporting capability for offshore areas; historically, EPA and the States placed little emphasis on developing this capability. States are therefore more likely to devote more resources to evaluating estuarine rather than coastal water quality. Summary water quality information for estuaries and coastal waters presented by the States in 1988 will be discussed below to the extent that data are available.

It should also be noted that information collected through the National Estuary Program and the Near Coastal Waters Program indicates that some designated use data reported below may not accurately reflect known impairment in estuaries and coastal waters. As EPA increases its emphasis on estuarine and coastal water reporting, the accuracy and comprehensiveness of these data should improve.

Estuaries

Support of Designated Uses

Twenty-three States, jurisdictions, and Interstate Commissions (hereafter referred to as States) provided use support information on their estuarine waters in their 1988 State Section 305(b) reports (see Table 4-1). A total of 26,676 square miles were assessed, 76 percent of the estuarine waters in these States.

Of these assessed waters, 19,110 square miles, or 72 percent, were found to fully support designated uses. About 2 percent of those estuarine square miles supporting uses were determined to be threatened by pollution and could become impaired if control actions are not taken. Twenty-three percent of assessed square miles (6,078 square miles) partially supported uses, and 6 percent (1,488 square miles) did not support their designated uses (see Figure 4-1). Nineteen of the estuarine States specified the basis of their assessment decisions; 23,049 square miles were assessed in these States, three-quarters using monitoring and one-quarter using evaluative methods, such as mathematical models or fisheries surveys.

Table 4-1. Designated Use Support in Estuaries

State	Estuary Square Miles	Square Miles Assessed			Sq. Miles Fully Supporting	Sq. Miles Threatened*	Sq. Miles Partially Supporting	Sq. Miles Not Supporting
		Total	Percent Evaluated	Percent Monitored				
Alabama	625	53	28	72	50	—	0	3
California	1,598	1,099	—	—	1,076	—	0	23
Connecticut	601	601	10	90	367	8	231	3
District of Columbia	6	6	0	100	0	0	5	1
Delaware River Basin	866	866	—	—	855	—	0	11
Florida	4,298	2,655	13	87	1,549	—	815	291
Georgia	594	594	85	15	583	—	7	4
Hawaii	134	134	0	100	40	0	94	0
Louisiana	7,656	4,928	88	12	2,731	0	2,077	120
Massachusetts	171	171	0	100	54	—	111	6
Maryland	1,981	1,981	0	100	0	—	1,974	7
Maine	1,633	1,633	—	—	1,595	—	38	0
Mississippi	133	133	90	10	126	6	6	1
North Carolina	3,200	3,194	4	96	2,974	9	218	2
New Hampshire	27	17	0	100	7	7	0	10
New Jersey	420	259	0	100	117	0	124	18
New York	1,564	1,564	0	100	1,151	12	145	268
Rhode Island	192	192	48	52	154	15	18	20
South Carolina	2,155	663	0	100	583	—	18	62
Texas	1,990	1,990	0	100	1,532	0	0	458
Virginia	2,382	1,800	0	100	1,604	—	105	91
Virgin Islands	29	29	—	—	25	—	1	3
Washington	2,943	2,114	4	96	1,937	293	91	86
Totals	35,198	26,676			19,110	350	6,078	1,488

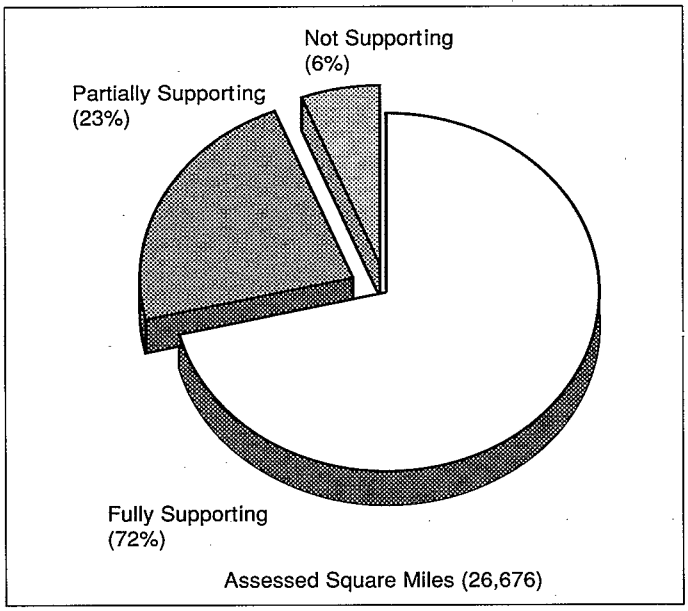
*Square Miles Threatened is a subset of Square Miles Fully Supporting. — Not reported. Source: 1988 State Section 305(b) reports.

While estuarine reporting appears fairly comprehensive, seven estuarine States failed to provide usable summary information on designated use support in their estuarine waters. Thirteen States claim that they assessed all of their estuarine waters in 1988, and of these, six report that their assessments were based entirely on monitoring data. Much as with rivers and lakes, the area of estuarine waters found to be fully supporting uses varied widely, from zero to 99 percent of assessed waters, with nine States finding that over 90 percent of their assessed estuarine waters fully support uses.

Causes of Impairment

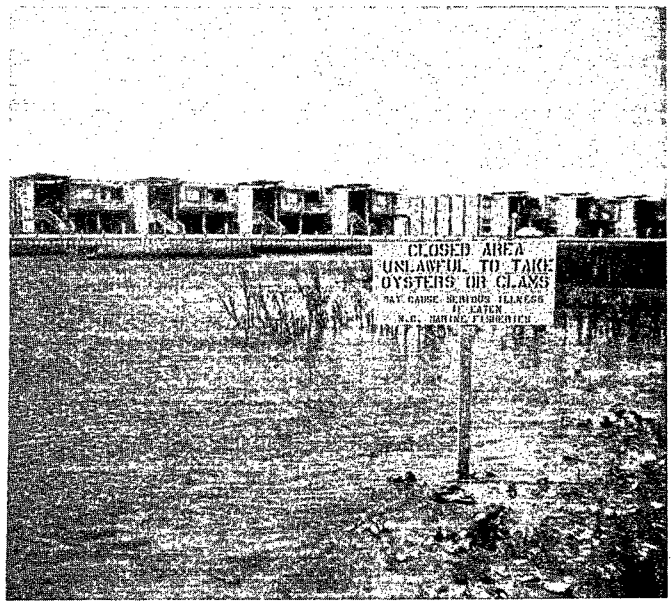
For their estuarine waters, 16 States provided information on the causes of nonsupport (see Table 4-2). States were asked to provide the number of estuarine square miles under each cause category that contributes to impairment and to assign a degree of impact of major or moderate/minor. Therefore, any given square mile may be counted under several categories if it is affected by a number of causes. The values reported are the total number of estuarine square miles affected by a particular cause of impairment, according to whether the cause is a major or moderate/minor contributor to impairment. The relative extent of each cause of nonsupport is determined by dividing the number of square miles in each cause category by the total square miles impaired (see Figure 4-2).

Nutrients and pathogens are reported by the States as the leading causes of nonsupport in estuaries, affecting 50 and 48 percent of total impaired square miles, respectively. Organic enrichment/low dissolved oxygen was found to affect 29 percent of impaired waters. This appears to indicate that eutrophication (caused by



Sources: State Section 305(b) reports.

Figure 4-1. Designated Use Supported in Assessed Estuaries



NC Division of Coastal Management

High levels of bacteria can lead to shellfishing closures.

overabundant nutrients) and high levels of bacteria—which can lead to shellfishing closures and restrictions in shellfishing waters—are the leading threats to the Nation's estuaries.

Other leading causes identified by the States were oil and grease, affecting 23 percent of impaired waters; metals, affecting 10 percent; siltation, affecting 7 percent; unknown toxicity, affecting 5 percent; and priority organics, affecting 4 percent.

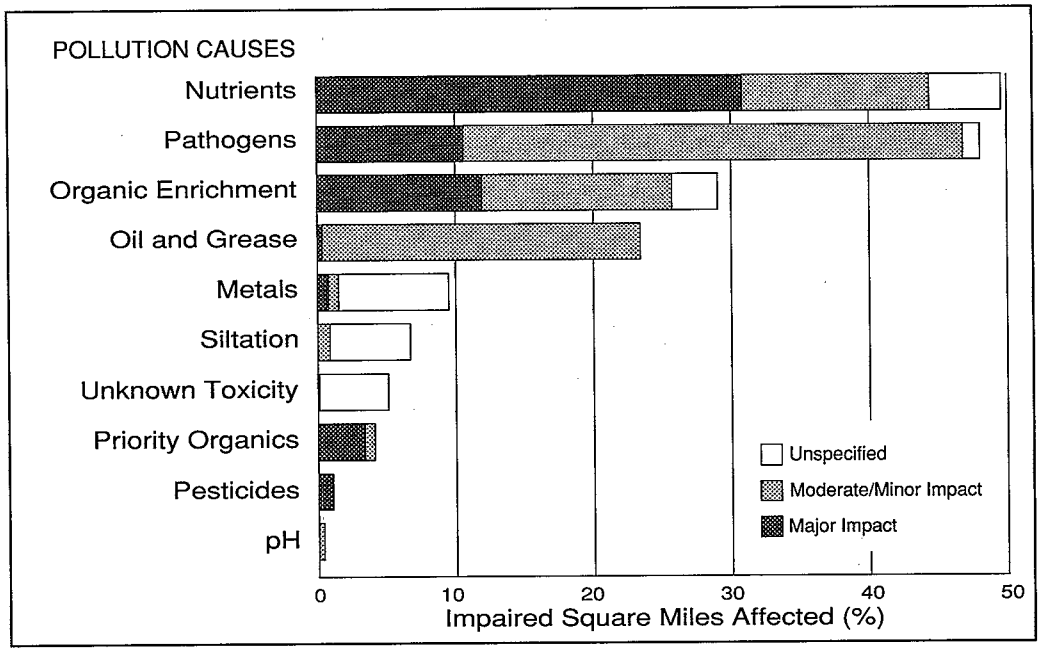
These numbers should be interpreted with care. As for all sources and causes in all waterbody types, certain States appear to account for a large proportion of the impact of various causes of nonsupport in estuaries. For example, Louisiana alone accounts for nearly all those estuarine waters affected by oil and grease and over half of those with pathogen impacts. Florida accounts for 84 percent of estuarine waters affected by metals, about 86 percent of those with siltation impacts, and nearly all of the estuarine waters affected by unknown toxicity.

Twelve States specified the degree of impact (i.e., major or moderate/minor) of the causes of degradation in their estuarine waters. Among these, major impacts far outweighed moderate/minor impacts for a variety of pollutants including priority organics, nutrients, and metals. For example, in 83 percent of waters impaired by priority organics, the impact was considered major, as was the impact of nutrients in 69 percent of affected waters and of metals in 52 percent.

Table 4-2. Impaired Estuary Square Miles Affected by Causes of Pollution

State	Total Impaired Waters*	Nutrients		Pathogens		Organic Enrichment		Oil & Grease	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama**	3	3	—	—	—	3	—	—	—
Connecticut	234	6	215	23	54	25	182	—	—
District of Columbia	6	—	5	1	5	1	—	—	1
Florida**	1,106	222	—	1	—	203	—	—	—
Georgia	11	—	—	—	—	12	—	—	—
Hawaii	94	—	46	—	—	—	—	—	—
Louisiana	2,197	62	568	120	1,815	62	568	25	1,561
Maryland	1,981	1,981	—	13	396	700	8	—	—
Mississippi	7	—	2	—	4	—	2	—	—
North Carolina**	220	135	—	26	—	—	—	—	—
New Jersey	142	70	—	142	—	—	—	—	—
New York	413	—	100	251	120	14	99	—	24
Rhode Island	38	9	—	24	—	8	—	—	—
South Carolina**	80	—	—	59	—	21	—	—	—
Virginia	196	—	—	90	16	2	66	—	—
Washington	177	—	—	67	93	—	25	1	5
Totals	6,905	2,488	936	817	2,503	1,051	950	26	1,591
Combined Totals			3,424		3,320		2,001		1,617
Percent of Impaired Waters			49.6%		48.1%		29.0%		23.4%

*The sum of partially and nonsupporting estuary square miles (Table 4-1).
**These States did not specify the degree of impact (i.e., Major or Moderate/Minor); estuary square miles were placed in the "Major"



Source: 1988 State Section 305(b) Reports.

Figure 4-2. Percent of Impaired Estuary Square Miles Affected by Each Pollution Cause

Metals		Siltation		Unknown Tox		Priority Organics		Pesticides		pH		Other Inorganics		Ammonia	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	26	—	—	—	—	—	26	—	—	—	—	—	—	—	—
—	6	—	1	—	—	—	1	—	—	—	5	—	—	—	6
550	—	398	—	345	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	3	—	46	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	2	—	—	—	—	25	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	3	—	—	—	—	—	—	—	—	—	—
—	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	70	—	70	—	—	—	—	—	—	—
—	—	—	—	—	5	145	4	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	2	21	—	—	—	—
40	15	1	11	—	—	21	14	—	2	—	—	—	—	—	5
605	50	404	59	345	8	236	47	70	2	2	26	25	—	—	11
	655		463		353		283		72		28		25		11
	9.5%		6.7%		5.1%		4.1%		1.0%		0.4%		0.4%		0.2%

column for national reporting purposes. — Zero or not reported. Source: 1988 State Section 305(b) reports.

Sources of Impairment

In their 1988 State Section 305(b) reports, 14 States provided information on the various sources of pollution contributing to use impairment in their estuarine waters. This information is displayed in Table 4-3. States provided the total number of square miles under each of the source categories that contribute to impairment, and in some cases assigned a degree of impact of major or moderate/minor.

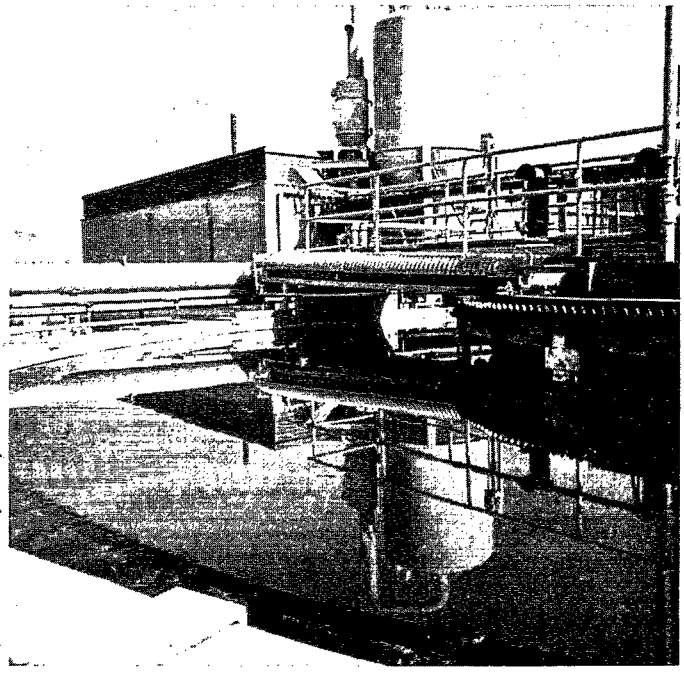
As discussed earlier, any given square mile may be counted under several categories if it is affected by a number of sources. The values reported are the total number of estuarine square miles affected by a particular source of pollution, according to whether the source is a major or moderate/minor contributor to impairment. The relative extent of each source of nonsupport is determined by dividing the number of square miles in each source category by the total square miles impaired (see Figure 4-3).

Table 4-3 illustrates that a somewhat different water quality picture exists for estuaries than for inland waters. The most extensive source of pollution cited by the States in their estuarine waters is municipal discharges (affecting 53 percent of impaired square miles), followed by resource extraction (affecting 34 percent), storm sewers/ runoff (affecting 28 percent), and land disposal (affecting 27 percent). To a lesser extent, agricultural runoff, construction, industrial discharges, and combined sewer overflows are also cited.

Table 4-3. Impaired Estuary Square Miles Affected by Sources of Pollution

State	Total Impaired Waters*	Municipal		Resource Extract		Storm Sewers/Runoff		Land Disposal	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama**	3	1	—	—	—	2	—	—	—
California**	23	1	—	—	—	—	—	—	—
Connecticut	234	54	169	—	3	—	160	9	5
District of Columbia	6	—	5	—	—	1	5	—	—
Florida**	1,106	744	—	68	—	109	—	571	—
Georgia	11	—	1	—	—	—	—	—	—
Louisiana	2,197	82	837	25	1,561	62	567	—	559
New Jersey	142	140	—	—	—	140	—	—	—
New York	413	59	190	—	—	102	71	5	70
North Carolina**	220	64	—	—	—	8	—	9	—
Rhode Island	38	7	29	—	—	17	17	1	—
South Carolina**	80	—	—	—	—	48	—	—	—
Virginia	196	43	8	—	—	18	3	—	—
Washington	177	84	53	—	—	21	29	48	51
Totals	4,846	1,279	1,292	93	1,564	528	852	643	685
Combined Totals			2,571		1,657		1,380		1,328
Percent of Impaired Waters			53.1%		34.2%		28.5%		27.4%

*The sum of partially and nonsupporting estuary square miles (Table 4-1).
**These States did not specify the degree of impact (i.e., Major or Moderate/Minor); estuary square miles were placed in the "Major" column for national reporting purposes.
— Zero or not reported.
Source: 1988 State Section 305(b) reports.



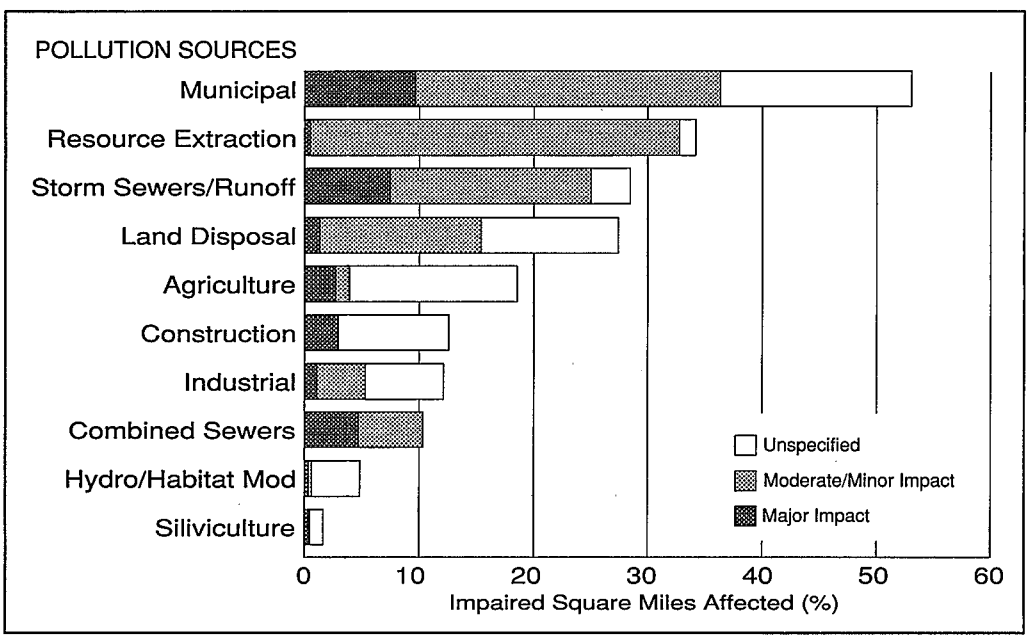
Puget Sound Water Quality Authority

States report that discharges from sewage treatment facilities are the most extensive source of pollution in estuarine waters.

Agriculture		Construction		Industrial		Combined Sewers		Hydro/ Habitat Mod		Silviculture	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	181	46	177	—	—	—	—
—	—	—	—	—	—	1	5	1	—	—	—
555	—	467	—	324	—	—	—	205	—	34	—
—	—	—	—	4	6	—	—	—	—	—	—
—	—	—	—	—	2	—	—	—	—	—	—
70	—	140	—	—	—	—	—	—	—	—	—
—	28	—	—	—	—	112	80	—	—	—	—
130	—	—	—	5	—	—	—	—	—	—	—
—	—	—	—	—	8	36	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	21	—
22	3	—	—	7	1	2	1	—	—	—	—
38	27	—	1	40	9	31	8	17	11	21	1
841	58	607	1	381	207	228	271	223	11	76	1
	899		608		588		499		234		77
	18.6%		12.5%		12.1%		10.3%		4.8%		1.6%

These findings should be interpreted with care. First, as mentioned previously, definitions of pollution sources are ambiguous (see discussion of Sources in Chapter One). Second, analysis of State data in Table 4-3 reveals that several States appear to account for a proportionally higher share of impacts than others. For example, 96 percent of the estuarine square miles with impacts from resource extraction are in Louisiana, as are 42 percent of those with land disposal impacts and 36 percent of those with municipal impacts; Connecticut accounts for nearly half of the miles affected by combined sewer overflows. Although these findings are fairly consistent with known pollution sources in these States (e.g., oil drilling in Louisiana offshore waters, combined sewers in Connecticut's older urban areas), reporting inconsistencies influence these results to some extent.

Nine States specified the degree of impact of pollution sources in their estuarine waters. Major impacts outweighed moderate/minor impacts in waters affected by construction, silviculture, agriculture, and hydrologic/habitat modification. For example, in 69 percent of the waters impaired by agriculture, the impact was considered major, as was the impact of hydrologic/habitat modification in 62 percent of affected waters.



Source: 1988 State Section 305(b) Reports.

Figure 4-3. Percent of Impaired Estuary Square Miles Affected by Each Pollution Source

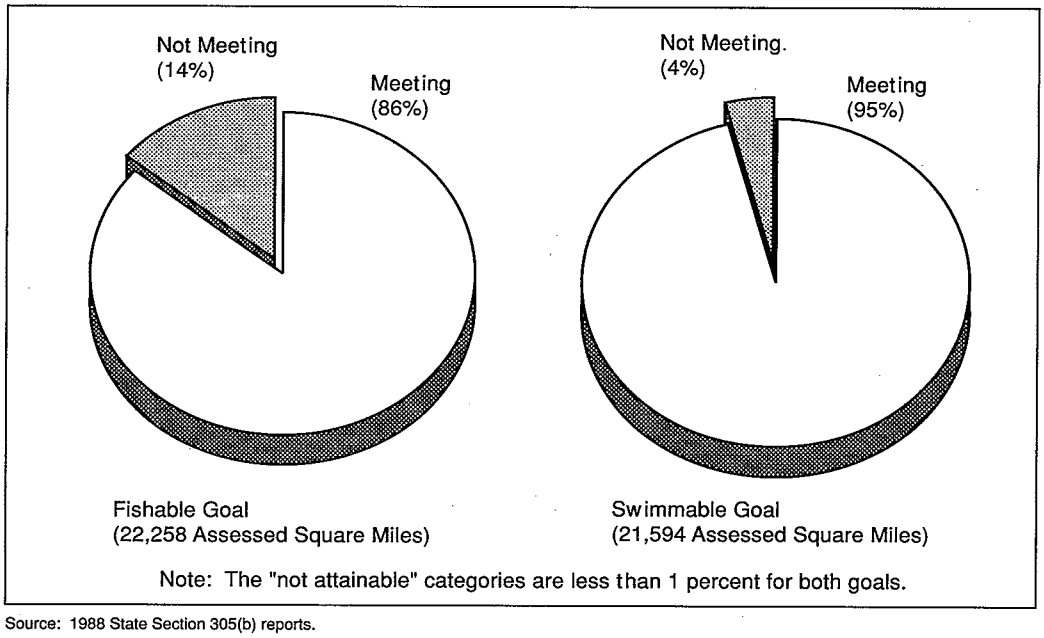
Attainment of the Clean Water Act Goals

The basic goals of the Clean Water Act—that waters be clean enough to support fishing and swimming—apply to the Nation's estuaries as well as to its rivers and lakes. Twenty States provided information on Clean Water Act (CWA) goal attainment in 1988 (see Table 4-4).

A total of 22,258 estuarine square miles were assessed for the fishable goal of the CWA. Of these, 86 percent attained fishing uses, 14 percent did not currently attain fishing uses but might in the future, and less than 1 percent (72 miles) were found to be "not attainable" (i.e., affected by irrevocable impacts or not designated by the State for fishing uses).

Nearly the same number of estuarine square miles were assessed for the swimmable goal of the CWA. A higher percentage of waters—95 percent of the 21,594 square miles assessed—were found to attain the swimming goal. About 4 percent did not currently attain the goal, and less than 1 percent were not attainable. Figure 4-4 illustrates progress toward attainment of the CWA goals in the Nation's estuaries.

Several States discussed reasons for significantly different fishable and swimmable figures. In Maryland, for example, the mainstem of the Chesapeake Bay generally meets the swimmable goal but fails to attain the fishable goal, primarily as a result of the loss of aquatic habitat. Shellfishing and fishing restrictions may also be the reason a greater percentage of estuarine waters did not meet the fishable goal in some States.



Source: 1988 State Section 305(b) reports.

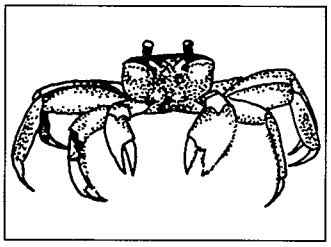
Figure 4-4. Attainment of Clean Water Act Goals in Assessed Estuary Square Miles

Table 4-4. Attainment of Clean Water Act Goals in Estuaries

State	Fishable Goal (square miles)				Swimmable Goal (square miles)			
	Assessed	Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Not Meeting	Not Attainable
Alabama	53	50	3	—	53	50	3	—
Connecticut	600	598	2	0	600	570	30	0
Delaware River Basin	866	845	21	—	866	855	11	—
District of Columbia	6	0	6	0	6	0	6	0
Florida	2,655	2,364	291	0	2,655	2,364	291	0
Georgia	594	584	10	—	—	—	—	—
Hawaii	40	40	0	0	40	40	0	0
Louisiana	4,928	4,926	2	—	4,928	4,928	0	—
Maine	1,633	1,595	38	0	1,633	1,623	10	0
Maryland	1,981	0	1,981	—	1,981	1,974	7	—
Massachusetts	171	116	55	—	171	79	92	—
Mississippi	133	132	1	0	133	132	1	0
New Hampshire	17	17	0	0	17	17	0	0
New Jersey	259	117	124	18	189	117	54	18
New York	1,564	1,234	283	47	1,564	1,487	30	47
Rhode Island	191	178	6	7	191	178	6	7
South Carolina	663	640	23	—	663	636	27	—
Texas	1,990	1,990	0	—	1,990	1,990	0	—
Virginia	1,800	1,604	196	—	1,800	1,604	196	—
Washington	2,114	2,008	106	0	2,114	1,963	151	0
Totals	22,258	19,038	3,148	72	21,594	20,607	915	72

— Not reported.

Source: 1988 State Section 305(b) reports.



Understanding Estuarine Water Quality: The Chesapeake Bay Perspective

The Chesapeake Bay, the Nation's largest estuary, historically produced bountiful harvests of oysters, crabs, and fish. Although crabs are still abundant, oyster and fish stocks continue to suffer serious declines due to degraded water quality and harvesting pressure. These declines have paralleled a rise in population and the conversion of forests to urban, suburban, and agricultural uses. Land use changes have severely affected water quality by increasing the input of nutrients, sediments, and toxic materials to the bay.

The decline of the Chesapeake Bay became the focus of national attention in the early 1980s. In an effort to restore the bay, top officials from Virginia, Pennsylvania, Maryland, the District of Columbia, and the U.S. Environmental Protection Agency (EPA) gathered in 1983 to sign the original Chesapeake Bay Agreement. This Agreement marked a milestone in that the bay was now to be managed as a complete ecosystem spanning its many political boundaries (see Figure 4-5).

Under the Chesapeake Bay Agreement, a Monitoring Subcommittee was established to oversee the development and implementation of a coordinated baywide monitoring program—a critical element in guiding the restoration and protection of the Chesapeake Bay. The three basic objectives of this monitoring program were to:

(1) Characterize current baywide conditions for key variables;

(2) Identify long-term changes in these variables in response to restoration and protection management actions; and

(3) Improve the understanding of processes important to management strategies, including the relationship between water quality and living resources.

Since the signing of the Agreement, significant progress has been made in meeting these objectives. Within the tidal waters of the bay, a monitoring network composed of 150 mainstem and tributary stations is operational. This network provides data on a comprehensive suite of physical, chemical, and biological water quality parameters 12-20 times a year. Significant progress has also been made in characterizing impacts to the bay's submerged aquatic vegetation, wetland, shoreline, and shellfish resources. The findings of the water quality network and efforts to characterize bay resources are presented below.

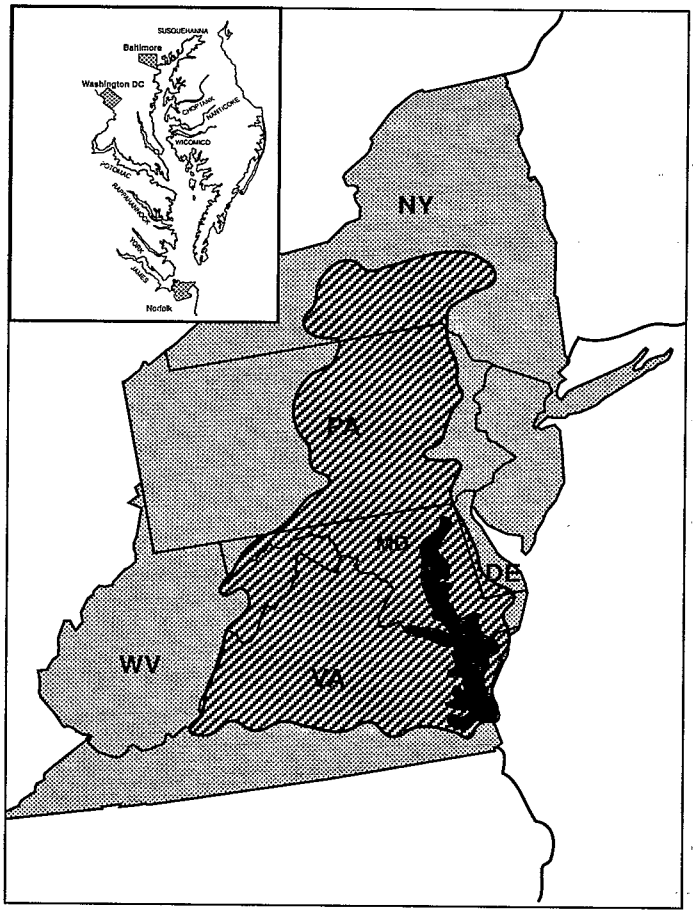


Figure 4-5. The Chesapeake Bay Watershed

Water Quality Findings

Nutrients

Nitrogen and phosphorus, nutrients required for phytoplankton growth, accelerate the eutrophication that is the bay's foremost problem. Total nitrogen generally increases in concentration towards the upper estuary reaches of the mainstem and its tributaries. This gradient reflects the large nonpoint source nitrogen inputs entering from the bay's watersheds and the gradual dilution downstream

as mixing occurs with nitrogen-poor coastal waters. Point source inputs, usually located in the upper estuaries, intensify the pattern. The highest nitrogen concentrations (>3 mg/l) are found in the Back River and the upper Patuxent River in Maryland—areas strongly influenced by sewage treatment plant effluent. The mainstem above the Chesapeake Bay Bridge and adjacent to Annapolis, Maryland, exhibits concentrations similar to those found in many of the upper tributaries (1-2 mg/l). The lowest concentrations in the bay system are found in the lower mainstem as concentrations decline from about 0.65 mg/l near the Patuxent River to about 0.45 mg/l off the bay mouth.

Concentrations for total phosphorus, as for total nitrogen, generally increase in an upstream direction from less than 0.1 mg/l in the mainstem to greater than 0.3 mg/l in the upstream reaches of several tributaries. This gradient again reflects the location of point and nonpoint source inputs entering the upper reaches of the system. The mainstem, however, does not fit this pattern since total phosphorus concentrations vary between about 0.03 and 0.06 mg/l without a strong upstream gradient. This difference may be explained by the influence of the Susquehanna River, at the head of the bay. The Susquehanna is dammed at the head of the bay; sediment containing much of the river's phosphorus load settles behind the dam and therefore does not enter the bay mainstem. Nitrogen, on the other hand, is in dissolved form and relatively unaffected by impoundment. A second factor accounting for the Susquehanna's relatively low phosphorus concentration is the lack of significant point sources in the river's lower reaches as compared to its freshwater flow.

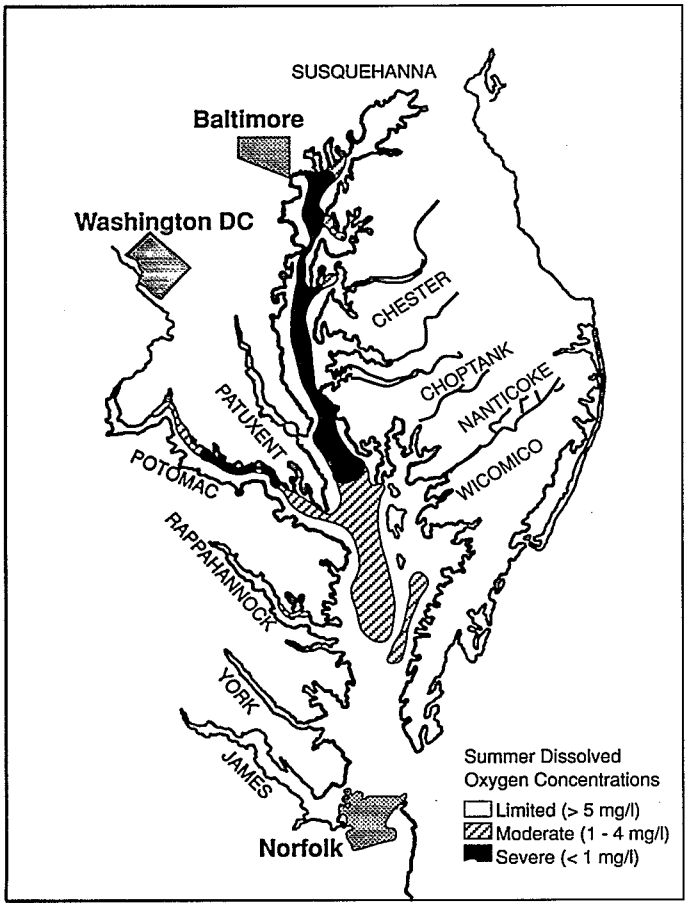


Figure 4-6. Average Summer Dissolved Oxygen Concentrations in Chesapeake Bay: 1985-1986

Dissolved Oxygen

One of the major results of eutrophication in the bay is seasonal development of low dissolved oxygen (hypoxia) in bottom waters. The most severe hypoxia (<1 mg/l dissolved oxygen [DO]) is found in the mainstem's "deep trough" region from the Baltimore-Annapolis area south to the Potomac River. More moderate hypoxia problems (1-4 mg/l DO) are observed just upstream and downstream of the severe areas and in the lower reaches of several other western shore tributaries—the Magothy, Severn, South, Patuxent, Rappahannock, and York Rivers. A few eastern shore areas—the lower Chester River, Eastern Bay, and Little Choptank Embayment—also experience moderate hypoxia (see Figure 4-6).

Toxic Contaminants

Thousands of potentially toxic substances enter the bay, representing a different and more complex threat to its resources. Beginning in 1984, a 2-year sediment sampling survey was conducted to measure both metal and organic compounds. A class of organic compounds, polynuclear aromatic hydrocarbons (PAHs), was detected in a consistent pattern during both years of the study. A pronounced peak in PAH concentrations (>7.5 ppm dry weight) was found in the vicinity of the Baltimore Harbor, a heavily populated industrial center. North and south of the Baltimore region, these concentrations decline (6.5-2.5 ppm). The lowest concentrations occur near the mouth of the bay (<0.5 ppm). The majority of the PAHs found in Chesapeake Bay samples can likely be attributed to the combustion of fossil fuels. Similar spatial patterns have emerged for other toxicants in the mainstem, and results are becoming available for various tributaries.

Abundance of Submerged Aquatic Vegetation

The dramatic decline in the baywide abundance and distribution of submerged aquatic vegetation (SAV) began in the 1960s and has led to the total disappearance of SAV in many areas of the bay. Results from a 17-year ground survey program and the multiyear baywide aerial survey program indicated that SAV coverage dropped to its lowest recorded levels in 1984 (see Figure 4-7). Since that year, some measure of stability and even a small resurgence in the abundance and distribution of SAV have been recorded. Managers and scientists have concluded that water quality problems, particularly those resulting in eutrophication and reduced light transmission (i.e., plankton blooms and suspended sediments) were primarily responsible for the baywide declines of all SAV species.

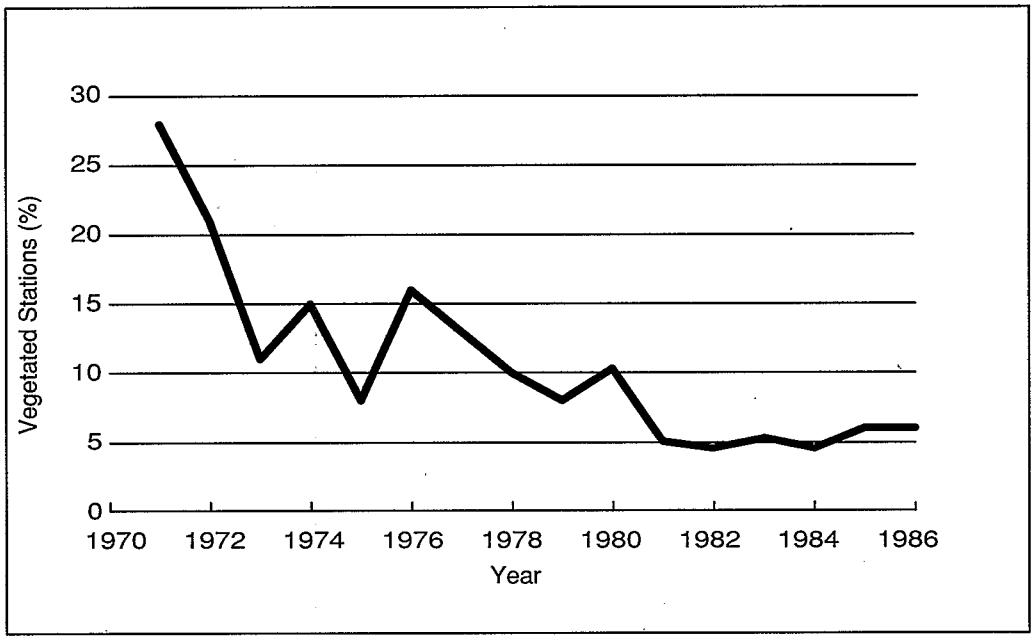
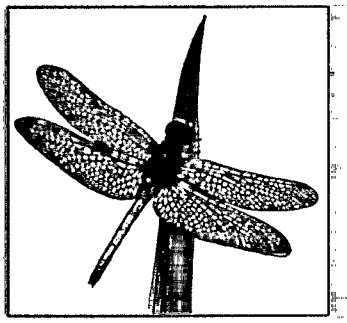


Figure 4-7. Percent of Maryland Chesapeake Bay SAV Ground Survey Stations with Vegetation Present

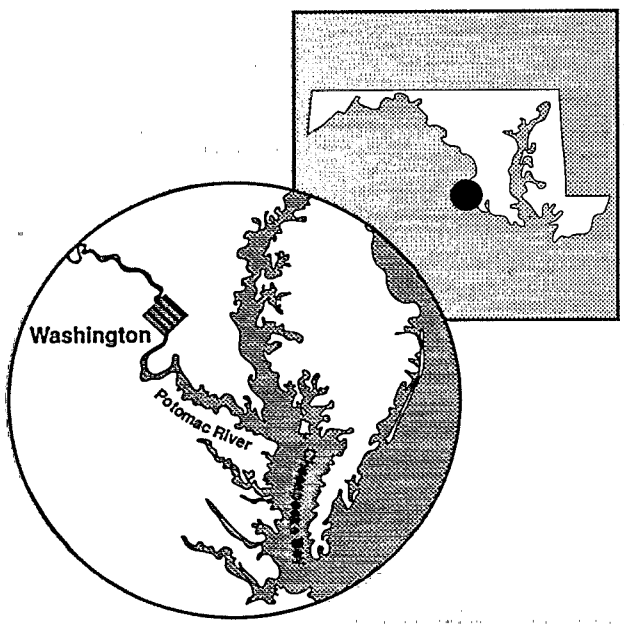


The Potomac River: The Multidecade Recovery of a Chesapeake Bay Tributary

Water quality in the upper Potomac estuary has improved substantially over the last two decades. Large-scale blooms of blue-green algae and very low dissolved oxygen (DO) levels frequently occurred in the Potomac River during the late 1960s but are now rare. Before the 1980s, submerged aquatic vegetation (SAV) had almost disappeared in the tidal portion of the river. Today, SAV beds have revegetated most of the upper tidal river shoreline and are continuing to reestablish former habitats in the lower river. The Potomac now supports a healthy and popular recreational fishery of many freshwater and anadromous finfish species. However, despite these water quality and habitat improvements, discharges from regional wastewater treatment plants, nonpoint sources, and combined sewer overflows have slowed a complete recovery of the upper Potomac estuary.

The Blue Plains Treatment Plant, serving the Washington, D.C., metropolitan area, is the largest sewage treatment plant in the upper tidal Potomac. The plant contributes about 70 percent of treated flows to the river. Over the past 15 years, Blue Plains has implemented several advanced-treatment measures to reduce BOD, suspended solids, and nutrient loadings to the estuary. Even though flows of wastewater have increased since 1970, loadings have decreased dramatically.

The recovery of the upper Potomac estuary is attributed to the control of point sources, particularly at regional wastewater treatment plants. The corresponding recovery of natural communities of submerged plants, benthic communities, and fishery populations is thought to have strengthened the pace of water quality improvements through increased filtering capacity and buffering of nutrient concentrations during the summer months. However, further improvements to the estuary are possible and, indeed, necessary. A pollutant source still of concern is the loading of nutrient-laden sediment from the upper Potomac River basin. Also of concern are pollution inputs from combined sewer overflows and stormwater runoff into the estuary from the Washington, D.C., metropolitan area.



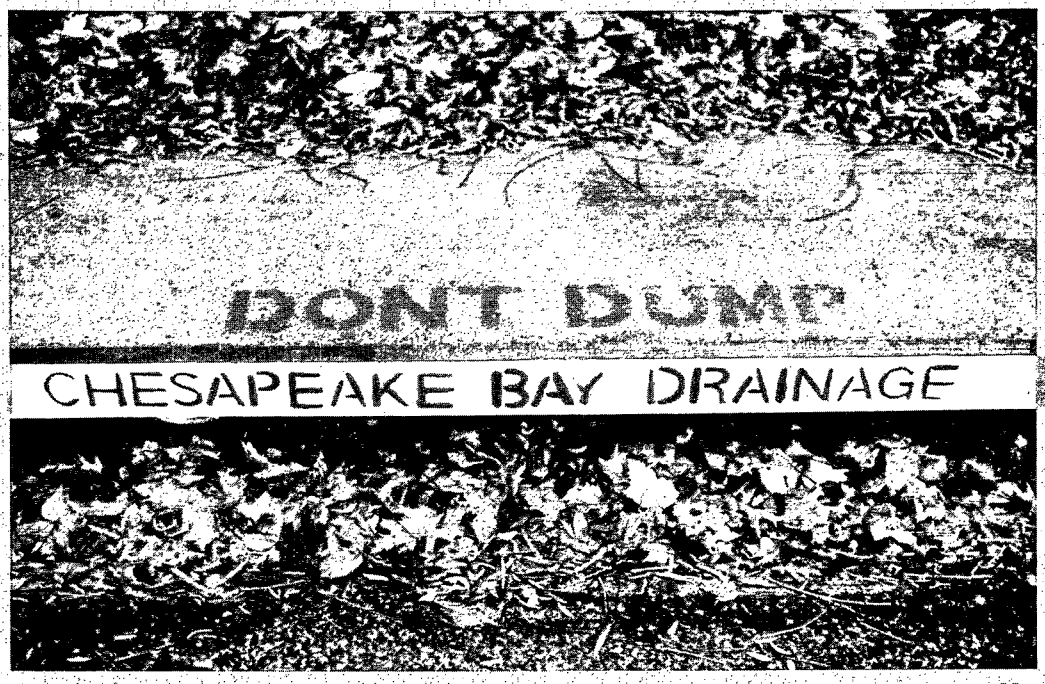
The Anacostia River: Severe Problems Remain

Unlike the Potomac River, its tributary, the Anacostia River, still suffers severe pollution problems. Pollutant sources include excessive nonpoint source sediment loadings from abandoned gravel and sand operations and urban areas, as well as bacterial and BOD loadings from combined sewer overflows (CSOs).

Fecal coliform concentrations frequently exceed the District's water quality standard for secondary contact recreation in the tidal Anacostia. Dissolved oxygen levels are extremely low, often resulting in fish kills in the tidal Anacostia. Water clarity is also extremely poor. Turbidity occurs because of high sediment loadings from the upper Anacostia watershed. Streambank erosion, resuspension of sediment in the tidal reaches, and CSOs in the District may also contribute to the problem.

To correct these problems, the District of Columbia and Maryland signed the Anacostia Watershed Restoration Strategy Agreement. This Agreement calls for the cleanup of the Anacostia River through CSO abatement measures within the District and implementation of soil erosion control measures in the watershed.

In 1984, the District began a two-phase CSO abatement program for the Potomac and Anacostia Rivers. After completion, these abatement measures should reduce the frequency of CSO events by 33 percent. In addition, the District is planning a nonpoint source monitoring program to quantify NPS pollutant loads prior to the development of NPS control measures. Local jurisdictions have also begun to establish stormwater management regulations.



Chesapeake Bay Foundation

Combined sewer overflows and storm-water runoff from metropolitan areas affect tributaries of the Chesapeake Bay.

Status of Estuarine and Inland Wetlands

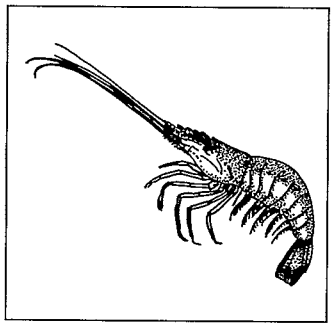
A 1987 survey of wetland types indicated that there are 1.2 million acres of wetlands—one-fifth estuarine and three-fourths inland—within the Chesapeake Bay drainage basin. From the mid-1950s to the late 1970s, destruction of estuarine wetlands, typically coastal marshes, occurred at an overall rate of 6.3 percent in Virginia and 9 percent in Maryland. Loss of coastal wetlands to estuarine waters was the most significant factor. This resulted from a combination of human and natural actions, including coastal impoundments, dredging projects, and the natural rise of sea level. Urban development was responsible for about one-fifth of the coastal wetlands losses. Since protective legislation was enacted in Virginia and Maryland in the early 1970s, losses of coastal wetlands have been essentially eliminated. State laws were also strengthened by the Federal Section 404 regulatory program.

During this same period (mid-1950s to late 1970s), inland vegetated wetlands in the Chesapeake Bay experienced even more dramatic losses. Maryland's inland wetlands decreased by 15.1 percent, while Virginia lost 57 percent of its inland vegetated wetlands. Agriculture and other development (mainly channelization related to farming) were equally responsible for nearly 60 percent of the inland vegetated wetland losses. Pond and lake construction were also significant; urban development had less impact. These losses of inland wetlands have continued virtually unabated to date, although wetland protection appears to be gathering both legislative and executive support.

Shoreline Erosion

A Chesapeake Bay Shoreline Erosion Study is being conducted by the U.S. Army Corps of Engineers in cooperation with Maryland and Virginia. Through this study, the average rate of shoreline erosion for the Chesapeake Bay has been estimated as 1 foot per year. Rates as high as 10 feet per year have been identified in some areas. About 4.7 million cubic yards of material—slightly more than half of the sediment entering the bay from all sources combined—are eroded from the shoreline in a typical year. This study also involves the construction and monitoring of field modeling projects to determine cost-effective shore protection measures. Six projects are planned for construction and will be monitored for 2 years.

Efforts to protect wetland areas within the Chesapeake Bay drainage area appear to be gaining support.



Declining Shellfish Harvest

The Chesapeake Bay has become world renowned for its oysters—historically the bay's most bountiful harvest. In recent years, however, a number of factors, including degraded water quality, sedimentation, harvesting pressure, and disease, have resulted in a declining oyster harvest. In the early 1980s, the total annual Maryland and Virginia oyster harvest was over 3 million bushels. The harvest dropped to approximately 2 million bushels in 1983 and was down to less than 1 million bushels in 1988 (see Table 4-5).

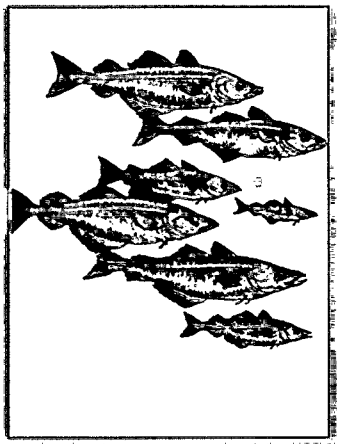
Future Directions

During the 1980s, monitoring and assessment efforts focused on the Chesapeake Bay have provided water quality managers and the public with a better understanding of the problems endangering this valuable estuary. With this increased awareness has come the challenge to implement needed control actions. In December 1987, a new Chesapeake Bay Agreement was signed committing the Governors of Pennsylvania, Maryland, and Virginia, the Mayor of the District of Columbia, the EPA Administrator, and the Chairman of the Chesapeake Bay Commission to a detailed set of objectives and commitments including a timetable for the development of specific baywide management plans. The centerpiece of the Agreement is the commitment to achieve a 40-percent reduction in total nitrogen and total phosphorus inputs to the bay by the year 2000.

Along with these ambitious targets for nutrient control, the 1987 Chesapeake Bay Agreement emphasizes the need to integrate the bay's living resources component into the overall management of this ecosystem. Measures are being developed to evaluate the success of pollution control and abatement programs in restoring the estuary's living resource habitats. These measures will enable managers to focus water quality restoration programs on those regions of the bay most critical to its living resources and vital to a healthy, productive estuary.

Table 4-5. Historical Record of Oyster Harvest from the Chesapeake Bay (in millions of bushels)

	1981	1982	1983	1984	1985	1986	1987	1988
Virginia	0.88	0.70	0.55	0.60	0.63	0.82	0.44	0.58
Maryland	2.53	2.31	1.48	1.08	1.14	1.56	0.98	0.35
Total	3.41	3.01	2.03	1.68	1.77	2.38	1.42	0.93



Coastal Protection in the Mid-Atlantic Bight

Description of Geographic Area

The Mid-Atlantic Bight includes the coastal and continental shelf areas from Nantucket Shoals, off the southern Massachusetts coast, to Cape Hatteras, North Carolina. The coastal zone varies from a glaciated and rugged coastline in the north to low relief further south to the New York Bight. South of New York, the coast is bordered by a 100-mile-wide coastal plain. The Continental Shelf ranges in width from 70 miles to more than 100 miles.

The beaches of the northern areas of the Bight are narrow, and inshore waters drop steeply. Along the coastal plain to the south, the beaches of the outer banks and barrier islands are wide, gently sloped, and sandy. Estuarine features include Narragansett Bay, Long Island Sound, the Hudson River Estuary, Delaware and Chesapeake Bays, and the nearly continuous band of estuaries behind the outer banks and barrier islands along southern Long Island, New Jersey, Delaware, Maryland, and Virginia. Also included are the estuaries of Currituck, Albemarle, and Pamlico Sounds behind the Outer Banks of Cape Hatteras.

Water Quality Problems

In the summer of 1988, unprecedented public attention was focused on ocean pollution problems plaguing the mid-Atlantic coastline as noxious debris—including potentially hazardous hospital wastes—washed ashore. Beach closures and the death of over 700 dolphins along the coastline from Maine to Florida received widespread attention.

Each year, fish diseases and mortality along the mid-Atlantic Bight cost the commercial fishing industry millions of dollars in loss of potential catch. Thousands of acres of shellfish beds are closed because of pathogen contamination or contamination by toxin-producing algal blooms such as red tide. Beach closures due to pathogen contamination and floatable debris affect the economic and recreational value of coastal areas and have become a common occurrence.

Historical Background

During the 1960s and the 1970s, a variety of industrial and municipal wastes were dumped into the ocean on the mid-continental shelf bordering Maryland and Delaware. U.S. EPA Region III (which includes the mid-Atlantic States from Pennsylvania to Virginia) managed four disposal sites in this area between 1972 and 1980.

With the passage of the Marine Protection, Research, and Sanctuaries Act of 1972 and subsequent regulations, EPA began a systematic review of the need for ocean dumping, the feasible alternatives to ocean disposal, and the impacts of dumping on the marine environment.

As a result, all four disposal sites were successfully phased out as environmentally acceptable land-based alternatives were developed.

EPA Region III conducted baseline surveys in and around the dumpsite used for disposal of sewage sludge from Philadelphia and Camden. A variety of impacts on the marine environment were found. These impacts included accumulations of heavy metals in organisms and sediments, the appearance of sludge deposits on the ocean bottom, the presence of sewage bacteria, changes in the benthic community with the loss of sensitive species, and the occurrence of necrotic lesions and melanization of gills in rock crab. After closure of the disposal sites, followup monitoring revealed systematic recovery of the benthic and fish species and improvements in water and sediment quality.

Monitoring Program

There are no active ocean dumpsites in EPA Region III. As a result, monitoring programs have been modified over the years to reflect changing utilization and stresses on the living resources in the area. In 1987, EPA's regional monitoring activities were again expanded in response to new concerns: dolphin mortality, atypical algal blooms, fish diseases, and floatable debris.

EPA Region III is pursuing additional strategies to better understand coastal pollution problems and take a more proactive approach to coastal protection. Baseline monitoring and surveillance work has been expanding. This includes coastal eutrophication and public health surveys in the area adjacent to the mouth of the Delaware Bay, down the Delmarva Peninsula to the region off the Virginia coast south of the Chesapeake Bay. In addition to water and sediment sampling, a marine mammal watch and floatable or plastic pollution watch are included as part of routine surveillance activities.

Mid-Atlantic Initiative

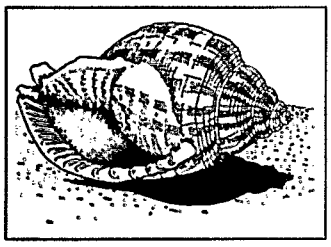
Recognizing that ocean pollution problems are seldom localized, EPA Region III initiated an effort to develop a broad-based Mid-Atlantic Initiative that would address coastal problems as a whole rather than from a regional or State-level perspective.

The Mid-Atlantic Initiative is a joint proposal involving EPA Regions I, II, III, and IV (including States from Maine to Florida) as a first step toward addressing common concerns in the Mid-Atlantic Bight and near coastal waters. The purpose of the initiative is to better define coastal problems, reorient existing EPA and State programs to more effectively address common high-priority problems, provide suggestions for solving these problems, and implement consistent ocean and estuarine policies where they are lacking in major regulatory areas.

Environmental Rapid Deployment Team

In 1988, EPA Region III organized an environmental rapid deployment team. Its purpose is to give EPA the ability to respond quickly to any new environmental or public health problems in Region III's near coastal waters. This effort includes active participation by State and Federal agencies such as the U.S. Coast Guard, U.S. Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, and the States of Maryland, Virginia, and Delaware. Local governments and citizens who have timely information on current or abnormal environmental conditions in their coastal communities are encouraged to take part in these activities.

NC NRCD



Ocean Coastal Waters

Support of Designated Uses

Ten States and two Territories (hereafter referred to as States) reported on the degree to which their ocean coastal waters support the uses for which they have been designated (see Table 4-6). These States assessed 3,755 coastal miles, 73 percent of their total miles but only about 20 percent of the Nation's estimated 19,200 miles of ocean coastline.*

Of those assessed coastal miles, 3,324 miles (89 percent) were found to fully support their designated uses. About 2 percent of these miles (73 miles) were determined to be threatened and likely to become impaired if pollution control actions were not taken. Eight percent of assessed coastal miles (307 miles) were identified as partially supporting uses, and 3 percent (124 miles) were found to be not supporting uses (see Figure 4-8). Ten States specified the basis of their assessment decisions (i.e., whether monitored data or evaluative information). In these ten States, 2,679 miles were assessed, 50 percent using evaluative information and 50 percent using monitoring data.

While these figures may satisfactorily portray coastal conditions in these 12 States, they are not necessarily representative of the Nation as a whole because they apply to so few waters. Problems with inconsistent reporting and assessment methodologies apply as well. For example:

- One State assessed only 4 percent of its coastal waters, while nine States report that they assessed 100 percent;
- Five States relied exclusively on evaluative data, and two States used only monitoring data; and

*Estimate excludes figures for Connecticut, Rhode Island, and Alaska.

Table 4-6. Designated Use Support in Oceans

State	Ocean Coastal Miles	Coastal Miles Assessed			Miles Fully Supporting	Miles Threatened*	Partially Supporting	Miles Not Supporting
		Total	Percent Evaluated	Percent Monitored				
Alabama	50	50	100	0	50	—	0	0
California	1,840	1,069	—	—	1,009	—	0	60
Florida	1,291	835	16	84	761	—	74	0
Hawaii	824	824	62	38	824	0	0	0
Maryland	32	32	100	0	32	—	0	0
Mississippi	81	81	0	100	40	40	30	11
New Hampshire	18	18	100	0	18	18	0	0
New York	130	130	0	100	60	0	70	0
Puerto Rico	434	434	71	29	250	15	132	52
Virginia	112	112	100	—	112	0	0	0
Virgin Islands	173	7	—	—	5	—	1	1
Washington	163	163	100	0	163	0	0	0
Totals	5,148	3,755			3,324	73	307	124

*Miles Threatened is a subset of Miles Fully Supporting.

— Not reported.

Source: 1988 State Section 305(b) reports.

■ Six States reported that all their assessed coastal waters supported designated uses, while in three States about half of the assessed waters supported uses.

Causes and Sources of Impairment

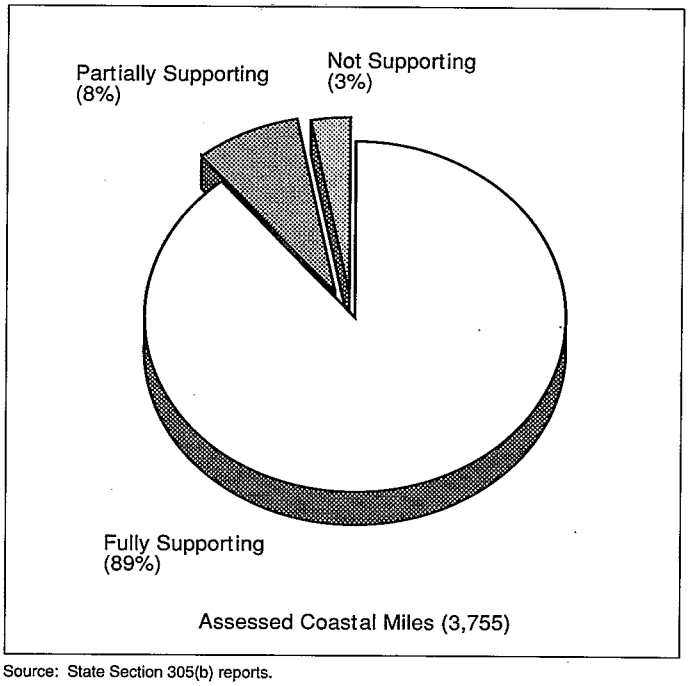
Two States and one Territory provided information on the causes and sources of nonsupport in ocean coastal waters not fully supporting uses (see Tables 4-7 and 4-8). Because these cause and source data include only a small proportion of ocean coastal waters, they may not be representative of coastal pollution influences

Attainment of the Clean Water Act Goals

Ten States provided information on the extent to which their ocean coastal waters attain the fishable and swimmable goals of the Clean Water Act. Table 4-9 displays this information.

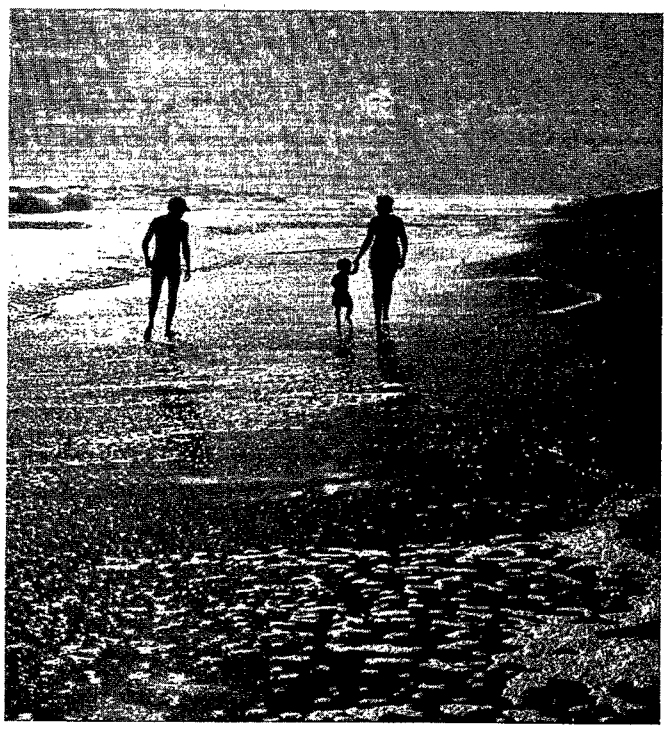
The same number of coastal miles were assessed for the fishable goal as for the swimmable goal. Figure 4-9 reveals that 97 percent of the 2,679 assessed coastal miles attained the fishable goal and 3 percent did not currently attain the goal but might in the future. No coastal miles were determined to be not attainable—i.e., irrevocably affected by pollution or not designated for fishing.

A slightly smaller percentage of miles—92 percent—were found to attain the swimmable goal. Only 1 percent of the miles were found to be not meeting the goal, but in 7 percent, the swimmable goal was determined to be not attainable (see Figure 4-9). This 7 percent comes exclusively from Puerto Rico, which did not identify the reason for nonattainability in its coastal waters.

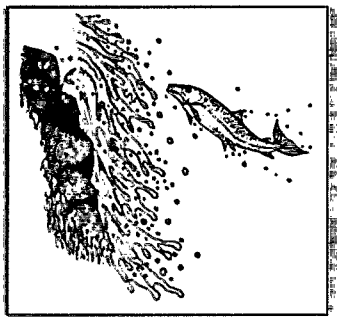


Source: State Section 305(b) reports.

Figure 4-8. Designated Use Supported in Assessed Oceans



NC Solid Waste Management Division



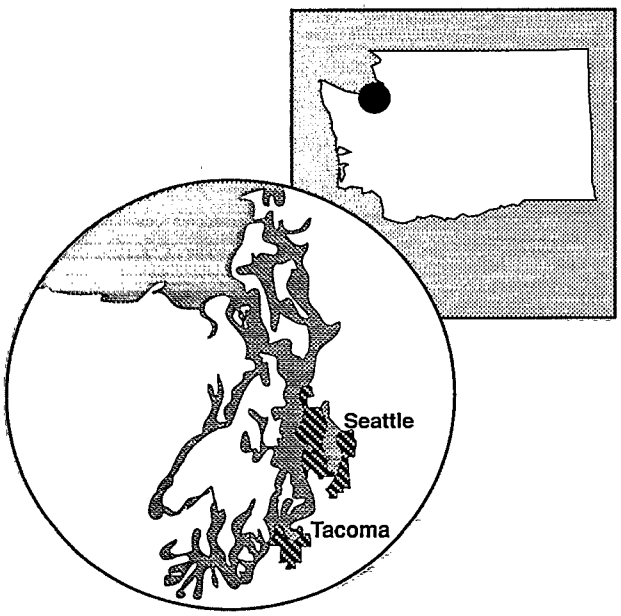
Port Townsend Bay

Description of Geographic Area

Port Townsend Bay is an embayment in the northeast corner of the Olympic Peninsula in Washington State. Its large northern outlet opens to Admiralty Inlet, which connects the Strait of Juan de Fuca (and the Pacific Ocean) to Puget Sound. At the southern end, a narrow connection to Puget Sound restricts exchange of water. Between the bay's two islands, Indian and Marrowstone, lies Kilisut Harbor.

The bay (excluding Kilisut Harbor) has a surface area of 30 square kilometers and a mean depth of 17.4 meters. Its shoreline is 20 percent urban (Port Townsend), 20 percent county urban/suburban, 30 percent conservancy/natural uses, and 30 percent U.S. Naval Reserve (Indian Island).

A variety of biological resources can be found in and around Port Townsend Bay. The glacous-winged gull, pelagic cormorant, pigeon guillemot, and black oystercatcher use the area for nesting. Commercial fishermen operate just north of the bay in Admiralty Inlet. The bay itself supports sport salmon fishing as well as spawning grounds and holding areas for the Pacific herring and shellfish beds of geoduck, clam, and oyster. Dungeness crab can also be found.



Water Quality Problems

At two locations in Port Townsend Bay in 1986 and at one location in 1987, commercial attempts to raise Atlantic salmon in pens failed because of a greater than 90 percent mortality. A pathology study concluded that the salmon mortality was caused by severe liver disease associated with waterborne toxicants. The bay is generally considered a nonurban area with little or no previous record of toxic contamination. A preliminary investigation at a proposed pen site in Glen Cove (on the western shore of the bay) found further evidence of an environmental problem: the diversity and numbers of bottom-dwelling and benthic organisms were severely limited.

Pollutant Sources

The major point source discharger to Port Townsend Bay is an unbleached kraft pulp mill that discharges 12 to 16 million gallons per day into Glen Cove through an outfall 1,800 feet offshore. In addition, the Naval Undersea Warfare Engineering Station (NUWES), Indian Island Annex, is permitted to discharge up to 36,000 gallons per day of treated domestic wastewater to waters off Crane Point on the eastern shore of the bay.

Other possible pollutant sources include the Navy Munition Steam-out Facility on Indian Island. Conventional explosives have been handled at this site since the mid-1970s. Although a permit exists to allow the discharge of treated "red water" from this facility, these wastes are not discharged at this site. A former ocean disposal area is located just outside the bay and two anchorages for ships carrying explosives are within the bay, one at the

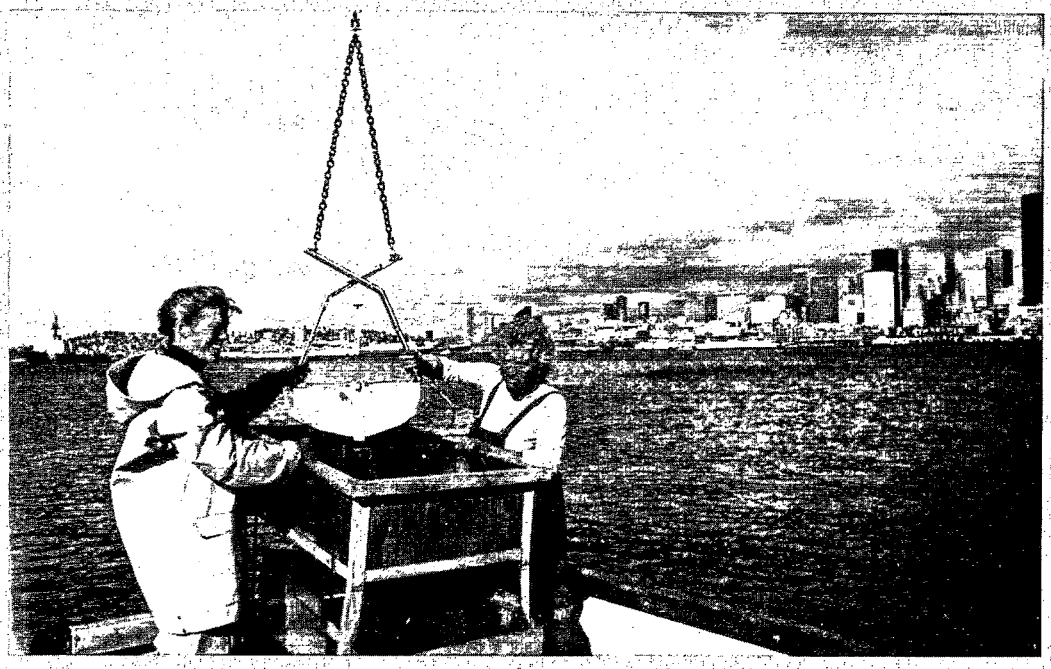
mouth and one off Indian Island. It is not known what materials may have been disposed of in the bay, either intentionally or accidentally. Nonpoint sources are also of concern and include surface runoff, septic leakage, and boat traffic.

Continuing Investigation

In October 1987, the Washington Department of Ecology (WDOE) began an investigation of the Port Townsend salmon mortality problem. Samples of salmon tissues both within and outside the bay, samples of seawater at the salmon net pens, and bottom sediments of the bay have been collected and analyzed for priority pollutants, chlorinated dioxin/furans, selected trace metals, resin acids, and munitions chemicals. A biomonitoring inspection of the Port Townsend Paper Company pulp mill and an inspection of the Navy Indian Island facility were also conducted in late 1987. None of these investigations revealed the source of the waterborne toxicant.

In 1988, further studies were conducted. Long-term bioassay testing of the pulp mill effluent, using Atlantic salmon, resulted in no liver lesions or significant mortality. Atlantic salmon, Chinook salmon, Donaldson trout, and shiner perch were also raised in pens off the Port Townsend marina and at Crane Point. Atlantic salmon suffered high mortality at both sites; young Chinook salmon suffered a significant, but lower, mortality rate at the marina site while no significant mortality was observed among larger Chinook salmon; and Donaldson trout displayed liver lesions but did not suffer mortality. The liver lesions appeared to be similar to those observed in previous years' testing. Additional water sampling conducted in 1988 by WDOE at the pen site off the marina revealed no problems.

The liver disease, first observed in Atlantic salmon, has now been observed in other salmonid species in Port Townsend Bay and does not appear to be caused by the pulp mill effluent. Other water and sediment sampling near the fish pens has not revealed any likely sources of the problem. Since Atlantic salmon with similar liver disease have been found in four unpolluted sites in British Columbia, EPA Region X is now encouraging further research to confirm the hypothesis that a natural algae-produced toxin may be the cause of the problem.



Puget Sound Water Quality Authority

Table 4-7. Impaired Ocean Coastal Miles Affected by Causes of Pollution

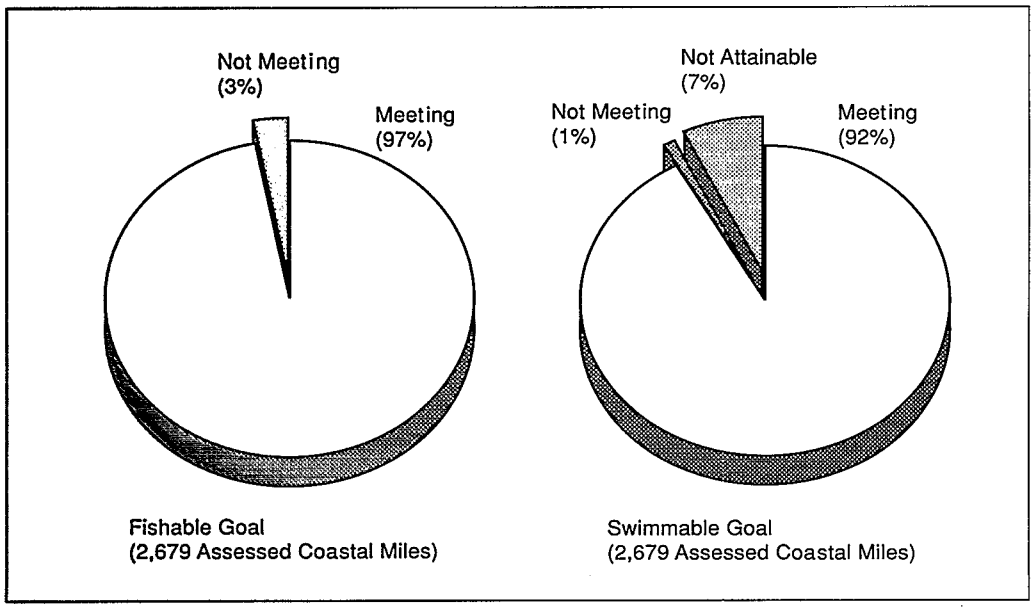
State	Total Impaired Waters*	Pathogens		Priority Organics		Nutrients		Siltation	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Mississippi	41	—	41	—	—	—	—	—	—
New York	70	12	—	—	70	—	—	—	—
Puerto Rico	184	10	14	—	—	10	27	12	22
Totals	295	22	55	0	70	10	27	12	22
Combined Totals			77		70		37		34

*The sum of partially and nonsupporting Ocean Coastal miles (Table 4-6).
— Zero or not reported.
NOTE: The State of Washington reports no impaired miles.
Source: 1988 State Section 305(b) reports.

Table 4-8. Impaired Ocean Coastal Miles Affected by Sources of Pollution

State	Total Impaired Waters*	Land Disposal		Storm Sewers/Runoff		Municipal		Industrial	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Mississippi	41	—	41	—	41	—	—	—	—
New York	70	—	—	—	—	—	12	—	—
Puerto Rico	184	2	43	5	14	12	10	16	2
Totals	295	2	84	5	55	12	22	16	2
Combined Totals			86		60		34		18

*The sum of partially and nonsupporting Ocean Coastal miles (Table 4-6).
— Zero or not reported.
NOTE: The State of Washington reports no impaired miles.
Source: 1988 State Section 305(b) reports.



Source: 1988 State Section 305(b) reports.

Figure 4-9. Attainment of Clean Water Act Goals in Assessed Oceans

Unknown Toxicity		Other Habitat Mod		Metals		Oil & Grease		Organic Enrichment		pH		Thermal Mod	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	25	17	11	2	8	6	1	3	3	1	2	—	1
7	25	17	11	2	8	6	1	3	3	1	2	0	1
	32		28		10		7		6		3		1

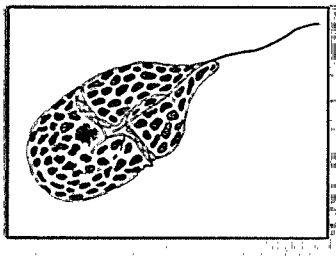
Combined Sewers		Hydro/ Habitat Mod		Silviculture		Construction		Resource Extract	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—
—	—	—	6	—	—	—	—	—	—
12	—	0	6	0	0	0	0	0	0
	12		6		0		0		0

Table 4-9. Attainment of Clean Water Act Goals in Oceans

	Fishable Goal (coastal miles)				Swimmable Goal (coastal miles)			
State	Assessed	Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Not Meeting	Not Attainable
Alabama	50	50	0	0	50	50	0	0
Florida	835	835	0	0	835	835	0	0
Hawaii	824	824	0	0	824	824	0	0
Maryland	32	32	0	—	32	32	0	—
Mississippi	81	81	0	0	81	81	0	0
New Hampshire	18	18	0	0	18	18	0	0
New York	130	60	70	0	130	129	1	0
Puerto Rico	434	415	19	0	434	219	24	191
Virginia	112	112	0	0	112	112	0	0
Washington	163	163	0	0	163	163	0	0
Totals	2,679	2,590	89	0	2,679	2,463	25	191

— Not reported.

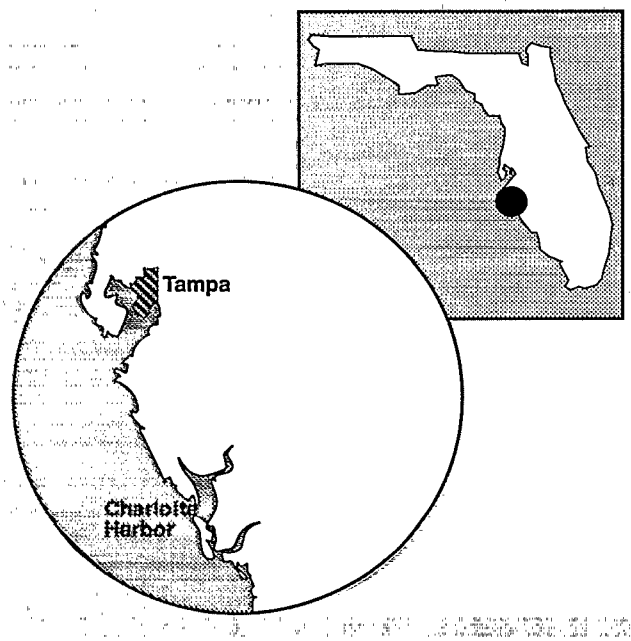
Source: 1988 State Section 305(b) reports.



Red Tide in the Eastern Gulf of Mexico

Description of Geographic Area

The west coast of Florida, from the Florida Keys to Cedar Key, is characterized by mangrove and barrier islands to the south and extensive mangrove swamps and spartina marshes to the north. The nearshore area is characterized by extensive shallows with seagrass beds and hard bottom communities. In addition to numerous smaller embayments and estuaries, the west coast includes Tampa Bay and Charlotte Harbor, the two largest open water estuaries in the State.



The southwest coast of Florida is not as developed as the east coast. Population centers include Fort Myers/Cape Coral, Sarasota/Bradenton, and Tampa/St. Petersburg. The barrier islands and coastal areas, from Naples to Clearwater, have undergone extensive residential and commercial development in the past 30 years, but inland areas have, to a large extent, remained in pastureland, citrus production, and pine/palmetto cover. Industrial development has been confined mostly to Tampa Bay and Charlotte Harbor.

Water Quality Problems

Red tides are a natural phenomenon in the eastern Gulf of Mexico caused by periodic blooms of the single-celled algae, *Ptychodiscus brevis*. This algae, classified as a dinoflagellate, produces potent toxins that are released to the water when the cell membrane is ruptured. Release of toxins in high concentrations causes fish kills, contaminates shellfishing areas, and can cause respiratory irritation in humans when aerosols are blown ashore. Red tides can result in severe economic and public health problems for coastal communities and significantly affect the marine and estuarine ecosystems in which they occur.

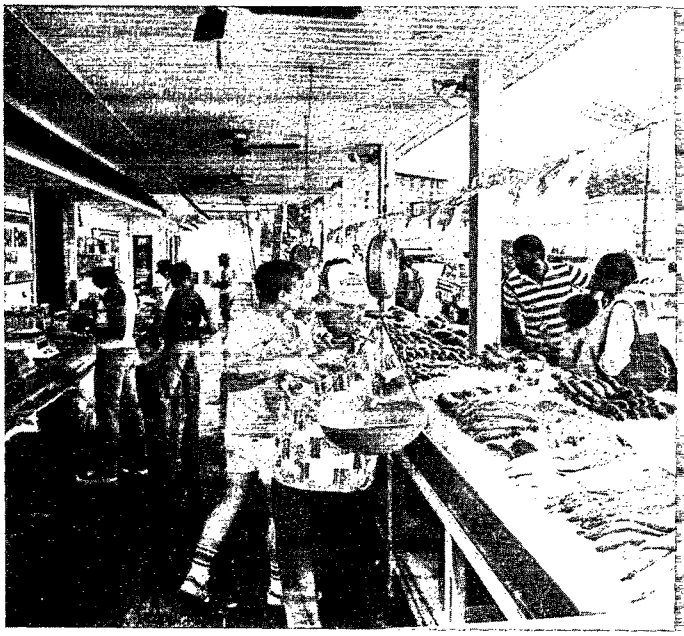
Red tide derives its name from the red-brown water color that occurs during an intensive bloom of dinoflagellates. Between 1975 and 1987, red tides in the eastern Gulf of Mexico generally occurred in the fall and winter and were most prevalent in the area between Tampa Bay and Charlotte Harbor. Historic information indicates that between 1916 and 1980 there were 24 occurrences of red tide on this coast, although the actual number of events was probably larger due to unobserved offshore occurrences.

Public Health Impact

The red tide algae *Ptychodiscus brevis* produces several neurotoxins that accumulate in filter feeding shellfish, causing neurotoxic shellfish poisoning (NSP) when consumed. Symptoms of NSP include central nervous system effects such as tingling of the face, throat, and extremities (with temporary paralysis in extreme cases), burning mucous membranes, and reversal of hot-cold temperature sensations, as well as somatic motor nervous system effects including loss of coordina-

tion, dizziness, headaches, and convulsions. Human intoxication has resulted after ingestion of both raw and cooked contaminated shellfish, indicating that the toxins are not destroyed by heat.

Unlike most toxic dinoflagellates, which are armored with a hard cell wall, *Ptychodiscus brevis* cells are unarmored and thus easily ruptured, releasing their toxins into the surrounding water. When incorporated into the surf, the toxins become associated with salt spray and aerosols, causing severe respiratory irritation, burning of the nose and throat, coughing, and choking. Although respiratory irritations usually subside when the victim is removed from the affected environment, the long-term effects of exposure are not known.



Ecological Impact

Red tides have been associated with mortalities of marine fish and invertebrates in the eastern Gulf of Mexico. Most of these events are caused by neurotoxins that kill the animal directly or indirectly via ingestion of toxin-contaminated prey organisms. In other cases, oxygen depletion caused by community respiration may cause mortalities. Ducks and shorebirds feeding on contaminated mollusks or fish are also at risk. In addition, it has been reported that manatees feeding on seagrasses during red tide events inadvertently consume contaminated tunicates and benthic invertebrates and are affected by disorientation and other symptoms of NSP.

Economic Impact

Fish kills and NSP in Florida have caused economic stress to local communities and a number of industries. The 1971 red tide caused an estimated economic loss of $20 million to the tourist industry alone, and a 1973-1974 red tide caused an estimated $15 million loss to that industry. Sportfishing, wholesale and retail seafood sales, and real estate sales were also affected. An "economic halo" effect occurs because public concern can lead to buyer resistance to all seafood products, even if they are safe to eat. This halo effect can extend far beyond the county or State involved, so that total economic impact is very difficult to measure.

Dynamics and Extent of the Red Tide

Although early investigators thought that blooms originated near shore and were linked to nutrient enrichment, further investigation found that *Ptychodiscus brevis* blooms begin in an "initiation zone" 28 to 74 kilometers offshore. Within this zone, it is speculated that benthic cysts for *Ptychodiscus brevis* exist in seed beds. This dormant resting stage can accumulate in localized areas and reinoculate the overlying water column. When Gulf Loop current meanders and eddies pass through these seed beds, cysts can be carried up to areas with favorable growth conditions of more light, warmth, and nutrient supply. As the algal population increases under these favorable conditions, the organisms can be concentrated into blooms by currents and winds.

Winds, currents, and tides move *Ptychodiscus brevis* blooms to coastal areas. In the eastern Gulf of Mexico, red tides usually move southward after reaching nearshore waters, and in some cases are transported around the Florida peninsula and then northward by Gulf Stream currents. The first documented occurrence of *Ptychodiscus brevis* red tide on the east coast of Florida

was in 1972, although it is likely that there were occasional events before that time.

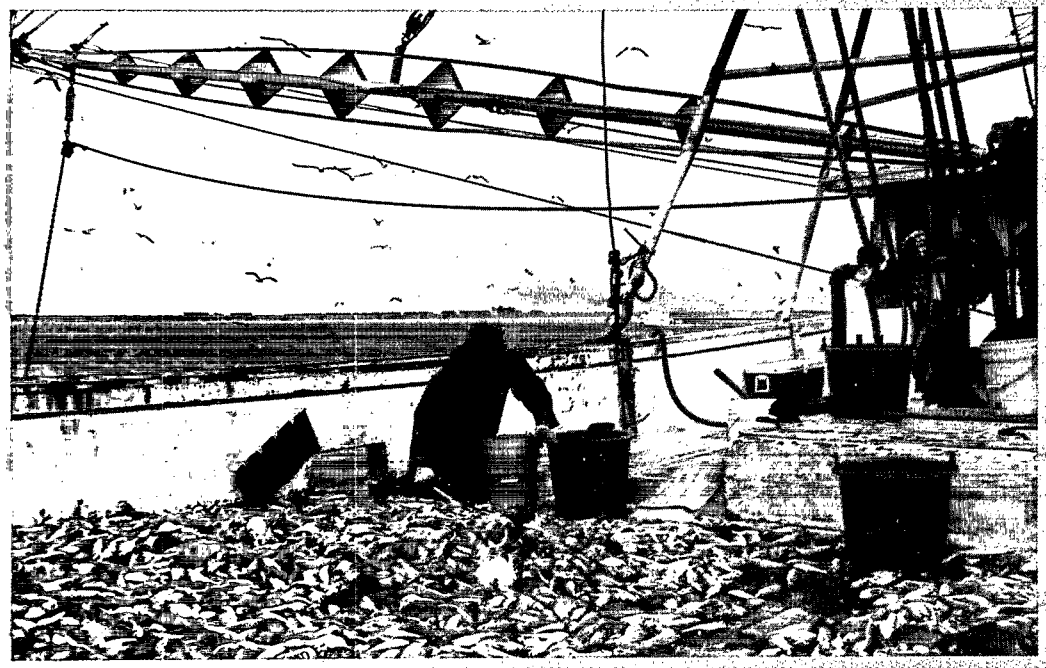
In the fall of 1987, an extensive red tide (identified as *Ptychodiscus brevis*) occurred in coastal and inshore waters of North Carolina. This bloom had a serious impact on shellfisheries in the area due to scallop mortalities and closed oyster harvesting areas. This was the first time a red tide had been documented in North Carolina waters. It was presumed that the Gulf Stream had transported the red tide north from south Florida. Satellite imagery from the NOAA weather service supported this hypothesis with evidence of a warm mass of Gulf Stream water moving into the North Carolina coastal area at the same time the red tide occurred.

Monitoring and Research Activities

The Florida Department of Natural Resources (DNR) is responsible for monitoring *Ptychodiscus brevis* concentrations in nearshore waters to determine locale and duration of shellfish bed closures. Shellfish beds are closed to commercial harvesting when *Ptychodiscus brevis* concentrations in the water column exceed 5,000 cells per liter. At this concentration the bloom is not detectable to the naked eye and would be unlikely to cause mass fish mortality. However, shellfish can concentrate the toxins in a low-magnitude bloom and present a risk of NSP to consumers.

Research is being conducted on environmental conditions that lead to bloom formation. The goal is to predict red tides and possibly control them at the source rather than after they have moved to coastal waters. If benthic cyst accumulations are indeed precursors of red tides and can be located, control methods may be developed to prevent blooms from developing in the offshore initiation zone.

An inexpensive screening technique is being developed to detect toxins in fish and shellfish meats and to monitor during and after a red tide event. Also under study is the question of whether or not human activity, which has increased the load of nutrients into coastal waters, contributes to the intensity of red tides.



New Initiatives for Estuarine and Coastal Waters

National Estuary Program

The National Estuary Program, established through the 1987 amendments to the Clean Water Act, confirmed the need to focus greater attention on the protection and improvement of water quality and the enhancement of living resources in the Nation's estuaries. Estuaries are to achieve these goals through collaborative efforts called comprehensive conservation and management plans (CCMPs). Development of CCMPs is carried out by management conferences. As of July 1988, management conferences were convened for 12 estuaries: Albemarle/Pamlico Sound, North Carolina; Buzzards Bay, Massachusetts; Long Island Sound, Connecticut and New York; Narragansett Bay, Rhode Island; Puget Sound, Washington; San Francisco Bay and Santa Monica Bay, California; New York-New Jersey Harbor, New York and New Jersey; Delaware Bay, Pennsylvania, New Jersey, and Delaware; Delaware Inland Bays, Delaware; Sarasota Bay, Florida; and Galveston Bay, Texas.

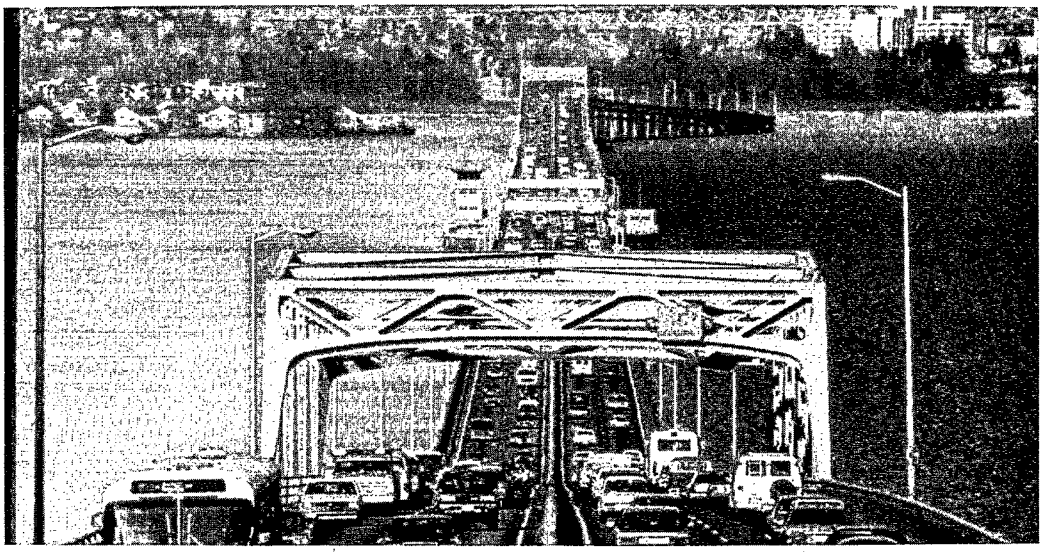
Near Coastal Water Pilot Projects

The Near Coastal Water Pilot Projects are joint State-EPA efforts to demonstrate in selected near coastal waters innovative management actions. These management actions can then be applied in other areas of the country. The following three projects were initiated in 1988:

- **Decision-making information system for Delaware's Inland Bays**—to develop a computerized Advanced Information System to help officials quickly and accurately assess impacts of proposed actions on natural resources.

- **Oregon Coastal Resource Action Plan**—to develop a comprehensive action plan for Oregon's coastal watersheds focusing on developing interagency management coordination to protect near coastal waters from point and nonpoint sources of pollution.

- **Perdido Bay Cooperative Management Initiative**—to develop a framework for management action strategies to protect and enhance Florida's and Alabama's Perdido Bay.



Puget Sound Water Quality Authority

5

NC Dept. of Environment, Health, and Natural Resources

Wetlands

Types of Wetlands

Wetlands are mostly semi-aquatic lands that are either inundated or saturated by water for varying periods of time during the growing season. In all wetlands, the presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic hydric soil properties. A Federal manual for delineating wetland areas has been developed with the involvement of the EPA, U.S. Fish and Wildlife Service (FWS), U.S. Army Corps of Engineers, and Soil Conservation Service (*Federal Manual for Identifying and Delineating Jurisdictional Wetlands*, January 1989). This manual defines wetlands based upon plants, soils, and hydrology, and is used as the basis for Federal regulatory activities that affect wetlands.

A wide variety of wetlands have formed across the country as the result of regional and local differences in vegetation, hydrology, water chemistry, soils, topography, climate, and other factors. In general, two broad categories of wetlands are recognized: **coastal** wetlands and **inland** wetlands. A national distribution of wetland types is shown in Figure 5-1.

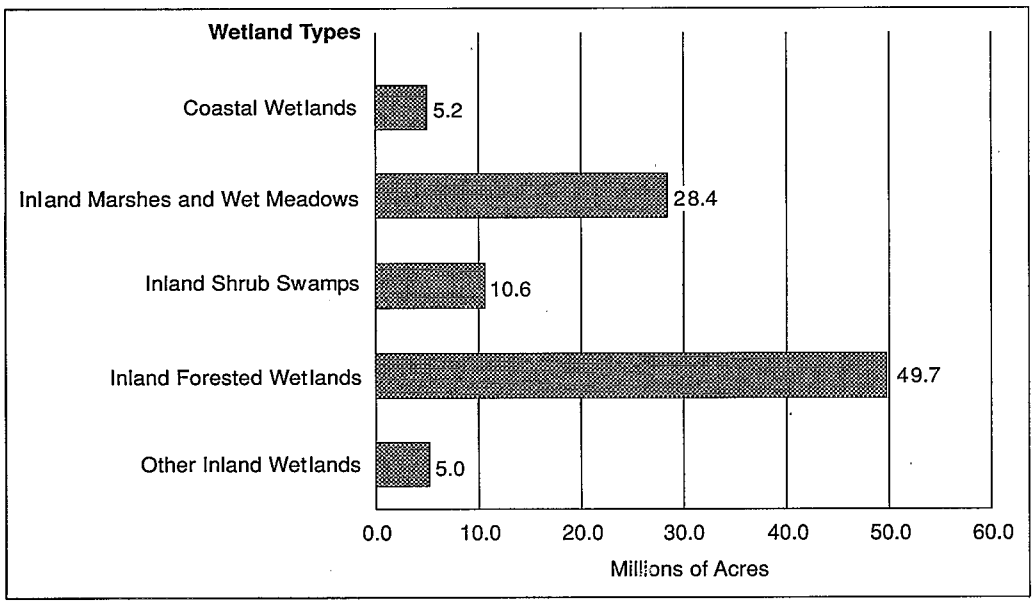
Coastal wetlands, as their name suggests, are found along the Atlantic, Pacific, Alaskan, and Gulf coasts. They are closely linked to estuaries, where seawater mixes with fresh water to form an environment of varying salinities. Saltwater and fluctuating water levels (due to tidal action) combine to create a rather difficult environment for most plants. Consequently, many shallow

coastal areas are unvegetated mud flats or sand flats. Some plants, however, have successfully adapted to this environment. Certain grasses and grasslike salt-loving (halophytic) plants form extensive colonies called "coastal marshes." These marshes are particularly abundant along the Atlantic and Gulf coasts. Mangrove swamps, dominated by halophytic shrubs or trees, are common in Hawaii and in southern Florida.

Inland wetlands occur throughout the Nation's interior. They are most common on floodplains along rivers and streams, in isolated depressions surrounded by dry land, and along the margins of lakes and ponds. Some even form at the upper edges of coastal marshes where saltwater influence ends. Inland wetlands include marshes and wet meadows dominated by grasses and herbs, shrub swamps, and wooded swamps dominated by trees, such as bottomland hardwood forests along floodplains. Some regional wetland types include the pocosins of North Carolina, bogs and fens of the northeastern and north-central States and Alaska, inland saline and alkaline marshes and riparian wetlands of the arid and semi-arid West, prairie potholes of Minnesota and the Dakotas, vernal pools of California, playa lakes of the Southwest, cypress-gum swamps of the South, wet tundra of Alaska, and tropical rain forests of Hawaii.

Wetland Values

In their natural condition, wetlands provide many benefits including food and habitat for fish and wildlife, water quality improvement, flood protection, shoreline erosion control, natural products for human use, and opportunities for recreation and aesthetic appreciation. Each wetland works in combination with other wetlands as part of a complex, integrated system. An assessment of any specific wetland must take this critical interrelationship into account.



Source: OPA-87-016.

Figure 5-1. Extent of Wetlands in the Lower 48 States

Fish and Wildlife Habitat

Wetlands are critical to the survival of a wide variety of animals and plants. For many species such as the wood duck, muskrat, cattail, and swamp rose, wetlands are primary habitats—the only places they can live. For others, wetlands are not primary residences but provide important food, water, or cover. Moreover, a number of rare and endangered species depend on wetlands for survival.

Altogether, wetlands are among the most productive natural ecosystems in the world. They can be thought of as the "farmlands of the aquatic environment" since they produce great volumes of food in the form of plant material. The major food value of wetland plants comes when the plants' dead leaves and stems break down in the water to form small particles of organic material (detritus). This enriched material is the principal food for many small aquatic invertebrates, various shellfish, and forage fish that are food for larger predatory fish, such as bluefish and striped bass. These larger fish are, in turn, consumed by people. Thus, wetlands provide an important source of food for people as well as for aquatic animals.

Flood Protection

Wetlands have often been referred to as natural sponges that absorb flooding waters. They actually function more like natural tubs, storing either floodwater that overflows riverbanks or surface water that collects in isolated depressions. By doing so, wetlands help protect adjacent and downstream property from flood damage. Trees and other wetland vegetation help slow the speed of floodwaters. This action, combined with water storage, can lower flood heights and reduce the water's erosive potential. In agricultural areas, wetlands can help reduce the likelihood of flood damage to crops. Wetlands within and upstream of urban areas are especially valuable for flood protection, since urban development increases the rate and volume of surface water runoff, thereby increasing the risk of flood damage.

Wetlands provide critical habitat to a wide variety of animals and plants.

Steve Delaney

Shoreline Erosion Control

Wetlands are often located between rivers and high ground and are therefore able to buffer shorelines against erosion. Wetland plants increase the durability of the sediment by binding soil with their roots, and dampen wave action and reduce current velocity through friction. So significant is the erosion control function of many wetlands that some States are recommending the planting of wetland vegetation to control shoreline erosion in coastal areas.

Natural Products

A wealth of natural products are produced by wetlands. Those available for human use include timber, fish and shellfish, wildlife, blueberries, cranberries, and wild rice. Much of the Nation's fishing and shellfishing industry harvests wetland-dependent species. For example, in the Southeast, 96 percent of the commercial catch and over 50 percent of the recreational harvest are fish and shellfish that depend on the estuary-coastal wetland system. Each year, the U.S. commercial fisheries' harvest is valued at more than $10 billion. Wetlands also produce fur-bearers such as muskrat, beavers, and mink. The Nation's harvest of muskrat pelts alone is worth over $70 million annually. Waterfowl hunters spend over $300 million annually to harvest wetland-dependent birds.

Water Quality Improvement

One value of wetlands is their ability to help maintain and improve the water quality of our Nation's rivers and other waterbodies. Wetlands do this by removing and retaining nutrients, processing chemical and organic wastes, and reducing sediment loads to receiving waters. Wetlands are particularly good filters. Because of their position between upland and deep water, wetlands can intercept surface water runoff from land before it reaches open water. They can also help filter nutrients, waste, and sediment from floodwaters.

Recreation and Aesthetics

Through the centuries, painters and writers have sought to capture the beauty of wetlands on canvas and paper. Today, such artists are often joined by others with cameras and video and sound recorders. An estimated 50 million people spend nearly $10 billion each year observing and photographing wetland-dependent birds alone. Wetlands also provide endless opportunities for other popular recreational activities, such as hiking and boating.

Information contained in the above sections was drawn from a brochure developed by the EPA Office of Wetlands Protection, *America's Wetlands: Our Vital Link Between Land and Water*, February 1988, OPA-87-016. For copies or further information, contact U.S. EPA, Office of Wetlands Protection (A-104F), Washington, DC 20460.

Overview of State Reporting

The information submitted by the States in their 1988 State Section 305(b) reports focused exclusively on the quantity of their wetland resources and certain State programs. The impact of chemical contaminants and other stresses on the quality of existing wetlands has not been addressed by the States and is not discussed in this report. Information on the quality of existing wetlands is generally not available because of the lack of State and Federal resources to monitor wetland quality.

Inconsistent reporting of wetland acreage and State programs is the result of several factors. First, there is a general lack of appropriate data bases and related tools to track the quantity and quality of wetland resources on consistent statewide or national scales. The FWS National Wetlands Inventory is one such tool relied on by some States for this purpose. However, as of 1988, only 60 percent of the lower 48 States and 16 percent of Alaska had been mapped.

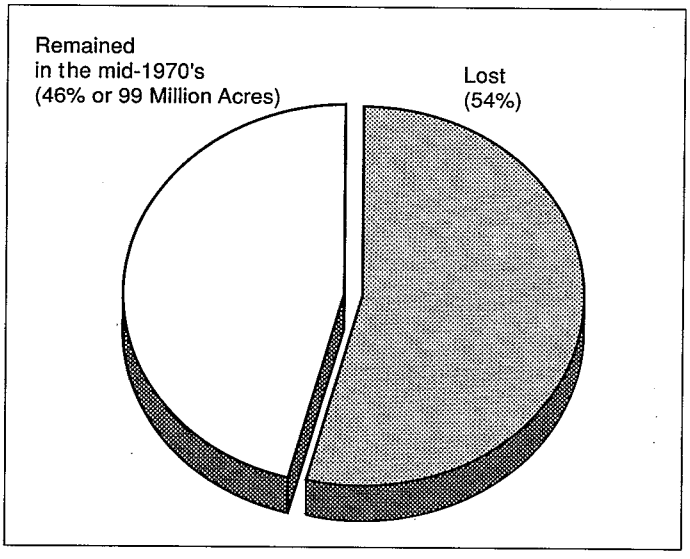
Second, wetlands are a complex, fragmented, and in some areas widely distributed water resource. The effort required to identify and assess all State wetlands on a biennial basis is enormous. Third, in the past EPA has not issued specific guidance on wetland reporting. Guidance issued by EPA in 1988 marks a first-time shift toward more consistent and complete State reporting on the quantity and quality of wetlands nationwide.

To provide a more complete assessment of State wetland resources, this report draws upon several sources of information to augment the information provided by the States. The following information is intended to provide a national overview of the Nation's wetland resources and a more consistent basis for State reporting for future 305(b) cycles.

Wetland Resources

A National Perspective

It is estimated that over 200 million acres of wetlands existed in the lower 48 States at the time of European settlement. Since then, extensive losses have taken place, with many of the original wetlands drained and converted to farmland. Today, less than half of our original wetlands remain (see Figures 5-2 and 5-3). This amounts to an area equal to the size of



Source: OPA-87-016.

Figure 5-2. Original and Remaining Acreages of Wetlands in the Lower 48 States

Human Impacts

- Drainage
- Dredging and stream channelization
- Deposition of fill material
- Diking and damming
- Tilling for crop production
- Grazing by domestic animals
- Discharge of pollutants
- Mining
- Alteration of hydrology

Natural Threats

- Erosion
- Subsidence
- Sea level rise
- Droughts
- Hurricanes and other storms
- Overgrazing by wildlife

Figure 5-3. Major Causes of Wetland Loss and Degradation

California. An additional 200 million acres of wetlands are estimated to exist in Alaska—covering slightly more than half the State—while Hawaii has approximately 100,000 acres. Next to Alaska, Louisiana and Florida have the largest wetland acreage in the U.S.

Two basic types of data collection efforts can be used to track the quantity of wetlands: (1) detailed maps and (2) status and trends reports. Detailed maps provide site-specific information on wetlands. Status and trends information is used to evaluate changes to the resource over time. The FWS has been extensively involved in these two areas over the last several years.

The only complete national assessment of the changes in the quantity of U.S. wetland resources over time is contained in a report entitled *Wetlands of the United States: Current Status and Recent Trends* (U.S. FWS, 1984). This report assesses the changes in the national wetlands resource between the mid-1950s to the mid-1970s. Estimates of wetland loss are based on the evaluation of wetland acreage within thousands of 4-square-mile plots located across the U.S. The number and locations of the plots were chosen to provide a given statistical precision when the information was extrapolated to the entire U.S.

Based on these data, the FWS estimates that the Nation's wetlands are being lost at an alarming rate. Between the mid-1950s and mid-1970s alone, about 11 million acres of marshes and swamps were destroyed, an area three times the size of New Jersey. The average annual loss was 458,000 acres (440,000 acres of inland wetlands and 18,000 acres of coastal wetlands) during this period.

Agricultural activities affecting wetlands, including drainage, filling, and road construction, were responsible for 87 percent of losses between the mid-1950s and mid-1970s. Agricultural activities had the greatest impact on forested wetlands, inland marshes, and wet meadows. Urban development and other development were responsible for 8 percent and 5 percent of wetland losses, respectively. Urban development was the major cause of coastal wetland losses outside of Louisiana, while submergence of Louisiana's coastal marshes by Gulf waters was the leading factor in that State. In addition to the direct physical destruction of wetlands, these habitats are

Agricultural activities led to 87 percent of wetland loss between the mid-1950s and mid-1970s.

also threatened indirectly by chemical contamination and other pollution.

In recent times, the most extensive losses of wetlands have occurred in Louisiana, Mississippi, Arkansas, North Dakota, South Dakota, Nebraska, Florida, and Texas. These and losses in other States have greatly diminished our Nation's wetland resources and the benefits they once provided. For example, increased flood damages and declining waterfowl populations are, in part, the result of wetland destruction.

The FWS is currently updating its 1984 report on wetlands status and trends and has recently prepared a similar report for the Mid-Atlantic Region of the U.S. (*Mid-Atlantic Wetlands: A Disappearing National Treasure*, June 1987). The methodology used to develop the national report was used to prepare this regional assessment.

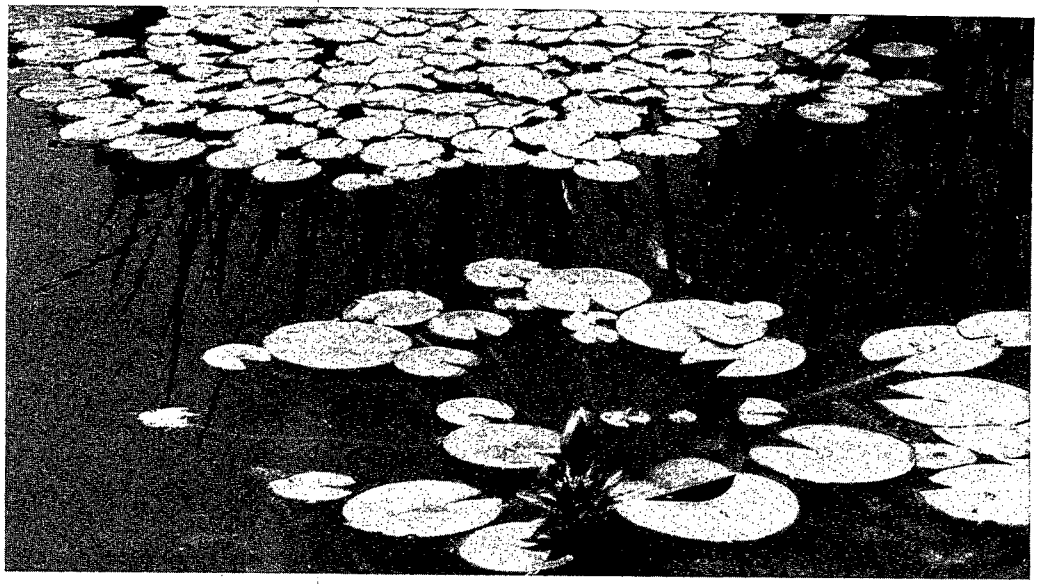
State-Reported Information

In their 1988 State Section 305(b) reports, 14 States reported on the acreage and causes of wetland loss. Many State estimates of wetland acreage are based on National Wetlands Inventory (NWI) information; others are independent estimates.

The following is a summary of State-reported information on wetland acreage and current rates and causes of loss. No attempt has been made to compare the estimates provided by the States with the data from NWI. NWI and State-generated data can provide a basis for consistent reporting of wetland acreage in future State Section 305(b) reports.

■ **California**—Over 90 percent of California's original 5 million acres has been lost by conversion to other land uses. Located in the interior are 240,000 acres of modified wetlands; 170,000 acres of coastal wetlands remain.

■ **Connecticut**—Total inland wetlands acreage is estimated at 435,000 acres, or about 15 percent of the State's land area. The Connecticut Department of Environmental Protection (DEP) estimates that 1,200 to 1,500 acres may be lost or altered annually. The primary cause of wetlands loss is land development for residential or commercial use. To further improve wetland protection efforts statewide, the DEP has instituted a comprehensive education and training program for local commission members.



It has been estimated that approximately half of the original tidal wetlands in Connecticut have been lost because of urban encroachment and other human activities such as dredging and filling. Since the enactment of the Tidal Wetlands Act in 1969, however, the DEP estimates that less than 1/10 of 1 percent of the remaining wetlands have been filled. Current estimates are that approximately 17,500 acres of tidal wetlands remain in the State. Additionally, State and local initiatives have resulted in the restoration of between 400 and 600 acres of previously degraded tidal wetlands.

■ **Illinois**—The State was once covered by more than 8 million acres of wetlands. Currently less than 500,000 acres remain.

■ **Maryland**—Prior to passage of the State's Tidal Wetlands Law, about 1,000 acres of wetlands were being destroyed each year. For the 25-year period between 1942 and 1967, wetland losses in Maryland exceeded 23,000 acres. Approximately 438,000 acres of wetlands remain.

■ **Mississippi**—Prior to 1973, Mississippi had lost approximately 10,000 acres of wetlands. Since 1973, fewer than 20 acres of coastal wetlands have been altered. It has been estimated that if this trend had been allowed to continue, Mississippi would have lost approximately 42 percent of its wetlands resources. With strong State and Federal legislation in place, the area affected is estimated to be less than 0.05 percent.

■ **New Hampshire**—The State has about 100,000 acres of freshwater and tidal wetlands. Although wetland drainage is not generally allowed, New Hampshire continues to lose about 25-50 acres per year, mainly as the result of residential and commercial development and road construction.

■ **New York**—The State has almost 2 million acres of freshwater wetlands and over 25,000 acres of tidal wetlands. Based on land-use trends and soil analyses, estimates are that over half of New York's wetlands have been lost since colonial times to draining, dredging, filling, and pollution. Since the 1950s, New York has lost over 40 percent of its tidal wetlands. Some losses continue to occur. Although all tidal wetlands are protected by State statute, only 60 percent of freshwater wetlands receive State statutory protection.

USDA-Soil Conservation Service

Wild ponies in a wetland area on Assateague Island, Maryland.

There have been some gains in wetlands in New York. New wetlands are being created or existing ones enlarged as the result of managed changes in beaver populations. Other wetland gains can be attributed to the restoration of agricultural land back to wetlands.

■ **North Carolina**—State wetland protection programs are generally limited to the 20 coastal counties. Most of the 3.4 million acres of wetlands in the State are tidal.

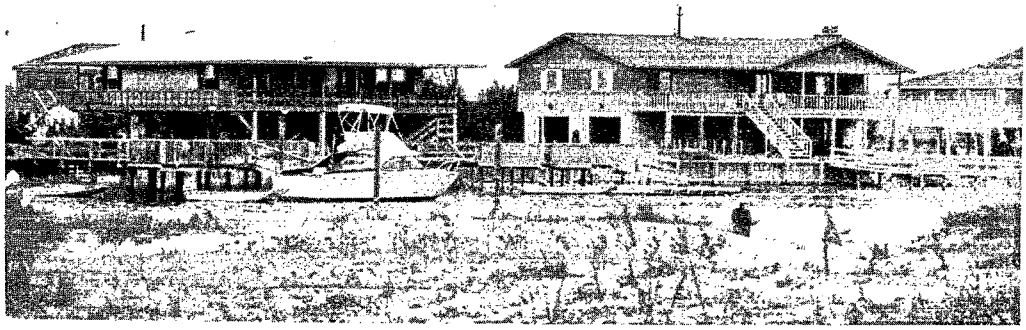
■ **North Dakota**—By 1980, nearly half of the original wetland acreage in North Dakota had been drained (about 2 million acres remain). Since 1980, the loss of wetlands is estimated at 20,000 acres per year. The annual loss of wetlands appears to be lessening. However, this may be attributable to the diminishing wetland base as well as the difficulty and cost associated with draining.

■ **Oregon**—By the 1970s, wetland areas in most estuaries in the State had been reduced by 50-95 percent as a result of agriculture and the siting of port/industrial activities. Early losses can be attributed to diking for the purpose of creating agricultural lands. Most of these conversions occurred prior to the 1930s and account for about 90 percent of the habitat losses. Since the 1930s, most losses have been attributed primarily to urban development.

■ **Pennsylvania**—An estimated 498,000 acres of freshwater wetlands remain. Strip mining in the western counties, development in the northeast, and the construction of impoundments on a statewide basis were the primary causes for the loss of these wetlands.

The most significant wetland loss in Pennsylvania is taking place as a result of second home development, coal mining, and urbanization. Second home development is an immediate threat to a large number of wetlands in the Pocono area, which has a greater concentration of bogs, swamps, and marshes than any other region in the Commonwealth. While there are approximately 45,000 year-round housing units in the three-county area, there are almost four times as many subdivided lots for second home development.

Coal mining affects wetlands through alteration of hydrologic conditions, acid mine drainage, erosion of spoil material, and drainage of water tables near mining sites. The greater reliance on coal to satisfy increasing energy demands, combined



Jim Page

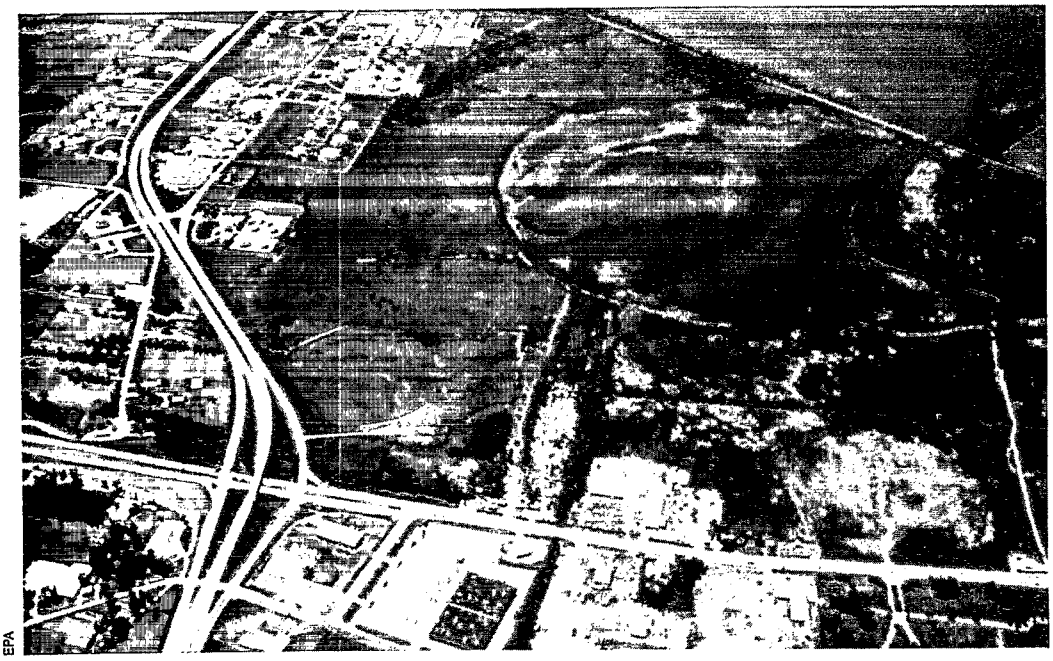
A North Carolina coastal community.

with the abundance of reserves, poses a formidable threat to wetland acreage in the Commonwealth. Since most floodplain development occurs in metropolitan areas, the relatively few remaining wetlands in and near major urban centers are in danger. Much of the existing wetland acreage in metropolitan areas is located along major waterways and is susceptible to industrial expansion, pollution, and floodwater inundation.

■ **Rhode Island**—Development pressures remain a major threat, as indicated by a significant rise in applications to alter wetlands. In 1984, 60 percent of the activities that led to alterations in the coastal zone were attributable to residential development.

■ **Vermont**—The State has approximately 220,000 acres of wetlands, representing about 4 percent of its land area. About 120,000 acres are forested wetlands, about 64,000 acres are scrub-shrub wetlands, and about 25,000 acres are emergent wetlands (marshes and wet meadows). A recent analysis of wetland impacts in the State found that 36 acres were lost between January 1986 and May 1987; the leading cause of loss was development for light industry. Road construction and residential development were also cited as causes of wetland loss.

■ **Wisconsin**—The State once had 7.5 to 10 million acres of wetlands. Now, less than half remain: the State has completed a statewide wetland mapping effort and estimates that it has 5,331,392 acres of wetlands. Since passage of the Federal Emergency Wetlands Resources Act of 1986, Wisconsin has taken some important steps to protect wetlands. A comprehensive wetlands inventory was completed in 1985. Mapping by county, township, and range was completed for all wetlands 5 acres or larger. A draft Wetlands Priority Plan has recently been submitted for review to the National Park Service. The plan addresses wetland preservation and protection, resource assessment, protection strategies, and criteria for acquisition.



EPA

Road building, light industry, and residential development are leading causes of wetland loss.

Wetlands Protection Programs

Summary of Federal Programs

Section 404 of the Clean Water Act gives the U.S. Army Corps of Engineers authority to issue permits for "the discharge of dredged or fill material into the navigable waters [of the United States] at specified disposal sites." Section 404 also gives EPA a number of responsibilities to ensure that the environment is sufficiently protected from the adverse impacts of these discharges. Although States may be granted the authority to assume 404 permitting, to date only Michigan has assumed that responsibility. Since 1972, the 404 program has developed into the most important Federal regulatory program for the protection of wetlands.

Inland freshwater wetlands constitute 95 percent of the remaining wetland resource in the United States and 97 percent of the estimated 300,000 acres of wetlands lost each year to development. Many of the losses are due to agricultural activities, some of which are not regulated under the 404 program. The 1985 Farm Bill should help mitigate this problem by discontinuing subsidies to farmers who drain and plant in wetlands.

Approximately 13,000 project applications under Section 404 and Section 404/10 (Section 10 of the Rivers and Harbors Act) are processed each year by the Corps of Engineers. EPA reviews and evaluates them using its 404(b)(1) guidelines, which contain the environmental criteria for 404 permit decisions. The FWS and the National Marine Fisheries Service also influence the 404 permitting process through their review of applications. After receiving comments from these agencies, the States, and other interested parties, the Corps of Engineers makes its permit decisions.

Before permits are issued, EPA has an opportunity under Section 404(c) to exercise its authority to prohibit, condition, or restrict the use of any site if such use is found to "have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas." However, this action occurs in only a small fraction of projects.

As a result of this process, the Corps of Engineers annually denies slightly more

The 1985 Farm Bill discontinued subsidies to farmers who drain and plant in wetlands.

than 3 percent of project applications. About one-third of the permits are significantly modified from their original application, and about 14 percent of the 13,000 annual permit applications are withdrawn by applicants. The Congressional Office of Technology Assessment has estimated that these denials, modifications, and application withdrawals save 50,000 acres of wetlands each year.

Summary of State Programs

The following is a summary of State wetland protection programs. Since State-submitted information alone does not provide a complete and consistent data base for reporting, the information presented below is drawn from several sources, including State Section 305(b) reports. This is intended to provide a national overview and consistent basis for State reporting for future 305(b) cycles.

In addition to the Federal Section 404 program, the States have developed a variety of programs to regulate activities affecting wetlands or to encourage wetlands preservation. These programs include permitting, coastal zone management, wetland acquisition, and heritage programs, to name a few.

Many coastal States (the term "coastal" here includes the Great Lakes States) have had permit programs for several years that regulate certain activities affecting marine and estuarine wetlands. Out of a total of 30 coastal States and 5 coastal Territories, 25 have their own permit programs (see Table 5-1). A far lower percentage of States have permit programs that apply to activities affecting freshwater or inland wetlands; only 16 States currently have inland wetland permit programs.

Information on nonregulatory programs is more difficult to summarize. In general, most coastal States have approved coastal zone management programs; five coastal States do not. Several States have a combination of acquisition programs, heritage programs, and Section 401 certification programs. Section 401 certification gives the States the authority to review and approve, disapprove, modify, or condition any Federal permit or license (e.g., Section 404 permits and Federal Energy Regulatory Commission licenses). Water quality standards provide the basis for State involvement in these Federal activities. EPA's Office of Wetlands Protection has developed a document entitled *Wetlands and 401 Certification* (April 1989) on the use of Section 401 certification to protect wetlands. Future State Section 305(b) reports should provide a more complete summary of State programs, including both regulatory and nonregulatory programs.

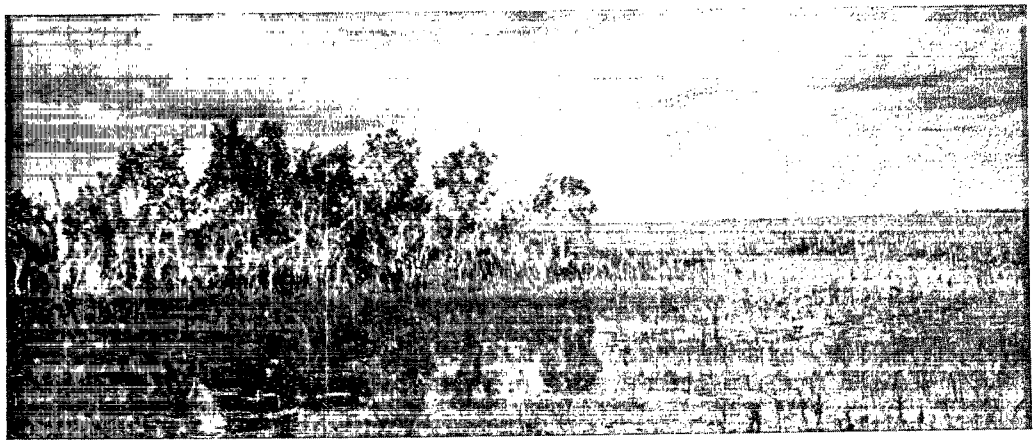
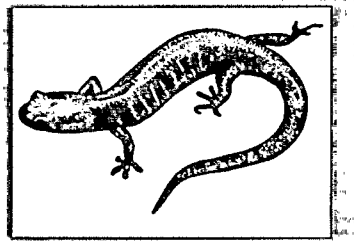


Table 5-1. Summary of State Permit and Other Selected Nonpermit Programs

State	Coastal Permit Program	Inland Permit Program*	Comprehensive Statewide Permit Program**	401 Program
Alabama	●	—	—	●
Alaska	—	—	—	●
American Samoa	●			●
Arizona	NA	—	—	●
Arkansas	NA	—	—	
California	—	—	—	●
Connecticut	●	●	●	
Colorado	NA	—	—	
Delaware	●	■	—	
Florida	●	●	●	
Georgia	●	—	—	
Guam	●	●	●	●
Hawaii	—	—	—	●
Idaho	NA	—	—	
Illinois	—	—	—	
Indiana	—	—	—	
Iowa	NA	—	—	
Kansas	NA	—	—	
Kentucky	NA	—	—	
Louisiana	●	—	—	
Maine	●	□	●	●
Maryland	●	▲	—	●
Massachusetts	●	●	●	●
Michigan	●	●	●	●
Minnesota		●		●
Mississippi	●	—	—	
Missouri	NA	—	—	
Montana	NA	—	—	
Nebraska	NA	—	—	●
Nevada	NA	—	—	
New Hampshire	●	●	●	
New Jersey	●	●	●	●
New Mexico	NA	—	—	
New York	●	▼	●	●
North Carolina	●	—	—	●
North Dakota	NA	—	—	
Ohio	—	—	—	●
Oklahoma	NA	—	—	
Oregon	●	●	●	●
Pennsylvania	●	●	●	●
Rhode Island	●	●	●	
South Carolina	●	—	—	●
South Dakota	NA	—	—	
Tennessee	NA	—	—	●
Texas	—	—	—	
Utah	NA	—	—	
Vermont	NA	●	●	●
Virginia	●	★	—	
Washington	●	●	●	Coastal program
West Virginia	NA	—	—	●
Wisconsin	●	●	●	
Wyoming	NA	—	—	●

● Program in place.
■ Convened a State task force to look into nontidal wetlands protection; study not yet completed.
□ Program in place; 10-acre limitation.
▲ Program in place; legislation enacted but not yet implemented; regulations to be developed.
▼ Program in place; can be delegated to local authorities; 12.4-acre limitation, some smaller wetlands of local importance (New York).
★ Nontidal legislation failed to pass, 1988.

*Freshwater/nontidal.
** Comprehensive programs cover both coastal and inland wetlands.



National Wetlands Policy Forum

In the Spring of 1987, EPA's Administrator asked the Conservation Foundation to convene an independent National Forum on wetlands. Its 20 members included three Governors; leaders from local government; developers; forestry, oil, and gas representatives; environmental conservation groups; farmers; and academic experts. Former EPA Administrator Lee Thomas and representatives of four other Federal agencies also participated as ex officio members.

The goal of the Forum was to provide policy recommendations to Federal, State, and local officials and to wetland owners and users on protecting wetlands in a more coherent and predictable manner, consistent with economic and social needs. The Forum conducted public workshops in three States and consulted widely with policy and technical advisors, individuals, and groups. On November 15, 1988, the Forum issued its report, *Protecting America's Wetlands: An Action Agenda.* A subgroup of the Forum continues to work on implementation of the recommendations, and the full Forum will reassess progress after 1 year.

The Forum recommended direct protection measures, improving the management processes, and specific implementation actions. EPA has adopted a short-term "Wetlands Action Plan" that begins to respond to many of the proposals of the Forum. The Plan includes highlights but is not intended to describe all work going on in the Office of Wetlands Protection or in other EPA offices to address wetlands needs.

Most importantly, in its Action Plan, EPA has adopted the Forum's goal of "no overall net loss" in the Nation's remaining wetland base and the restoration and creation of wetlands, where feasible. EPA will participate on the Domestic Policy Council's interagency wetlands task force which will examine implementation of the "no net loss" goal. One major action of the task force is to revise and strengthen the Executive Orders on wetlands and floodplains.

The Agency will also cooperate as Congress evaluates legislative changes to improve wetlands protection benefits of farm programs, strengthen permitting programs, and provide incentives for States to assume regulatory responsibility, expand set-aside areas under the Coastal Barrier Resources Act, and strengthen the Resource Conservation and Recovery Act to improve wetlands protection. Specifically, EPA has identified

Al Puopolo

seven objectives in its Action Plan to implement the recommendations of the Forum:

1. Provide technical support and participate in the application of planning approaches, including the preparation of State Wetlands Conservation plans.

2. Provide guidance, technical assistance, and support to strengthen the protective role of State and local governments.

3. Work with the Corps of Engineers to increase enforcement under Section 404; work with the Corps specifically on reducing uncertainty and confusion in implementing this legislation; work toward consistency in planning, permitting, and enforcement.

4. Implement the policy that unavoidable wetland impacts should be fully offset by wetlands restoration or creation.

5. Increase public awareness of wetlands' functions and values and of regulatory and nonregulatory programs.

6. Develop and test methods for assessing the cumulative effects of wetland loss and degradation. Incorporate these approaches into planning and permit decisions.

7. Identify opportunities and initiate projects to restore and create wetlands.

In addition, President Bush has adopted the "no net loss" recommendations of the Forum in public statements, speeches, and, most recently, in his FY 90 budget proposals to Congress.

Many of the EPA activities are designed to assist the States in meeting the "no overall net loss" goal. The information submitted in future Section 305(b) reports will help the Nation meet this goal by providing an improved accounting of remaining wetlands, their status, and the threats they face. Copies of the Forum Report and the EPA Action Plan can be obtained from the U.S. EPA, Office of Wetlands Protection (A-104F), Washington, DC 20460.

NALMS

Water Quality Standards for Wetlands

Water quality standards are used to regulate the many activities that affect surface waters, including wetlands. These activities include municipal and industrial point source discharges, nonpoint source discharges, actions under RCRA and CERCLA, and dredge and fill activities under Section 404 of the CWA.

The provisions of the Clean Water Act and the State standards designed to implement the CWA's goals and objectives apply to all "navigable waters." Navigable waters are defined in Section 502(7) of the CWA as "waters of the United States," which are in turn defined by regulation (40 CFR Part 230; 45 *FR* 85345, dated December 24, 1980) to include wetlands adjacent to other waters such as rivers, lakes, estuaries, and the ocean, and isolated wetlands that are used for interstate commerce. Congress and the Courts have made it clear that the jurisdiction over wetlands is to be as extensive as the Constitution permits. Therefore, the general provisions of the CWA that apply to "navigable waters" also apply to wetlands.

NC Division of Coastal Management

Water quality standards laws for each State were reviewed to identify whether the laws specifically mention wetlands in their definition of "State waters." Standards were also reviewed to identify any use classifications, criteria, or antidegradation provisions specifically for wetlands. Information was taken from the Bureau of National Affairs "Environment Reporter" (updated as of March 1989). This information is provided here to serve as a baseline for future State Section 305(b) reports. A final report, dated August 17, 1989, is available from either the Office of Water Regulations and Standards or the Office of Wetlands Protection, U.S. EPA.

Of the 56 States and Territories that were reviewed, 26 include wetlands in their definition of "State waters." States have generally not established use classifications, criteria, or antidegradation procedures specifically for wetlands. However, some States include certain wetlands in their waterbody-specific classification systems and some identify a limited number of specific wetlands for protection as "outstanding resources" under Tier III of antidegradation.

The inclusion of wetlands in the definition of "State waters" is not necessarily an indication of the strength of a State's wetlands protection program. However, water quality standards for wetlands can play a pivotal role in the development of State regulatory and nonregulatory programs to protect wetlands, and provide a framework for reporting under Section 305(b). The inconsistency in State Section 305(b) wetland reporting may be the result, in part, of the lack of fully developed water quality standards for wetlands.

State-Reported Information

In their 1988 State Section 305(b) reports, 13 States provided information on specific programs or legislation designed to protect their wetland resources. The following information was reported by the States in their Section 305(b) reports:

■ **California**—In November 1983, the California Department of Fish and Game published "A Plan for Protecting, Enhancing, and Increasing California's Wetlands for Waterfowl," pursuant to State Senate Concurrent Resolution No. 28. This resulted from enactment of Chapter 7 of the California Public Resources Code known as the

California Wetlands Preservation Act (Keene-Nejedly). The areas identified in this plan are to be acquired for the public domain. Proposals for State funding to acquire new wetlands and recommendations for increased Federal support are included in the plan.

■ **Connecticut**—In 1969, Connecticut enacted its Tidal Wetlands Act. Since then, the loss of tidal wetlands has virtually stopped. This success is attributable to the implementation of the Act and broad public support for wetlands conservation in the State.

The passage of the Inland Wetlands and Watercourses Act in 1972 placed considerable restrictions upon indiscriminate alteration, and subsequent loss, of the State's freshwater wetlands and watercourses. Connecticut's landmark inland wetlands legislation is considered to be among the most stringent in the Nation. The State law provides for delegation of regulatory authority to volunteer municipal wetlands commissions. These citizen boards operate under the guidance and oversight of the Department of Environmental Protection (DEP) Commissioner and Wetlands Management Section. The DEP has adopted model municipal wetlands regulations and provides technical assistance and training to town wetlands commissions.

■ **Florida**—The Warren B. Henderson Wetlands Protection Act, passed in 1984, recognizes the value of wetlands in its mission to protect, maintain, and improve the quality of water throughout the State. The Act requires that a detailed monitoring record be kept of wetland acreage in order to control dredge and fill activities, as well as to identify the number of acres being lost, disturbed, created, improved, and preserved.

Several State land acquisition programs help to protect Florida wetlands. The "Save Our Rivers" program has purchased over 250,000 acres of floodplain since its inception. The "Save Our Coasts" program has bought 72,000 acres of land. About a half million acres of land, much of it wetlands, have been purchased by the State since 1979.

■ **Illinois**—In 1984, the Illinois Department of Conservation initiated a comprehensive wetland protection and management program designed to identify critical issues, examine existing government programs, and develop needed technical information and procedures. The wetland program is governed by the Wetlands Committee, a subgroup of the Governor's State Water Plan Task Force. The Committee is responsible for developing policy and program recommendations and is composed of policymakers from agencies responsible for programs that affect Illinois' water resources.

■ **Maryland**—The State has had a tidal wetlands regulatory program since 1970. This program is administered by the Department of Natural Resources and the State Board of Public Works through a public interest review and permit process. The law requires property owners to obtain permission from the State before altering tidal wetlands. If a permit or license is necessary, the State will issue a public notice, if required, and hold any requested public hearings.

Chesapeake Bay Foundation

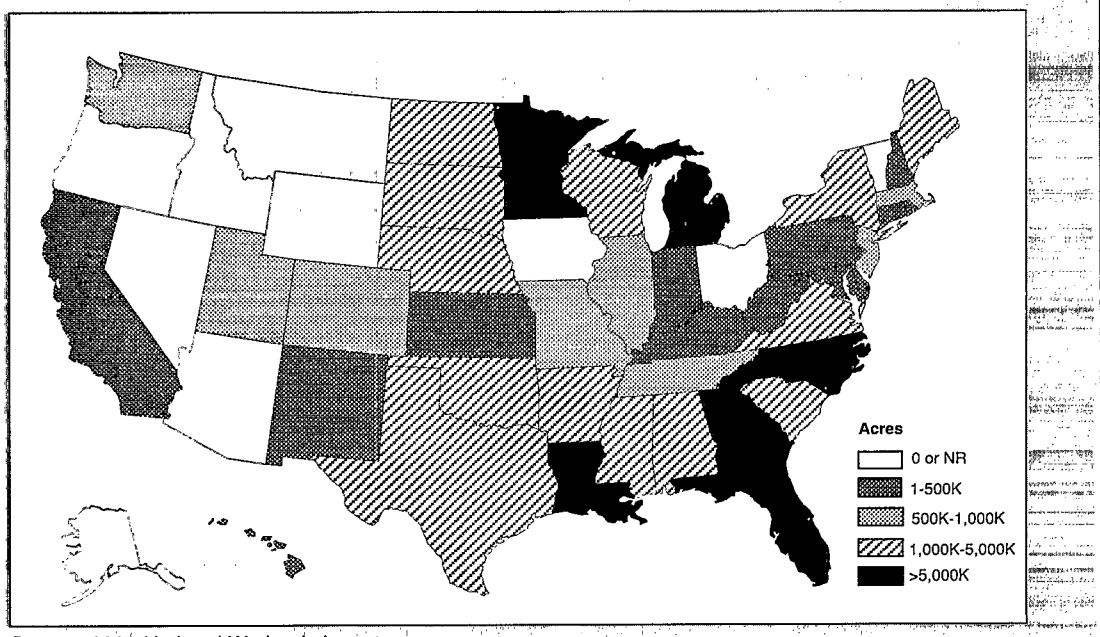
The National Wetlands Inventory

The National Wetlands Inventory (NWI) is a long-term program of the U.S. Fish and Wildlife Service to map the Nation's coastal and inland wetlands. Wetland maps developed by the NWI provide important information on the extent of State wetland resources and provide a basis for a wide variety of regulatory and nonregulatory activities. The NWI also provides a consistent way of reporting the extent of wetlands by State.

Wetlands are mapped primarily by the use of good-quality, high-altitude aerial photography. Wetlands are identified from these photos, and their boundaries are transferred to maps. Wetland acreage is then estimated from the completed maps. To date, approximately 60 percent of the lower 48 States, 100 percent of Hawaii, and 16 percent of Alaska have been mapped.

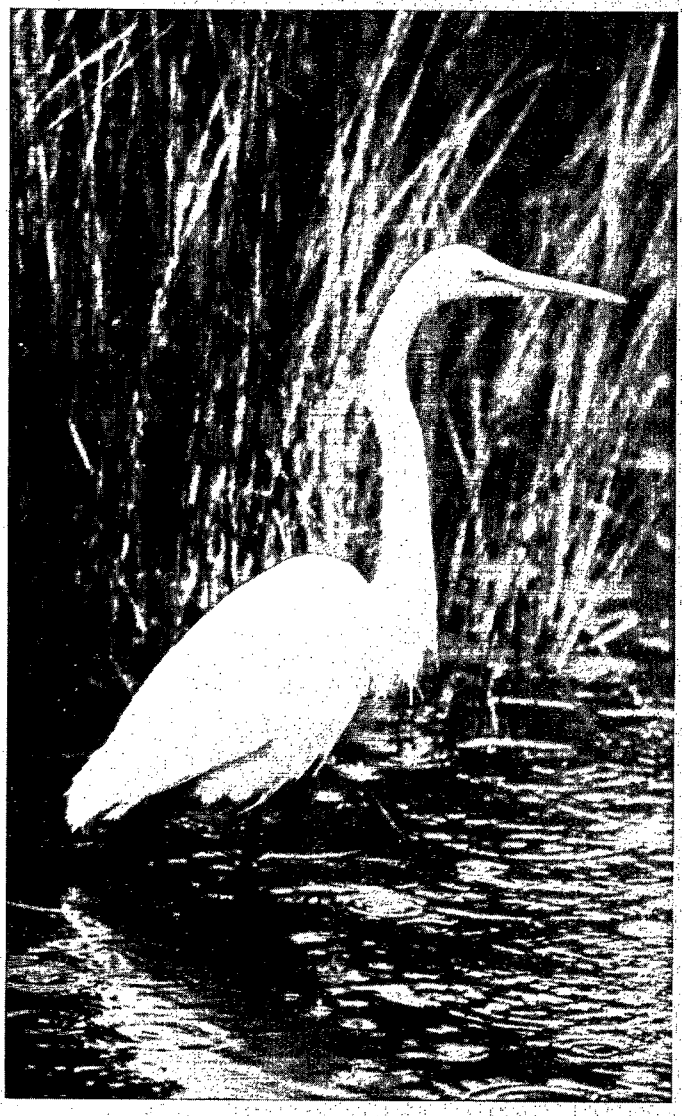
Table 5-2 summarizes wetland acreage by State. Six States have greater than 5 million acres of wetlands, 12 States have between 1 and 5 million acres, 8 States have between 500,000 and 1 million acres, and 13 States have less than 500,000 acres of wetlands (see Figure 5-4). Reliable data are not available for 11 States.

As discussed earlier in this report, several States provided estimates of current wetland acreage in their 305(b) reports. In order to provide a consistent basis for comparing wetland acreage between States, Table 5-2 includes wetland acreage estimates provided only by NWI. No attempt has been made to compare what the States reported in 1988 against the findings of the NWI.



Source: 1988 National Wetlands Inventory.

Figure 5-4. Wetlands Acreage Distribution Nationwide



Steve Delaney

Table 5-2. Estimated Wetland Area by State

State	Acres (in thousands)	Percent of Total State Land Area
Alabama	3,069	9
Alaska	—	—
Arizona	—	—
Arkansas	2,764	8
California	389	1
Colorado	675	1
Connecticut	261	8
Delaware	223	18
Florida	11,333	33
Georgia	5,298	14
Hawaii	110	—
Idaho	—	—
Illinois	712	2
Indiana	285	1
Iowa	—	—
Kansas	435	1
Kentucky	205	1
Louisiana	8,674	30
Maine	1,731	9
Maryland	438	7
Massachusetts	542	11
Michigan	5,583	15
Minnesota	7,540	15
Mississippi	4,067	13
Missouri	836	2
Montana	—	—
Nebraska	1,906	4
Nevada	—	—
New Hampshire	190	3
New Jersey	916	19
New Mexico	482	1
New York	1,184	4
North Carolina	5,690	18
North Dakota	2,868	7
Ohio	—	—
Oklahoma	1,270	3
Oregon	—	—
Pennsylvania	498	2
Rhode Island	84	13
South Carolina	4,659	24
South Dakota	1,548	3
Tennessee	787	3
Texas	3,957	2
Utah	584	1
Vermont	—	—
Virginia	1,045	4
Washington	748	2
West Virginia	102	>1
Wisconsin	4,410	13
Wyoming	—	—

— Reliable wetland area data not available.

Source: U.S. Fish and Wildlife Service, *National Wetlands Inventory*, June 1988.

■ **Mississippi**—Prior to 1973, the State's shoreline, including wetlands of the Gulf Coast, was significantly altered by man. Primary impacts were associated with residential development and industrial expansion into wetlands areas. In 1973, the Mississippi Legislature passed the Coastal Wetlands Protection Law. This law established a regulatory program for wetlands protection and curtailed human encroachment into wetlands. Subsequent to the wetlands law, the legislature enacted the Mississippi Coastal Program, which further strengthened the State's ability to protect the coastal environment.

NC Division of Coastal Management

■ **New Hampshire**—The State's long-standing wetlands protection program is a cooperative effort involving the State, through the Wetland Board, and local governments through their Conservation Commissions. Generally meeting weekly, the Board considers any dredge or fill activity occurring within a wetland or surface water. The local Conservation Commissions review wetland alteration applications for the Wetland Board. Special emphasis has been placed on the protection of coastal wetlands.

■ **New Jersey**—On July 1, 1987, the Freshwater Wetlands Protection Act of 1987 was enacted. The Act authorizes the New Jersey Department of Environmental Protection to issue permits for regulated activities. The permit program will not affect tidal wetlands regulated under the separate Wetlands Act of 1970. In addition, the new Act contains several provisions relating to wetland mitigation requirements and establishes a Wetlands Mitigation Council.

■ **New York**—Special wetland categories and unique wetland systems have been identified under a Significant Habitat program and the State's Natural Heritage program. These specifically designated and protected areas, along with active acquisition programs, are helping to curb further losses of wetlands. New York is an active participant in the North American Waterfowl Joint Ventures, which is coordinating multiple opportunities to protect, create, and restore large acreages of wetlands in key areas of the State. Recent educational efforts—e.g., focusing on local governments, school children, tax assessors, and land owners—will involve other parties in wetland protection.

■ **North Carolina**—In coastal counties, the Coastal Area Management Act (CAMA) and Section 404 of the Clean Water Act combine to effectively protect salt marshes. Section 404 applies to wetlands statewide, but there are no State laws that protect wetlands outside of the coastal zone. While the 404 program offers limited protection for inland freshwater wetlands, it has not been effective in limiting wetland conversion because of enforcement problems and the limited scope of the program.

Wetland acquisition programs in North Carolina have set aside some 85,000 acres of wetlands, both privately and publicly owned. Freshwater wetlands receive the most attention in these programs because of the lack of regulatory protection.

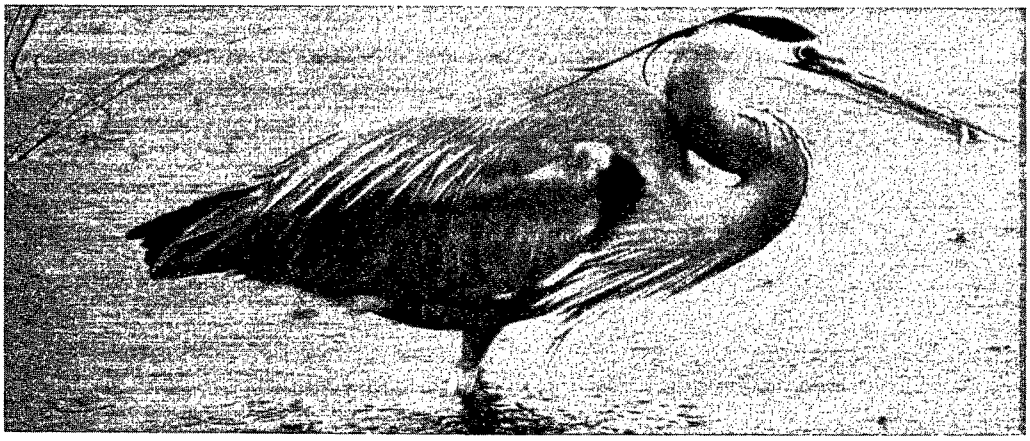
■ **North Dakota**—The State recently enacted a law (Senate Bill 2035) initiating a "No Net Loss" program. The basic concept of the program requires that for every permitted acre of wetland that is drained, an equal acreage of wetlands must be restored. The landowner who drains must pay 10 percent of the costs for the restored acres, with the remainder coming from other sources. Fifty percent of the restored wetlands should be located in the county where the drainage occurred.

■ **Rhode Island**—The Freshwater Wetlands Act of 1971 (FWWA) recognizes swamps, marshes, and other freshwater wetlands as buffer zones and absorption areas for floodwaters, recharge areas for ground water, high-value wildlife habitat, and recreation areas.

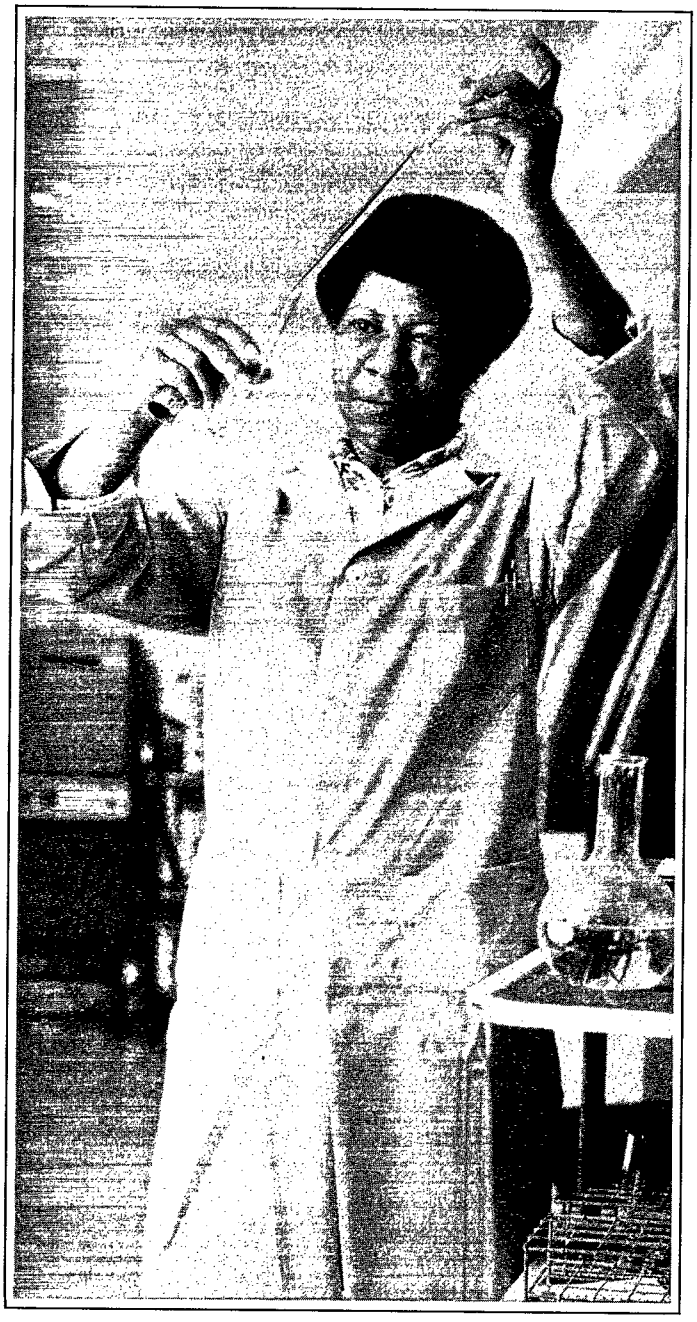
In 1971, the State created the Coastal Resources Management Council (CRMC), which is Rhode Island's lead agency under the Federal Coastal Zone Management Act.

■ **Vermont**—In 1986, the State legislature passed a wetlands act that provides the basis for a broad measure of protection to many of Vermont's wetlands. The Act restricts activities that could potentially degrade the function or value of significant wetlands. In addition, the State Development Control Law (Act 250) requires a permit for every major land development and subdivision in the State; among the criteria for permit issuance are several that afford protection to wetlands. However, most agricultural and silvicultural activities are not regulated under Act 250, nor are small-scale industrial, commercial, and residential projects.

Other statutes provide some measure of wetland protection in Vermont. These include the Management of Lakes and Ponds statute and the Stream Alteration Law. The State is currently compiling a master list of wetlands to be acquired.



6



Public Health/Aquatic Life Concerns

In 1988, States were asked to report specifically on pollution problems affecting public health and aquatic life. Among the topics they were to address were fishing advisories and bans, pollution-caused fish kills, problems with toxic contamination of sediments, and closures of bathing areas or surface drinking water supplies due to pollution. Many of these impacts are the result of toxic contaminants.

Although any pollutant may have toxic effects if it is found in sufficient amounts, a number of pollutants appear to have adverse and long-term effects at extremely low concentrations. These toxic substances may be either synthetic or naturally occurring, may persist in the environment for long periods of time or dissipate quickly, and may have a variety of different effects on public health and aquatic life. Examples of toxic pollutants include heavy metals, pesticides, and PCBs.

Our knowledge of the health effects of many toxic pollutants in water and fish tissue is still limited. We know that some are linked to human health problems such as cancer, kidney ailments, and birth defects. Some chronic health effects may result only after long-term exposure; others may develop years after a short period of exposure. Exposure routes from the aquatic environment to humans may include drinking water; contaminated fish, shellfish, and waterfowl; and contact recreation sites such as swimming beaches.

In addition to public health problems, toxic pollutants can damage aquatic ecosystems by eliminating sensitive species or causing disease in the species that remain. Some toxins may

persist in the environment for decades, posing a continuing threat to humans, aquatic organisms, birds, and other wildlife. This is clearly the case with pesticides such as DDT and dieldrin, which have been removed from use for a number of years yet continue to be found in the environment.

To a large extent, our understanding of the prevalence of toxic substances, exposure routes, and levels of concern is limited by the difficulty and expense of monitoring and conducting long-term health effect studies. The Federal government has developed 62 numeric human health criteria and 25 aquatic life criteria for toxic pollutants against which sampled concentrations can be measured. Many more toxic substances affect the aquatic environment, and State adoption of existing criteria is not universal. Therefore, the following discussion of toxic contamination is only in terms of "elevated" levels reported by the States. These elevated levels are defined as exceedances of State water quality standards; criteria developed by EPA under Section 304(a) of the Clean Water Act; Water Quality Advisories developed by EPA; or "levels of State concern" where numeric criteria do not exist.

Total Size of Waters Affected by Toxics

Reporting on the extent of toxic contamination of waters was more comprehensive in the 1988 State Section 305(b) reports than in previous years. Table 6-1 summarizes this reporting by State, for all waterbody types.

These numbers reflect substantial increases compared to data for previous years on waters affected by toxic pollutants. This increase most likely occurred because a greater number of States provided information in 1988. Increased monitoring activity may also have led to the detection of more problems. Table 6-1 illustrates the following:

- **Rivers and streams:** 28 States reported that they monitored for toxic substances in about 67,500 river miles and found roughly one-third of these waters to be affected. An additional seven States did not provide data on the number of river miles they monitored for toxic pollutants, but reported that an additional 17,085 stream miles are affected by elevated levels.

Some toxins are persistent in the environment.

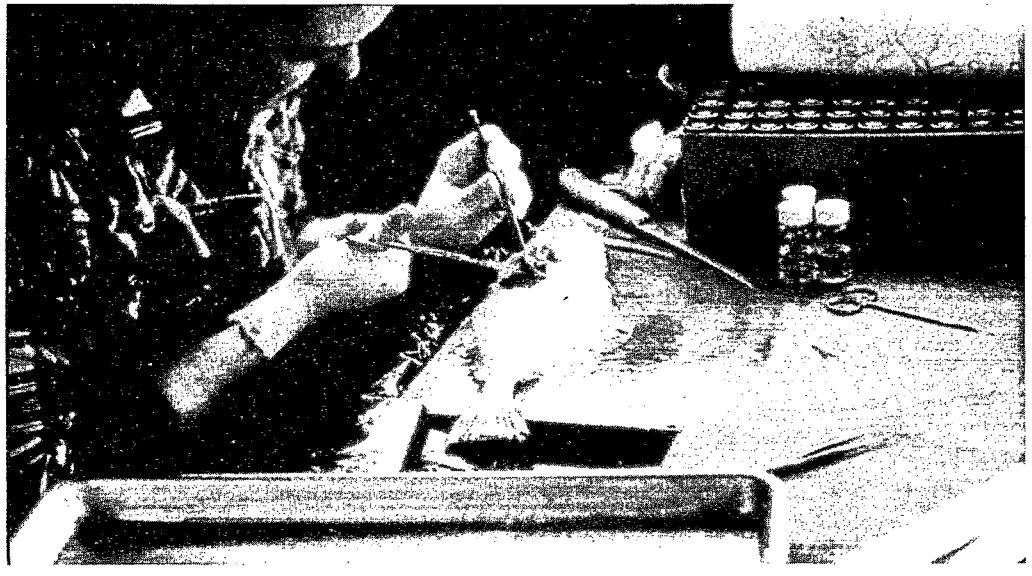
■ **Lakes and reservoirs:** 23 States reported that they monitored for toxic pollutants in about 4,981,600 acres of lakes and found roughly one-third to be affected. An additional five States did not report on the number of lake acres they monitored for these substances, but reported that about 56,200 lake acres are affected by elevated levels of toxic pollutants.

■ **Estuaries:** 13 States reported that 5,980 square miles of their estuaries were monitored for toxic substances, and about a fourth were found to be affected by elevated levels.

■ **Coastal waters:** Four States reported that they monitored 560 coastal shoreline miles and found about a third to be affected by elevated levels of toxic substances.

■ **Great Lakes:** Four States reported that 955 of their Great Lakes shoreline miles were monitored for toxic pollutants, and about 90 percent were found to be affected. One additional State did not report on shoreline miles monitored for toxic pollutants, but reported that about 199 shoreline miles are affected.

In some cases the percentage of monitored waters found to have elevated levels of toxic substances appears high. However, because monitoring for toxic substances is an expensive, resource-intensive process, States are most likely to monitor primarily in those waters suspected or known to have toxic problems (e.g., waters with multiple industrial dischargers or waters with known sediment contamination problems). EPA and the States have gained considerable experience over the last decade in monitoring for toxic substances and in targeting monitoring to areas most likely to be contaminated. Because we cannot always predict where contamination is likely to occur, monitoring for toxic compounds must also be conducted in previously unmonitored waters. Nevertheless, based on the results presented by the States, it appears that we are making progress in identifying these sites.



Puget Sound Water Quality Authority

Examining English sole for evidence of tumors.

Table 6-1. Size of Surface Waters Affected by Toxic Substances

State	Rivers (miles)			Lakes (acres)		
	Total Waters	Monitored for Toxics	Elevated Toxics	Total Waters	Monitored for Toxics	Elevated Toxics
Alabama	40,600	619	110	504,336	202,680	86,080
Arizona	6,671	1,451	906	—	—	—
Arkansas	11,508	2,873	74	—	—	—
Colorado	14,100	4,600	1,294	265,982	10,093	0
Delaware River Basin	291*	155	45	—	—	—
District of Columbia	36	26	26	377	136	136
Florida	12,659	2,695	510	2,085,120	546,560	50,560
Georgia	20,000	1,119	10	417,730	39,878	0
Hawaii	349	—	—	—	—	—
Idaho	16,146	—	1,468	727,202	—	32,000
Illinois	14,080	5,425	1,834	305,847	—	13,381
Indiana	90,000	2,306	922	104,540	54,686	1,106
Iowa	18,300	2,624	2,097	81,400	20,700	0
Kansas	19,791	2,697	556	175,189	92,098	0
Kentucky	18,465	—	1,084	228,385	—	—
Louisiana	14,180	—	116	713,719	—	1,170
Maine	31,672	865	435	994,560	38,106	400
Massachusetts	10,704	999	264	—	—	—
Minnesota	91,944	1,855	1,599	3,411,200	1,367,131	1,245,929
Mississippi	15,623	1,075	271	500,000	45,578	0
Missouri	19,630	3,650	458	288,012	—	561
Montana	20,532	—	890	756,450	—	9,100
New York	70,000	3,400	345	750,000	668,000	130,946
North Carolina	37,378	—	382	305,367	282,909	9,688
North Dakota	11,284	6,829	560	625,503	399,381	0
Ohio	43,917	—	1,637	117,323	91,226	29,729
Oklahoma	19,791	4,997	4,608	—	—	—
Pennsylvania	50,000	—	1,508	—	—	—
Puerto Rico	5,373	1,710	1,505	11,146	2,982	981
Rhode Island	724	80	59	16,520	4,968	0
South Carolina	9,900	2,518	180	525,000	354,114	8,560
South Dakota	9,937	3,080	163	1,598,285	548,000	0
Virginia	27,240	3,535	296	161,562	57,992	0
Washington	40,492	1,189	846	613,582	134,834	134,822
West Virginia	28,361	4,574	3,795	19,171	13,465	4,655
Wyoming	19,437	544	7	427,219	6,098	0
Totals	861,115	67,490	30,860	16,730,727	4,981,615	1,759,804

*Includes 85 miles of Delaware estuary.

— Not reported.

Source: 1988 State Section 305(b) reports.

Estuaries (sq. miles)			Oceans (coastal miles)			Great Lakes (shore miles)		
Total Waters	Monitored for Toxics	Elevated Toxics	Total Waters	Monitored for Toxics	Elevated Toxics	Total Waters	Monitored for Toxics	Elevated Toxics
625	35	0	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
782	—	—	—	—	—	—	—	—
6	6	6	—	—	—	—	—	—
4,298	1,648	938	8,460	262	85	—	—	—
594	44	0	—	—	—	—	—	—
134	34	0	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	63	63	63
—	—	—	—	—	—	43	43	43
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
7,656	—	—	—	—	—	—	—	—
1,633	10	10	—	—	—	—	—	—
171	39	16	—	—	—	—	—	—
—	—	—	—	—	—	272	272	272
133	7	0	81	40	0	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1,564	1,564	154	130	130	70	577	577	492
3,200	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	236	—	199
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	434	127	35	—	—	—
192	100	17	—	—	—	—	—	—
2,155	319	2	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
2,382	1,800	18	—	—	—	—	—	—
2,943	370	214	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
28,468	5,976	1,375	9,105	559	190	1,191	955	1,069

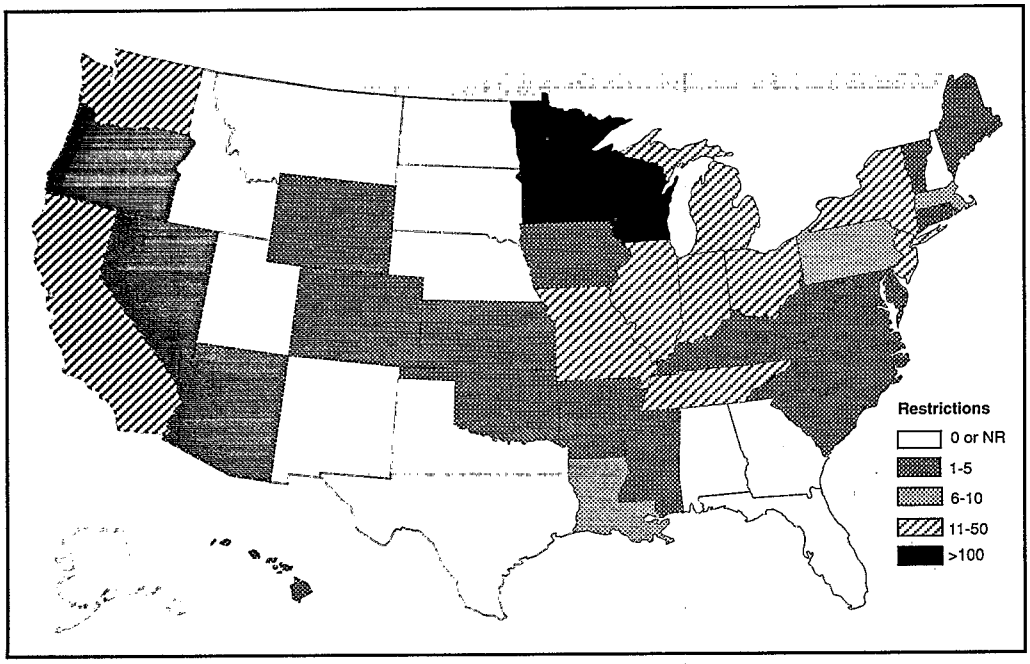
Fish Consumption Advisories and Bans

Toxic chemicals discharged to rivers, lakes, and estuaries may be absorbed or ingested by aquatic organisms that are, in turn, consumed by larger predators such as fish. Toxic pollutants can collect (bioaccumulate) in the tissues and organs of these fish, which poses a potential health hazard to people who eat them. Various methodologies (e.g., FDA "action levels, "Water Quality Criteria, or levels of State concern) have been used by the States or local authorities to impose fish consumption restrictions. To determine whether the levels of fish tissue contamination could be harmful to the public, some States have considered local factors such as consumption rates for general consumers, sportsmen, or subsistence fishermen; type of fish consumed; and duration of exposure.

In 1988, 29 States reported finding concentrations of toxic contaminants in fish tissue exceeding FDA action levels or other levels of concern in localized areas. Many States respond to the finding of elevated levels of toxic substances by imposing fishing bans or fish consumption advisories. Advisories typically recommend limiting consumption of certain species of fish from given waterways to a few meals per week or month and differentiate between general consumers and those who are more sensitive (e.g., children and women of childbearing age). Fishing bans generally prohibit consumption of one or more species of fish and apply to all potential consumers.

National statistics on fishing restrictions are incomplete. Many States rely on local authorities to impose these restrictions, and therefore do not keep statewide tallies of their numbers, locations, and the species of fish affected. However, as water quality reporting improves, we are gathering more information on this topic.

In their 1988 State Section 305(b) reports, 47 States, jurisdictions, and Interstate Commissions (hereafter referred to as States) provided information on fishing advisories and bans in their waters. Of these, eight States reported that no fishing restrictions were in place in their waters. Table 6-2 summarizes this information by State. Figure 6-1 illustrates the national distribution of fishing advisories and bans combined. Thirty-nine



Source: 1988 State Section 305(b) reports

Figure 6-1. Fishing Restrictions Nationwide

Table 6-2. Fishing Restrictions Reported by the States

	No. of Restrictions		Area Affected			
	Advi-sories	Bans	River Miles	Lake Acres	Estuary Sq. Mi.	Great Lakes Shore Miles
Arizona	2	0	—	—	—	—
Arkansas	0	1	—	—	—	—
California	8	12	92	292,867	3	—
Colorado	5	0	—	—	—	—
Connecticut	3	0	65	—	225	—
Delaware	2	0	—	—	—	—
Delaware River Basin	4	0	—	—	—	—
District of Columbia	0	0	—	—	—	—
Florida	0	0	—	—	—	—
Hawaii	2	0	—	—	—	—
Illinois	8	4	534	990,021	—	—
Indiana	10	12	585	—	—	43
Iowa	1	0	—	—	—	—
Kansas	3	1	44	—	—	—
Kentucky	1	1	112	—	—	—
Louisiana	6	0	25	1,066	—	—
Maine	1	4	128	1,976	—	—
Maryland	3	1	—	—	—	—
Massachusetts	7	1	—	—	—	—
Michigan	38	3	383	24,128	—	3,288
Minnesota	235	50	1,599	1,245,929	—	272
Mississippi	0	1	12	—	—	—
Missouri	15	0	833	700	—	—
Montana	1	0	—	—	—	—
Nevada	1	0	—	—	—	—
New Hampshire	0	0	—	—	—	—
New Jersey	6	7	—	—	72	—
New Mexico	0	0	—	—	—	—
New York	16	24	—	—	—	—
North Carolina	1	0	—	1,900	—	—
North Dakota	0	0	—	—	—	—
Ohio	5	6	160	—	—	—
Ohio River Valley	1	0	40	—	—	—
Oklahoma	2	0	—	—	—	—
Oregon	1	0	—	1,139	—	—
Pennsylvania	6	2	—	—	—	—
Rhode Island	1	1	—	—	—	—
South Carolina	2	0	—	—	—	—
South Dakota	0	0	—	—	—	—
Tennessee	13	0	204	—	—	—
Vermont	1	1	0	174,175	—	—
Virgin Islands	0	0	—	—	—	—
Virginia	2	1	296	—	—	—
Washington	12	0	19	—	34	—
West Virginia	1	0	48	—	—	—
Wisconsin	160	1	304	102,083	—	495
Wyoming	0	1	4	0	—	—
Totals	586	135	5,487	2,835,984	334	4,098

— Not reported.

Source: 1988 State Section 305(b) reports.

States reported a total of 586 advisories, and 21 States reported 135 bans. The pollutants most commonly identified as causing advisories or bans include PCBs, chlordane, mercury, dioxin, and DDT. Table 6-3 indicates how many States cited particular pollutants as causing fishing restrictions.

General categories of sources contributing these contaminants include industrial discharges; land disposal (hazardous waste sites and landfills); nonpoint sources such as spills, in-place contaminants, and atmospheric deposition; and agricultural activities. Table 6-4 depicts the number of States attributing fishing restrictions to these sources.

In addition to reporting on the number, causes, and sources of restrictions, States were asked to report on the area affected by fishing advisories and bans. Twenty-one States reported that 4,487 stream miles were affected, 4 States reported that 334 estuarine square miles were affected, and 12 States reported that 2,835,984 lake acres were affected (including 976,640 acres of Lake Michigan, reported by Illinois). Four States reported that 4,098 Great Lakes shoreline miles were affected by fishing restrictions.

These numbers summarizing fishing advisories and bans should be interpreted with caution and should not be compared with the findings of previous State Section 305(b) reports until standardized and complete reporting is in effect. Bans and advisories, once imposed, tend to remain in place for a number of years because of the persistence of many of the chemicals involved. Thus, a large apparent change in the number of bans and advisories reported by the States over a 2-year period is more probably the result of increasingly comprehensive reporting and monitoring rather than actual water

Table 6-3. Pollutants Associated with Fishing Restrictions

Pollutant	Number of States Reporting
PCBs	22
Chlordane	17
Mercury	15
Dioxin	9
Other Metals	9
DDT	7
Organics (unspecified)	5
Dieldrin	4
Pesticides (unspecified)	4

Source: 1988 State Section 305(b) reports.

Table 6-4. Sources Associated with Fishing Restrictions

Source	Number of States Reporting
Industry	14
Land Disposal	8
Other Nonpoint Sources	8
Agriculture	7
Urban Runoff	6
Resource Extraction	5
Municipal Facilities	3
Natural Sources	3

Source: 1988 State Section 305(b) reports.

quality changes. In addition, for any given waterway a combination of advisories and bans may be imposed for different fish species or may apply differently to different segments of the waterway or to different people (e.g., children or women of child-bearing age). Last, a great deal of variability is evident between States in the criteria used to impose fishing restrictions and the programs in place to monitor, analyze, and report fish tissue data.

Therefore, the high numbers of restrictions reported by some States are more likely attributable to the criteria and procedures used in deciding on restrictions and to sophisticated, well-established fish tissue monitoring programs in those States, rather than to unusually degraded water quality conditions. By the same token, States with no data or with only a few fishing restrictions may not have extensive monitoring programs to detect fish tissue contamination.

The following examples cited by the States in 1988 help illustrate the variety of pollutants and sources responsible for fish tissue contamination and subsequent fish consumption restrictions.

■ In Arizona in 1986-1987, intensive pesticide analyses of fish and other tissues were conducted in the vicinity of the Gila River below metropolitan Phoenix. Findings of toxaphene and metabolites of DDT in fish tissue and sediment samples at Painted Rock Borrow Pit Lake and the Gila River upstream have resulted in a continuing health advisory against consuming fish caught there.

■ As a result of a special study of a number of urban drainage areas in Maryland, the State has issued advisories against consumption of channel catfish, carp, black crappie, and American eels taken from Back River, Baltimore Harbor, and Lake Roland (Jones Falls watershed). The warning, issued in 1986, was imposed because of chlordane contamination. Other finfish, oysters, and crabs were not found to be affected, and no other toxic compounds were identified as problems.

■ Maine reports that a health advisory was issued in May of 1985 recommending that consumption of fish caught from the Androscoggin River be limited to two or three times per month. The advisory was issued by the State after dioxin contamination was detected in a whole-fish sample collected by the U.S. EPA; dioxin levels in the fillet were determined to be below the FDA action level. Kraft-process pulp manufacturing was determined to be the source of the dioxin.

■ Nevada reports that an intensive study of mercury contamination in the Carson River, its sediments, and fish tissue led to the imposition of a health advisory in 1985. Sediment contamination was found throughout the lower Carson River system, from Dayton to the lower reaches, and in the canal networks of the Newlands irrigation project, Indian Lakes complex, and the Carson sink. The fish consumption advisory was revised in 1986 and remains in effect; the source of the mercury is believed to be mining operations conducted in the late 1800s.

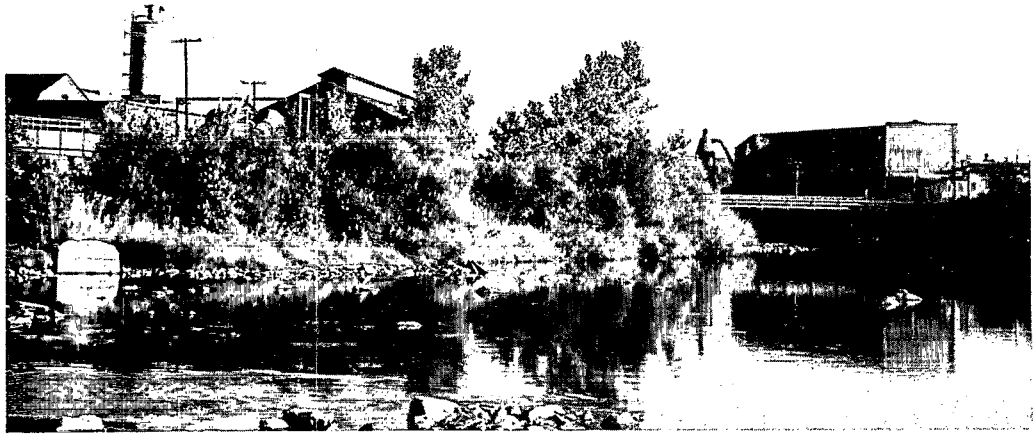
■ In July 1986, South Carolina issued a health advisory cautioning people not to eat fish taken from Langley Pond in Aiken County. Levels of mercury above the FDA action levels were found in fish tissue, and sediments were found to contain high levels of chromium, mercury, and PCBs. The sediment contamination is tied to discharges of partially treated or untreated wastewater, primarily from textile manufacturing facilities, discharged in the area since the late 1800s. Several former dischargers are under order to conduct a study to determine the sources, nature, and extent of contamination in Langley Pond.

■ In Vermont and New York, a fishing advisory for all of Lake Champlain (174,175 acres) went into effect in August 1987 because of elevated levels of PCBs found in lake trout. Individuals over 15 years old were advised to eat no more than one meal or 1/2 pound of lake trout per month. Children under 15, pregnant women, and women planning to bear children were advised to avoid consuming lake trout. The sources of the contamination may include a nearby Superfund site, urban runoff/combined sewer overflows in Burlington and other communities along the lake, and atmospheric deposition.

Sediment Contamination

Contamination of stream, lake, and estuarine sediments by toxic substances has been identified by some States as a growing concern. Although some contaminants are broken down by microbes in sediments, others can be retained for many years after a discharge has ceased, and serve as a continuing source of toxics to the water column and to aquatic organisms. Bottom-dwelling animals such as aquatic insects, for example, may take in sediment contaminants as part of their feeding activities and may themselves serve as food for animals higher in the food chain (including humans).

In addition to potential impacts on the water column and biota, sediment contamination can pose obstacles to the maintenance dredging of harbors and navigation channels. Disposal of dredge spoil can become a difficult issue if that spoil contains unacceptable levels of PCBs, mercury, dioxin, and similar chemicals. Methods of disposal such as open water dumping, confinement in diked containment areas, and spreading in coastal areas, wetlands, and "reclaimed lands" could clearly create new—and possibly more severe—environmental



J.L. Platkin

Contaminants in sediments can be retained for many years after a discharge has ceased.

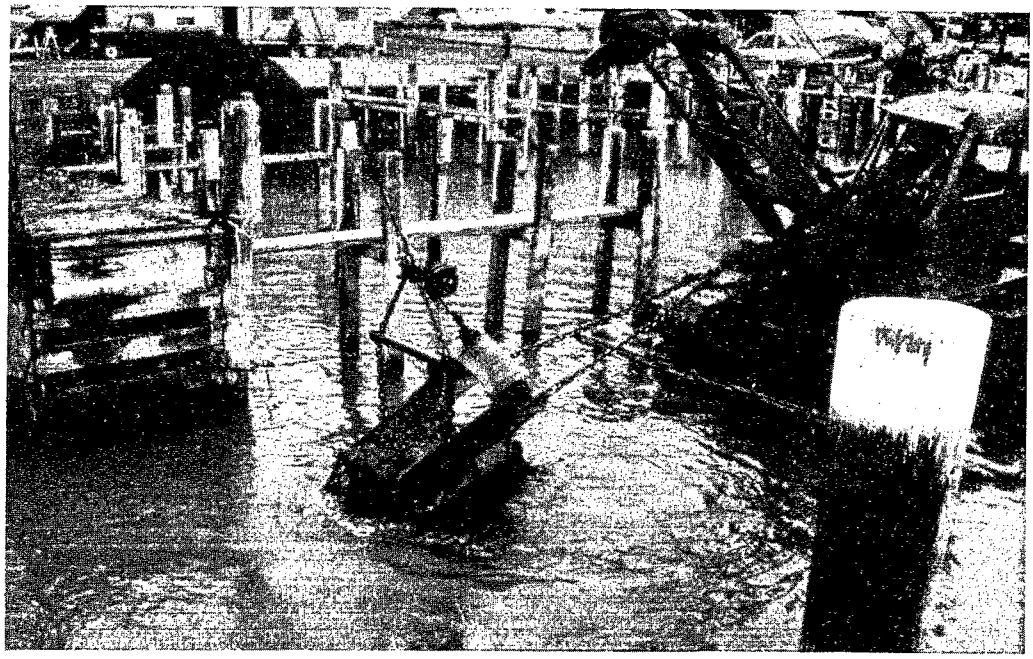
problems. Other impacts that may occur in certain cases when dredging takes place include resuspension of toxics into the water column, habitat alteration, and the smothering of bottom-dwelling aquatic organisms. Since it may be necessary to dredge harbors simply to keep them open for navigation purposes, the States face difficult decisions where sediment contamination is a concern.

Methods of analyzing sediments and interpreting analytical results are still in their infancy. EPA is in the process of issuing criteria for 12 contaminants in sediments and is beginning to document methodologies for assessing contamination. Many States, therefore, do not have the analytical tools and resources for sediment monitoring; others may not have reported on available data. Therefore, the following discussion of State-reported information on sediment contamination is limited and probably understates the extent of the problem. As methodologies develop and more emphasis is placed on reporting, the comprehensiveness of State data will doubtless improve.

Thirty-five States provided some information on sediment contamination in their waters. Thirty-four of these States indicated that instances of sediment contamination exist in their waters; one State reported no problems. A total of 533 separate instances of sediment contamination are reported by 30 of the 35 States. Eight States specify that about 2,700 stream miles are affected, and six States report that roughly a thousand acres of lakes show impacts from sediment contamination. Leading pollutants associated with sediment contamination include heavy metals (e.g., copper, mercury, lead, cadmium, chromium, and zinc); PCBs; pesticides such as DDT, chlordane, and dieldrin; and dioxin.

The following examples from the 1988 State Section 305(b) reports serve to illustrate the variety of pollutants and sources contributing to sediment contamination problems.

■ In Connecticut's urban harbors (such as portions of Stamford, Norwalk, Blackrock, New Haven and New London Harbors), historical wastewater discharges, runoff from urban areas, and other sources have resulted in the contamination of some



California Regional Water Quality Control Board

Sediment contamination can pose obstacles to the maintenance dredging of harbor and navigation channels.

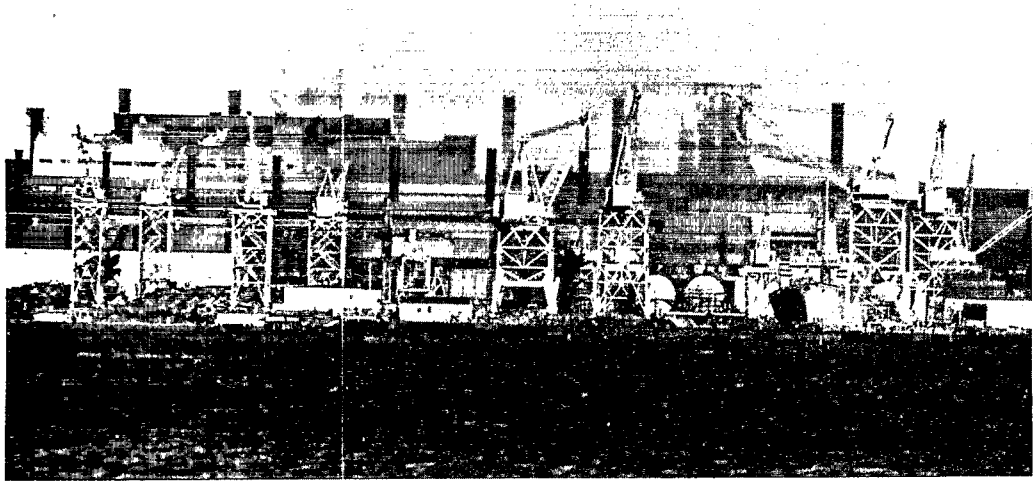
sediments with heavy metals, oil and grease, and other synthetic organics.

The State reports that dredging is routinely performed in coastal waters to maintain navigation channels and access to marinas. Dredge material disposal involves the use of four open water disposal sites in Long Island Sound. A dredged material management plan entitled "Interim Plan for the Disposal of Dredged Material from Long Island Sound" (1980), prepared by the former New England River Basins Commission, guides State and Federal decision-making on dredged-material disposal. This plan establishes three tiers of sediment quality and requires special management practices for the disposal of contaminated sediments.

■ In Illinois, sediment chemistry samples are collected through several programs such as intensive basin stream surveys and fixed station networks. Sediment chemistry results are compared to a classification system developed by the Illinois EPA. Among the findings reported in 1988 were elevated levels of heavy metals (such as arsenic, lead, and copper) and organics (such as chlordane and DDT) in some sediments in the Des Plaines river basin. The sources of the heavy metals are believed to be municipal dischargers and surface runoff; nonirrigated crop production and surface runoff were identified as the most significant sources of organics.

■ Louisiana reports on sediment contamination in Devil's Swamp Lake, northwest of Baton Rouge. In late 1985, PCBs were detected in sediment from the lake and an effluent channel flowing into the lake from a nearby active hazardous waste disposal facility. Followup sediment sampling in 1986 confirmed the presence of PCBs, and fish tissue analyses found elevated concentrations of two toxic hydrocarbons. A major portion of Devil's Swamp north of the lake had been previously identified as contaminated by an abandoned hazardous waste disposal facility. A cleanup plan has been established for the site, and a swimming and fish consumption advisory was issued for Devil's Swamp Lake.

■ Michigan reports that sediment contamination in the Detroit River is widespread, with higher concentrations on the U.S. side downstream of the Rouge River and in the Trenton Channel. These sediments may be a source of contaminants to Lake Erie through translocation; they may be



Chesapeake Bay Foundation

available to aquatic animals for bioaccumulation or may cause direct physiological effects through resuspension. However, the significance of these in-place pollutants to human health, to aquatic biological organisms, and as a source to Lake Erie is still unknown. A 1982 study by the Michigan Department of Natural Resources found 43 priority pollutants in the soft sediments of the Detroit River, including heavy metals, polynuclear aromatic hydrocarbons, and PCBs.

■ In North Dakota, approximately 30 acres of sediments in Nelson Lake have been affected by arsenic, zinc, and copper. The source of the contaminants is a nearby coal-fired power station.

■ Virginia reports that sediments in the Elizabeth River, a tidal tributary of the James River estuary, contain relatively high levels of over 300 toxic metals and organic compounds. Biological studies have shown that communities of bottom-dwelling organisms and fish are affected.

In 1983, the Chesapeake Bay Program identified the Elizabeth River system as one of the most highly polluted bodies of water in the entire Bay watershed. State and local officials recognized that a comprehensive water quality management plan was needed, including setting water quality goals and standards, controlling point and nonpoint sources of pollution, addressing toxics, and dredging.

Through the cooperative efforts of State and local officials, industry representatives, researchers, and environmental organizations, a *Comprehensive Elizabeth River Restoration Strategy* has been developed for implementation during 1988-1990.

New Initiatives

Efforts are under way at EPA to provide States with better tools to assess and control sediment contamination problems. EPA has established steering and technical Sediment Oversight Committees to identify, coordinate, and provide guidance on activities relating to the assessment and management of contaminated sediments, and to facilitate the decisionmaking process. Among the activities of these committees are to:

■ Develop a Program Summary Report identifying EPA sediment-related activities among different offices and under varying statutory authorities;

■ Develop a Sediment Classification Methods Compendium—an "encyclopedia" of the methods used to assess chemically contaminated sediments;

■ Revise the *Technical Support Document for Water Quality-Based Toxics Controls* to account for the effects of sediment on water quality;

■ Prepare Sediment Chemical Fact Sheets summarizing all known toxicity and regulatory data on 47 toxicants; and

■ Coordinate EPA-wide (and eventually interagency) contaminated sediment-related activities.

The Office of Water Regulations and Standards/ Criteria and Standards Division has developed interim sediment quality criteria for 12 nonionic organic contaminants using the Equilibrium Partitioning Approach. The method for generating interim sediment criteria is being reviewed by EPA's Science Advisory Board, and the results of this review are expected in August of 1989. A major effort is under way that focuses on the development of a method for generating sediment criteria for metal contaminants. Science Advisory Board review of this

method will also be sought.

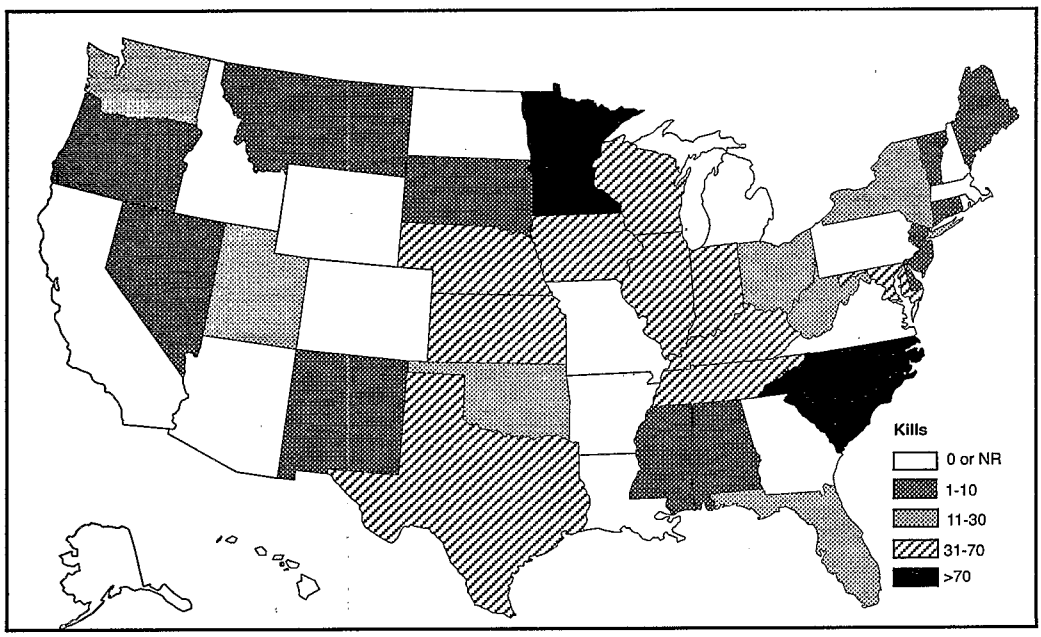
In addition to the development of sediment criteria, efforts are under way that focus on developing standard bioassays that can be used to assess chronic and bioaccumulation effects of contaminants in sediments.

Fish Kills Caused by Pollution

One obvious and important indicator of water quality problems is the occurrence of fish kills caused by pollution. Information on fish kills is not complete; the information presented below, reported by the States in 1988, most probably underestimates the extent of the problem for several reasons. In many cases it is the public—fishermen, campers, and hikers—who first notice fish kills and report them to fish and game wardens or other State officials. Many fish kills may go unnoticed or unreported; others may be difficult to investigate. (Dead fish may be carried quickly downstream, for example, or may be difficult to count because of turbid conditions.) Reporting on pollution-caused fish kills is new to the State Section 305(b) process, and a number of States either did not provide data, did not present a comprehensive tally of kills, or did not specify the cause and/or magnitude of kills. Available data reported by the States are presented in Table 6-5.

Table 6-5 shows that 37 States provided some information on the occurrence of pollution-caused fish kills during the 1986 to 1988 reporting period:

- Two of these States indicated that no pollution-caused kills occurred in their waters.
- Thirty-five States provided information on the number of kills, for a total of 996 incidents (see Figure 6-2).
- In the 24 States that indicated the number of fish killed, over 36 million fish were reported killed. Sixty-four percent of that total was in one State alone (Texas).
- Toxic substances such as heavy metals and pesticides appear to be a less common cause of fish kills than conventional pollutants such as biochemical oxygen-demanding substances. In those States that specified the distinction, nearly five times more kills were attrib-



Soure: 1988 State Section 306(b) reports.

Figure 6-2. Fish Kills Distribution Nationwide

Table 6-5. Fish Kills Caused by Pollution*

State	No. of Fish Kills	No. Fish Killed	Kills Caused by Toxics Pollutants		Kills Caused by Conventional Pollutants	
			No. Kills	No. Fish	No. Kills	No. Fish
Alabama	8	43,370	6	33,370	2	10,000
Connecticut	6	2,820	2	1,710	4	1,110
Delaware	1	124,588	—	—	1	124,588
District of Columbia	3	—	0	—	3	—
Florida	25	5,500,000	—	—	—	—
Hawaii	0	0	—	—	—	—
Illinois	49	561,049	—	—	—	—
Indiana	41	428,331	—	—	—	—
Iowa	45	286,601	10	119,324	35	167,277
Kansas	51	174,263	11	133,708	40	40,555
Kentucky	53	359,143	6	19,155	47	339,988
Maine	6	6,450	—	—	6	6,450
Maryland	40	—	8	—	32	—
Minnesota	80	112,419	11	5,663	69	106,756
Mississippi	6	70,400	4	69,500	2	900
Montana	9	3,000	9	3,000	—	—
Nebraska	52	—	—	—	—	—
Nevada	4	—	—	—	—	—
New Jersey	9	—	1	—	8	—
New Mexico	5	—	2	—	3	—
New York	24	21,980	13	12,530	11	9,450
North Carolina	88	4,052,000	4	1,200	84	4,050,800
North Dakota	0	0	—	—	—	—
Ohio	28	608,042	4	30,720	24	577,322
Oklahoma	16	74,160	1	2,000	15	72,160
Oregon	2	200	1	—	1	200
Puerto Rico	16	—	2	—	14	—
South Carolina	144	—	14	20,382	130	—
South Dakota	3	—	—	—	—	—
Tennessee	33	—	6	—	27	—
Texas	69	23,225,000	—	—	—	—
Utah	13	—	7	—	6	—
Vermont	1	—	1	—	—	—
Virgin Islands	2	—	—	—	2	—
Washington	13	—	—	—	—	—
West Virginia	17	52,322	6	24,739	11	27,583
Wisconsin	34	411,394	6	43,365	28	368,029
Totals	996	36,117,532	135	520,366	605	5,903,168

*During 1986-1988 reporting period only; excludes kills due to natural causes when a breakout was possible.

— Not reported.

Source: 1988 State Section 305(b) reports.

uted to conventional pollutants than to toxic substances.

■ Leading causes of fish kills include biochemical oxygen demand/low dissolved oxygen, oil and gas, pesticides, ammonia and chlorine, temperature changes, and herbicides (Table 6-6).

■ The most commonly reported sources of fish kills are agriculture (in particular, runoff from animal holding areas and feed lots and application of fertilizers and nutrients), spills, municipal sewage treatment plants, and industrial dischargers (Table 6-7).

Bathing Area Closures

Information reported by the States on the closure of bathing areas such as beaches and recreational lakes is extremely limited. As for other types of information in this section, beach closures are often the responsibility of State health agencies and local governments (i.e., cities and counties) that may not coordinate reporting with pollution control agencies preparing the State Section 305(b) reports. Thus, comprehensive tallies of bathing area closures are not yet available.

Thirty-one States provided some information on the closure of bathing areas. In 13 States, no closures were reported to have occurred; in the remaining 18 States, 224 beach closure incidents were reported. Most of these closures were probably of short-term duration and are attributed primarily to microbial pathogen indicators such as fecal coliform bacteria, which may indicate the presence of disease organisms from municipal sewage treatment plants, combined sewer overflows, urban runoff, and spills.

Table 6-6. Pollutants Associated with Fish Kills

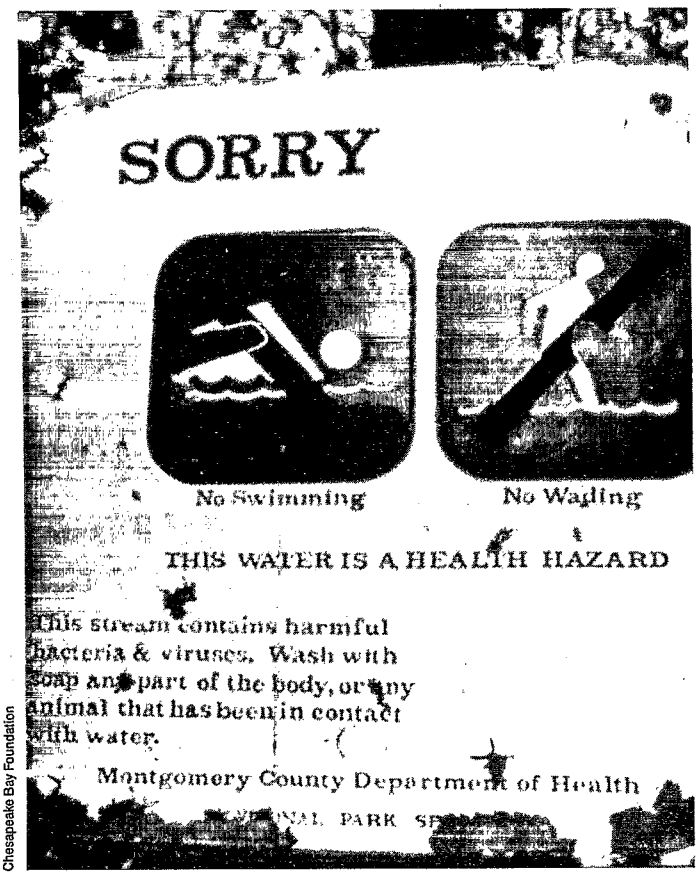
Pollutant	Number of States Reporting
BOD/DO	19
Oil and Gas	14
Pesticides	14
Ammonia	8
Chlorine	8
Temperature	8
Acidity	6
Inorganics	5
Nutrients	5

Source: 1988 State Section 305(b) reports.

Table 6-7. Sources Associated with Fish Kills

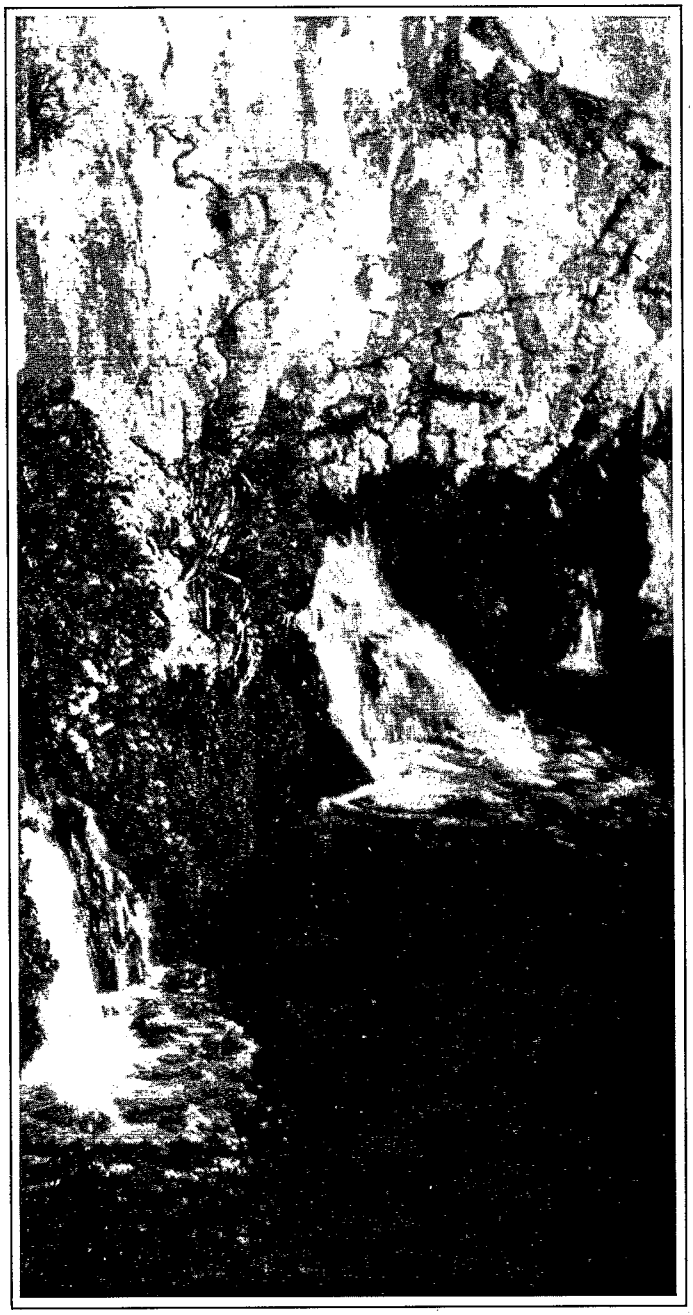
Source	Number of States Reporting
Agriculture	24
Spills	17
Municipal Facilities	16
Industry	13
Land Disposal	6
Urban Runoff	4

Source: 1988 State Section 305(b) reports.



Chesapeake Bay Foundation

Ground-Water Quality and Protection



Ron Hoffer

Introduction

Ground water is a vital natural resource that is withdrawn for drinking water, irrigation, industrial use, and livestock watering. In many parts of the United States, ground water is the only reliable source of water. Under certain geological conditions, ground water can also be quite vulnerable to contamination. An increasing number of pollution incidents affecting both public water supplies and private wells have been reported throughout the country. While in a majority of situations only low levels of contamination have been found, there are some localities that have experienced contamination above the drinking water standards. As a result of a growing awareness of the important nature of this resource and its vulnerability, many States and Territories are developing and expanding legislation, regulations, and programs to address ground water.

Ground-water protection is especially important because of the difficulty and expense involved in cleaning up contaminated aquifers, providing alternative water supplies, or adding treatment to public water systems. The States and Territories have identified a broad range of contaminants and contamination sources, such as underground storage tanks, septic systems, and landfills. Controlling these sources of contamination has become a central focus of State ground-water protection programs.

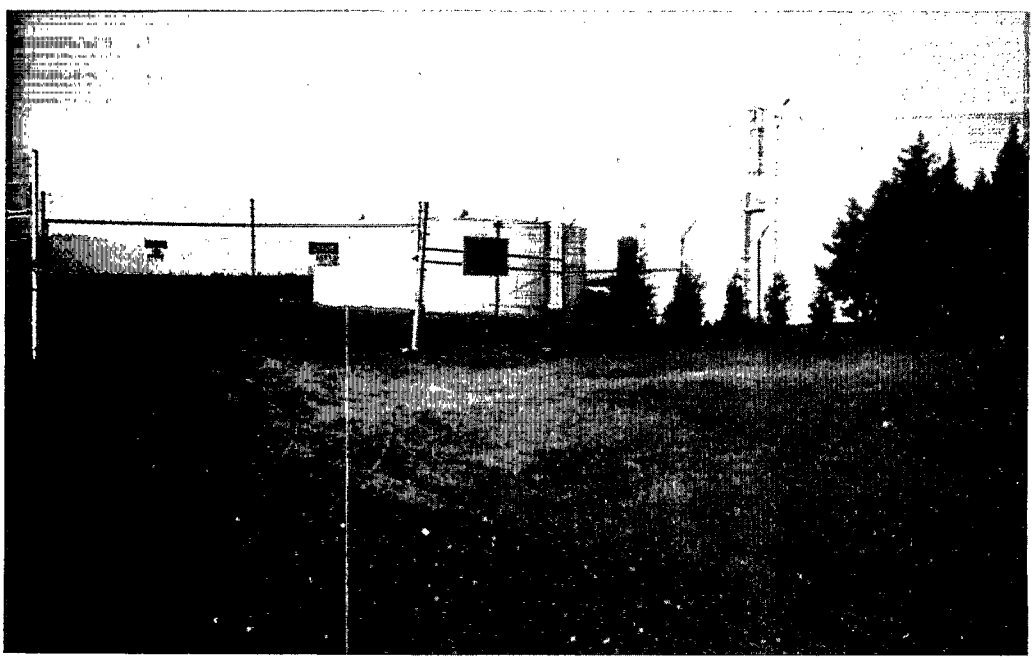
This section discusses many of these State and Territorial programs (e.g., ground-water protection strategies, Wellhead Protection Programs, and aquifer classification and mapping projects) and the contaminants and sources of contamination addressed by

these activities. In addition, Federal activities to protect ground water are described in this section. However, this section is not intended to provide a summary of all State and Territorial ground water-related activity. Instead, it describes only certain State and Territorial programs in order to illustrate the scope of ongoing activities. The absence of a State description under one or more of the section headings does not indicate that a particular State program does not exist.

The Agency collected the information reported in this section primarily from 1988 State Section 305(b) reports. Under Section 106 of the Clean Water Act, the Federal government has provided grant money to the States to develop their water quality programs. The States have, in turn, been required to submit data and information describing their State programs under the Section 305(b) reporting process. EPA requested that each State and Territory provide information concerning its ground-water protection program, the sources of ground-water contamination identified in the State, and the contaminants observed in the State's ground water. This chapter summarizes the data provided by 52 States and Territories and the District of Columbia; information was not available for two States and one Territory.

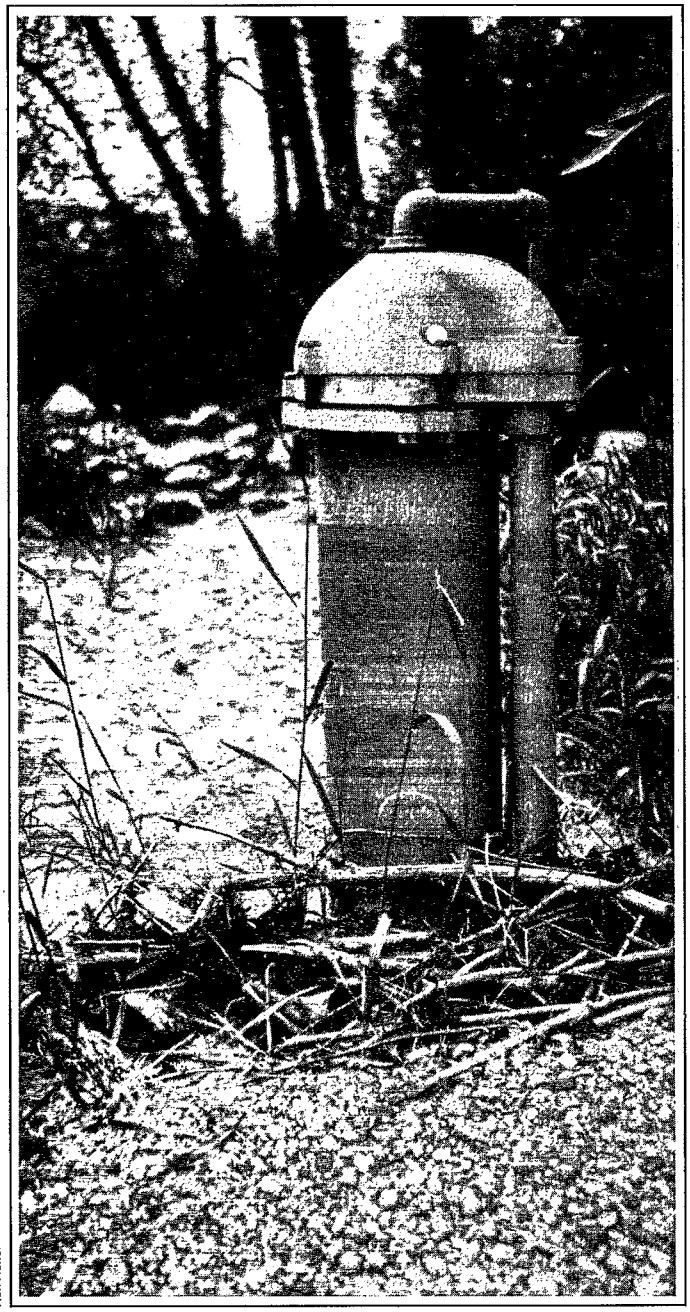
In addition to the data from the State Section 305(b) reports, this section reports supplemental ground-water use data from the U.S. Geological Survey's 1984 and 1986 National Water Summaries and Open File Report 88-112. Reports prepared by the U.S. EPA Office of Ground-Water Protection were also used in the development of this section.

This section summarizes the following information: ground-water withdrawals and use, ground-water quality, State ground-water legislation and programs, and Federal statutes and programs to protect ground water.



California Regional Water Quality Control Board

7



Ron Hofler

Ground-Water Quality

Current Ground-Water Use

Just over 50 percent of the Nation's population relies on ground water as a source of drinking water (U.S. Geological Survey, 1986 National Water Summary). Figure 7-1 depicts the distribution of population served by ground water for domestic supply in the U.S. The importance of good-quality ground water as a drinking water source is illustrated by the heavy reliance on ground water in all regions of the country. In 12 States and Territories (hereafter referred to as States), ground water supplies drinking water for greater than 75 percent of the population. The vast majority of the Nation's rural population relies on potable ground-water sources to provide water for domestic use. Only five States rely on ground water to provide domestic supply for less than 25 percent of their population.

In many parts of the country, ground water is also relied upon as a water source for uses other than domestic supply: 68 percent of all ground-water withdrawals in the U.S. are used for irrigation; 13 percent are consumed by industry; and a small percentage (less than 2 percent) of withdrawals are used for watering livestock. In the East and South, ground-water withdrawals are largely used for industrial and domestic purposes. In the West, most ground water is withdrawn for irrigation.

In 1985, ground-water withdrawals in the U.S. totaled approximately 76 billion gallons per day. As shown in Figure 7-2, these withdrawals are concentrated in a limited number of States. California and Texas both withdraw greater than

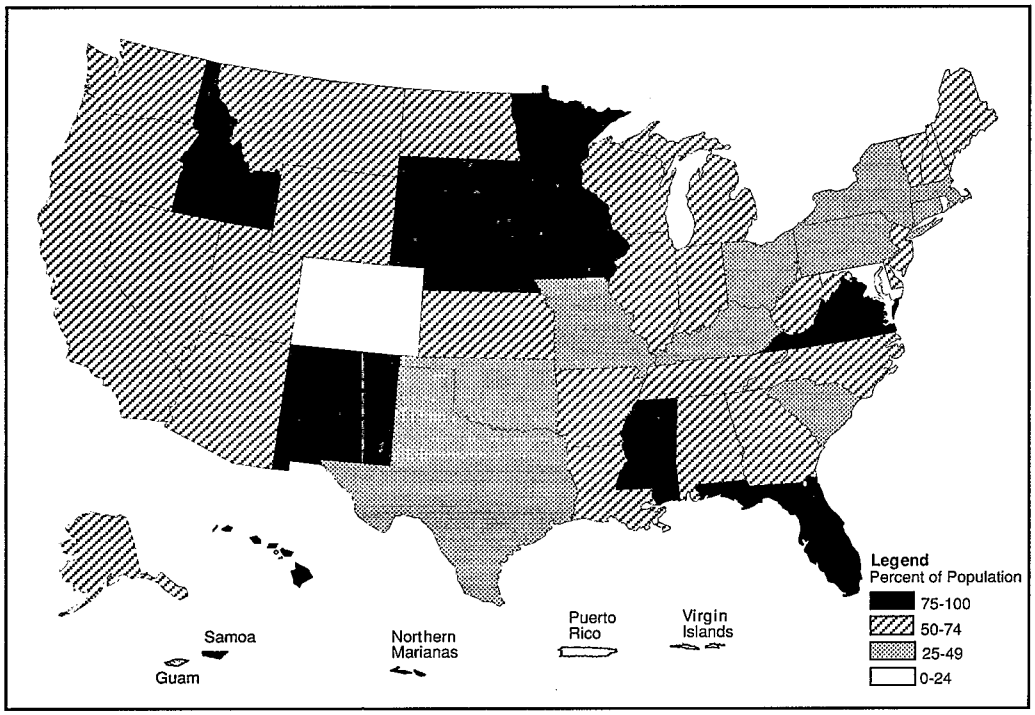
10 billion gallons per day and together account for approximately one-third of the Nation's total withdrawals. Five other States—Arizona, Arkansas, Idaho, Kansas, and Nebraska—each withdraw more than 4 billion gallons of ground water per day. These seven States use ground water primarily for irrigation and are responsible for two-thirds of the Nation's ground-water withdrawals.

The national use of ground water has grown significantly over the last 40 years. Figure 7-3 illustrates the trend in ground-water withdrawals from 33 billion gallons per day in 1950, to a high of 82 billion gallons per day in 1980, and to approximately 76 billion gallons per day in 1985.

Ground-Water Quality

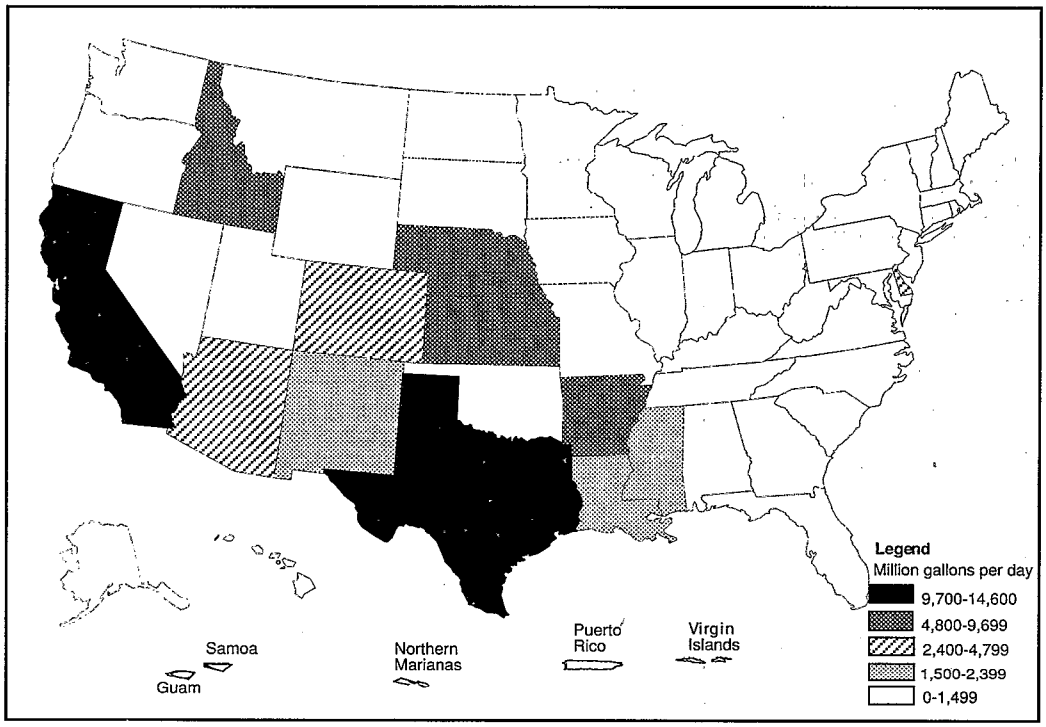
The States are demonstrating a growing awareness and interest in ground-water quality. Nine States reported that their ground-water quality is excellent, and 17 States reported generally good quality. The remaining States did not express a judgment. The 1988 State Section 305(b) reports indicate that, overall, the quality of the Nation's ground water is quite good, based on the testing that has been done to date. Human activity may occur in zones where ground water is withdrawn for public water supply; under certain geological conditions, these wells can be vulnerable to contamination. At issue is keeping ground-water quality high so that costly remedial actions are not required.

In an effort to protect and maintain their resources, many States are engaging in studies to better understand the quality of their ground water, identify potential sources of contamination, and determine the vulnerability of the resource to pollution. This section describes a number of these State studies and concludes with a discussion of the contamination sources and ground-water contaminants reported by the States.



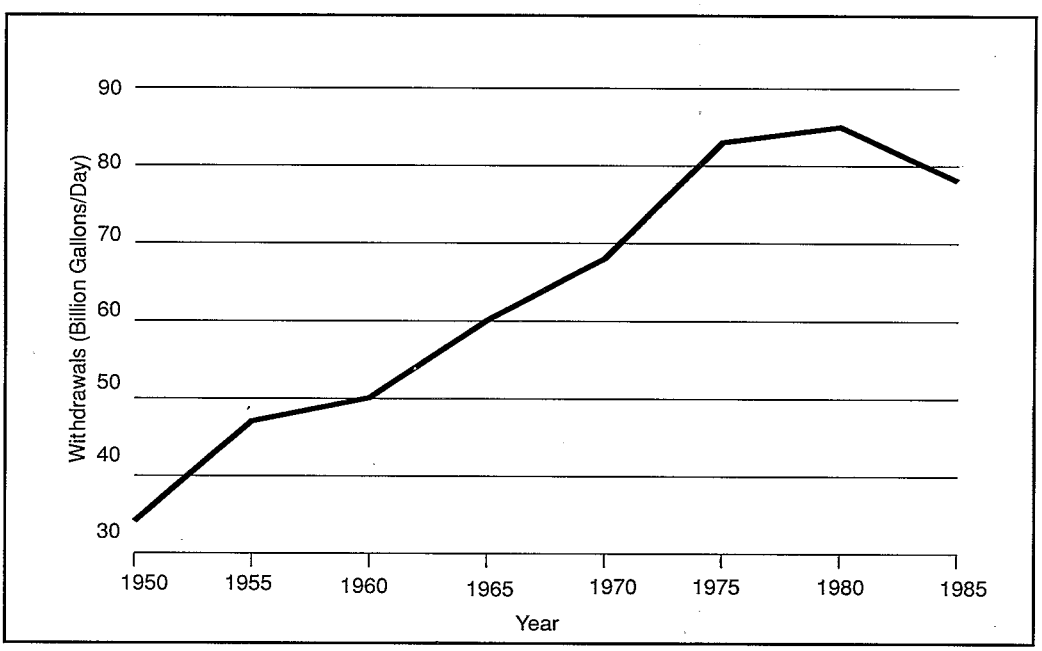
Source: 1988 State 305(B) Water Quality Reports or 1986 USGS National Water Summary

Figure 7-1. Percentage of State and Territory Populations Served by Ground Water for Domestic Supply



Source: 1988 State 305(b) Water Quality Reports or 1986 USGS National Water Summary.

Figure 7-2. National Breakdown of Ground-Water Withdrawals



Source: U.S. Geological Survey Open-File Report 88-112.

Figure 7-3. National Use of Ground Water 1950-1985

Ground-Water Studies

Over 30 States reported conducting broad-ranging ground-water quality studies, with an average of 1 to 3 studies by each State. A few States have also begun studying more innovative approaches to ground-water protection (e.g., aquifer vulnerability and land use studies).

The most common types of assessments reported by the States were ground-water quality studies. At least 10 States conducted both statewide studies and more localized or regional studies; another 10 States conducted broad statewide sampling studies alone, and the remaining 10 States conducted only localized studies in response to anticipated contamination problems. The majority of these studies involved monitoring programs aimed at evaluating the impact of a specific contaminant (e.g., nitrate) or a contaminant source (e.g., septic tanks).

Statewide surveys are becoming more common as many States are seeking to track their ambient ground-water quality. The Texas Water Development Board maintains a 5,800-well ground-water quality monitoring network and analyzes water quality samples from approximately 1,200 of those wells annually. Data from these surveys will be maintained in the Texas Natural Resource Information System. New Jersey will sample 25 to 30 wells in 1988 in its ambient ground-water

quality network. New Jersey will also intensively study 40 to 45 additional wells in the northern portion of the State. Florida is tracking ambient ground-water quality in a statewide monitoring program.

A number of the States conducting ground-water quality studies have established or are beginning to establish data bases to catalog ground-water data and known or suspected contamination incidents throughout the State. For example, Indiana has created a data base to track known incidents of ground-water contamination. This data base currently contains 228 case histories of ground-water contamination. Of the 228 cases, 16 percent involved public water systems. Florida is developing a data base to manipulate the data from its State ground-water quality monitoring program. New Mexico has started work on a ground-water/vadose zone contamination inventory. Presently, there are over 850 identified ground-water contamination incidents in New Mexico, involving over 1,000 documented wells. The inventory will include a narrative abstract of each situation and will have many variables available for cross-referencing, including location, depth to ground water, aquifer, contaminants, contaminant concentrations, and monitoring dates. Virginia also maintains a data base to track ground-water pollution complaint investigations. The Virginia data base incorporated 301 new event reports during the 1988 reporting period.

In many States, the focus of concern for ground-water studies is on regional problems. In 1987, Kentucky undertook studies of domestic well water quality in eight counties. Well water was analyzed for 81 constituents including bacteria, pesticides, primary and secondary drinking water constituents, and priority pollutants. The studies indicated isolated incidents of contamination, specifically high fecal coliform bacteria levels.

States have also reported agricultural activities as a regional source of concern, and many studies have been initiated to investigate this problem. For example, during 1986 and 1987, Kansas completed two phases of a three-phase Farmstead Well Contamination Study. The study estimated the number of farmstead wells in Kansas contaminated by volatile organic compounds (VOCs), inorganic compounds, or pesticides and helped identify the factors contributing to such contamination. The information gathered in Phases I and II will be used in the third phase to develop an educational program. The program will address ground-water contamination and its relationship to agricultural practices, farmstead activities, well construction, and well siting.

Minnesota recently conducted a ground-water survey designed to determine the extent of the problems caused by "normal" use of pesticides in pesticide-sensitive areas (i.e., pesticide use not associated with spills, leaks, or mishandling). The study was a cooperative effort by the Departments of Agriculture and Health. The Department of Agriculture sampled ground water by using shallow observation wells placed at the edge of agricultural fields. The Department of Health focused on sampling public and private drinking water supplies in rural areas. Of the 500 water well and drinking water samples collected, 38 percent had detectable levels of one or more pesticides. The State did not report the number of these samples that exceeded drinking water standards.

Connecticut recently sponsored investigations of pesticides in groundwater and detected concentrations of 1,2-dichloroethylene, atrazine, and metalochlor at several sites above State drinking water standards and EPA advisory levels.

Salt-water intrusion has also become a local ground-water quality problem in

many areas. The U.S. Geological Survey has established a sampling network of 240 wells in New Jersey specifically to track saltwater encroachment. Delaware and Maryland are conducting a joint study on the prevention of saltwater intrusion in their States. Virginia has also begun a saltwater intrusion study program.

Other States assessed ground-water quality, either regional or statewide, by focusing on specific contaminants. During the past 2 years, North Dakota has performed a nitrate screen on over 4,000 private well samples. Nitrate-nitrogen in excess of 2 mg/l was found in 23 percent of the samples, and 11 percent of the samples exceeded the drinking water standard of 10 mg/l.

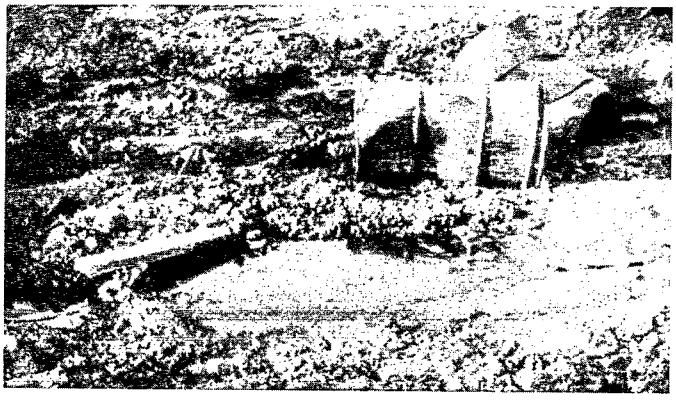
A few States combined ground-water quality studies with contamination source investigations. As part of the U.S. EPA-funded 205(j) program, Arizona examined the VOC content in ground water surrounding the City of Mesa. Water samples were collected from 47 wells, and 4 VOCs (trichloroethylene, perchloroethylene, dichloroethene, and Freon-113) were found to exceed Arizona Department of Health Services action levels. The largest area of detectable VOC in ground water was near a municipal landfill.

In some instances, States examined specific sources of contamination. Rhode Island and Colorado conducted studies of the impact of surface impoundments on ground-water quality. Washington investigated the effect of 45 existing on-site sewage systems on ground water and completed a study of agricultural chemicals in ground water in 3 counties. The agricultural chemicals survey sampled 81 wells in the 3 counties and found detectable levels of sampled pesticides in 23 of the wells and nitrate levels above health standards in 18 wells. Washington did not report whether the detected pesticides exceeded health standards.

A few States have developed studies to assist in broadening the scope of ground-water protection in their States. Studies include assessments of current regulatory programs and, in some cases, development of new approaches to ground-water protection regulation. The New Mexico Environmental Improvement Division conducted a study to determine the quantitative contribution of major chemical and biological contaminants from domestic septic tanks to ground water. The study evaluated the adequacy of the State liquid waste regulations regarding lot size and disposal-field clearance in preventing both short- and long-term degradation of ground-water quality. Iowa is also investigating the use of protection standards in its ground-water regulatory program and the impact of ground-water contamination on human health in the State.

Other unique activities are being developed by the States to support their ground-water programs. North Carolina developed a computer-based Ground Water Advisory system to assist the permitting staff in evaluating the potential impact of waste disposal activities on ground-water quality. Minnesota has initiated a project to assess the relative susceptibility of ground water to contamination in the State. Data from digitized base maps is being combined and ranked to highlight those areas of the State most vulnerable to contamination from land surface and near-surface activities. This program will assist in setting priorities for Minnesota programs and raising public awareness of the vulnerability of ground water in the State.

In addition to those studies described above, the States also require routine monitoring of certain water wells to assess ground-water quality (e.g., monitoring public water supplies, testing individual domestic wells, and monitoring at waste disposal unit boundaries). All of these State studies are geared toward understanding or controlling the contamination sources and contaminants described below.



NC Solid Waste Management Division

Overview of Contamination Sources

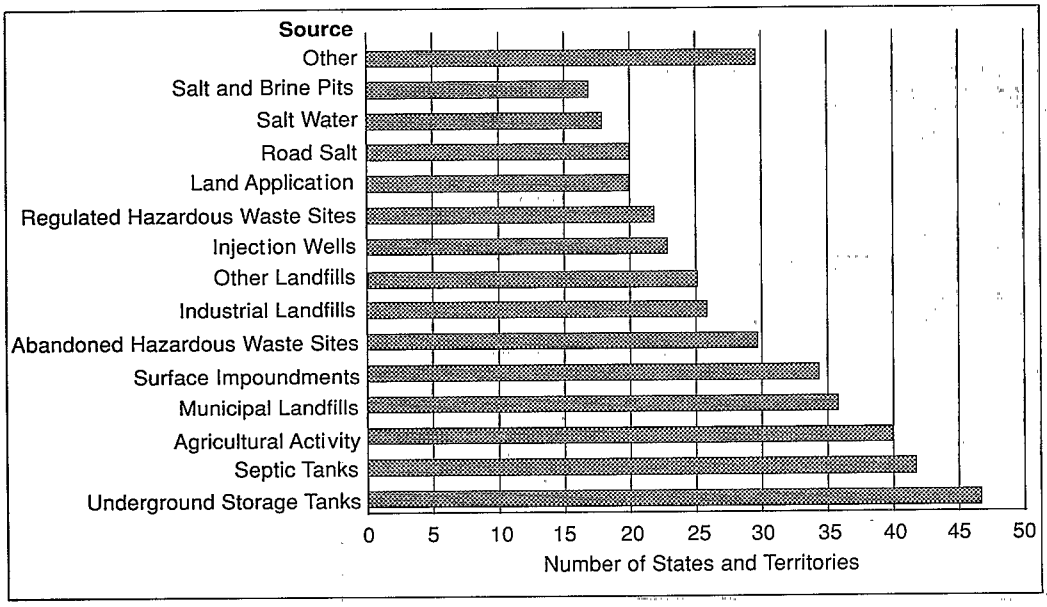
The States identified major sources of ground-water contamination in their Section 305(b) reports. The number of States identifying each of the sources as a priority of concern is indicated in Figure 7-4. Over half classified underground storage tanks, septic systems, agricultural activities, municipal landfills, surface impoundments, and abandoned hazardous waste sites as major threats to ground-water quality. With very minor differences, these are the same sources of concern reported in the 1986 State Section 305(b) reports.

Many of the States assigned a priority ranking to these contamination sources that reflects their level of concern about each source. Figure 7-5 illustrates these rankings. The most frequently noted top priority concern was underground storage tanks (ranked first by 15 States). Abandoned hazardous waste sites were ranked as the top priority concern by eight States, while agricultural activity and septic tanks were each identified as the top priority concern by five States.

Underground storage tanks were most frequently identified among the top five contamination sources of concern (ranked by 34 States). Twenty-five States characterized municipal landfills among the top five sources of concern, while 23 States ranked agricultural activity among the top five. Abandoned hazardous waste sites (ranked by 21 States) and septic tanks (ranked by 20 States) ranked fourth and fifth, respectively, among the top five sources of concern.

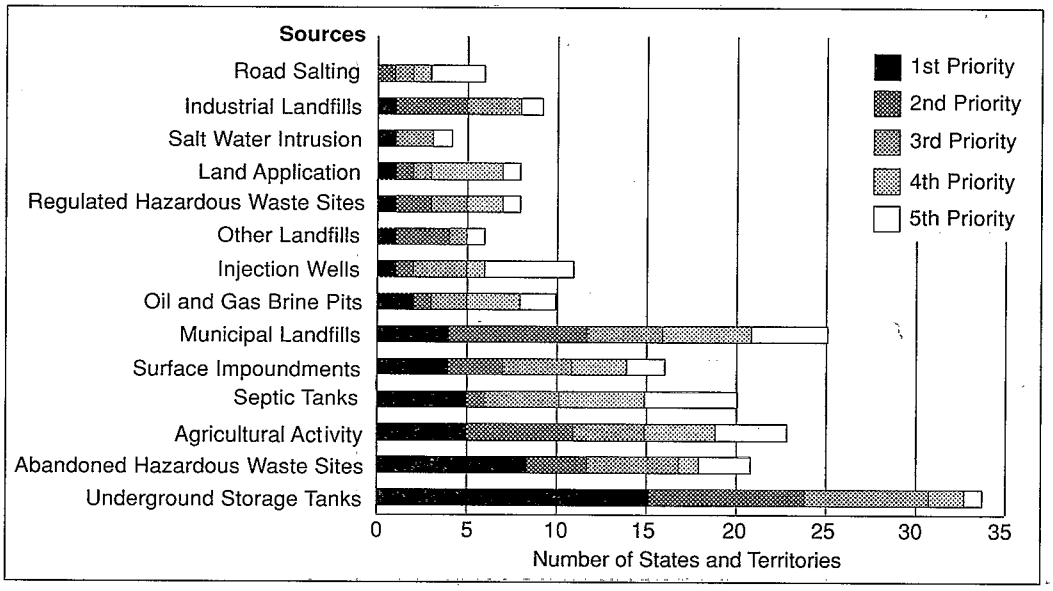
In addition to the sources of contamination listed in Figures 7-4 and 7-5, the States identified other contaminant sources of concern, such as hazardous material spills, mining waste, abandoned and poorly constructed wells, and aboveground tanks. The priority rankings assigned to these other contaminant sources are indicated in Figure 7-6. Mining wastes, sewer leaks, cyanide heaps, construction, and manufacturing were each identified by one State as its top priority source of concern.

The broad range of activities identified by the States as priority contaminant sources indicate that ground-water protection from unacceptable contamination requires controlling many different processes and waste management practices.



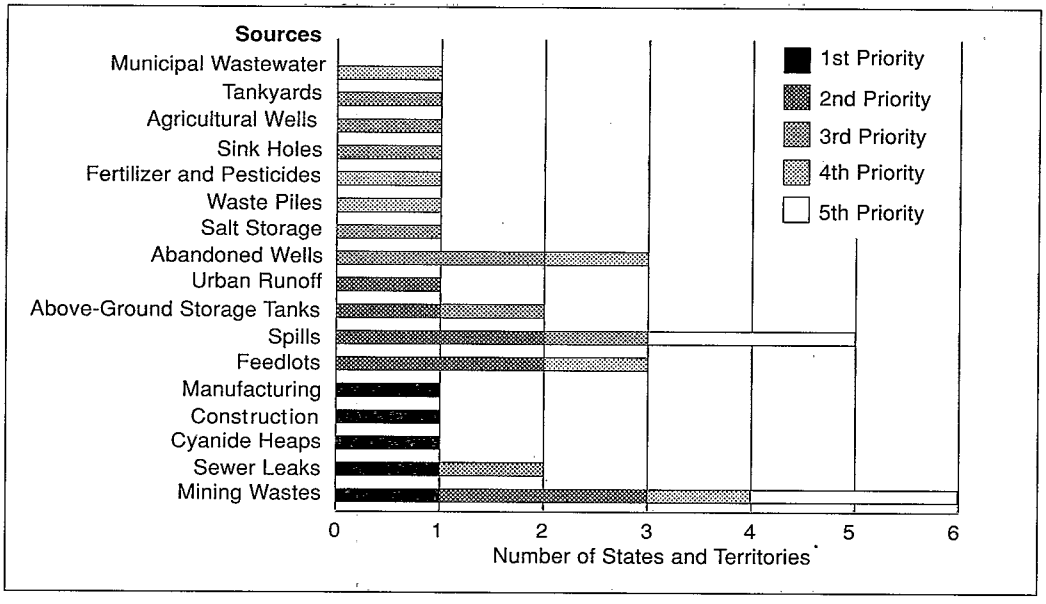
Source: 1988 State Section 305(b) reports.

Figure 7-4. Frequency of Reported State and Territory Concern with Ground-Water Contamination Source



Source: 1988 State Section 305(b) reports.

Figure 7-5. Priority Ranking of Ground-Water Contamination Sources



Source: 1988 State Section 305(b) reports.

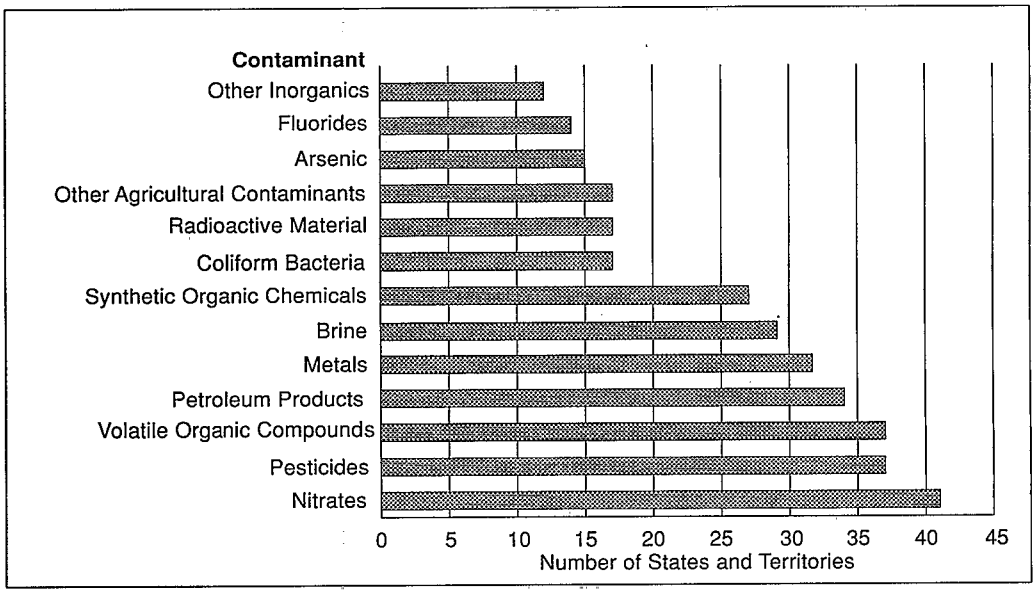
Figure 7-6. Priority Ranking of "Other" Ground-Water Contamination Sources

Overview of Contaminants

In addition to identifying sources of contamination, the States identified the contaminants they have observed in their ground water. Figure 7-7 presents these ground-water contaminants of concern. As shown in the figure, more than half of the States identified nitrates, pesticides, volatile organic compounds, petroleum products, metals, and brine as contaminants of concern. Other contaminants reported by the States include bacteria, solvents, acids, and tanning wastes.

In 1986, the States reported sewage, nitrates, synthetic organic chemicals, volatile organics, brine/salinity, and metals to be the most common ground-water contaminants. The current reports generally parallel this earlier finding; the only exception is a reduction in the number of States reporting sewage problems in 1988.

In another approach to assessing ground-water contamination and trends across the United States, EPA has used State data reported to the Federal Reporting Data System to analyze the degree to which ground water-based water supply systems are meeting all applicable Maximum Contaminant Levels (MCLs). EPA used this indicator to provide: information on the number and proportion of ground water-based public drinking water systems meeting applicable MCLs and some indication of the degree of risk posed by those systems not meeting the standards; the geographic distribution of that risk across States; and an indication and identification of the specific contaminants that are responsible for that risk. In 1986, 12.3 percent of the ground water-based systems, serving 6.8 percent of the population using these systems, violated MCLs; in 1987, 11.1 percent of these systems, serving 6.4 percent of the population, violated MCLs.



Source: 1988 State Section 305(b) reports.

Figure 7-7. Number of States and Territories Reporting Ground-Water Contaminant as a Concern

8

Ground-Water Protection Programs

State Programs

The States are currently engaged in a number of ground-water protection activities to address contaminants and sources of contamination. These activities include: adopting and implementing ground-water protection strategies; enacting ground-water legislation to create comprehensive ground-water protection programs and develop protection regulations, standards, and special controls for specific contaminant sources; adopting wellhead protection and ground-water classification and mapping programs; and establishing procedures to better coordinate the ground-water management activities of State agencies.

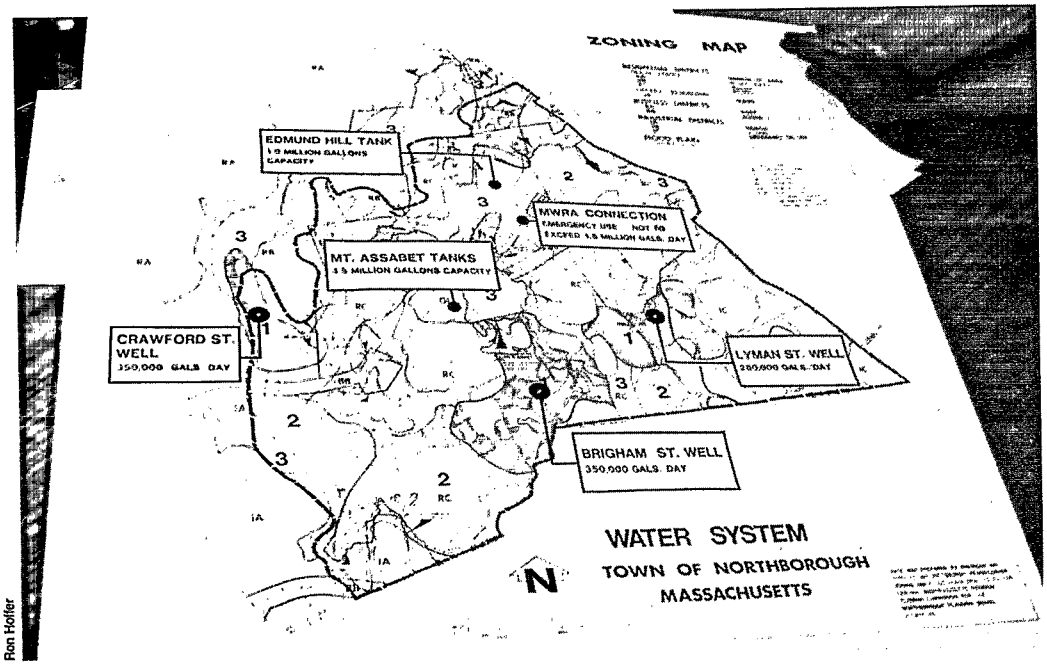
Ground-Water Protection Strategies

At least 49 States and Territories (hereafter referred to as States) have Ground-Water Protection Strategies or are in the process of developing them. Many of the States reported that they used portions of their Section 106 grants under the Clean Water Act to prepare their Strategies. These Strategies typically outline goals and objectives for addressing ground-water problems; contain information on the nature and location of ground water in the State; and describe legislative and regulatory programs to protect groundwater and develop public interest and support for protection activities. Many of these State Strategies have also been accompanied by

changes in State laws or regulations to bolster ground-water protection activities. The following section contains examples of the comprehensive legislative and regulatory programs that have been adopted by many of the States to achieve the goals of their Strategies.

In November 1987, Kentucky published its Ground-Water Protection Strategy. Kentucky describes its Strategy as a working document that announces major new ground-water initiatives. The foremost component of the Strategy is the adoption of a ground-water protection goal to maintain and protect the resource for its highest and best use, and to minimize or prevent ground-water degradation. Program elements announced in the Strategy include: a proposed classification system equivalent to that proposed by U.S. EPA; the development of ground-water classification and discharge regulations for regulating all discharges to ground water; a proposed program to certify well pump installers and all non-water well drillers in Kentucky; a proposal to reform oil and gas laws; and various funding proposals to protect aquifers, cleanup non-Federal abandoned hazardous waste sites, and expand ground-water research and data management.

The Florida Ground-Water Protection Strategy focuses on programs to control ground-water contamination and on plans to implement ground-water monitoring and data collection activities. The Florida Strategy outlines a number of activities to protect ground water, including the implementation of federally mandated programs such as underground injection control, underground storage tank monitoring and remediation, and hazardous waste management. The Florida Strategy also outlines State initiatives such as a ground-water discharge permitting program, septic system regulations, and ground-water classification to create special aquifer protection areas. Florida is developing water supply well location guidelines to control drilling in known or suspected areas of contamination. The Florida Strategy describes an extensive ambient ground-water quality monitoring network and a computerized data base to track water quality data. Florida eventually plans to use these data to support the development of a geographic information system to track expected sources and areas of ground-water contamination.



Ground-water planning map for Northborough, Massachusetts. Ron Hoffer

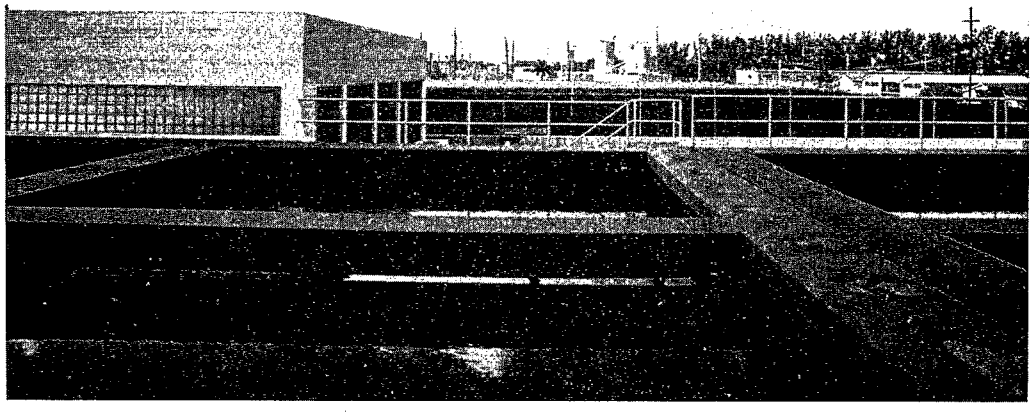
Virginia has prepared a Ground-Water Protection Strategy that is overseen and implemented by an interagency committee, the Groundwater Protection Steering Committee. The components of the strategy include a Virginia pollution abatement permit program to control animal waste lagoons, industrial waste lagoons, and land application of sludge, as well as regulations affecting underground storage tanks, landfills, and new well construction. The Virginia strategy also calls for ground-water data collection and management and technical training and educational programs.

The Ground-Water Protection Strategies described above generally form the basis for ground-water quality control programs in the States. To implement these protection activities, many States are adopting or amending ground-water legislation and regulations. A sample of these legal and regulatory activities are described below.

Ground-Water Protection Legislation, Regulations, and Standards

Although most of the States have authority to develop ground-water protection programs under general clean water statutes, over the past several years a majority of the States have either passed legislation designed specifically to protect ground water, or have amended existing water quality statutes to better account for ground-water problems. At least 31 States have adopted specific ground-water protection legislation.

This legislation has led to the promulgation of regulations that, in many States, stipulate controls for the management of specific sources of contamination and standards for ground-water quality protection. These standards may be used to apply limits on the allowable discharges from contamination sources or to set contaminant targets or threshold levels for ground-water cleanup. Ground-water protection standards can involve either narrative descriptions of nondegradation goals or numeric levels that set allowable health-based concentrations for specific compounds in ground water.



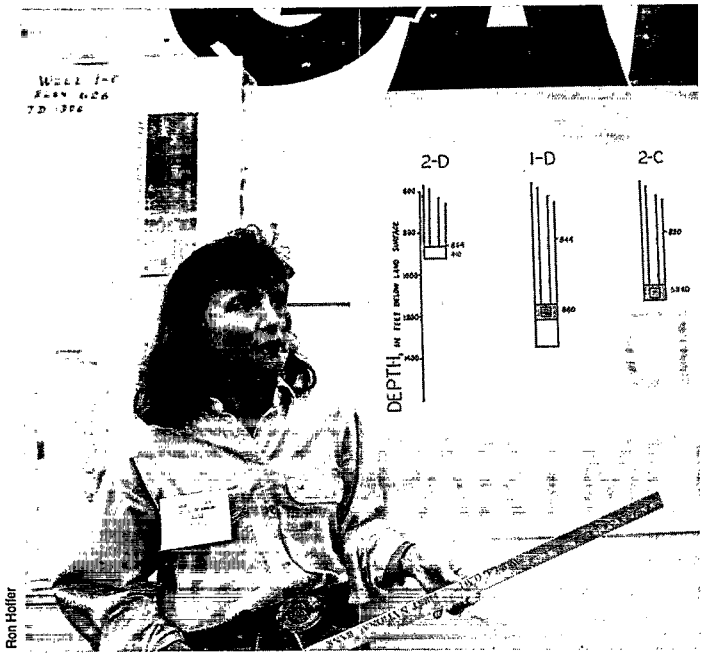
Ron Hoffer

A water treatment facility in Florida.

Portions of three State programs are summarized briefly to illustrate the broad array of ground-water protection activities throughout the United States.

Under the Arizona Environmental Quality Act of 1987, the Arizona Department of Environmental Quality was given primary responsibility to protect aquifers supplying drinking water to the State. The Act stipulates statewide monitoring of ground water and soils to detect contamination. Monitoring requirements are also included in the public drinking water supply programs, hazardous waste management programs, and Federal and State "Superfund" programs. The Arizona Department of Water Resources and the U.S. Geological Survey have primary responsibility to study and manage available ground-water supply in the State. To facilitate ground-water protection planning, Arizona has adopted a ground-water basin scheme. The basins are designed primarily on the basis of local physiography, surface drainage patterns, subsurface geology, and aquifer characteristics. Based on this scheme, Arizona has identified four "Active Management Areas" where ground-water supplies are imperiled. The State has developed management plans to protect both ground-water quality and safe yields.

Illinois enacted a Ground-Water Protection Act in 1987 that established a protection policy to prevent degradation and to preserve beneficial uses of ground water. The Act requires the State to identify sources of ground-water contamination and establish technical requirements to control these sources, especially within public water supply recharge areas. Three State agencies have responsibilities under the Act—the Department of Energy and Natural Resources, the Department of Public Health, and the Environmental Protection Agency. These responsibilities include a permit program for noncommunity wells, a ground-water protection planning program, a ground-water data collection and automation program, ground-water standards development, an interagency coordinating committee, a ground-water protection needs assessment, and community water well surveys. Furthermore, the State Department of Energy and Natural Resources is planning a considerable research effort to implement the goals of the Act. This effort includes water supply recharge area mapping, evaluation of the impact of pesticide use on ground-water quality, a statewide ground-water quality and quantity assessment, and the creation of an automated system to track ground-water data.



Ron Hofler

Display of a cross section of monitoring well locations.

South Dakota recently passed legislation mandating the development of State wellhead protection guidelines to be used by local governments in their program development efforts. The program elements described in the Governor's Centennial Environmental Protection Act mirrors the elements in the Federal Safe Drinking Water Act. The State intends to have these guidelines in place by June 1989.

In addition to improved planning, monitoring activities, and specific source controls (such as those mandated under underground storage tank, underground injection control, and solid and hazardous waste regulations), a number of States are also protecting their ground water through the adoption of underground discharge permitting programs. New Jersey's program is described below.

Ron Hofer

The New Jersey Department of Ground-Water Quality Management issues ground-water discharge permits under the general authority of the New Jersey Discharge Elimination System. Ground-water discharges that have been or can be issued a permit include surface impoundments, infiltration/percolation lagoons, landfills, injection wells, spray irrigation, overland flow, and land application of residuals for hazardous and nonhazardous wastes. Work involved in permit issuance ranges from pre-application conferences and application reviews to public notices and hearings. All permitted facilities must perform routine discharge and aquifer (upgradient and downgradient) monitoring. Final permits are issued for 5 years. New Jersey also conducts a review of other permit requirements for potential ground-water discharges. These reviews include industrial waste management facilities, the statewide sludge management program, and best management practices for stormwater and emergency cleanup from major industrial facilities. New Jersey is also revising its statute addressing "Standards for Individual Subsurface Sewage Disposal Systems." The new standards will reflect current scientific knowledge and engineering practices to protect ground-water quality and to reduce the frequency of septic system malfunctions.

In addition to the controls the States have established on well-known sources of ground-water contamination, such as landfills and septic systems, other States and Territories have adopted specific controls on other minimally regulated sources of contamination. For example, Puerto Rico established an animal waste management system to help control contamination from animal runoff. Michigan requires storage permits and pollution prevention plans for nonhazardous wastes. Guam regularly monitors urban runoff collection surface impoundments for pesticides and heavy metals.

Wellhead Protection Programs

Since the reauthorization and amendment of the Safe Drinking Water Act in 1986, many States and local governments are actively moving to develop and implement Wellhead Protection (WHP) Programs. Section 1428 of the Act specifies that each State must prepare a WHP Program and submit it to EPA by June 19, 1989. To date there have been 30 submittals to EPA. EPA has provided States and local governments with extensive assistance in this area, including technical assistance documents, workshops, training sessions, and pilot projects.

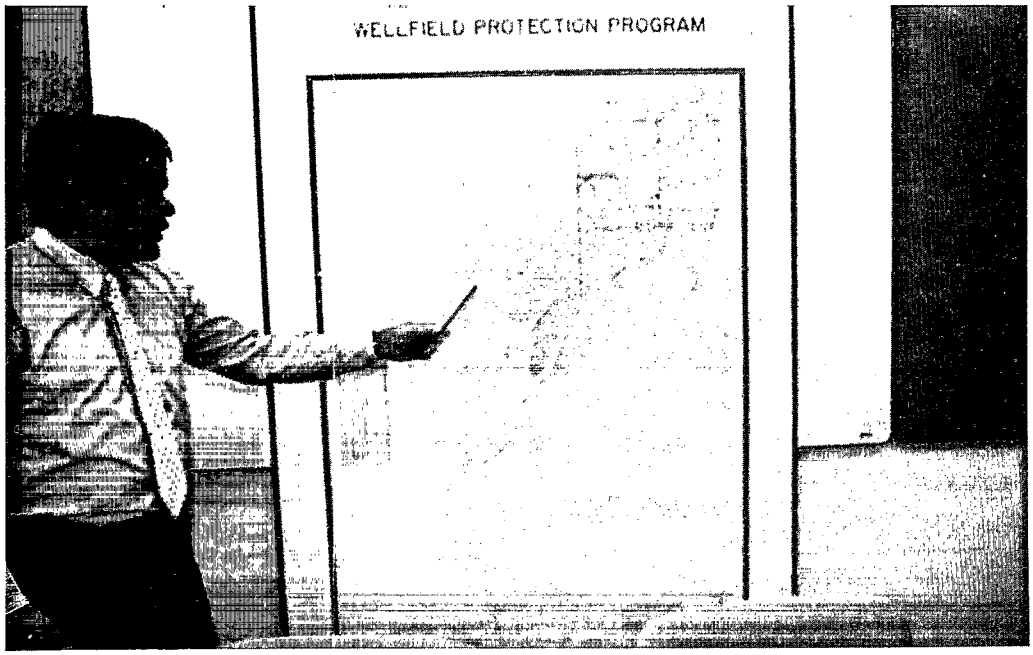
The State summaries listed below are representative of the types of WHP Programs

being developed by the States and give a clear indication that many States and local governments are actively conducting specific WHP activities.

The Connecticut General Assembly has recently adopted the recommendations of a legislative task force to begin an aquifer protection program statewide. The State is requiring water companies to delineate zones of contribution to public water supplies and is also requiring towns to create local boards to consider ground-water protection. A legislative task force is developing recommendations on which land-use controls should be exercised in the aquifer protection areas. Connecticut has submitted a WHP Program to EPA.

Maine's ground-water protection program is coordinated by the State Planning Office with technical assistance from the Department of Environmental Protection. Together they are finalizing the statewide ground-water protection strategy. The WHP Program was drafted for review by the State WHP Program workgroup. The program was published for review in November 1988. The resulting State WHP Program underwent public review and was submitted to the legislative session (Winter-Spring 1989) and then to EPA.

The Missouri Department of Natural Resources submitted a coordinated work plan for WHP activities in late 1988. The State then began implementing the activities identified in the WHP work plan, with the goal of having a program in place within 2 years. The State has also put together a proposal for a GIS pilot project that would complement various elements of an actual WHP Program. The project includes mapping all public water supply wells/wellfields in the State, locating contaminant sources around those supplies, and identifying alternate water supply sources for those communities using ground water as their public water supply source. Part of this project also involves developing a ground-water flow/transport model that can be used by emergency response personnel to track the movement of a contaminant spill from an identified source within a WHP Program, should such an event occur.



Ron Hoffer

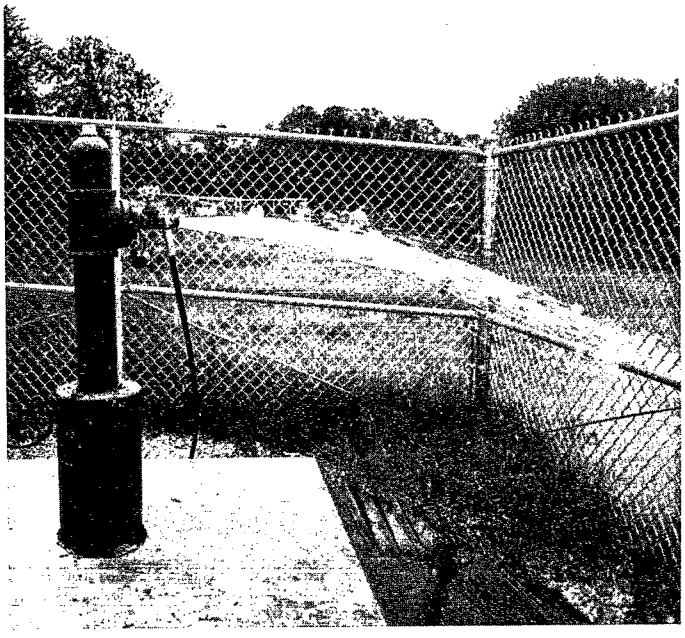
Wellhead protection map for Dade County, Florida.

In New York, the responsibilities for ground-water management and public water supply protection are divided between the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health, respectively. The NYSDEC has been designated as the lead agency for developing and implementing a statewide WHP Program. The State has submitted a WHP Program to EPA.

The Texas Water Commission has launched a program for local education and technical assistance on WHP. The Commission is conducting a series of seminars for local officials and public water system operators on the State's existing ground-water protection programs and what can be done on a local level to protect ground water. The Commission offers its technical assistance to any municipality that wants to develop a WHP Program and, to date, has completed two such projects in the State. The Commission also has proposed a Class V injection well regulatory strategy that would include participation by local governments and would incorporate WHP. In addition, Austin has enacted local regulations to protect several aquifer recharge areas. The Del Rio area has implemented a WHP Program designed to prevent contamination of an open spring, which is the town's only water source. Texas has submitted a WHP Program to EPA.

Vermont is conducting a joint pilot study between the Department of Health and the Department of Environmental Conservation to demonstrate the coordination of inventories of Class V underground injection wells with implementation of WHP plans in Vermont. A Source Protection Plan has been developed that will be incorporated into the WHP project. The Source Protection Plan addresses the identification and assessment of threats, along with the management of the existing risk. Vermont has submitted a WHP Program to EPA.

A free-flowing artesian well.



Ron Hoffer

Ground-Water Classification and Statewide Mapping Programs

Over 40 States report active programs to classify the ground waters of the State or map vulnerable sources of ground-water supply. Many of the State classification programs are designed to support the application of ground-water quality standards. A few examples are cited below.

Colorado's ground-water classification program was established under the State Water Quality Control Act. The State is planning to classify its groundwater according to water use or potential use and water quality, to the extent that the quality affects the appropriate use of the water. Based on the ground-water classifications, the State will apply numeric organic water quality standards on a site-specific basis. The State is also planning to adopt an aquifer-based classification system because of the need for a more resource-oriented approach. The Colorado Water Quality Control Commission has promulgated rules to implement basic control regulations and intends to promulgate numerical standards in the fall of 1989.

Hawaii is in the process of mapping and classifying ground water on all the islands using a methodology created by the Water Resources Research Center at the University of Hawaii. This methodology was derived using definitions for Class I, II, and III ground water contained in EPA Draft Classification Guidelines.

Coordination of Protection Programs Among State Agencies

Sources of ground-water contamination have historically been regulated by many different agencies within the States. Coordinating the activities of these agencies to ensure an effective ground-water protection program is a priority in at least 12 States.

The diffuse responsibilities for ground-water regulation typically found in the States is clearly illustrated by the situation in Louisiana. Seventeen different agencies have a responsibility for various aspects of ground-water protection in Louisiana. Of the 17, the Department of Environmental Quality is the lead agency for ground-water quality. To date, coordination between the agencies has been primarily informal. However, on certain issues, memoranda of understanding (MOU) have been developed. One major goal of the State's Ground-Water Protection Strategy will be to develop a series of MOUs between the agencies that have specific responsibilities for ground-water protection.

Federal Ground-Water Protection Programs

In recent years, the Federal government has joined the States in their efforts to protect the Nation's ground water. The following sections briefly describe the Federal programs and laws that deal specifically with the control and study of contaminant sources.

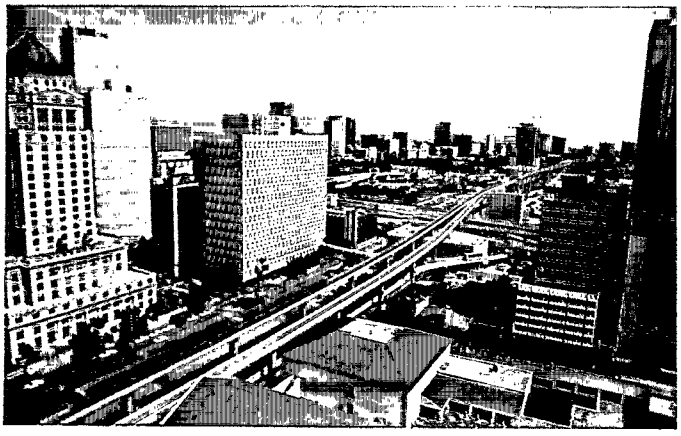
Ground-Water Protection Strategy

In 1984, EPA developed a Ground-Water Protection Strategy that provides an approach to integrating source-specific control and cleanup programs into a comprehensive policy and institutional framework for protecting the resource.

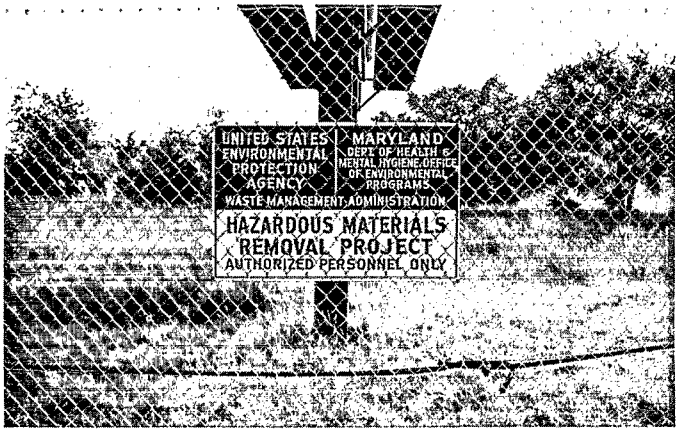
The Strategy recognizes that the most effective way to increase national institutional capability to protect ground water is to strengthen State programs. Accomplishments over the last 4 years include addressing major sources of contamination more comprehensively through stronger statutory authorities and EPA initiatives, and building States' capabilities through more effective and coordinated use of resources for State grants, technical support, and research and development.

Ground-Water Classification System

As a part of the EPA Ground-Water Protection Strategy, EPA developed a ground-water classification system, and EPA is now developing additional guidelines for performing site-by-site classification. Class I ground waters are highly vulnerable, irreplaceable as sources of drinking water, or ecologically vital. These receive the highest level of activity necessary to protect ground water. Current or potential drinking water



Ron Hofter



Ron Hofter

sources not meeting Class I requirements are designated Class II ground waters. Class III ground waters are those ground waters that are not potential drinking water sources because of widespread human or natural contamination or insufficient yield.

National Survey for Pesticides in Drinking Water Wells

This Survey is jointly sponsored by EPA's Offices of Drinking Water and Pesticide Programs. It is a national statistical survey designed to determine the presence of pesticide residues in two distinct populations of drinking water wells: public water system wells and private, domestic drinking water wells. Over 1,300 wells are being analyzed for over 100 pesticides specifically selected for their propensity to leach and their degradation products. Each well will also be analyzed for nitrate. The Survey is scheduled for completion in 1990.

Ground-Water Data Management

To better support Federal and State ground-water protection efforts, EPA has been working to improve ground-water data management requirements. As an initial step in developing data standardization, EPA has developed a minimum set of data elements for ground water and has convened a workgroup to develop definitions and formats for these terms. Ground-water data accessibility will be addressed by improving capabilities to share information among programs and organizations. EPA has also begun initiatives, such as the study of geographic information systems and improvements to the STORET system, to enhance ground-water data analysis capabilities.

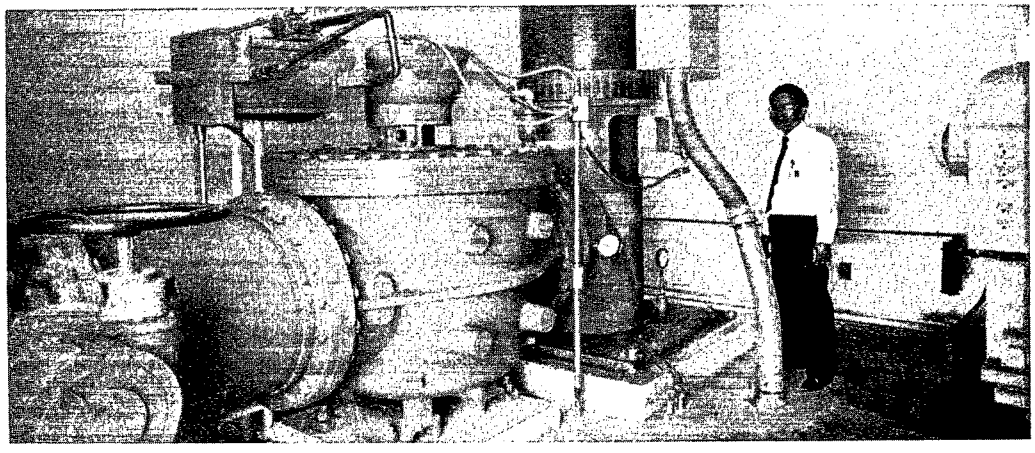
In addition to these EPA programs, Federal statutes mandate certain ground-water protection activities.

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act and its 1986 amendments created three programs to protect ground water.

- The **Underground Injection Control Program** establishes technical criteria and standards for the construction, operation, monitoring, and testing of wells to control the underground injection of wastes. Many States reported enforcing their own underground injection control programs.

- The **Sole Source Aquifer Program** authorizes EPA to undertake a special review of possible ground-water impacts from federally funded projects in designated areas that receive Federal financial assistance.



Ron Holfer

Large public water supply well.

■ The **Wellhead Protection Program** provides assistance to States to develop programs to protect the wellhead area of all public water systems from ground-water contaminants that may adversely affect human health. EPA has published guidelines to assist the States in developing their Wellhead Protection Programs.

Clean Water Act (CWA)

The Clean Water Act authorizes two programs directly relevant to ground-water protection.

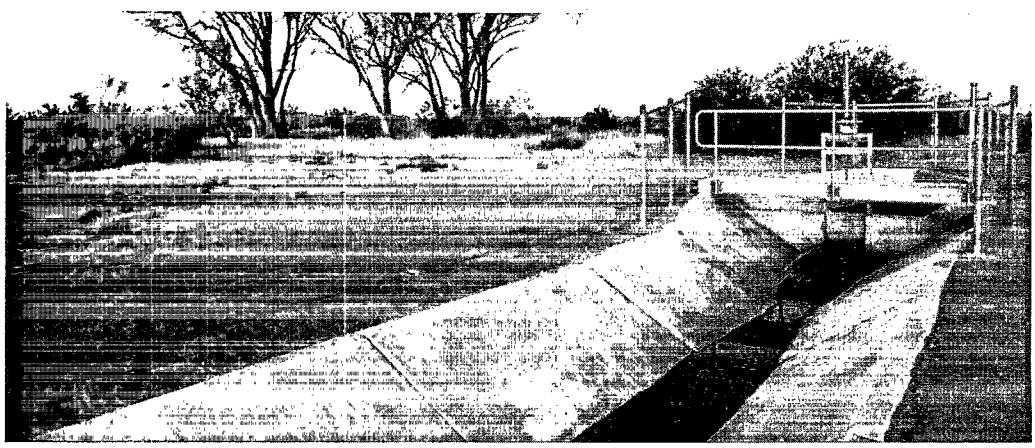
■ The **CWA Section 106 Grant Program** supports State programs to improve institutional capabilities through the development of State ground-water protection strategies.

■ The **Nonpoint Source Control Strategies** are required from the States by the 1987 CWA Amendments. Under CWA Section 319, States must describe strategies to coordinate and implement best management practices; measures to control nonpoint sources; and the nature of State and local nonpoint source control programs. In addition, under Section 319(i), the EPA Administrator may make grants to States to conduct ground-water quality protection activities that will advance the State toward implementing a comprehensive nonpoint source pollution control program.

Resource Conservation and Recovery Act (RCRA)

A number of programs established under RCRA provide for ground-water protection and cleanup. These programs emphasize prevention of releases to ground water and other environmental media through management standards and cleanup requirements. Most States are currently managing or developing new programs derived from the following major sections of RCRA:

■ **Subtitle C—Hazardous Waste**—requires design, operating, and closure standards for all hazardous waste treatment, storage, and disposal facilities. It also requires post-closure care and ground-water monitoring for land disposal facilities.



Ron Hoffer

An irrigation canal in Arizona.

■ **Subtitle D—Solid Waste**—requires minimum national management standards for municipal solid waste landfills to be adopted and implemented by States.

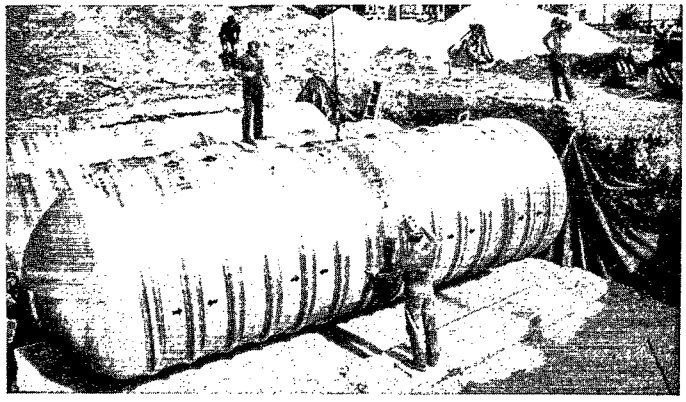
■ **Subtitle I—Underground Storage Tanks**—requires EPA to develop a comprehensive program for managing certain categories of underground storage tanks containing petroleum and chemical substances.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA and the Superfund Amendments and Reauthorization Act of 1986 (SARA) created several programs being operated by EPA and States that act to protect or clean up contaminated ground water. Using its emergency response authority under "Superfund," EPA responds to releases of hazardous substances into the environment, thereby removing those hazardous substances before they have the opportunity to contaminate ground water. In a Superfund remedial action, EPA undertakes long-term efforts to provide a permanent remedy to existing releases of hazardous wastes that pose a serious, but not immediate, danger to public health. Remedial actions often involve cleaning up contaminated ground water. The "Title III" Emergency Planning and Community Right-to-Know Act (a free standing act created as part of SARA) requires industry and Federal, State, and local governments to work together in developing emergency plans, emergency release notification procedures, "community right-to-know" reporting, and toxic chemical release reporting.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA protects ground water indirectly by controlling the use of pesticides through registration and certification procedures. EPA may deny registration for a pesticide if its normal use will result in unreasonable adverse effects on the environment, including groundwater contamination.

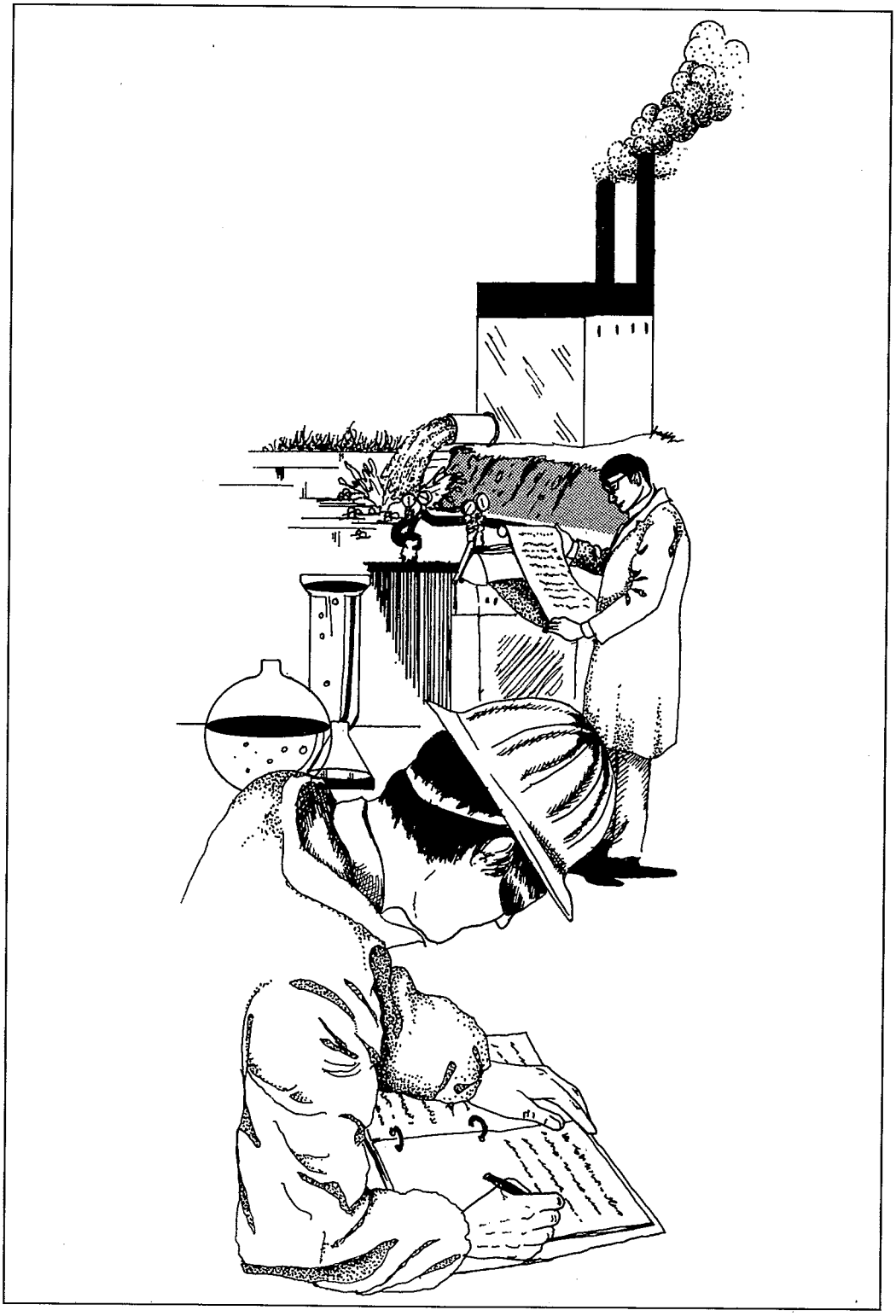


Ron Hofler

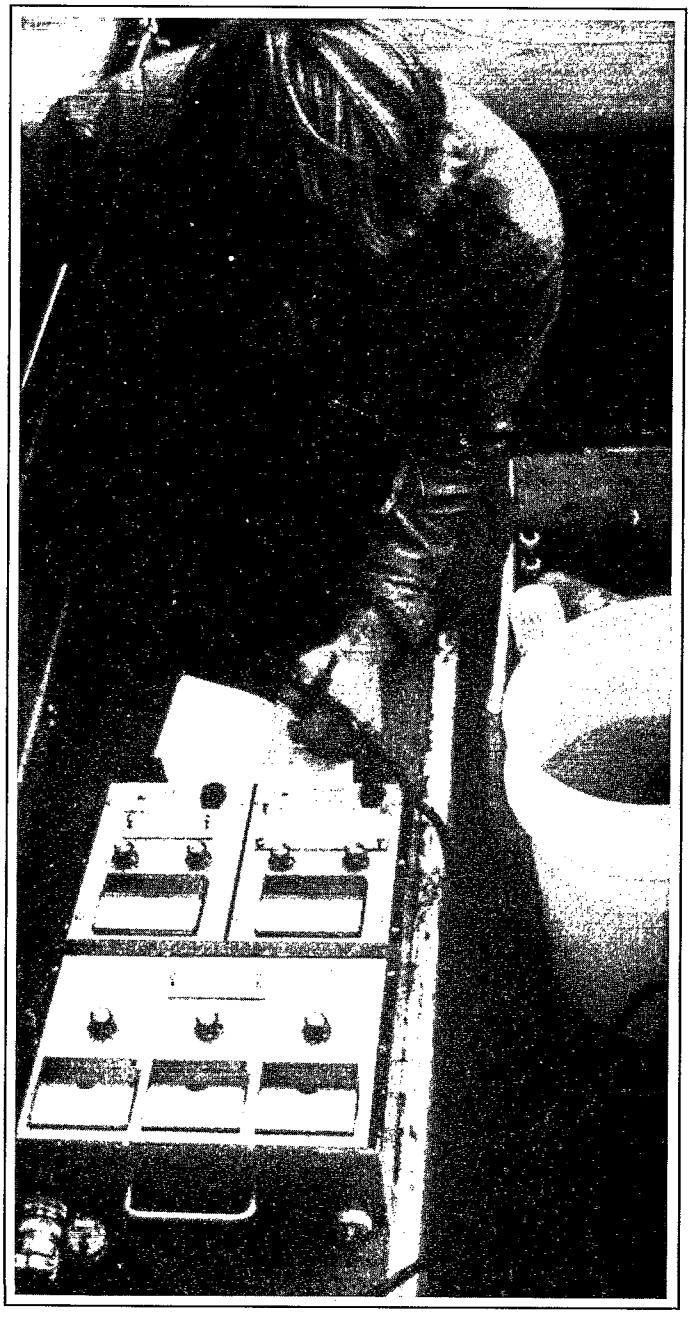
Installation of underground fuel tanks.

Ron Hofler

A Superfund site in Pennsylvania.



Water Pollution Control Programs



NACMS

Introduction

The Clean Water Act of 1972 determines the way the Federal government and the States regulate point and nonpoint sources of pollution.

The Clean Water Act (CWA) established two basic types of approaches for controlling pollution from point sources: the technology-based approach and the water quality-based approach. Technology-based controls consist of uniform, EPA-established standards of treatment that apply to certain industries and municipal sewage treatment facilities. These effluent standards are limits on the amounts of pollutants that may be discharged to waterways. Limits for industries are derived from the technologies that are available for treating the effluent and removing pollutants, and on considerations of economic achievability. These standards vary by industry, depending on pollutants typically discharged, treatment technologies available, etc., but are applied uniformly to every facility in a regulated industrial category. Technology-based limits for publicly owned treatment works provide for "secondary treatment," as specified in the Act. Technology-based limits for industries and municipal sewage treatment plants do not take into consideration the condition of the water to which the effluent is dicharged.

Water quality-based controls, on the other hand, are based on the quality of the receiving water. This approach relies on the use of water quality standards set by the States and approved by EPA. State water quality standards consist of designated uses to be made of the streams (e.g., fishing and swimming) and the criteria (or limits on pollutants) necessary to protect those

uses. Individual discharge requirements are based on the effluent quality that is needed to ensure compliance with the water quality standards. The water quality-based approach is used to develop stricter effluent limits where technology-based controls will not be stringent enough to ensure that waters can support their uses. EPA's point source regulatory approach may therefore be characterized as one in which technology-based controls provide a baseline level of surface water pollution requirements, and water quality-based controls provide regulatory supplements to deal with environmental "hot spots," critical habitats, and otherwise sensitive waters.

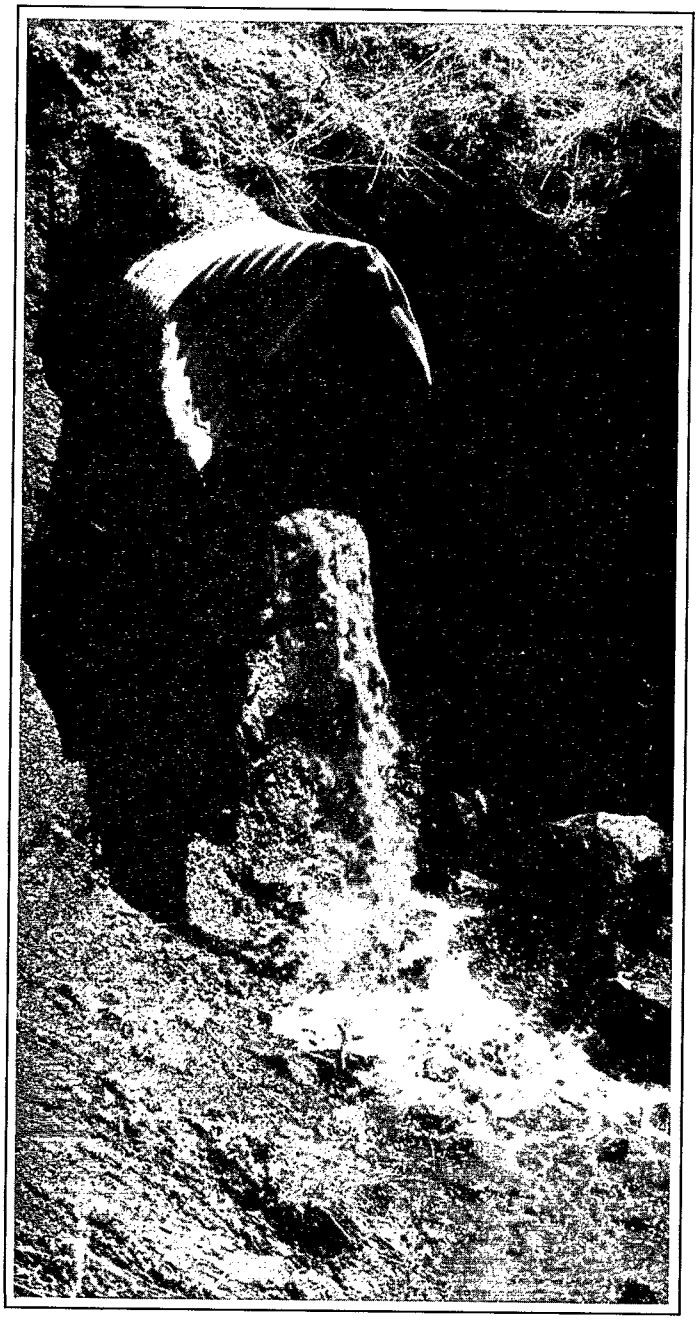
The CWA provides the impetus for nonpoint source controls but does not provide direct authorities to regulate these sources. Water quality standards must be developed for all waters of the U.S., and these standards are to be attained regardless of the sources of pollution. However, nonpoint source pollution is difficult to control because of its diffuse, episodic nature. To address nonpoint sources, State and local governments develop control programs that are sometimes regulatory but for the most part encourage voluntary actions, with incentives and technical support provided by a number of State and Federal agencies. Nonpoint pollution controls are often applied on a case-by-case basis and are generally administered at the local or State level.

Programs to control point and nonpoint source pollution will be discussed in more detail below, along with obstacles to their implementation, successes achieved, and new initiatives for the future. Further information on programs specific to lakes, estuaries, coastal waters, and wetlands, can be found in Chapters 2, 3, 4, and 5.

NACMS

Water-quality standards must be developed for all waters of the U.S.

9



Point Source Control Program

The Water Quality Act of 1987 (WQA) reinforced both the water quality- and technology-based approaches to point source control, requiring EPA to develop and update technology-based standards and adding specific direction as to how water quality-based limits should be used to achieve additional improvements. One of the Act's primary emphases lay in strengthening the Nation's toxics control program.

Toxics Control: Section 304(l) of the Clean Water Act

Section 304(l) of the CWA requires States to develop lists of impaired waters, identify point sources and the amounts of pollutants they discharge causing toxic impacts, and develop individual control strategies for each such point source. These individual control strategies are National Pollutant Discharge Elimination System (NPDES) permits with new or more stringent limits on the priority pollutants of concern and with supporting documentation to show that the permit limits will meet water quality standards within the satisfactory timeframe. The general effect of Section 304(l) is to immediately focus national surface water quality protection programs on addressing known water quality problems due entirely or substantially to point source discharges of Section 307(a) toxic pollutants. Controls for these pollutants must be established as soon as possible but no later than the statutory time frames set forth in Section 304(l).

EPA has been implementing control measures for all toxic pollutants as part of its ongoing surface water

program. Section 304(l) emphasizes the importance of the water quality-based and technology-based approaches in protecting surface waters from the priority toxic pollutants and establishes a number of one-time requirements. After the Section 304(l) deadlines pass, EPA will continue identifying impaired waters and controlling the discharge of toxic and other pollutants through existing reporting, standards setting, and permitting programs.

Identifying Impaired Waters

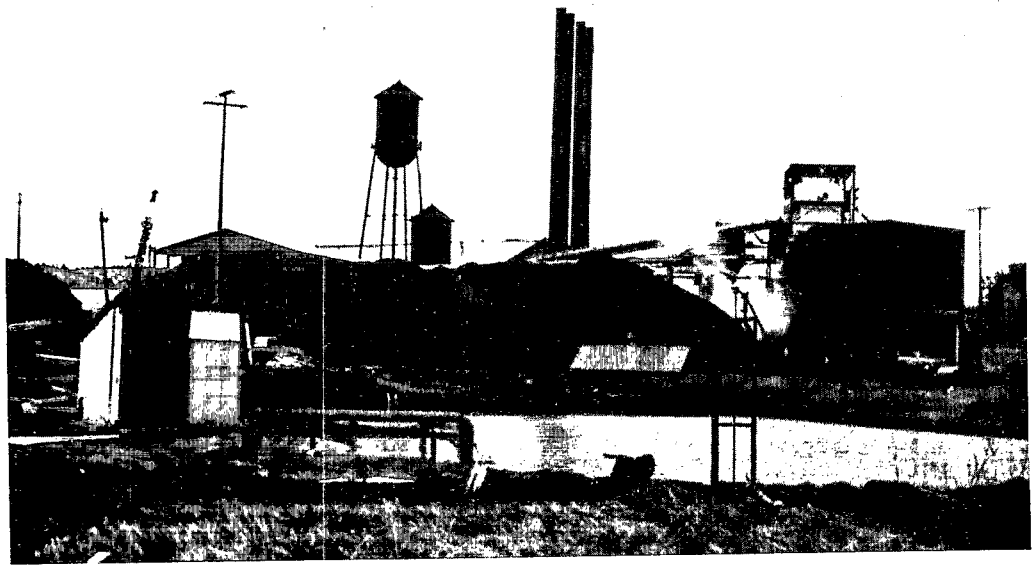
In developing lists of impaired waters, States used a variety of available data sources (including State Section 305(b) reports). At a minimum, dilution analyses were conducted based on existing or readily available data. Where data could be readily developed to complete preliminary listing activities or to refine preliminary lists, States were asked to develop needed data quickly. EPA asked States to report preliminary lists of waters, point sources, and amounts by April 1, 1988, in their Section 305(b) reports. These lists were then refined and expanded by the statutory deadline of February 4, 1989.

The immediate emphasis of Section 304(l) and the national program for toxics control is for States and EPA to address problems identified through review of existing and readily available data. However, States and EPA Regions will continue to collect new water quality data as an ongoing obligation under the national program to ensure that changes in water quality are identified and any important gaps in existing data are filled to provide a reasonable basis for identifying and addressing impaired waterbodies.

Developing Control Strategies

Section 304(l) requires that individual control strategies (ICSs) be developed by February 4, 1989, to reduce the discharge of toxic pollutants from each point source identified under Section 304(l)(1)(c).

These ICSs are to consist of effluent limitations under 402 of the CWA. This is the provision establishing the NPDES permit program. Therefore, to ensure compliance with the 1992 deadline, each ICS is to consist of final enforceable NPDES permits, to the extent possible, and accompanying documentation (i.e., fact sheets). Where a State demonstrates that a final permit cannot be issued by February 4, 1989, a draft permit and supporting documentation may be accepted as an ICS. However, such a



California Regional Water Quality Control Board

A lumber mill in California.

draft permit must be accompanied by a schedule providing for final issuance by no later than February 4, 1990, and providing for compliance with the limitations such that water quality standards will be achieved by June 1992.

Section 304(1)(2) requires that EPA approve or disapprove the lists of waters and each ICS within 120 days after the February 4, 1989, deadline for the submittal of lists of waters and ICSs. Controls must achieve the applicable water quality standard within 3 years (no later than June 4, 1992). If the lists or ICSs are disapproved, or if the State fails to submit the required lists or ICSs, EPA must, in cooperation with the States, develop these lists and ICSs within 1 year (June 4, 1990) and controls must ensure that standards are met no later than 3 years thereafter (June 4, 1993).

Results of 304(l) (as of June 1989)

As of June 9, 1989, the EPA Regions had made approval or disapproval decisions on Section 304(l) submissions from 55 States and Territories.

Nationwide, as of June 12, 1989, States had listed 495 waterbodies as impaired primarily by point source discharges of Section 307(a) toxic pollutants. EPA added 100 waters to these lists for a total of 595. In addition, States indicated that 769 point source discharges were primarily responsible for impairing the quality of these waters, and EPA added 110 point sources to this list for a total of 879.

The States were also required to submit "long" lists of all waters impaired by any pollutant from either point or nonpoint sources. States' long lists of waters ranged from zero to as many as 1,745. States initially listed a total of 16,719 waters and EPA added a total of 646 for a national total of 17,365 on the long list as of June 12, 1989. The long list will be used for long-term planning and setting of priorities for monitoring, total maximum daily load (TMDL) development, nonpoint source controls, and permit revisions.

Of the listed facilities contributing to toxic contamination, about 240 are municipal (such as sewage treatment plants and combined sewer overflows) and about 627 are industrial, including 135 metal-finishing and manufacturing facilities, 94 pulp and paper mills, 21 petroleum-refining facilities, and 27 organic chemical and plastics and synthetics plants. All other industrial categories numbered 20 or fewer facilities. In addition, there are 12 Federal facilities on the lists.

EPA is providing public notice and requesting comment on the States' lists and individual control strategies that it disapproved. EPA is also providing public notice if a State did not involve the public when it was developing its lists and individual control strategies. EPA will consider public comments and make its final decisions no later than June 1990.

J. L. Plafkin

Setting a seine to trap and evaluate a representative sample of stream fauna.

Treating Municipal Wastewater

Municipal treatment facilities receive wastewater from residential sources, as well as from industry, ground-water infiltration, and stormwater runoff. The array of pollutants that may be associated with these sources includes suspended solids, organics, heavy metals, nutrients, acids, viruses, and bacteria.

Adequate treatment of municipal wastewater is important for the protection of the Nation's water resources and public health. Without adequate treatment, this pollution poses a potentially serious threat to fish and shellfish communities, recreational opportunities, surface water drinking supplies, ground-water drinking supplies, and the general health and stability of many of the Nation's streams, rivers, lakes, and estuarine ecosystems.

The Clean Water Act requires municipalities to achieve treatment levels based on technology performance. A July 1977 deadline, extended by the 1981 CWA amendments to July 1, 1988, for eligible plants, was established for the achievement of "secondary treatment," a level of treatment that removes at least 85 percent of several key conventional pollutants. If secondary treatment is not enough to meet water quality standards, the Clean Water Act mandates additional treatment, as necessary.

Under the Clean Water Act, EPA is authorized to help municipalities solve their wastewater treatment problems by providing grants (and now loans) for construction. For this purpose, $18 billion was originally appropriated to the Construction Grants program. Funding has continued since the initial appropriation, and the Federal investment in municipal wastewater treatment is approximately $50 billion to date. Projects eligible for grant assistance include wastewater treatment facilities that provide secondary or advanced treatment, interceptor sewers, and correction of infiltration/inflow problems in sewer systems. The grants process includes the ranking of each project using a State priority system that is based on water quality and public health objectives; the development of a detailed facilities plan and project design; the distribution of Construction Grant funds to States (based on an allotment formula specified by the CWA); and, finally, the issuance of grants to fundable high-priority projects.

These expenditures, along with funding from State and local sources, have produced significant gains in municipal wastewater treatment. In 1972, 85 million people were served by facilities providing secondary treatment or better. Today, 77 percent of all facilities provide secondary or advanced levels of treatment for approximately 144 million people. These facilities process 84 percent of the Nation's wastewater. Fewer than 1 percent of all facilities (serving about 1.5 million people) are currently discharging raw sewage. Table 9-1 displays the improvements in treatment capabilities (by number of facilities, design capacity, and population served) from 1984 to 1988.

The States, in their 1988 Section 305(b) reports, provided some examples of water quality improvements due to municipal construction and upgrading. For example:

- Alabama reports that since the enactment of the Clean Water Act, the State has reduced the discharge of primary-treated wastewater from 65 million gallons per day (MGD) to none and the volume of raw discharge

Table 9-1. Levels of Municipal Wastewater Treatment (1984-1988)

	Number of Facilities			Design Capacity (MGD)			Population Served (millions)		
Treatment Level	1984	1986	1988	1984	1986	1988	1984	1986	1988
Raw	202	149	118	—	—	—	1.3	1.6	1.5
L.T. Secondary	2,617	2,112	1,789	6,510	5,529	5,030	33.7	28.8	26.5
Secondary	8,070	8,403	8,536	14,603	15,714	16,087	70.7	72.2	78.0
G.T. Secondary	2,965	3,115	3,412	13,874	14,373	15,488	59.5	54.9	65.7
No Discharge	1,726	1,762	1,854	938	973	1,034	5.5	5.7	6.1
Totals	15,580	15,541	15,709	35,925	36,589	37,639	170.7	163.2	177.8

Source: U.S. EPA. *1988 Needs Survey Report to Congress.*

from 2.5 MGD to none. A total of 112 public wastewater treatment facilities have been constructed/upgraded.

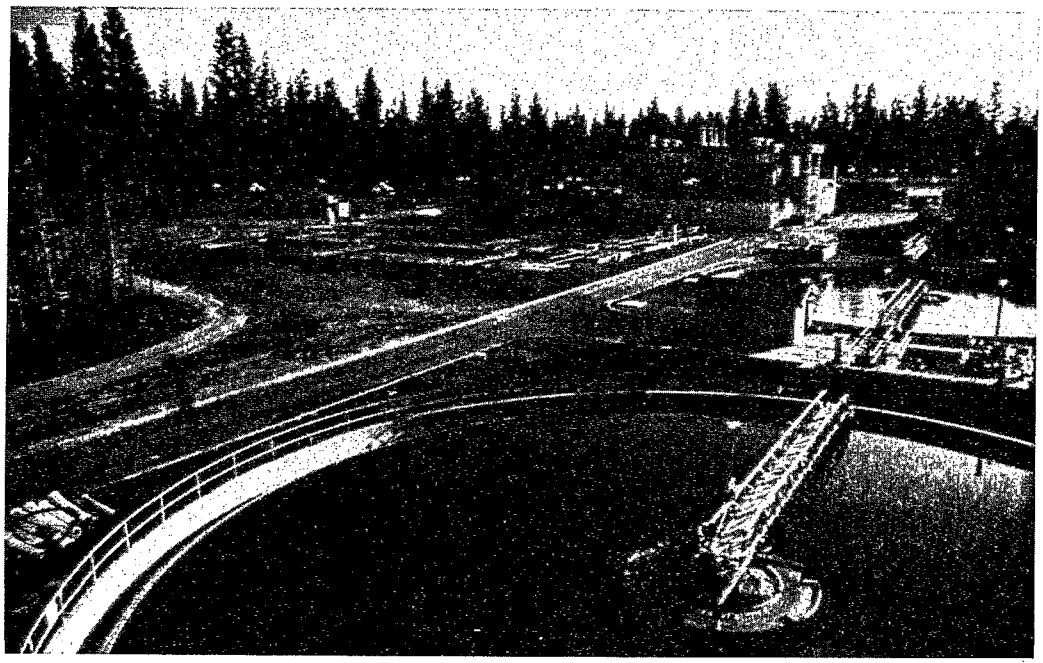
■ The District of Columbia reports on improvements made to the Blue Plains sewage treatment plant, a large sewage treatment plant that contributes about 70 percent of the municipally treated water directly entering the Potomac River. Over the past 15 years, with assistance from the Construction Grant program, Blue Plains has implemented several advanced treatment measures to reduce biochemical oxygen demand (BOD), suspended solids, phosphorus, and nitrogen loadings to the estuary. Although flows of wastewater have increased since 1970, loadings of nutrients, BOD, and total suspended solids have decreased dramatically.

■ Idaho reports that more than 30 State and EPA grant-assisted projects have been completed in Idaho during the 2-year reporting period. As a result, nearly 30,000 more people are now receiving full secondary treatment services.

■ Massachusetts reports that significant segments of the Assabet, Hoosic, Millers, Charles, and Merrimack Rivers have improved dramatically because of the construction of municipal facilities.

■ In New Hampshire, the Winnipesaukee River and most of the upper Merrimack River are now fishable/swimmable because of the construction of the Winnipesaukee River collection and treatment system as well as the construction of facilities on tributaries to the Merrimack. Completion of the Hall Street facilities in Concord has led to a resurgence in recreational interest in the Merrimack River. New facilities in Bennington, Hillsborough, and Hopkinton have significantly improved the quality of the Contoocook River.

■ In North Carolina, water quality problems in the upper Deep River have been addressed by upgrading treatment facilities at four plants. A substantial reduction in the amount of oxygen-demanding substances being discharged to the River has been noted, along with a reduction in the toxicity of these wastes. While some



A sewage treatment facility with settling basins in foreground.

water quality problems remain in portions of the river, a steady improvement can be seen in most areas. The greatest improvements were observed below the old Jamestown sewage treatment plant (ceased discharge in 1984) and below the Asheboro plant (upgraded in 1986).

■ Rhode Island, reporting on the results of recent sewage facility upgrades, notes that the upgrading of a facility in Westerly, Rhode Island, coupled with sewerage works construction in Stonington, Connecticut, has resulted in the opening of shellfishing areas in Little Narrangansett Bay. The upgrading of the Woonsocket plant has raised the Blackstone River from a Class D to a Class C stream, making it consistent with water quality goals. Improvements at the Warren and Scarborough plants have improved bathing water quality at nearby beaches, and shellfishing areas were reopened in Warren.

■ Since 1972, Virginia has completed 149 Construction Grant projects at a total cost of over $1 billion. These projects have extended treatment to populations not previously served by treatment facilities. As a result of this construction activity, Virginia reports a general trend towards an increase in treated flow from municipal sewage treatment plants over the past decade. Compared with 1976, the average statewide aggregate flow of municipal wastewater has increased by about 46 percent. However, over the same period, the amount of BOD discharged from these facilities decreased by 45 percent, and the amount of TSS discharged dropped by about 47 percent. These changes are the result of construction of new treatment facilities. The new, larger facilities have increased flow because they serve a larger percentage of the population, and the population is growing. However, since the newer plants provide a higher degree of treatment, the actual quantities of pollutants discharged have dropped.

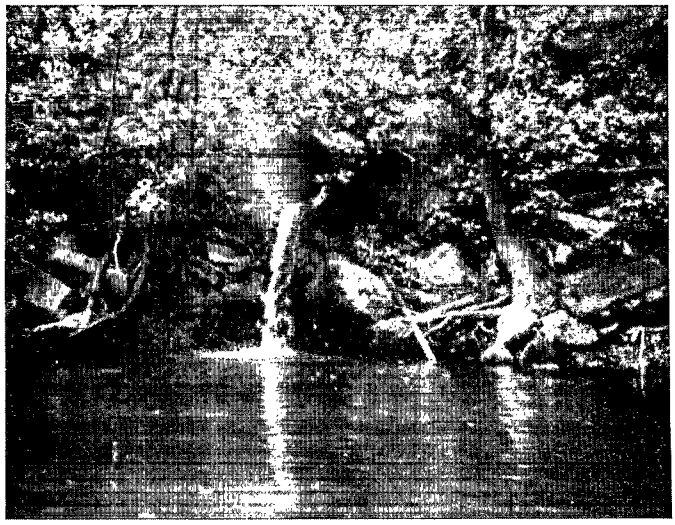
Funding Needs for Wastewater Treatment

The Needs Survey, a biennial Report to Congress, is the primary mechanism for assessing national wastewater treatment needs. Based on the latest survey, $36.9 billion is needed for upgrading or constructing secondary wastewater treatment facilities, correcting infiltration/inflow problems, or building new interceptor sewers. As shown in Table 9-2, three other categories of projects are reported in the Needs Survey—replacement

Table 9-2. Needs for Publicly Owned Wastewater Treatment Facilities (January 1988 Dollars, in Billions)

Needs Category		Current 1988 Needs	Design Year 2008 Needs
I	Secondary Treatment	$20.2	$26.8
II	Advanced Treatment	3.9	5.0
IIIA	Infiltration/Inflow Correction	2.9	2.9
IIIB	Replacement/Rehabilitation	3.7	3.7
IVA	New Collector Sewers	10.9	13.8
IVB	New Interceptor Sewers	9.9	14.9
V	Combined Sewer Overflow	16.4	16.4
Categories I-V		67.9	83.5
Treatment Categories I and II		24.1	31.8
Categories I, II, IIIA, and IVB		36.9	49.6

Source: U.S. EPA. *1988 Needs Survey Report to Congress.*



Mike McCarthy

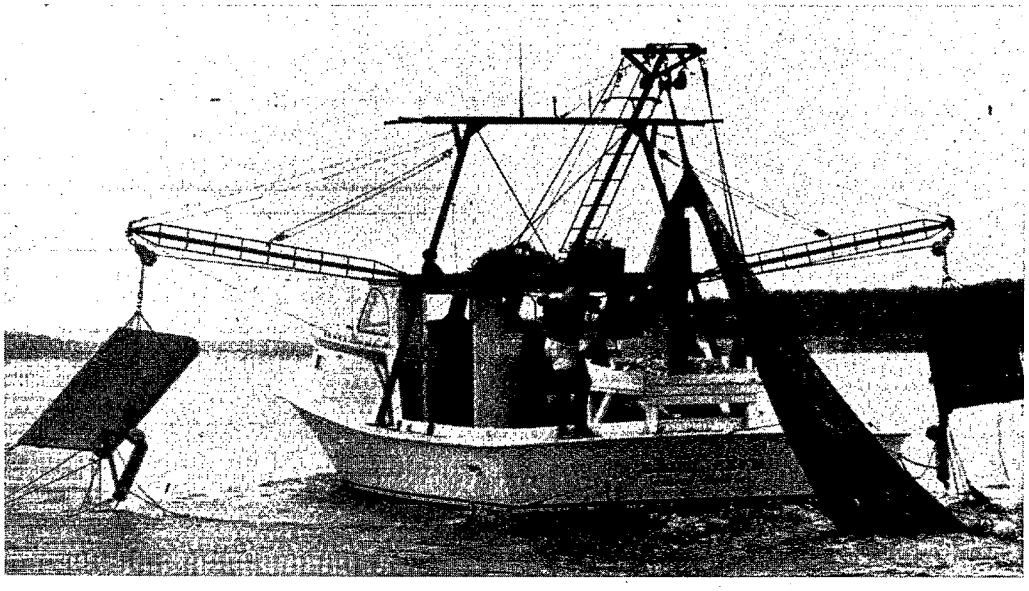
and rehabilitation for sewers, new collector sewers, and combined sewer overflows. These projects are typically ineligible for Construction Grants funding. However, because the Clean Water Act (CWA) allows a Governor to use up to 20 percent of the State's Construction Grants allotment on these projects, these needs are included. Needs for these latter three categories were $31 billion; thus, the aggregate for meeting current wastewater treatment needs is $67.9 billion.

"Design year needs" (current needs plus needs to serve the population through the year 2008) have also been included in this table. Based on Needs Survey data, $83.5 billion is required to meet all needs for the population through the year 2008. A number of national benefits could result if all needs were met. For example:

- The population receiving treatment or collection would increase by approximately 40 percent.
- National treatment capacity would increase by approximately 20 percent.
- The number of facilities providing secondary treatment or greater would increase by 25 percent, while the number of facilities providing less than secondary treatment would decrease by almost 100 percent.
- All facilities still discharging raw sewage would be eliminated or replaced.
- The removal of biochemical oxygen demand and total suspended solids would increase by approximately 75 percent and 60 percent, respectively.

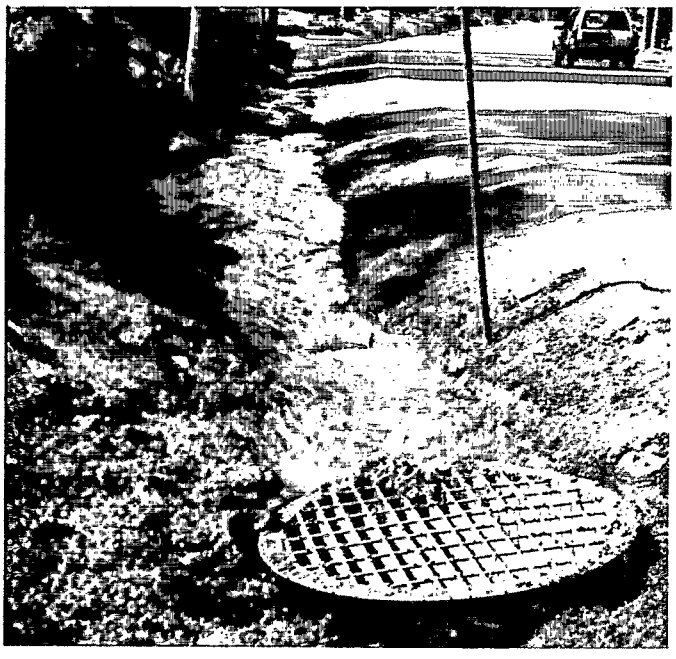
The 1987 Amendments to the CWA will affect many areas of wastewater treatment. For example, in those areas where waters are not meeting designated uses because of toxicity, States are required to determine the extent to which municipal facilities are contributing to the problem. If they are contributing, municipal facilities will be required to develop control strategies to reduce or eliminate toxicity to the greatest degree possible.

Sludge, the residual material from the wastewater treatment process, can also be a source of environmental pollution. Approximately 7.6 million dry metric tons of sludge are generated by the municipal wastewater treatment process every year. Pursuant to the 1987 Amendments, EPA is required to identify all toxic pollutants of concern in sludge, set



numerical limits for each pollutant, and establish management practices. Standards for sludge use and disposal are to be implemented through permits. The 1987 Amendments also direct EPA to impose conditions in sewage treatment plant permits or take other appropriate measures to protect public health and the environment from the adverse effects of pollutants in sewage sludge *prior to* the promulgation of the standards for sludge use and disposal.

The amendments also direct attention to stormwater management. A timetable was established for EPA to develop regulations for issuing permits for: (1) municipal stormwater sources serving more than 100,000 people and (2) industrial stormwater sources.



California Regulatory Water Quality Board

Stormwater runoff.

Perhaps the most significant item in the Amendments relating to municipal treatment was the provision creating a new financing mechanism for municipal wastewater treatment. In order to transfer financial responsibility for wastewater treatment from the Federal government to the States, Congress provided for the use of a State Revolving Fund (SRF) program as an alternative to the Construction Grant program. Federal seed money will be appropriated to the States to establish the loan program while the Construction Grant program is gradually being phased out.

Under the grant program, strict requirements limited how money could be spent. Funding was directed primarily toward upgrading or constructing treatment facilities, except for the Governor's 20 percent discretionary monies, which allowed funding for other types of projects. The SRF loan program provides States with much more discretion in selecting projects for funding. States are now able to finance projects they may consider to be of higher priority, such as nonpoint source, estuarine, combined sewer overflow, or stormwater control projects. Thirteen States had approved SRF programs in place as of January 1989.

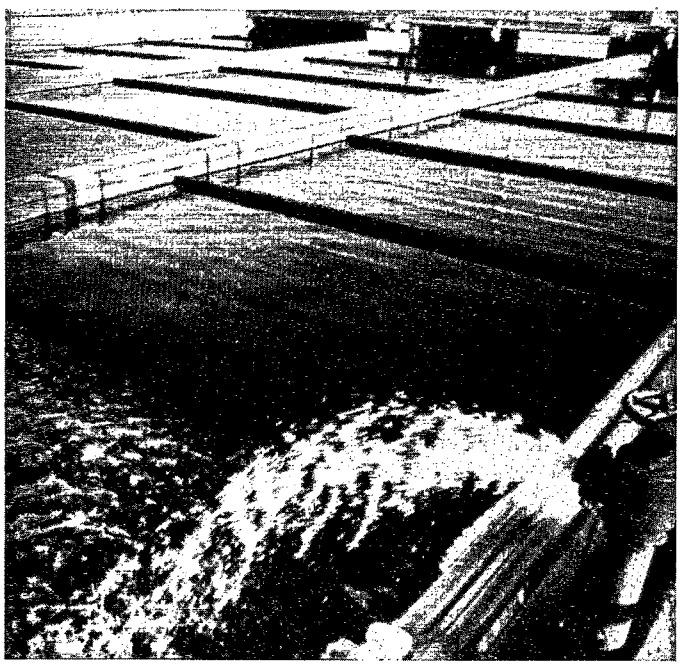
Treating Industrial Wastewater

The Clean Water Act required EPA to establish uniform, nationally consistent effluent limitation guidelines for industrial discharges. At this time, EPA has established Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) guidelines for about 28 industrial categories. EPA has also promulgated technology-based guidelines for approximately 15 additional secondary industries that represent Best Practicable Control Technology Currently Available (BPT) levels. EPA is studying an additional dozen industries for future guideline development.

In addition to these technology-based requirements, in 1984 EPA issued a policy on the water quality-based control of toxic pollutants discharged by point sources. In 1985, a technical guidance document was issued to support the national policy. Both the policy and guidance recommend using overall toxicity as a measure of adverse water quality impact and as a regulatory parameter. The use of toxicity testing as a regulatory tool is a relatively new concept, but, coupled with

chemical testing for pollutants that are hazards through bioaccumulation, provides a powerful means of detecting and controlling toxic problems.

States are making progress in developing the capability to assess and regulate toxic discharges using biological techniques. As of May 15, 1989, 20 delegated States required effluent toxicity monitoring by dischargers. Four States either required toxicity testing in over half of their major NPDES permits or had more than 50 permits with testing requirements; 489 permits included permit limitations on effluent toxicity; at least 496 major permits required effluent toxicity monitoring; and 2,424 permits required ambient field biological assessment.



Pretreatment

The goal of the National Pretreatment Program is to protect municipal wastewater treatment plants and the environment from damage that may occur when toxic or hazardous wastes are discharged by industries into a sewer system. This protection is achieved by regulating the wastewater discharged to municipal facilities from industrial or nondomestic users. The principal responsibility for administering the program lies with the municipalities that, by virtue of the size or environmental significance of their treatment works, must develop and receive approval to operate local pretreatment programs.

EPA and the States have begun evaluating municipal programs and have continued to enforce requirements for pretreatment among the estimated 50,000 significant industrial users (SIUs). Full implementation will significantly reduce loading of metals and organic toxic pollutants to municipal facilities, thus providing protection to publicly owned treatment works and receiving streams.

As of September 30, 1988, 1,429 local programs had been approved out of a total of 1,481. Of those remaining, 43 municipalities were recently identified and are on compliance schedules to develop local pretreatment programs. Eight other sewage treatment facilities have been sued to develop approvable programs and implementation.

Based on data reported by the control authorities, about 13 percent of the SIUs are significantly violating pretreatment requirements. This compares with a rate of 7 percent of the industrial majors in the NPDES program that discharge directly to waterbodies. The EPA has recently begun an enforcement initiative because 47 percent of the sewage treatment facilities are failing to implement the pretreatment program.

There are three types of pretreatment standards. **Categorical pretreatment standards** are developed for specific industrial categories and are based on an assessment of available treatment technologies and economic impact on the industry. EPA's 1986 Report to Congress on the Discharges of Hazardous Wastes to Publicly Owned Treatment Works (the "Domestic Sewage Study") projected a 94-percent reduction in total metals loadings to sewage treatment facilities after full implementation of categorical pretreatment standards for 30 industrial categories.

National prohibited discharge standards forbid certain types of discharges by any nondomestic sewage system users, regardless of whether or not these discharges are covered by categorical pretreatment standards. Discharges that are prohibited include those that create a fire hazard, have a pH less than 5.0, are solid or viscous enough to interfere with the operation

of the sewage treatment facility, or are hotter than 104° Fahrenheit.

Local limits, the third type of pretreatment standard, are established by sewage treatment facilities to address site-specific conditions. Local limits are numeric limitations implementing the national prohibited discharge standards. Where necessary to achieve pretreatment objectives, local limits are more stringent than categorical standards.

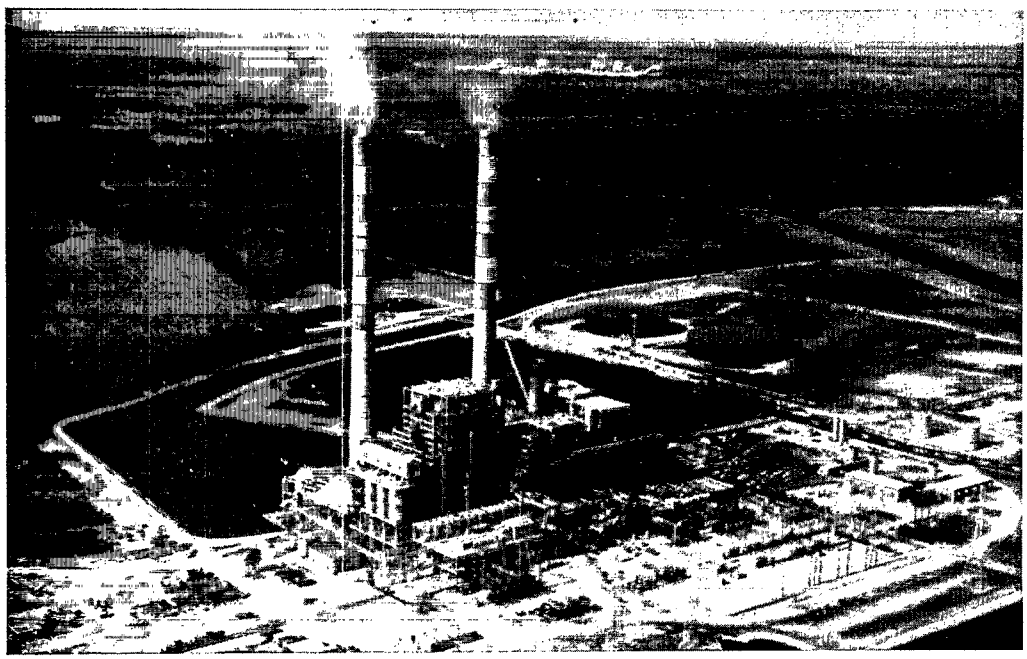
Pretreatment of toxic wastes has produced significant improvements in environmental quality, increased effectiveness of sewage treatment systems, and reduced contamination of sewage sludge. Pretreatment has also reduced the potential for sewage collection system and treatment plant corrosion, explosions, and worker hazards. For example:

- In the early 1960s, fish kills occurred regularly in Michigan's Grand River as the result of cyanide and heavy metals in the wastewater discharged by the Grand Rapids sewage treatment plant. Controls on industrial discharges of cyanide and metals were implemented in 1969. Since that time, concentrations of heavy metals have been reduced by over 90 percent in both incoming and treated wastewater.

- In the early 1970s, sewage sludge from Virginia's Hampton Roads Sanitation District showed high metals levels because of industrial discharges. The District began its sanitation program in 1972. By 1985, the quality of the sludge from eight of nine treatment plants had improved enough to allow land application.

- The City of Rockford, Illinois, decreased levels of cadmium, chromium, and zinc in treated wastewater by more than 85 percent after implementing local pretreatment limits and national categorical pretreatment standards. Toxic metal concentrations in the nearby Rock River declined by almost 50 percent.

The continued implementation of effective local pretreatment programs will achieve the environmental benefits envisioned by Congress. However, the task of the pretreatment program is far from complete. Such items as revising and/or implementing EPA regulations in response to recommendations of the Pretreatment Implementation Review Task Force (PIRT) and the Domestic Sewage Study (DSS), and following through



NC NRCD

with the National Enforcement Initiative still lie ahead.

The PIRT final rule was promulgated on October 17, 1988. The purposes of the PIRT revisions are to address deficiencies in the existing pretreatment regulations, respond to the recommendations of the PIRT Task Force, and make pretreatment regulations compatible with equivalent provisions of the NPDES regulations. The next task is to foster implementation of these new PIRT regulations in sewage treatment plant pretreatment programs.

On February 22, 1989, the comment period closed on the DSS regulatory revisions. These revisions were designed to implement the recommendations of the Domestic Sewage Study and ensure adequate control of hazardous waste discharges to sewage treatment plants through Clean Water Act programs. EPA expects to promulgate the final rulemaking in early 1990.

The National Enforcement Initiative has begun against sewage treatment facilities that failed to adequately implement their approved pretreatment programs. A schedule has been established to identify noncomplying facilities and to initiate appropriate enforcement action.

EPA is expected to promulgate sludge standards by late 1991 for the safe and beneficial use of municipal sludge. The application of increasingly stringent discharge standards governing toxic pollutants to municipal treatment plants is also expected. Where industrial or other nondomestic wastes are limiting a municipal treatment plant's sludge management practices or compliance with its discharge permit, the plant's pretreatment program will be the vehicle for achieving the necessary pollutant reductions.

Permitting

During the early 1980s, the rate of permit issuance fell behind the rate of permit expiration, and large backlogs of unissued permits developed. Efforts to remedy these backlogs have been largely successful. As Table 9-3 illustrates, the backlog of major unissued permits has been brought down to about 13 percent and the backlog of minors to about 32 percent.

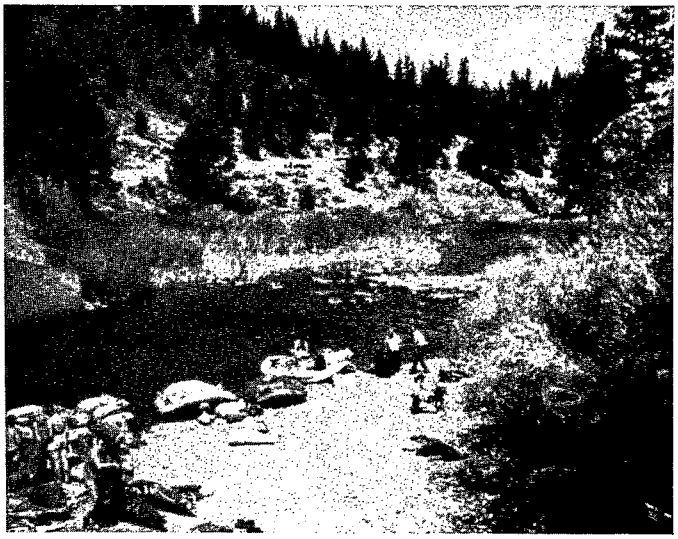
Compliance and Enforcement

Despite examples of water quality improvements associated with the construction and upgrading of municipal sewage treatment plants, 13 percent of major municipal facilities that have completed construction do not meet the requirements of their National Pollutant Discharge Elimination System permits. Industrial

Table 9-3. Status of Permit Issuance

	Major Permits	Minor Permits
Total Facilities*	6,986	51,089
EPA-Issued:		
Total	2,405	11,768
Expired	452	6,163
Percent	19	52
State-Issued:		
Total	4,581	39,321
Expired	430	10,267
Percent	9	26

*Note: Totals do not include 111 major and 4,308 minor "unknown" permits issued.
Source: Permit Compliance System, January 3, 1989.



California Regulatory Water Quality Board

permittees have achieved a higher rate of compliance and as of December 31, 1988, only 7 percent of the completed facilities are now unable to meet their final permit limits.

EPA and the States are responsible for ensuring that municipal and industrial facilities comply with the terms of their discharge permits. Currently, 39 States have approval to administer their own NPDES programs. EPA has the lead implementation responsibility in the remaining States. Along with the States, EPA monitors discharger compliance with permit limits. Facilities in noncompliance are subject to Federal as well as State enforcement action.

Table 9-4 illustrates rates of significant noncompliance, based on statistics maintained by EPA for the reporting period of June 1984 through September 1988. It is important to note that at the beginning of FY 1986, the NPDES program modified its definition of significant noncompliance to promote greater consistency and clarify what quantifiable and qualitative violations needed to be reported by the States. This redefinition included a strict interpretation of the resolution of significant noncompliance and a stronger emphasis on violations of reporting requirements and enforcement orders. As a result, rates of significant noncompliance increased during FY 1986.

Table 9-4. National Composite Rates of Facilities in Significant Noncompliance (in percents)

Quarter Ending	Non-Municipals	Municipals
12/31/83	8	19
3/31/84	10	20
6/30/84	6	14
9/30/84	6	13
12/31/84	5	12
3/31/85	5	13
6/30/85	5	10
9/30/85	5	9
12/31/85*	8	14
3/31/86*	8	16
6/30/86*	8	15
9/30/86*	7	14
12/31/86*	7	14
3/31/87*	8	13
6/30/87*	9	16
9/30/87*	7	14
12/31/87*	7	14
3/31/88*	7	16
6/30/88*	7	14
9/30/88*	6	12

*Reflects NPDES Rule Change.

The National Municipal Policy

Because of the generally poor municipal compliance record, and because of Congressional concern over the performance of treatment plants built substantially with Federal funds, EPA and the States developed the National Municipal Policy (NMP) to address the entire spectrum of municipal noncompliance. On January 23, 1984, the EPA Administrator signed the NMP into effect. The NMP clarifies and emphasizes EPA's resolve to ensure that municipalities comply with the Clean Water Act as quickly as possible, regardless of whether Federal grant assistance is available for treatment facility construction.

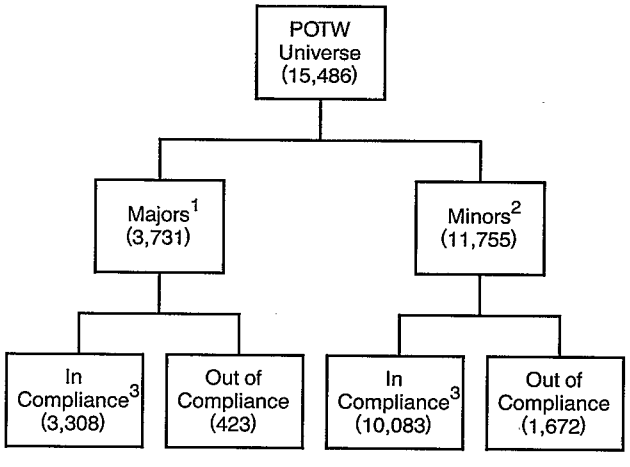
Steve Delaney

The NMP required EPA and the States to identify affected municipal facilities and their construction needs and to prepare individual facility action plans to bring these facilities into full statutory compliance by July 1, 1988. After the NMP took effect, EPA and the States identified about 1,500 major and over 2,000 minor facilities that needed some construction to meet requirements. A major municipal sewage treatment facility is one that discharges one million gallons per day or greater, or serves an equivalent population of 10,000.

In February 1986, EPA issued a revised Clean Water Act Penalty Policy for determining penalties that are appropriate for settlements. The principles of the policy have been adopted by States and accepted in several court decisions as equitable and logical approaches to assess penalties for violations of NPDES permit conditions.

Results of NMP efforts immediately following the July 1, 1988, deadline are displayed in Figure 9-1. Eighty-seven percent of all publicly owned sewage treatment plants met the deadline. Eighty-nine percent of all majors came into compliance under the NMP, and 86 percent of all minors achieved compliance. This represents increases in overall compliance of 28 and 7 percent for majors and minors, respectively. EPA is committed to continuing the drive for 100 percent compliance for all facilities.

In the 1987 Water Quality Act amendments to the Clean Water Act, EPA was given authority to seek administrative penalties from violators of the Clean Water Act. EPA issued guidance and delegated the authority to the regional level in August 1987. The first Administrative Penalty Order (APO) was issued in September 1987. Through January 1989, more than 175 APOs have been issued. These orders have addressed many individual violations, such as spills or isolated reporting violations, which had not been penalized in the past. The APO is filling an important niche in the overall enforcement scheme.



[1]Majors are facilities serving 100,000 or more people or treating 1 million gallons of wastewater per day.
[2]Minors are facilities serving less than 10,000 people or treating less than 1 million gallons of wastewater per day.
[3]"In compliance" means that the facility does not meet criteria for listing under the Significant Noncompliance Regulation.

Figure 9-1. Status of Compliance for Municipal Facilities (July 1, 1988)

New Initiatives in Point Source Control

Toxicity Testing

The States and EPA Regional offices are incorporating toxicity limits and toxicity testing requirements into permits. When toxicity testing shows a permittee's discharge contains toxicity at unacceptable levels, permit limitations and conditions require the permittee to reduce toxicity so that no unacceptable effects occur instream.

Toxicity reduction evaluations (TREs) are a way to identify and implement whatever actions are needed to reduce effluent toxicity to the levels specified in the permit. TREs combine toxicity testing, chemical analyses, source investigations, and treatability studies to determine either the actual causative agents of effluent toxicity and/or the control methods that will reduce effluent toxicity. EPA is currently documenting successful TREs conducted by permittees, States, and EPA researchers. Methods and procedures for conducting TREs are described in several EPA guidance documents.

In addition, EPA's *Permit Writer's Guide to Water Quality-Based Permitting for Toxic Pollutants* urges the use of an integrated toxics control strategy with both

whole effluent toxicity-based assessment procedures and pollutant-specific assessment procedures to uphold State water quality standards.

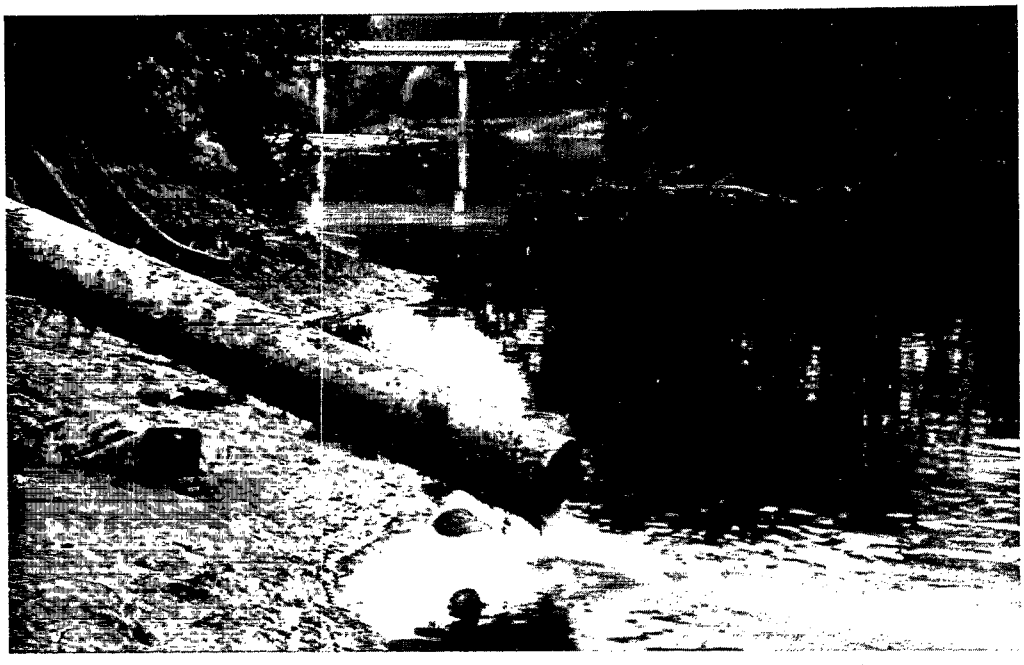
Sludge Management

The need for effective sludge management is continuous and growing. In the United States, the quantity of municipal sludge produced annually has almost doubled since 1972. Municipalities currently generate approximately 7.6 million dry metric tons of wastewater sludge per year, or approximately 32 kilograms per person per year. Improper sludge management could lead to significant environmental degradation of water, land, and air. Failure to properly dispose of sludge could have impacts on ground water and wetlands, as well as human health.

Prior to the 1987 amendments to the Clean Water Act, the authorities and regulations related to the use and disposal of sewage sludge were fragmented and did not provide States and municipalities with adequate guidelines on which to base sludge management decisions. There was no single legislative approach or framework for integrating the various Federal laws to ensure that sludge would be used or disposed of in a consistent or environmentally acceptable manner. While the Clean Water Act, the Clean Air Act, the Resource Conservation and Recovery Act, the Marine Protection, Research and Sanctuaries Act (MPRSA), and the Toxic Substances Control Act all regulate some aspect of sludge management, coverage is uneven, and the requirements are based on different methodologies and approaches.

Section 406 of the Water Quality Act of 1987, which amends Section 405 of the Clean Water Act, for the first time sets forth a comprehensive program for reducing the environmental risks and maximizing the beneficial uses of sludge. The program is based on the development of technical requirements for sludge use and disposal, and the implementation of such requirements through permits.

Pursuant to Section 405, EPA is developing regulations for each of the major use and disposal options for sewage sludge. These options include land application, incineration, landfilling, distribution and marketing, and surface disposal sites. EPA will ensure that these regulations also comply with other relevant statutes such



NC NRCD

The States and EPA are incorporating toxicity limits and toxicity testing requirements into permits.

as the Solid Waste Disposal Act. The first set of regulations, addressing 28 pollutants in sewage sludge, was proposed in February 1989. Development of a comprehensive set of disposal option regulations will give the States and municipalities a basis for making environmentally appropriate and cost-effective sludge management decisions.

In May 1989, EPA promulgated regulations for including sludge management conditions in NPDES permits and to issue sludge-only permits. These proposed rules also outline the requirements for State sludge management programs that seek EPA approval to implement the new statutory requirements. In addition, regulations that address sewage sludge disposal in municipal solid waste landfills were proposed in August 1988 and are scheduled to be promulgated in December 1989.

Combined Sewer Overflow Control

Large projects to mitigate the water quality impacts of combined sewer overflow (CSO) discharges have been undertaken in a number of municipalities. However, most CSO discharges are currently not addressed or are inadequately addressed in NPDES permits. In recognition of this, EPA issued the final National CSO Control Strategy in August 1989. The objectives of the strategy are to ensure that if CSO discharges occur, they are only as a result of wet weather; to bring all wet weather CSO discharge points into compliance with the technology-based requirements of the CWA and applicable State water quality standards; and to minimize water quality, aquatic biota, and human health impacts from wet weather overflows. The National CSO Control Strategy calls upon States to develop statewide permitting strategies by January 15, 1990, for the development and implementation of measures to reduce pollutant discharges from CSOs.

NPDES Stormwater Controls

Since 1972, State and EPA efforts under the NPDES program have traditionally focused on controlling pollutant discharges from publicly owned treatment works (POTWs) and industrial process wastewaters. As these sources of pollution came increasingly under control, the need for controlling pollutants in stormwater point source discharges became more critical to efforts to achieve the goals of the CWA. As reflected in this report, stormwater discharges from a variety of sources, including storm sewers discharging urban runoff, feedlot runoff, construction

Chesapeake Bay Foundation

The need to control pollutants in stormwater is becoming more critical as other sources come under control.

site runoff, runoff from resource extraction activities, and runoff from land disposal sites are major sources of use impairment. In addition, man-made stormwater drainage systems can directly or indirectly cause hydromodification impacts.

Prior to enactment of the Water Quality Act of 1987 (WQA), EPA had promulgated effluent guideline limitations for stormwater discharges from a number of industrial categories, including petroleum refineries, certain mining activities, and large feedlots. Section 405 of the WQA established a timetable and framework for EPA to address other stormwater discharges under the NPDES program by adding Section 402(p) to the CWA. On December 7, 1988, EPA proposed permit application requirements for discharges from municipal separate storm sewer systems serving populations of 100,000 or more, and for stormwater discharges associated with industrial activity. In the December 1988 notice, EPA proposed to address stormwater discharges from a number of industrial sources, including manufacturing facilities, mining activities, oil and gas facilities, certain construction activities, and land disposal sites that received hazardous and/or industrial wastes. EPA is also developing two stormwater reports to Congress. The first will identify stormwater discharges, and determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges. The second study is for the purpose of establishing procedures and methods to control stormwater discharges to the extent necessary to mitigate impacts on water quality. Based on the two studies, EPA is required to issue regulations by no later than October 1, 1992. These regulations are to designate additional stormwater discharges to be regulated to protect water quality and establish a comprehensive program to regulate such designated sources, including requirements for State stormwater management programs.

10

Nonpoint Source Control Program

Sections 208 and 303(d) of the Clean Water Act of 1972 established the framework for addressing nonpoint sources of pollution. Funds provided by EPA under Section 208 were used by States and local planning agencies to analyze the extent of nonpoint source (NPS) pollution and develop water quality management programs to control it. Best management practices were evaluated, assessment models and methods were developed, and other types of technical assistance were made available to State and local water quality managers.

In fact, under the Clean Water Act, as amended, States are granted primary authority to prevent and control nonpoint source pollution. Because of their very nature, nonpoint source problems are diverse and site-specific; States are closest to the problems, have the legal authority to regulate and control nonpoint sources, and are in the best position to weigh local needs and conditions.

Traditionally, then, EPA's role has been to provide program guidance, technical support, and limited funding to the States in their efforts to manage and control nonpoint sources. Various nationwide programs begun in the late 1970s with EPA sponsorship or cooperation have had significant results, including the Model Implementation Program, the Nationwide Urban Runoff Program, and the Rural Clean Water Program (RCWP). These projects were not comprehensive, but did result in some successes. (See "References and Further Reading" for a list of reports summarizing the results of these projects.)

Either as part of these nationwide projects or in addition to them, a number of States have made progress in reducing the impacts of

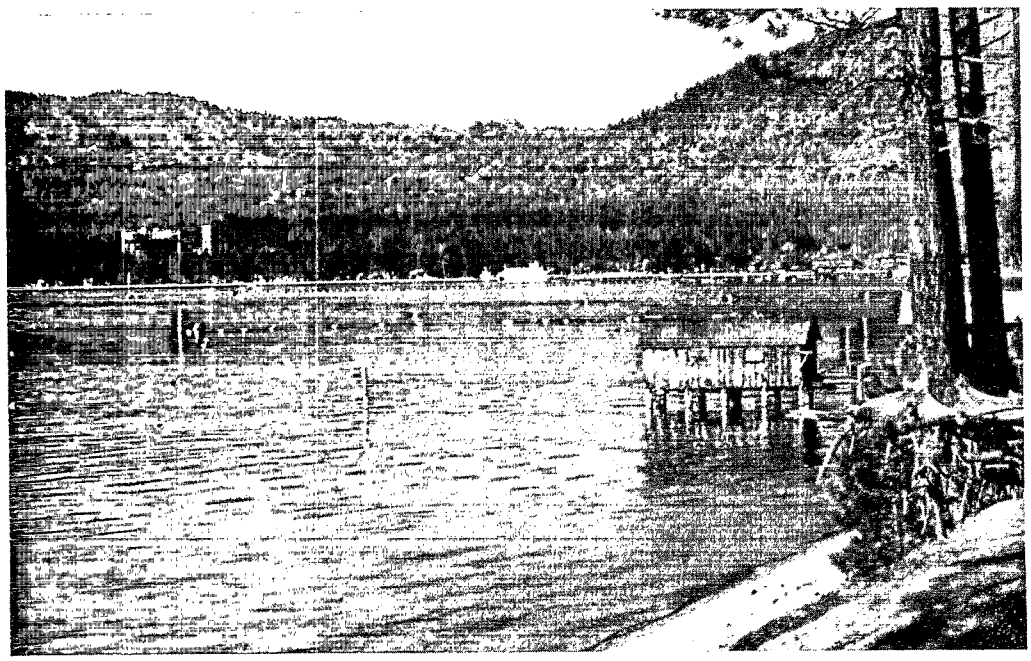
nonpoint sources in specific waters. Some highlights of these State nonpoint source activities are described below.

Urban NPS Control: The City of Baltimore, with assistance from EPA's Clean Lakes Program, retrofitted existing stormwater detention ponds for water quality purposes. Initial analysis of the quality of the water entering and leaving the modified basins indicates that the retrofit design removes over 90 percent of all particulate material and between 30 and 40 percent of total phosphorus. The low cost of the modifications and the high degree of sediment removal make this project a model for urban NPS control projects.

Other Clean Lakes projects, such as Lake Jackson (Florida), Iroquois Lake (New York), and Lake Hopatcong (New Jersey), have documented the effectiveness of retention and detention areas for runoff and stormwater control. In addition, other urban NPS controls, such as runoff and construction ordinances, have been demonstrated as effective in the South Fork Rivanna Reservoir (Virginia), Lake Ballinger (Washington), and Devil's Lake (Oregon).

Agricultural NPS Control: Through the Clean Lakes Program, the Illinois Environmental Protection Agency, in cooperation with various Federal and State agencies, demonstrated the effectiveness of watershed management in improving the water quality in Lake Le Aqua-Na. After implementation of all watershed management activities, sediment yields fell 57 percent from prerestoration levels. Continued monitoring of dissolved oxygen and visual examinations indicate that in-lake water quality is continuing to improve. Other Clean Lakes Projects recently completed (Green Valley Lake, Iowa; Spiritwood Lake, North Dakota; Panguitch Lake, Utah; Swan Lake, Iowa; and Broadway Lake, South Carolina) show water quality improvements as a result of agricultural NPS control activities.

Several RCWP projects have documented water quality improvements associated with agricultural NPS management. These projects include: Rock Creek, Idaho (irrigated agriculture); Taylor Creek, Florida (dairy management); Tillamook Bay, Oregon (dairy management); Highland Silver Lake, Illinois (soil erosion control); Prairie Rose Lake, Iowa (soil erosion control); and St. Albans Bay, Vermont (manure management).



Lake Tahoe Visitors Authority

In-place Pollutants: The State of Vermont, with assistance from the Clean Lakes Program, successfully demonstrated the treatment of phosphorus-laden, hypolimnetic sediment with alum and sodium aluminate to reduce internal phosphorus loading in Lake Morey. Two years of post-treatment monitoring documented a reduction in total phosphorus concentration ranging from 50 to 75 percent from pretreatment concentrations. Dredging, another technique that is used to abate in-place pollutant problems, was successfully used in Clean Lakes projects in Lake Lansing, Michigan, and Ada City Lake, Oklahoma.

State Program Activities: In addition to those activities described above, States have initiated or continued many activities for which water quality improvements are anticipated yet have not been measured to date. For example:

- The Massachusetts transportation bond bill authorizes $5 million for stormwater runoff grants to cities and towns.

- The new Chesapeake Bay Agreement calls for a 40 percent reduction of nitrogen and phosphorus loads to the Bay by the year 2000.

- Pennsylvania is promoting nutrient management techniques in 14 watersheds in the Susquehanna River basin.

- North Carolina's Agriculture Cost Share Program provides $7 million per year to share, with farmers, the costs of implementing best management practices.

- Illinois enacted a 5-year, $20 million component of the "Build Illinois" program for cost-sharing to enhance efforts to meet "T by 2000" goals established in 1985.

- Indiana established a "T by 2000" program that included a lake enhancement component. The program is funded from a dedicated tax on tobacco.

- Wisconsin adopted legislation in 1988 that created regulatory authority for nonpoint source abatement associated with severe water quality problems.

- Wyoming initiated a contract to test the effectiveness of best management practices in controlling channel erosion from irrigated lands in the Ocean Lake watershed.

The Water Quality Act of 1987

Based upon lessons learned from past and ongoing Federal and State NPS programs, Congress established a comprehensive framework for accelerated efforts to control NPS pollution. This framework was established as part of the Water Quality Act (WQA) Section 319 amendments of 1987. Major new requirements for States are that each State prepare and submit to EPA, by August 4, 1988, a nonpoint source Assessment Report and Management Program. The Assessment Report must identify State waters that will not attain or maintain water quality standards without additional nonpoint source controls; the categories of nonpoint sources or particular nonpoint sources responsible; the process to identify best management practices (BMPs) for each nonpoint source category or particular nonpoint source; and the State and local programs that would implement controls. The Management Program, covering a 4-year period, must identify the following: actual BMPs to address the problems documented in the Assessment Report and programs to implement the BMPs; sources and proposed uses of all nonpoint source control funding; and Federal programs and projects that States wish to review for consistency with their own nonpoint source programs.

The WQA provided several funding sources for implementing Section 319 Management Programs. Under Section 319, the WQA authorizes a total of $400 million from fiscal year 1988 to 1991 to be used for implementing approved Management Programs. However, no Section 319 funds have been appropriated to date. In addition, the WQA reserves under Section 205(j)(5) an additional 1 percent of each State's annual Construction Grant allotment to be used to prepare the Assessment Report and Management Program and to implement the Management Program. The WQA also makes implementation of approved nonpoint source Management Programs eligible for funding under the Governor's 20 percent discretionary set-aside of the State's annual Construction Grant allotment (Section 201(g)(1)(B)) and under the State Water Pollution Control Revolving Fund (Section 603(c)(2)). Both the 1 percent reserve and 20 percent set-aside depend upon Construction Grant funds that are not authorized for appropriation after fiscal year 1990.

In addition, as described in Chapter 9, the Water Quality Act of 1987 established new deadlines for the development of a permit program for stormwater discharges associated with industrial activities and municipal separate storm sewers. This new program will be used to address runoff from urban areas. The substantive requirements of these programs are still being evaluated.

Finally, EPA is required to provide annual reports to Congress on the States' progress in controlling nonpoint source pollution. At the end of the 4-year period provided by Congress for the States' initial Management Programs, EPA is further required to recommend programs (including enforcement) that are needed to control nonpoint sources sufficiently to attain and maintain water quality standards and the goals of the Act.

The State Section 319 Reports

The NPS Assessment Reports and Management Programs developed by the States under Section 319 are a critical element of EPA's national NPS program. They will be of great value in providing direction for NPS activities in the States, among other Federal agen-

cies, and within EPA; identifying NPS-related problems in all media (air, surface water, sediments, ground water) and assisting in setting priorities and targeting funds for their mitigation; identifying areas requiring stormwater discharge permits; developing management plans for national priority areas such as the Great Lakes, Puget Sound, and the Chesapeake Bay; and expanding NPS pollution control efforts to more fully address ground water, wetlands, estuaries, and coastal zones.

The NPS Agenda Task Force

In 1988, EPA initiated an NPS Agenda Task Force to lay out plans for its NPS activities for FY89-93. The Task Force was created to explore new, creative, proactive approaches to implementing the NPS provisions of the Water Quality Act of 1987. The Task Force established the following national NPS agenda goal:

> To protect and restore designated uses of the Nation's waters by providing strong leadership for the national nonpoint source program, and by helping States and local governments overcome barriers to successful implementation of NPS measures.

Other Federal agencies, private interest groups, and environmental groups were invited to comment on an early draft of the NPS agenda, and a widespread public comment period was held prior to deciding on the final Agenda. The Agenda focuses on the Section 319 State NPS Management Programs as the cornerstone of the national NPS program. Approved by the EPA Administrator on January 18, 1989, the Agenda includes the following general themes:

1. *Public Awareness*—Help States and local governments raise the level of public awareness about how NPS pollution affects water quality and their daily lives.

2. *Successful Solutions*—Provide States and local governments with information on practical, feasible solutions to prevent or control NPS pollution.

3. *Financial Forces and Incentives*—Examine the economic forces that drive behavior causing the NPS problem.

4. *Regulatory Programs*—Help States and local governments improve their capability to develop their own regulatory solutions.

5. *Good Science*—Develop the tools States and local governments need to establish sound water quality-based programs for NPS, particularly water quality criteria and monitoring protocols that are specifically designed to evaluate NPS controls.

New Directions

As part of the new initiatives brought about by Section 319, EPA's NPS program will work with the Agency's monitoring programs to develop and refine NPS assessment, analysis, and quantification techniques. EPA will also provide leadership for State and local information/education programs and define NPS research needs. EPA will work with the States to develop adequate water quality criteria for assessing NPS impacts and will work with various Federal agencies to identify where NPS concerns can be addressed within their regulatory, financial assistance, and technical support programs.

The President's Water Quality Initiative

President Bush recommended a new initiative for enhancing water quality in his 1990 budget proposal to the Congress, presented on February 9, 1989. The President's initiative defines a vigorous effort to protect ground and surface water from potential contamination by agricultural chemicals and wastes, especially pesticides and nutrients.

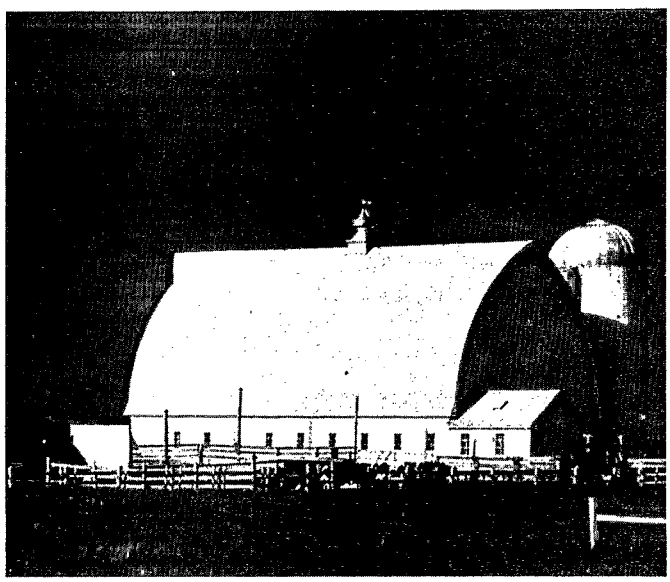
The primary goal of the Water Quality Program is to provide farmers, ranchers, and foresters with the knowledge and technical means to respond independently and voluntarily in addressing on-farm environmental concerns and related State water-quality requirements. The Administration plans to achieve this goal in a way that reduces the need for restrictive regulation and sustains an economical and safe supply of food and fiber.

The primary objectives of the multi-agency, multi-disciplinary plan for this program are to: (1) determine the precise nature of the relationship between agricultural activities and ground-water quality, and (2) develop and facilitate the adoption of technically and economically effective agrichemical management and agricultural production strategies to protect water quality.

The plan has three major integrated and interdependent functional components: (1) education and technical assistance; (2) research and development; and (3) data base development and evaluation.

The Administration's Water Quality Program supplements existing programs. Its distinction arises from its particular focus on agricultural chemicals and ground-water contamination, and the extensive degree of interagency coordination, collaboration, and program integration required to successfully achieve its goals.

A total of eight principal USDA Agencies and their cooperating State institutions and Agencies are collaborating with EPA, the US Geological Survey, and the National Oceanic and Atmospheric Administration in this program.



11

Loren Bahls

Surface Water Monitoring

EPA works with the States to monitor the quality of surface waters in the U.S. Under the Clean Water Act, States receive Federal grants to conduct water monitoring activities and report the results of their assessments to EPA. EPA, in turn, provides monitoring guidance and technical support to the States and sponsors special studies addressing issues of national concern.

There are two main approaches to water quality monitoring:

■ *Source monitoring* involves assessing the composition of industrial or municipal effluents discharged into waterbodies, and of the mixing zone where effluents merge with the receiving water. It may be conducted through self-monitoring by dischargers, compliance sampling inspections that check on discharger self-monitoring, or effluent characterization studies used by EPA to determine typical constituents of specific types of industrial dischargers.

■ *Ambient monitoring* involves all forms of monitoring conducted beyond the immediate influence of a discharge pipe. It can include water column, sediment, or biological sampling, and may be conducted through networks of fixed stations, special surveys, or statistically designed special studies.

States most often use a combination of fixed station networks and intensive surveys to conduct their ambient monitoring. At fixed stations, samples are repeatedly collected over time to provide an overview of water quality conditions and trends at specific sites. Intensive surveys are more detailed studies of water quality, sediments, and/or aquatic life

at specific sites or in relatively well-defined areas such as river basins. Special studies, such as EPA's Dioxin Study, are most often one-time surveys with a broad geographic coverage and a specific focus.

In addition, EPA encourages States to supplement their water monitoring activities with evaluations based on the best professional judgment of trained personnel and data such as mathematical models, citizen complaints, results of citizen monitoring, and surveys of fisheries personnel.

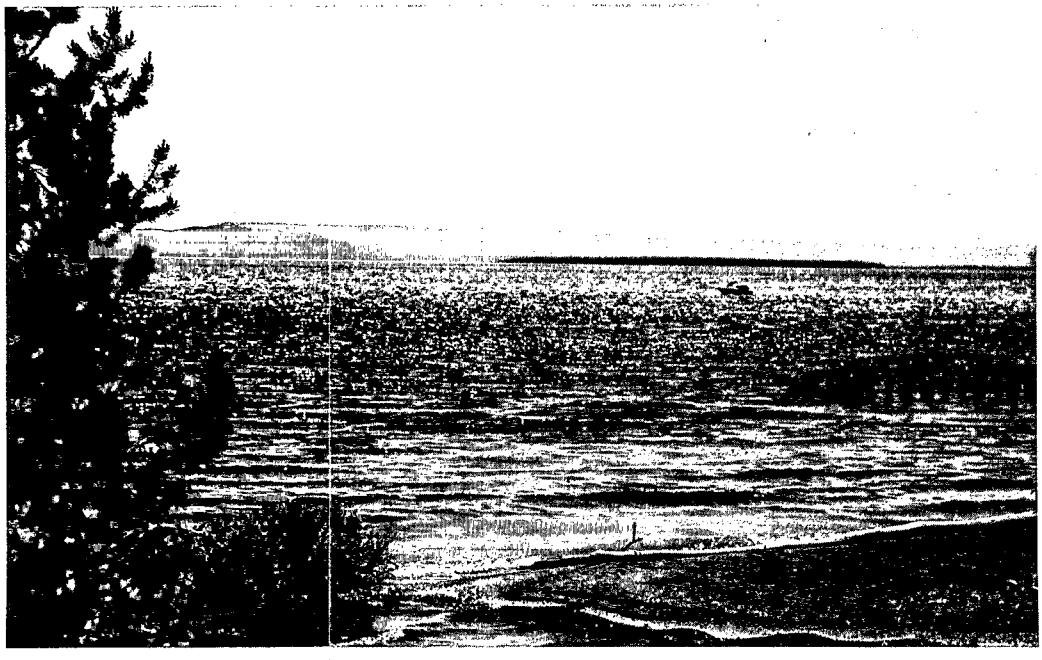
Goals of the Water Monitoring Program

The primary objectives of the surface water quality monitoring program are to: (1) characterize the quality of the Nation's water resources and identify problem waters; (2) support the development of water quality management priorities, plans, and programs; and (3) evaluate the effectiveness of pollution control actions.

Monitoring to characterize water quality should identify whether or not waterbodies meet EPA-approved water quality standards (criteria and designated uses) and the fishable/swimmable goals of the Clean Water Act. Ideally, monitoring to characterize ambient water quality also identifies specific pollutants, the sources of pollution, and any impacts such as fishing restrictions or fish kills. Results of ambient water quality monitoring are reported to EPA via Section 305(b) and other provisions of the Clean Water Act (e.g., Sections 303(d), 319, and 314).

Monitoring conducted in support of water quality management programs is used to establish or revise designated use categories in water quality standards, classify specific waterbodies as to their assigned designated uses, develop site-specific or State-specific criteria to support designated uses, and provide site-specific data to develop wasteload allocations for permit limits and nonpoint source controls, or determine compliance with pollution control requirements. In addition, ambient data and discharger self-monitoring data may be used in developing priorities for control, regulation development, or additional monitoring.

Monitoring to evaluate the effectiveness of pollution control actions, while not traditionally an emphasis in the water quality monitoring program, is becoming increasingly important. In general, this type of moni-



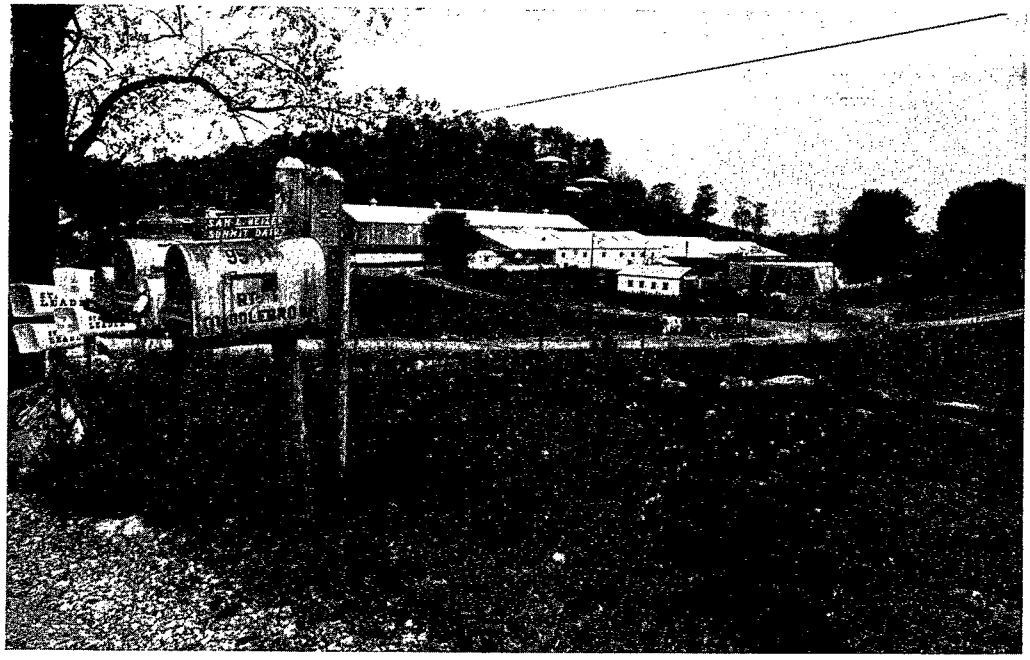
toring consists of "before-and-after" studies to document the effects of municipal construction or upgrades, watershed monitoring to assess the effects of nonpoint source management practices, or assessments of water quality problems at permitted dischargers.

The Need for Change

A number of concerns have been raised about the methods, capabilities, and direction of the surface water monitoring program. For example, comparatively little monitoring is currently aimed at detecting problems caused by diffuse sources of pollution such as agricultural runoff, in part because they are so difficult to identify. Similarly, monitoring for toxic substances in water, fish tissues, and sediment may not be sufficiently extensive in some States. Finally, more effort must be made to assess the ecological health of our water resources in order to adequately address nonpoint source-related problems and wetland preservation, as well as more traditional concerns.

In part, these deficiencies stem from the cost and complexity of monitoring. Nonpoint source loadings are often episodic and unpredictable, and may vary from long-term, low-level inputs to high-level, concentrated pulses. They may be associated with toxic and nontoxic pollutants, as well as with stresses that States have not traditionally addressed, such as habitat loss. Monitoring for toxic substances is limited by the high cost of laboratory analysis. In addition, a bewildering array of toxic substances can make their way into surface waters. Difficult to analyze toxicologically, their effects may be influenced by site-specific factors and exposure conditions, which in themselves are difficult to assess. Ecological monitoring is often limited by a shortage of skilled personnel in State monitoring programs.

Another reason that the monitoring program has not adequately addressed these issues is that monitoring has been principally oriented toward point source pollution problems. Historically, States relied on periodic sampling of water column chemistry at fixed stations to characterize water quality, identify problem waters, and determine trends. Fixed station monitoring was generally designed to measure the impacts of localized point sources of pollution and tended not to support conclusions about



USDA

upper watershed problems, assessment of habitat and ecological conditions, or detection of episodic problems. Further, most States are strongly oriented toward measuring conventional pollutants such as oxygen-demanding substances and nutrients, and have only recently begun to monitor for "priority pollutants" and use ecological assessment methods.

Surveys are also usually conducted to support point source control activities such as construction of wastewater treatment plants and permitting of major industrial and municipal dischargers. To a certain extent, more intensive surveys are now being conducted to aid in defining limits for toxic chemicals in industrial discharges and to support other point source control decisions. However, in order to conduct more intensive surveys, many States have had to reduce their number of fixed stations.

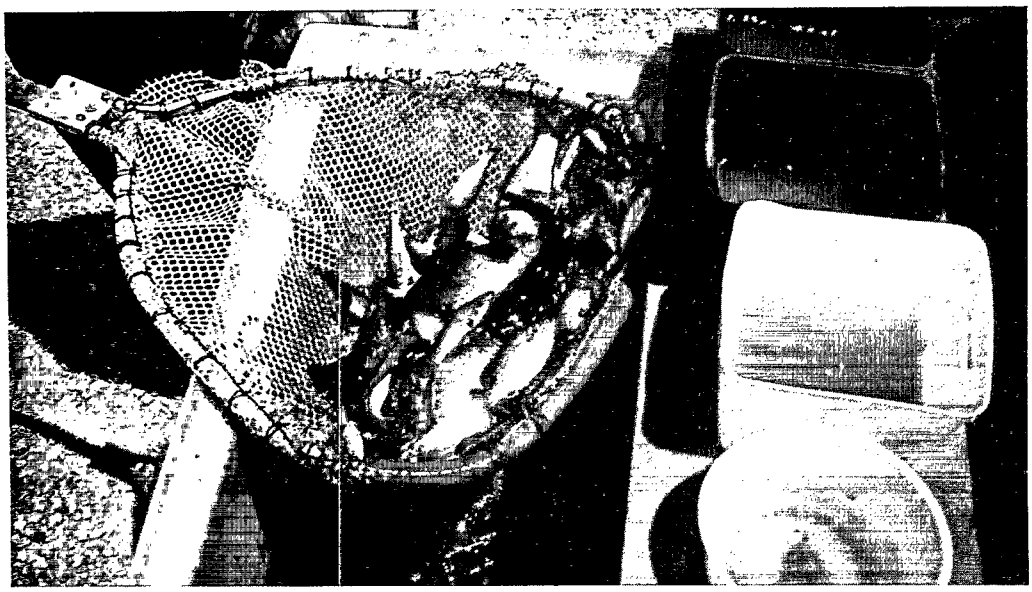
Despite these problems, the need for monitoring data has never been greater. The Water Quality Act of 1987 included new requirements for water quality information, particularly on toxic substances and nonpoint sources. According to the Act, States were to identify waters affected by these problems and develop control strategies or management plans to address them. New emphasis was also placed on increasing our understanding of lakes and estuarine/coastal waters.

At about the time of the passage of the Water Quality Act, EPA's Offices of Water and Policy, Planning, and Evaluation issued a major study of the Agency's surface water monitoring activities. This study, *Surface Water Monitoring: A Framework for Change*, evaluated the performance of the EPA and State water quality monitoring program.

The study identified numerous deficiencies in the monitoring program and recommended that EPA and the States:

- Develop guidance on designing scientifically sound, cost-effective assessment programs that make use of new and emerging approaches such as ecoregions, volunteer monitoring, and biological monitoring methods to complement traditional water chemistry techniques;

- Accelerate the development and application of promising biological monitoring techniques and evaluate the role that biological methods should play in monitoring programs;



Ed Rankin

A recent EPA study recommended accelerated development of biological monitoring methods.

■ Analyze the feasibility of requiring NPDES permittees to conduct ambient monitoring;

■ Improve their ability to document progress in water pollution control;

■ Centrally coordinate EPA activities to integrate water-related data; and

■ Make existing monitoring data more accessible and useful to water quality managers.

New Water Monitoring Initiatives

EPA recognizes that implementing the recommendations made in the "framework for change" study will enhance State/EPA capabilities to characterize problems, evaluate the effectiveness of water quality management actions, and promote the use of water data in decision-making. Therefore, EPA has developed a number of initiatives to implement the "framework" recommendations.

■ EPA is organizing regular national symposia to discuss technical and programmatic surface water quality issues and build consensus between States and the Federal government on ways to address them.

■ A Federal/State workgroup has been established to develop revised program guidance for monitoring activities and develop a 5-year framework to provide support to State programs.

■ EPA is developing a Nonpoint Source Monitoring and Evaluation Guide that outlines data needs, recommends monitoring approaches, and discusses analytical methodologies appropriate to the assessment of nonpoint source pollution.

■ EPA is also preparing a guidance document on developing volunteer monitoring programs within State monitoring programs. A second guidance document and a videotape are being developed for volunteer lake monitoring programs.

■ EPA is developing national policy statements on the role of ambient water quality information and on the more specific topic of the use of ecological assessments and biocriteria.

■ EPA is exploring ways to use "indicators" of environmental accomplishments to judge the effectiveness of its programs.

Villa Brewer

Indicators of environmental accomplishments will help EPA judge the effectiveness of pollution control programs.

■ EPA has developed rapid ecological assessment methods for wadeable streams. The methods manual has been published, training workshops are being held throughout the U.S., and a training videotape is being developed.

■ EPA has developed a data system to manage water quality assessment information. This system, the Section 305(b) Waterbody System, makes assessment information more accessible for management decision-making. The system also helps integrate the various assessments that are often developed by different agencies within the State.

■ EPA has initiated studies to examine methods used to determine designated use support and methods used to estimate total waters in a State. A Federal/State workgroup will be established to develop recommendations for these two issues.

■ EPA has established the Water Quality Data Systems Steering Committee to advise senior EPA management on direction for all data systems handling water quality information.

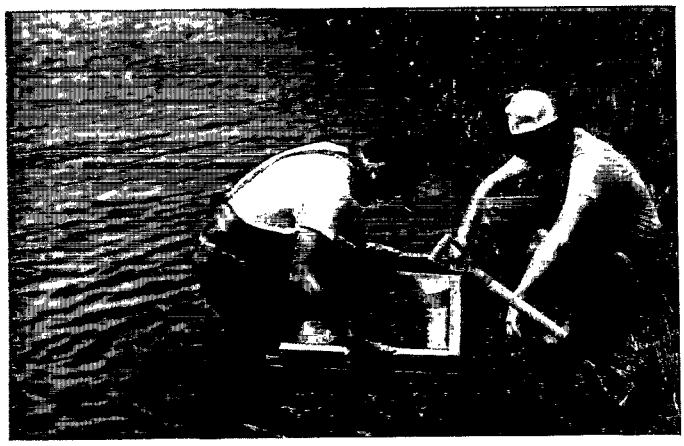
■ EPA has integrated several separate CWA assessments pursuant to 303(d), 319(a), and 314(a) with the State Section 305(b) reporting process. These assessments are to be coordinated with each other, and EPA has proposed rules to combine these assessments (especially 303(d)) through the biennial State Section 305(b) process.

■ EPA is encouraging States to supplement water column chemical criteria with criteria for water column toxicity, sediment quality, habitat quality, and biological quality.

■ EPA has conducted a feasibility study on requiring NPDES permittees to conduct ambient monitoring and the feasibility of imposing permit fees to fund monitoring. EPA is encouraging use of ambient monitoring in NPDES permits through program guidance.

Outlook for Water Quality Monitoring

By developing and implementing these new initiatives and continuing various successful current monitoring efforts, the monitoring program is moving from a fragmented, reactive approach to one with forward-looking objectives and the ability to meet the growing demand for ambient data. The ultimate goal is to develop an integrated monitoring program that serves as an early warning system in detecting emerging problems; effectively integrates data



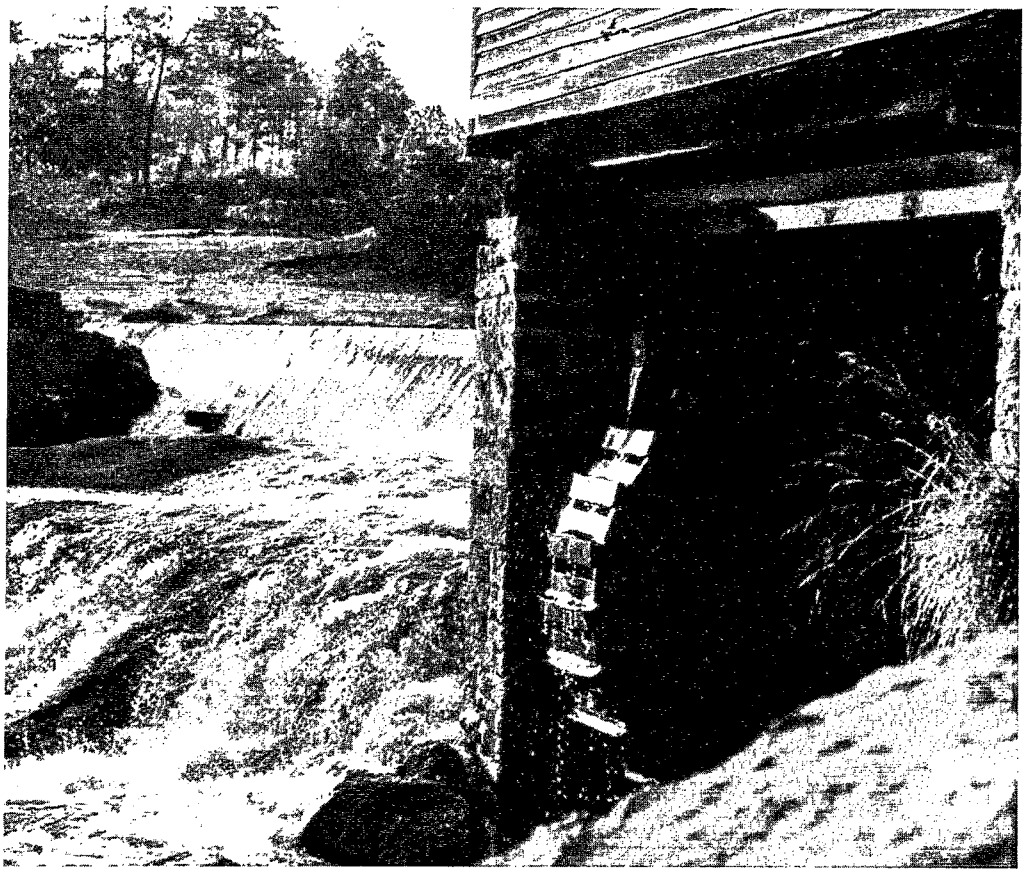
NCNRCD

J.L. Plafkin

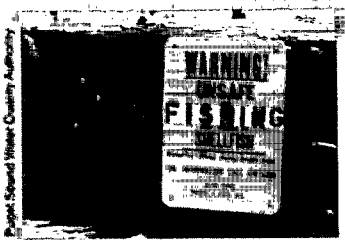
from a variety of sources, agencies, and monitoring approaches; analyzes these data and makes the data accessible to water quality managers at all levels of government; evaluates the effectiveness of control programs and tells us where we need to focus our pollution control resources; and fosters a sense of public ownership of our natural resources by involving citizens in identifying problems and working toward solutions.

We have already made progress toward this goal. For example, current monitoring programs such as EPA's Bioaccumulation Study are at the vanguard of efforts to characterize emerging toxic contamination problems; State and EPA activities under Section 304(l) of the Water Quality Act to identify waters with toxic impacts have shown that data from many sources can be successfully integrated; and many States have already demonstrated that citizens can provide valuable contributions to the assessment and decisionmaking processes.

EPA is committed to continuing this progress by implementing the new initiatives resulting from the "framework for change" study and helping States meet the challenges of the water quality management issues they face. Forging a strong working partnership among Federal authorities, State and local governments, and citizens is key to the success of this effort.



Al Peoples



Puget Sound Water Quality Authority

Citizen-Based Surface Water Monitoring

The field of water pollution control has become increasingly complex. While the regulatory focus of the 1970s was on controlling conventional pollutants from point sources, most current controls address conventional and toxic pollutants from point sources as well as from less defined nonpoint sources. These water quality problems are harder to identify and controls are more difficult to design and implement. Environmental managers are faced with increasing needs for monitoring information and decreasing resources to spend on data collection and analysis. In many areas of the country, citizen volunteers have been mobilized to collect some of this much-needed environmental data.

In May 1988, EPA and Rhode Island Sea Grant sponsored a workshop on the Role of Citizen Volunteers in Environmental Monitoring. The participants in this workshop identified approximately 37 active citizen monitoring programs that collect environmental data. Of these, 22 are designed to collect surface water data. The geographical distribution of these programs is shown in Figure 11-1.

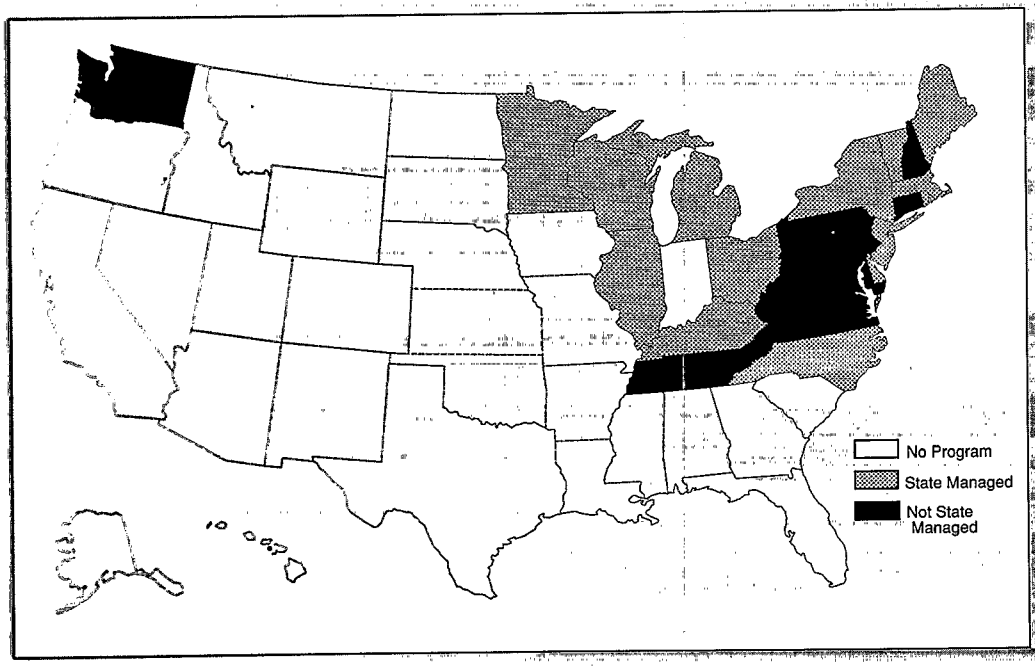


Figure 11-1. States with Citizen Monitoring Programs (CMPs)

Existing citizen monitoring programs cover a broad spectrum of waterbody types and use volunteers to collect data on a wide variety of water quality parameters. The programs fulfill three overall monitoring objectives: identification of long-term water quality trends, studies of specific water quality problems, and identification and resolution of acute water quality impairments.

1. *Monitoring to identify long-term water quality trends:* These programs use volunteers to collect water quality data at fixed stations on a regular basis over an extended time. Good examples of this overall type of program are volunteer lake monitoring programs.

2. *Monitoring to study specific water quality problems:* These programs use volunteers to collect water quality data at selected sites over a short time period. Data are used to address specific water quality issues such as acid inputs due to atmospheric deposition.

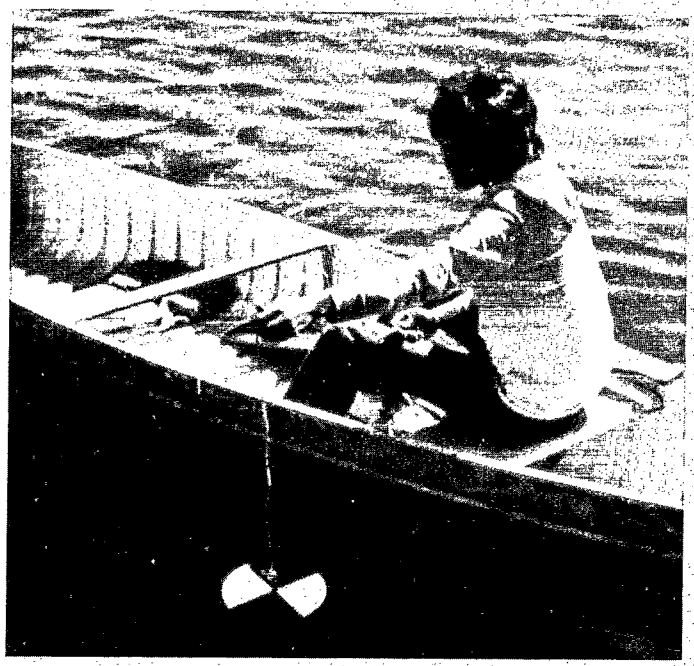
3. *Monitoring to identify and resolve acute water quality impairments:* These programs use

citizen volunteers to evaluate water quality conditions in their local areas and report on acute problems and violations of water pollution control laws and regulations.

An Emerging Area for Citizen Involvement—Nonpoint Source Pollution Assessment

Nonpoint source pollution is primarily caused by land use and misuse. Since land use is generally controlled at the local level, public awareness of NPS problems and their solution is considered critical to effective NPS management. Citizen monitoring and involvement programs can greatly assist in raising the level of public awareness, identifying NPS problems, and evaluating the effectiveness of controls. The contribution of citizens is especially significant since citizens often have a local knowledge of water resources and are familiar with stream conditions before, during, and after stream events; are familiar with land uses in their areas and can help identify specific sources of pollution; and have a vested interest in evaluating best management practices and monitoring their progress.

Volunteers measuring water clarity using a Secchi disk.



NALMS

Obstacles to Citizen Monitoring Efforts

Citizen monitoring efforts have been very successful in many areas of the country. However, a number of obstacles remain to be overcome, including the following:

- Professional distrust of volunteer data: Many water quality professionals are skeptical about using citizen-collected data despite evidence that volunteers can collect scientifically credible data.

- Mismatches between information needs and the capabilities of citizen volunteers: Managers of volunteer programs need to carefully select volunteers who can provide the type of information most likely to be accepted and used.

- Insufficient funding: Although citizen monitoring is cost-effective, adequate funding and management support are needed.

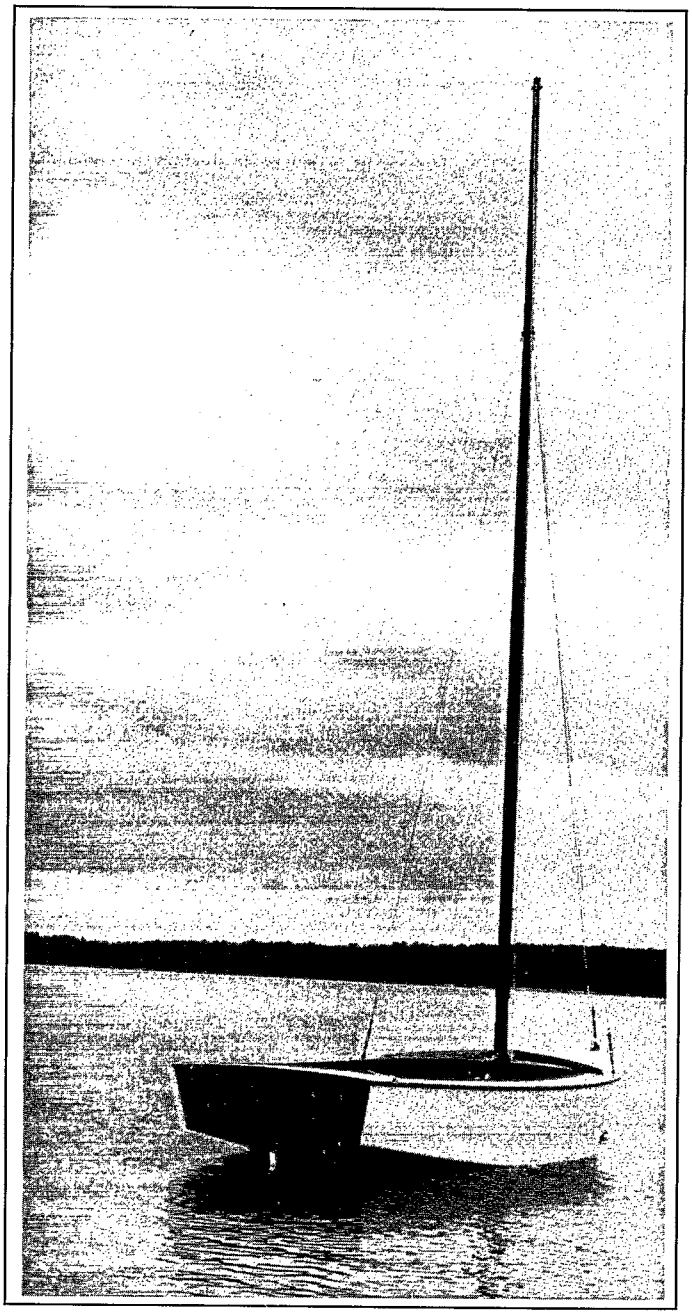
- Insufficient data sharing and coordination: Citizen monitoring programs must share data and techniques and coordinate their activities if they are to succeed.

EPA Support of Citizen Monitoring

EPA is actively researching existing citizen monitoring programs. A guidance document directed at State managers is being developed to provide information on how to start and manage a citizen monitoring program. EPA will also be writing a methods manual for citizen-based lake monitoring. Citizen monitoring is a central component of EPA's National Estuary Program and is also being incorporated into the nonpoint source program.

EPA has recognized the usefulness of citizen monitoring programs and will be working to further integrate these programs into its water pollution control efforts. As citizen monitoring activities grow in popularity throughout the U.S., EPA can and will help encourage and coordinate these programs to maximize their benefits to State monitoring programs.

12



Robert Beauchamp

Costs and Benefits of Pollution Control

Section 305(b) of the Clean Water Act calls for States to provide estimates of the economic and social costs necessary to achieve the objectives of the Act. States are also requested to report on the economic and social benefits of these achievements. This section draws upon information submitted by the States and additional information collected by other State and Federal agencies that address the costs and benefits of water pollution control.

Costs

In those instances where cost information is presented by States, most report the capital costs for wastewater treatment systems funded with State and Federal grants. This information does not include local and industrial expenditures for water pollution control or the costs of administering environmental programs at the local, State, and Federal levels. Therefore, more inclusive data, prepared by the U.S. Department of Commerce's Bureau of Economic Analysis, are shown in Table 12-1.

Government capital expenditures for water pollution control (primarily wastewater collection and treatment) peaked in the mid-1970s when the Federal government was heavily financing construction of sewage treatment facilities. Since 1982, government capital expenditures have begun to rise again as local governments have sought to meet the deadlines for compliance with secondary wastewater treatment guidelines. Estimated government expenditures on new capital rose to $7.7 billion in 1986—an increase of $0.8 billion since 1984. The cost of maintaining the growing

stock of wastewater treatment capital has contributed to the steady increase in government operating and maintenance expenditures from $3.4 billion in 1972 to $6.6 billion in 1986.

Capital expenditures by private industry peaked a few years earlier than did government capital spending in the 1970s, have continued to decline into the mid-1980s, but have leveled off at about $3.0 billion since 1983. Private industry operation and maintenance expenditures have risen at a rate comparable to that of government expenditures, although at a slightly lower aggregate level—from $2.7 billion in 1972 to $5.3 billion in 1986.

Expenditures on pollution control, defined here as the costs of private and government research and development, and government regulation and monitoring, have remained relatively constant since 1972. Private industry expenses have accounted for 50 to 60 percent of the total research and development annual expenditures, the remainder being primarily Federal research. Government expenditures for regulation and monitoring were split 50-50 between Federal and State/local in 1983, but in 1986 State and local governments were bearing 55 percent of these costs.

The results of a survey of State expenditures for environmental and natural resource programs in 1986 are presented in Table 12-2. The results have been summarized according to the per capita expenditures for water quality and quantity programs managed by States, and the percentage of total State funds allocated to these programs. The results indicate that State expenses for water quantity/quality programs range from less than $5 per capita to over $15 per capita. The table suggests that there is no apparent relationship between State expenditures for water quantity/quality programs and delegation of NPDES authority to States. States without NPDES authority do not tend to

Table 12-1. Spending for Water Pollution Abatement and Control (billions of constant 1986 dollars)

	Pollution Abatement								*Pollution Control*		
	Operation & Maintenance			*Capital*							
Year	Government	Industrial	Other*	Government	Industrial	Other	Nonpoint Controls	*Total Abatement*	Research & Development	Regulation & Monitoring	*Total Abatement & Control*
1972	3.4	2.7	0.2	8.1	3.7	2.3	2.1	22.6	0.4	0.4	23.3
1973	3.8	3.1	0.3	8.5	4.1	2.4	2.4	24.5	0.5	0.5	25.4
1974	3.9	3.1	0.5	9.5	3.8	1.9	1.9	24.6	0.4	0.6	25.6
1975	4.0	3.3	0.6	10.6	4.8	1.5	1.6	26.2	0.4	0.6	27.2
1976	4.3	3.7	0.5	11.0	5.2	1.6	1.7	28.1	0.4	0.6	29.0
1977	4.8	4.1	0.5	11.0	5.0	1.8	1.1	28.3	0.4	0.7	29.4
1978	5.2	4.3	0.6	11.9	4.9	2.2	1.8	30.7	0.4	0.7	31.8
1979	5.4	4.6	0.6	11.5	4.5	2.0	1.8	30.5	0.4	0.7	31.5
1980	5.5	4.5	0.3	10.5	4.2	1.7	1.6	28.3	0.4	0.7	29.4
1981	5.8	4.6	0.2	8.1	3.7	1.5	1.4	25.3	0.4	0.7	26.3
1982	6.1	4.4	0.3	7.2	3.5	1.5	1.4	24.3	0.4	0.6	25.3
1983	6.1	4.7	0.5	6.2	3.0	1.7	1.2	23.5	0.3	0.4	24.3
1984	6.0	4.9	0.5	6.9	3.0	2.0	1.3	24.6	0.3	0.4	25.3
1985	6.0	5.0	0.7	7.1	2.9	2.0	1.2	25.0	0.3	0.5	25.8
1986**	6.6	5.3	0.6	7.7	2.9	2.0	1.2	26.3	0.3	0.5	27.1
Totals	76.9	62.3	6.9	135.8	59.2	28.0	23.6	392.8	5.4	8.6	406.8

*Consists largely of spending for private connections to public sewer systems.
**Preliminary.

Note: Pollution abatement and control expenditures cover: direct pollution abatement expenditures by industry, household, and governmental units for reduction of point and nonpoint source discharges; regulation and monitoring expenditures by government for activities that "stimulate and guide action to reduce pollutant emissions"; and research and development expenditures to support abatement and increase the efficiency of regulation and monitoring.

Source: Kit Farber and Gary Rutledge. "Pollution Abatement and Control Expenditures, 1983-1986," *Survey of Current Business*, May 1988, p. 22.

Jim Platt

Table 12-2. Distribution of 1986 State Expenditures for Water Quantity/Quality Programs

	Percent of State Budget Allocated for Water Programs*			
	Less than 0.1%	**0.1% to 0.2%**	**0.2% to 0.3%**	**Greater than 0.3%**
Less than $5 expended per capita	Arkansas** Hawaii	Georgia Texas** Ohio Kentucky S. Carolina Minnesota W. Virginia New York	Indiana Oklahoma** Iowa Alabama N. Carolina Kansas Connecticut Nevada Louisiana**	Pennsylvania Nebraska
$5 to $10 expended per capita			Colorado New Mexico** Arizona**	Vermont Illinois Virginia Maine** Wyoming Utah Mississippi Maryland Tennessee Florida** Missouri Washington
$10 to 15 expended per capita				Michigan N. Dakota
Greater than $15 expended per capita				Oregon Rhode Island Massachusetts** Idaho** Delaware New Hampshire** New Jersey Montana California Wisconsin Alaska** S. Dakota**

*Expenses expressed as a percentage of total State expenditures for all services in 1986 fiscal year. Expenditures for water quality and quantity include drinking water, marine and coastal programs, watershed management districts, water quality, and water resources. Other categories may serve to improve water quality, but they were not included (e.g., mining reclamation, land management, soil conservation).

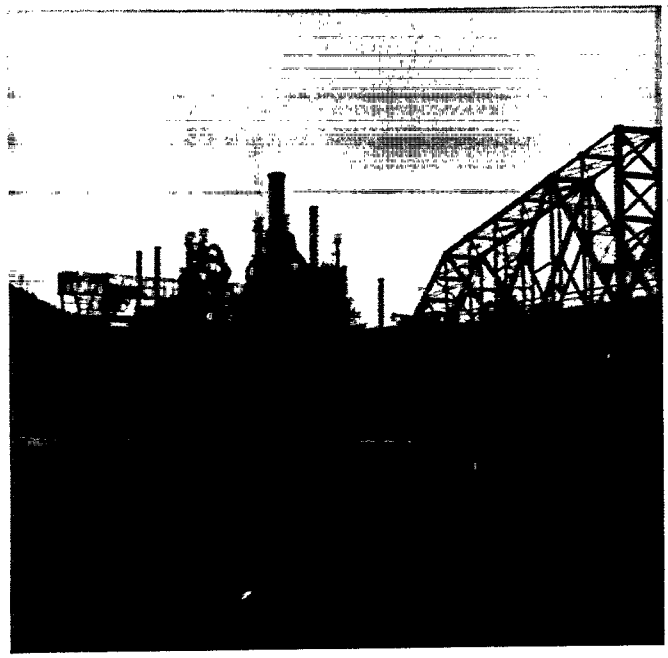
**States to which NPDES delegation had not been granted by 6/30/86.

Source: *Resource Guide to State Environmental Management*. Council of State Governments: Center for the Environment and Natural Resources, 1988.

spend less on water quantity/quality programs than do States with NPDES authority.

As States assume a greater proportion of the regulation and monitoring responsibility and the many new requirements of the 1986 Amendments to the Safe Drinking Water Act and the 1987 Amendments to the Clean Water Act, the administrative expense of their expanded water pollution control programs will increase greatly. A report prepared by EPA, using State needs figures generated by the Association of State and Interstate Water Pollution Control Administrators and the Association of State Drinking Water Administrators, estimated the costs of operating State water programs in the wake of this new legislation. Table 12-3 provides an estimate of 1988 State water quality program expenditures for activities managed by States. Total current (1988) annual expenditures are estimated to be $429 million for all State water programs. Surface water quality programs, which include monitoring, permitting, enforcement, and other activities, cost $316 million. The remaining $113 million is spent to manage State drinking water programs. Ground-water resource protection programs occur in both areas.

The incremental State expenses of meeting new and expanded water program requirements as a result of recent legislative amendments are projected to total $559 million for the 3 years between 1988 and 1990 combined. The largest incremental costs are projected for drinking water, ground water, nonpoint sources, pretreatment, and control of toxic substances.



Mike McCarthy

Benefits

Although economic costs can be readily described, calculating the economic value of water quality improvements presents a greater challenge to local, State, and Federal authorities. Many States have prepared descriptive information on chemical and biological improvements in water quality or reductions in physical pollutant loadings from industrial, municipal, and nonpoint sources. Few have chosen to translate these changes into economic values. As a result, comparisons of the economic costs and benefits of water pollution control programs cannot yet be made at the national level.

Selected local projects, often involving a single or homogeneous class of pollution sources (e.g., wastewater treatment outflows, agricultural runoff), constitute the few instances where economic benefit-cost analyses have been performed. While useful as a tool for aiding local decisionmakers on water quality projects and demonstrating methods of valuing environmental improvements, these studies can only serve as anecdotal evidence of the potential total economic benefits that have accrued as a result of past efforts to achieve the fishable and swimmable water quality goals of national and State environmental legislation.

In the few instances where States reported on economic benefit-cost studies performed to support a water quality program, benefits were shown to exceed the costs of the program. Several States acknowledge that the growing sums of money spent on pollution control have led to a greater demand for benefit-cost information. The incremental costs of recent programs aimed at reducing even greater amounts of water pollution loadings carry a higher price tag than did efforts undertaken in the early 1970s. Furthermore, the shift in the burden from Federal funding sources to State and local sources will likely serve to promote the

Table 12-3. Distribution of State Water Quality Program Expenditures 1988 and 1988-1990 Estimated Incremental Needs (millions 1988 dollars)

Category	States' Base Program: 1988	States' Incremental Needs: Total for 1988-1990
Water Quality Management		
Emergency Response	$ 10	
Enforcement	43	
Indians	0	
Monitoring/WLA	54	
Nonpoint Sources	5	
Permits	46	
Pretreatment	10	NOTE: Breakdown
Program Management	30	into program categories
Sludge	0	not available.
Stormwater	0	
Wetlands	0	
Water Quality Planning	17	
Water Quality Standard	10	
Groundwater Strategy	8	
ASIWPCA Additional*	70	
Other**	13	
Subtotal Water Quality Management	316	289
Drinking Water		
Public Water Systems	98	158
Underground Injection	15	23
Wellhead Protection	0	89
Subtotal Drinking Water	113	270
Total Surface Water and Drinking Water	$ 429	$ 559

*The Water Quality Management needs numbers are from the original EPA needs estimates. The "ASIWPCA Additional" number reflects ASIWPCA's estimate of the additional money States spent in the 1988 base program.

** "Other" includes various water pollution-related activities that do not fit into the above categories, such as shellfish protection, public participation, office automation, etc.

Source: "State Funding Study," EPA Office of Water, May 1989.

development and implementation of economic benefit valuation techniques.

In their 1988 State Section 305(b) reports, several States cited water quality improvements that have been associated with economic benefits. For example:

■ In Connecticut, the Connecticut River has enjoyed a resurgence in commercial and recreational activities compared to conditions that persisted in the late 1960s. Hartford attracts a larger number of tourists to its waterfront festivals since providing municipal sewage treatment to sources discharging to the river. Excursion boats now operate on the river, and commercial and sport salmon and shad fisheries are returning. The quantity of shellfish harvested in Long Island Sound has also increased in comparison with 1970 harvests.

■ In New York, several of Lake Erie's tributaries now have large runs of coho and chinook salmon and steelhead trout. Smallmouth bass are now able to use these waters as spawning grounds. Improvements in these streams are attributed to reductions in municipal sewage and food processing wastes. Skaneateles Creek, once so polluted that fish could not survive in its waters, is now one of the prime trout streams in the State. Similar success stories have helped contribute to the massive direct and indirect impact of anglers on the economy.

■ In Vermont, visitors to St. Albans Bay Park are now using the park for swimming after a 10-year hiatus due to poor water quality. The city's sewage treatment plant has been upgraded, and agricultural nonpoint source management practices are in use to control runoff. Resultant water quality improvements have increased bayfront property values, enhanced recreational opportunities, and reduced maintenance costs to facilities relying on water from the lake. A study by the U.S. Department of Agriculture's Agricultural Research Service found that the quantified benefits exceeded the costs by a ratio of 1.3 to 1. Neither point nor nonpoint control measures individually would have had a benefit-cost ratio greater than 1.0, but together they provided the necessary improvements to water quality conditions in St. Albans Bay.

■ In West Virginia, the sport fishing industry is recovering in the Ohio, Kanawha, and Monongahela Rivers. This improvement, in turn, contributes to improvements in other forms of water-based recreation such as boating, water-skiing, and swimming. Mount Storm Lake's pH and its fishery have been enhanced at minimal cost because of a permit variance granted to the Virginia Electric Power Company.

These and other examples in the State Section 305(b) reports qualitatively document water quality improvements and enhanced uses of the Nation's waters. In time, States will be able to prepare water quality assessments that systematically address the benefits and costs of water quality improvements. At that time, a more useful national assessment of the economic benefits of water quality programs can be conducted. Until then, we must rely on case studies and qualitative discussions of water quality improvement to evaluate the merits of the dollars spent on water pollution control.

Washington's Centennial Clean Water Program

Some States have developed innovative programs to help finance the costs of water pollution control activities. An example of such a program is the State of Washington's Centennial Clean Water Program. In 1986, the State legislature created the Centennial Clean Water Fund, a source of financial assistance—raised through a tax on tobacco products—for water pollution control projects. The legislature has authorized $45 million per year through 2021 to support projects such as the construction of sewage treatment facilities and the reduction of combined sewer overflows or stormwater discharges to marine waters; prevention or reduction of ground-water pollution; lake protection and restoration activities; control of nonpoint sources of pollution; public education; and innovative projects.

The Centennial Clean Water Fund forges a partnership between State and local government. The State provides financial assistance and experienced guidance; the recipient—usually a county, city, conservation district or other political subdivision—administers the project and provides the "local match" (cash, labor, and in-kind contributions). The local share may be financed through taxes, bond sales, formation and assessment of Local Improvement Districts, fines and penalties, or a variety of other methods. Projects are rated based on such factors as the seriousness of the problem they are to address, local support for the project, and the nature of the project (i.e., preventive, corrective, or both).

Washington's Centennial Clean Water Fund provides an innovative, effective approach to the financing of pollution control activities. By helping local communities meet water quality, health, and safety requirements, the State has taken a crucial step in protecting its rivers, lakes, marine waters, and ground water for current and future generations.

13

State Recommendations

In their 1988 reports, 26 States and Territories discussed recommended program actions needed to make additional progress toward the Clean Water Act's goal of fishable and swimmable waters. These recommendations are often expressed in terms of State objectives or continuing needs and cover a range of actions at the Congressional, Federal, State, and local levels. These recommendations are discussed below. It should be emphasized that this discussion is restricted to the recommendations reported by the States themselves in 1988 and does not attempt to assess their merits. However, many of the State recommendations for action also reflect EPA program priorities.

A theme common to almost all State recommendations is insufficient funding to carry out burgeoning State water quality protection responsibilities. For example, Louisiana writes:

"New program requirements for the State such as the toxics program, Clean Lakes, and the nonpoint source program will require a shift of limited resources from already critically short areas. While it is agreed that such programs are beneficial and needed, the decisions of where to concentrate manpower and where to set priorities are extremely difficult. There have been increases in grant conditions from the Federal government and increased expectations from the people of the State in the area of water quality management as public awareness has increased. However, there has been little or no increase in funding and no increase in manpower resources. Increased funding and expanded

staffing will be necessary in order for the State to meet the demands and requirements being placed upon it."

In general, State recommendations fall into nine major categories. Ranked by the frequency with which they are reported, these categories are nonpoint source abatement, water quality monitoring, municipal facilities, toxics identification and control, water quality criteria and standards, ground-water protection, lake protection, data management/coordination, and wetlands protection. Other topics less frequently cited by the States include pretreatment, permitting and enforcement, combined sewer overflows, and sludge management.

Nonpoint Source Abatement: Recommendations most often cited by the States concern the identification, prevention, and control of nonpoint sources (NPS) of pollution. Most commonly, States cite the need for additional funding for NPS programs and the need for better monitoring and assessment methods to detect NPS, assess their impacts, and determine the effectiveness of NPS controls. Several States also indicated that they are in the process of developing and refining NPS Management Plans and recommend that additional funds be made available to carry out the goals of those plans.

NCNRCD

Water Quality Monitoring: Beyond expressing a general need to enhance water quality monitoring activities and the evaluation of them to be certain they are providing needed data, a common theme of State monitoring recommendations was to increase the emphasis on biological monitoring. Specifically, States recommended developing or adopting bioscreening techniques, biotic indices, biosurvey methodologies, bioassay techniques, and in-stream macroinvertebrate biomonitoring. Other monitoring recommendations include seeking EPA and State support to expand toxics monitoring programs, increase long-term intensive survey efforts, and study cause/effect relationships in the environment.

Municipal Facilities: Continued funding for the maintenance, upgrade, and construction of municipal sewage treatment facilities remains a leading recommendation of the States. Several States cite problems with proper operation and maintenance of older sewage treatment facilities. Several States also recommend the use of State Revolving Loan Funds to finance the construction of facilities as Federal/State funding ends under the Construction Grants program. Another recommendation concerns the untreated direct discharge of household sewage in areas that are too economically depressed to shoulder the cost-share burdens of the Construction Grants program. This can be a significant water quality/public health concern in certain areas. EPA is urged to provide assistance to help meet these sewage treatment needs.

Identification and Control of Toxic Substances: The States strongly recommend expanding efforts to gather data on toxic pollutants and to develop or implement State toxic control programs. Specific recommendations include more monitoring for toxics in fish tissue; improvement of Federal data bases on toxic substances; establishment of an EPA clearinghouse for literature reviews such as risk assessments conducted by the States; and greater use of toxicity testing results in establishing effluent limitations.

Water Quality Criteria and Standards: The States' ability to assess water quality conditions depends heavily on criteria (limits) for specific pollutants, established by the States and approved by EPA. When these criteria are violated, beneficial uses may not be met. Together, the criteria and the uses they protect form the State's

water quality standards. A number of States recommend updating their standards by taking such actions as adopting numerical criteria for toxics or developing more specific use designations and appropriate criteria. Federal leadership was urged in continuing to refine and develop criteria for substances causing risks to human health. EPA was also encouraged to continue its research on better criteria for contact recreation uses.

Ground-Water Protection: Clear priorities many States and Territories have expressed are to gain a better understanding of the quality of their ground water, to identify and map their ground-water resources, to identify potential sources of contamination, and to determine the vulnerability of their resources to pollution. The States recommend continued collection and analysis of ground-water data. Their recommendations include the establishment of a national ground-water research program; more Federal funding to allow States to expand ground-water monitoring, management, and standards development; and action by EPA to incorporate ground-water quality data into existing computerized data bases.

Lake Protection: The States strongly recommend that Congress appropriate funds to support the Clean Lakes Program. States cite the need for additional data on lake water quality conditions and trends, expanded reporting requirements under Section 314 of the Clean Water Act, and vulnerability of lakes to acid deposition.

Data Management/Coordination: EPA and the States are actively engaged in developing computerized data management systems to handle a wide range of water quality and program information. A common State recommendation is to integrate and enhance these various data bases. States also urge more effective coordination among State, local, and Federal agencies to better address diverse environmental problems such as wetlands protection, hazardous waste disposal, agricultural runoff, and fish tissue contamination.

Wetlands Protection: A number of States call for increased effort in protecting valuable wetland resources. Specific recommendations vary from the need for additional Federal appropriations for wetland protection to better enforcement by the Corps of Engineers of permitted and unpermitted activities in wetland areas.

Montana Dept. of Health and Environmental Sciences

References and Further Reading

In addition to the 1988 State water quality assessments, the following documents were cited in this report and are recommended for further reading.

Council of State Governments, Center for the Environment and Natural Resources. 1988. *Resource Guide to State Environmental Management.*

Farber, Kit, and Gary L. Rutledge. 1988. Pollution abatement and control expenditures, 1983-1986. In: *Survey of Current Business.* May.

North Carolina State University, U.S. Environmental Protection Agency, and U.S. Department of Agriculture. 1988. *Rural Clean Water Program: 1988 Workshop Proceedings.* National Water Quality Evaluation Project. December.

U.S. Environmental Protection Agency. *Ground-Water Protection Strategy, 1984.* Office of Ground-Water Protection.

U.S. Environmental Protection Agency. 1983. *Results of the National Urban Runoff Program.* Office of Water. December.

U.S. Environmental Protection Agency. 1987. *Permit Writer's Guide to Water Quality-Based Permitting for Toxic Pollutants.* Office of Water. Publication No. EPA-440/4-87-005. July.

U.S. Environmental Protection Agency. 1987. *Surface Water Monitoring: A Framework for Change.* Office of Water and Office of Policy, Planning and Evaluation. September.

U.S. Environmental Protection Agency. 1988. *America's Wetlands: Our Vital Link Between Land and Water.* Office of Wetland Protection. Publication No. OPA-87-016. February.

U.S. Environmental Protection Agency. 1989. *Needs Survey Report to Congress, 1988.* Office of Municipal Pollution Control. Publication No. EPA 430/09-89-001. February.

U.S. Environmental Protection Agency. 1989. *Nonpoint Source Agenda for the Future.* Office of Water. January.

U.S. Environmental Protection Agency. 1989. *Report to Congress: Activities and Programs Implemented under Section 319 of the Clean Water Act, FY 1988.* Office of Water. Publication No. EPA-506/9-89/003. August.

U.S. Environmental Protection Agency. 1989. *Report to Congress: Water Quality of the Nation's Lakes.* Office of Water. Publication No. EPA-440/5-89-003.

U.S. Environmental Protection Agency. 1989. *State Funding Study,* Office of Water. May.

U.S. Environmental Protection Agency. U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers. 1989. *Federal Manual for Identifying and Delineating Jurisdictional Wetlands.* January.

U.S. Fish and Wildlife Service. 1984. *Wetlands of the U.S.: Current Status and Trends.*

U.S. Fish and Wildlife Service. 1987. *Mid-Atlantic Wetlands: A Disappearing National Treasure.* June.

U.S. Geological Survey. 1988. *1986 National Water Summary.* Water Supply Paper 2325.

Appendix

Alabama

To obtain a copy of the Alabama 1988 305(b) report, contact:

Alabama Department of Environmental Management
Planning and Projects Branch
1751 Cong. W. L. Dickinson Drive
Montgomery, AL 36130

Surface Water Quality

During the reporting period, Alabama assessed 11,174 miles of streams, 491,566 acres of lakes, 53 square miles of estuaries and 50 coastal miles. Approximately 91 percent of river miles assessed were found to be fully supporting their designated uses, 82 percent of lake acres were fully supporting their designated uses, 94 percent of estuary square miles were fully supporting uses, and all of the ocean coastal miles were fully supporting uses.

Alabama also conducted an assessment of the extent to which its waters support the fishable/swimmable goal of the Clean Water Act. Eighty-nine percent of assessed river miles, 82 percent of assessed lake acres, 94 percent of estuary square miles, and all of ocean coastal miles were found to be meeting the fishable/swimmable goal.

The main causes of nonsupport of designated uses were determined to be excessive levels of nutrients and organic enrichment leading to depleted levels of dissolved oxygen. Inadequately treated effluents from municipal discharges, industrial discharges, and nonpoint source runoff appear to be leading sources of pollution in the State.

A significant concern to the State is lack of information on lakes, estuaries, and wetlands. Lack of National Clean Lakes funding has hampered the State's ability to develop a reservoir monitoring program; a preliminary assessment of lake water quality was provided in this 1988 report, and Alabama has applied for Clean Lakes funding to improve future assessments. The State is also planning to increase its data-gathering capabilities for estuarine and wetland areas.

Ground-Water Quality

Currently, Alabama does not have a comprehensive ground-water quality monitoring network. Available information based on a limited ground-water monitoring network of 77 wells indicates that the overall quality of ground water in Alabama is good. The only problems indicated by the current monitoring data are localized instances of highly mineralized water and one instance of saltwater intrusion. Volatile organic sampling of 113 public ground-water supplies in 1985 found only six wells with detectable concentrations of organics; these were well below recommended safe levels of exposure.

Presently, Alabama responds to ground-water concerns under general statutory authority provided by the Alabama Water Pollution Control Act. While existing problems can be addressed fairly effectively in this manner, there is a need for a more coordinated approach to specific sources of potential ground-water contamination. Items outlined by the State as concerns or objectives to be incorporated into their ground-water management program are: (1) response to instances of ground-water contamination; (2) development of a State ground-water strategy; (3) additional statutory authorities, where needed; (4) implementation of a ground-water classification system; and (5) addition of new, related regulations under the Alabama Water Pollution Control Act.

In addition to these initiatives, vulnerability assessments for major aquifers in the State have been completed. This information will be incorporated into the classification effort and implementation of the overall ground-water management plan.

Arizona

To obtain a copy of the Arizona 1988 305(b) report, contact:

Office of Emergency Response and Environmental Analysis
2005 North Central Avenue
Phoenix, AZ 85004

Surface Water Quality

During water years 1986-1987, 2,279 river miles were assessed in Arizona, 34 percent of river miles with water quality standards. Of the river miles assessed, 69 percent fully supported designated uses while 21 percent did not meet standards. The largest segment (297 miles) not meeting criteria was the Little Colorado and Purco Rivers. These rivers are contaminated with radiochemicals and heavy metals. The lower Salt and Gila Rivers (110 miles) do not meet uses because of pesticide contamination in addition to metals and other inorganics.

Because of Arizona's extreme aridity, its wetlands are particularly valuable aquatic resources. A substantial proportion of the State's wetlands were destroyed by overgrazing, wood-cutting, mining, water diversions, and construction activities. Arizona is beginning to address wetlands issues through the Statewide Comprehensive Outdoor Recreation Planning Process.

Ground-Water Quality

Ground-water quality is a major concern in Arizona because it is the State's principal source of public water. The four most documented sources of ground-water contamination are leaking underground storage tanks, septic tanks, agricultural practices, and wastes from high technology industries.

Four Active Management Areas (AMAs) were defined in the 1980 Ground Water Management Act to encompass geographic areas where ground-water supplies are imperiled. These AMAs comprise the populated areas of Phoenix, Tucson, Pinal, and Prescott. Common sources of contaminants within the AMAs include leaking underground storage tanks, septic tanks, agriculture, mining, and high technology industry. Major causes of pollution contributed by these sources include petroleum hydrocarbons, nitrates, coliforms, pesticides, sulfate, metals, and volatile organic compounds VOCs).

Arizona has completed a preliminary ground-water protection strategy that contains background information on the goals and statutory framework for ground-water protection, ongoing and future ground-water program activities, and interagency coordination. The basis for the goals is to protect public health; preserve, enhance, and protect water quality; provide minimization, prevention, mitigation and remedies of past, present, and future potential discharges to aquifers; protect surface waters which are fed by, or discharge, to aquifers; and prohibit discharge of toxic pollutants to aquifers.

Arkansas

To obtain a copy of the 1988 Arkansas 305(b) report, contact:

Arkansas Department of
Pollution Control and
Ecology
Water Division
8001 National Drive
Little Rock, AR 72209

Surface Water Quality

For this reporting period, Arkansas assessed 4,107 miles of streams, which represents 36 percent of the State's total river miles. Approximately 42 percent of assessed river miles fully support their designated uses.

In its 1988 305(b) report, the State provided regional assessments of water quality. Water quality in the Delta Region is significantly influenced by agricultural runoff. The vast majority of waterways in this region have been channelized for agricultural development and therefore have impaired uses. The Gulf Coastal Region exhibits site-specific impacts due to resource timber extraction. Silviculture is the predominant land use in the Ouachita Mountains Region; the region is characterized by exceptionally high water quality although concerns have been voiced about the effects of harvesting practices. In the Arkansas River Valley Region, zero flows are common during summer critical conditions. During peak runoff events, contaminants enter the Region's streams from agricultural sources. The Boston Mountains Region is highly used for recreational purposes and has extremely good water quality. Potential water quality degradation is of concern because of conversion of hardwoods to pasturelands, expansion of confined animal operations, timber management practices, and localized natural gas production. Lastly, in the Ozark Highlands Region, water quality problems are directly related to the high rate of animal management activities such as chicken, swine, and cattle operations. The waste from this animal production is generally land-applied and therefore has the potential to contaminate both surface and ground waters.

Ground-Water Quality

Use of ground water in the 1980s has varied between four and five billion gallons per day. About 93 percent was for agricultural use, 2 percent for industrial use, 2 percent for municipal use, 2 percent for rural domestic use, and 1 percent for thermoelectric energy. Fifty-five percent of the population depends upon ground water for drinking water and domestic use.

Contamination of shallow domestic wells and springs by human and animal wastes is the most prominent ground-water problem in the State, as evidenced by high nitrate concentrations. Some surficial aquifers have been contaminated by industrial wastes which include both heavy metals and organic chemicals; some of these are being monitored under the Superfund and RCRA programs.

Contamination of fresh ground water by saline water has occurred in several places due to large-scale pumping. Continued large-scale pumping has the potential to increase contamination. In some areas, the occurrence of saline water appears to be of natural origin and not the result of human activity. Some saltwater contamination in south Arkansas is due to oil and gas exploration, production, and disposal practices.

Ground-water levels are declining in large areas of the State where pumping rates exceed recharge rates. Ground-water levels in the Sparta Sand aquifer have declined as much as 320 feet in the vicinity of El Dorado, as much as 225 feet in the vicinity of Magnolia, and as much as 60 feet in the vicinity of Stuttgart. The greatest decline in the alluvial aquifer has been in Poinsett County, where water levels at one point are

almost 120 feet below land surface—a decline of some 70 feet since the early 1900s when it was first used as an irrigation source.

Potential ground-water problems are found statewide. Potential threats to ground water include a large number of waste impoundments, landfills, and open dumps, especially those located in moderate to high aquifer recharge zones. Contamination from waste impoundments, storage tanks, and dumps has occurred. Hazardous substances transported by vehicles and trains have been involved in accidents resulting in ground-water contamination. The potential for leaks and accidents is always present.

California

To obtain a copy of the 1988 California 305(b) report, contact:

California State Water
Resources Control Board
Division of Water Quality
901 P Street
Sacramento, CA 95801

Surface Water Quality

Over three-fourths of California's assessed stream miles and half its lake acres are classified as having water quality that generally supports designated uses. Some of the largest waterbodies not supporting uses in the State include harbors, bays, and lagoons in the San Diego Region (15,300 acres); Clear Lake in Lake County (44,000 acres); and the Salton Sea (220,000 acres).

Pollution sources in streams not fully supporting uses include agriculture, abandoned and active mines, and other nonpoint sources such as urban runoff, erosion, individual disposal systems, and animal grazing. The remaining stream pollution sources consist of point sources and natural or unknown causes.

Lakes are mostly affected by natural causes and agricultural return flows. Municipal and industrial point sources are prohibited from discharging directly to lakes in California.

Point sources and nonpoint sources are about equal contributors of pollution in harbors and bays. Urban storm runoff and erosion are major nonpoint pollution sources in San Francisco, San Diego, Newport, and Mission Bays.

Trends in water quality reflect the above concerns and indicate that California surface waters have improved or been protected from overall degradation due to point sources. There do not appear to be significant changes in the overall quality of marine and estuarine waters, although major improvements in bacterial quality have been noted in Humboldt/Arcata Bay, portions of San Francisco Bay, and San Diego Bay. However, a significant increase is noted in the detection of toxic pollution.

Major pollutants affecting waters of the State include bacteria, nutrients, dissolved solids, pesticides, herbicides, other toxic organics, and metals. Toxic substances are now recognized as a constantly expanding threat to water quality. Toxic substances have been, and probably still are, dumped illegally into community sewer systems, municipal landfills, vacant lands, and surface waters. California is moving aggressively to address the toxic pollution issue with new legislation, more severe penalties, and new programs.

The State identifies the following as statewide issues of concern: ground-water pollution, hazardous waste disposal sites, pollution of harbors and bays, agricultural impacts on water quality, and mine drainage.

Ground-Water Quality

The water in California's underground basins and the storage space in these basins are among the State's most valuable resources. About 40 percent of California's annual applied water needs is obtained from ground-water basins. Apart from the Central Valley, the greatest concentrations of ground-water withdrawals are in southern California and in the Santa Clara and Salinas Valleys. Most cities in the San Joaquin Valley are supplied entirely by ground water, and ground water is a significant part of the public supplies in southern California and the Santa Clara Valley.

Less than 2 percent of the ground waters assessed have water quality classified as not supporting designated uses; however, about half of the State's ground-water resource is of unknown water quality. Areas with the most numerous and widespread ground-water problems are the San Francisco Bay Region, the Central Valley Region, and the three South Coastal Regions of Los Angeles, Santa Ana, and San Diego. Naturally occurring poor quality ground water is fairly common throughout the Lahontan Basins and in the Colorado River Region.

Pollution of ground-water supplies can occur from many sources. These include individual disposal systems, solid and liquid waste disposal sites, underground chemical storage tanks, surface spills of toxic substances, applications of agricultural chemicals, urban runoff, deep injection well disposal, and other as yet unknown sources. About 12 percent of the identified ground-water pollution is from industry, including military installations and railroad centers. A high incidence of contamination from organic solvents is noted. Agriculture and other nonpoint sources contribute pesticides, nitrogen, and dissolved salts. Stormwater runoff used for ground-water recharge is also a toxic pollution source.

Colorado

To obtain a copy of the Colorado 1988 305(b) report, contact:

Colorado Department
of Health
Water Quality Division
4210 East 11th St.
Denver, CO 80220

Surface Water Quality

Colorado has 14,100 miles of streams, nearly all of which are classified under State water quality standards. A total of 4,600 stream miles have been or are being routinely monitored, and 5,400 have been evaluated by special studies as to their chemical and biological quality. Of these assessed streams, 86 percent fully support uses, 7 percent are partially impaired, and 7 percent are not supporting uses.

There are roughly 149,000 acres of lakes in Colorado; 124,746 lake acres were assessed and nearly all are reported to be fully supporting designated uses.

Man's activities have affected water quality in the South Platte River more than any other major river basin in Colorado. Exceedances of water quality standards for dissolved oxygen, unionized ammonia, fecal coliforms, and metals have been identified within the basin. Phosphorus, nitrates, and dissolved solids concentrations in parts of the basin are generally among the highest in the State. Total suspended solids concentrations, however, are comparatively low.

Water quality in the Arkansas River basin reflects early mining activity in the Leadville area, burgeoning population in the middle basin, and agriculture in the lower basin.

Overall, the quality of water in the Colorado River mainstem basin and its main tributaries is probably the best in the State. This quality has been maintained through the investment of considerable manpower and fiscal resources into the basin since the early 1970s.

There are several stream segments in this basin that reflect Colorado's early mining history. These streams have high metal loads and some do not support aquatic life. The most likely parameter to exceed standards is copper and much of this loading is likely due to natural causes. The other metals known to be high on various segments in the Colorado River mainstem basin are lead, zinc, and cadmium.

The San Juan basin has high quality water except for the Animas River in its headwaters near Silverton. Because of previous mining activities, high metals loads in the mainstem and several tributaries have significantly affected their ability to support aquatic life.

Metals impairment of several stream segments in the Rio Grande basin are that basin's only identified water quality problem. No water quality problems have been identified in the Republican or Green River basins.

Connecticut

To obtain a copy of the Connecticut 1988 305(b) report, contact:

Connecticut Department of
Environmental Protection
Water Compliance Unit
122 Washington Street
Hartford, CT 06106

Surface Water Quality

As of 1988, 582 of Connecticut's 880 miles of major rivers and streams fully support water-quality goals. An additional 239 miles partially support goals. The remaining 59 miles do not support most water uses, other than perhaps limited aquatic habitat use, navigation, and industrial activities. Major sources of water-quality impairment are municipal sewage treatment plants, toxic and conventional pollutants from industrial discharges, combined sewer overflows, and nonpoint sources.

The most heavily impacted estuaries in the State are the urbanized harbors and tidal portions of major tributary rivers. Approximately 234 of the 601 square miles assessed are suspected of having water-quality problems. The sources of pollution, in descending order of relative impact, are: municipal sewage treatment plants; combined sewer overflows; toxic and conventional pollutants from industrial sources; and nonpoint sources, such as failing septic systems and urban runoff.

The Department of Environmental Protection is an active participant in the Long Island Sound Water Quality Study, which began in 1985. The magnitude of the Sound's problems are being researched, pollution sources identified, and a management plan and mathematical model of the entire Sound are being developed.

There are 69 major recreational lakes having public access in the State. The most common water-quality concern in these lakes is growth of nuisance weeds and algae caused by nutrient enrichment. Nutrient conditions in impaired lakes are attributed to natural sources and a variety of nonpoint sources such as household wastewater systems, surface runoff, land development, and highway runoff. The State's eutrophication abatement program has resulted in meaningful water-quality improvements for 37 percent (by area) of the lakes assessed. These efforts will soon be supported by a new State grant program for lake restoration established by recent legislation.

Less than 1/10 of 1 percent of Connecticut's 17,500 acres of tidal wetlands have been filled since implementation of the Connecticut Tidal Wetland Act in 1969. A State permit program regulates activities in tidal wetlands, with very little filling authorized.

Ground-Water Quality

Approximately 32 percent of the population depends on ground water for potable water supply. Over 90 percent of the State's ground-water resources is presumed to be suitable for drinking without treatment. Impacts from improper solvents handling and disposal, leaking underground petroleum storage tanks, landfill leachate, pesticides (EDB), and improper road salt storage have resulted in the contamination of 1,332 public and private water supply wells as of February 1988.

The State of Connecticut has taken numerous steps to increase protection of its ground-water resources. Among these are the publication of a Ground-Water Management Strategy; an inventory of the State's largest aquifers and known or suspected contamination threats; and the formation of an Aquifer Protection Task Force. Ground-water monitoring activities include programs administered by the Department of Health Services, Department of Environmental Protection, and U.S. Geological Survey.

Delaware

To obtain a copy of the Delaware 1988 305(b) report, contact:

Delaware Department of
Natural Resources and
Environmental Control
89 Kings Highway
P.O. Box 1401
Dover, DE 19903

Surface Water Quality

Delaware's surface waters are, for the most part, in good condition. Most of the State's designated uses and the Clean Water Act fishable/swimmable goals are supported. Ninety-three percent of assessed stream, lakes, and estuarine waters are of sufficient quality to support (in whole or in part) all uses designated in the State's *Water Quality Standards for Streams.* Further, about 94 percent of the State's waters are determined to be fishable, and 96 percent are swimmable.

Excessive bacteria (fecal coliform and/or enterococcus) levels continue to be one of the major water-quality problems in some of the State's surface waters. In most cases, however, these levels are not so excessive as to suggest public health hazards and impairment of recreational uses.

Excessive nutrient levels are a water-quality problem inherent in many of Delaware's waterways. Most of Delaware's lakes and ponds are eutrophic. In some cases, the elevated nutrient levels detected are natural conditions and do not result from anthropogenic activities.

Of major concern to the State are contamination of harvestable shellfish and steep reductions in hard clam landings throughout the Inland Bays/Coastal Sussex estuarine waters. These phenomena are strong indications of environmental problems. The landing of hard clams by commercial interests has declined significantly since 1958 due in part to the closure of clamming areas because of public health concerns and decreased clam density. Bacterial contamination, sedimentation, and low dissolved oxygen are cited as primary reasons for reduced harvests. Sources of pollution contributing to the problem include treated waste discharges, nutrient enriched ground water, surface runoff, septic system overflows, and natural conditions.

Ground-Water Quality

More than 38 billion gallons of high quality ground water are withdrawn each year for all uses in the State. The domestic water needs of approximately two-thirds of the State's population are met with ground water provided through municipal and private wells. All of the fresh water for farm use and most of the water used for irrigation and self-supplied industrial use is also derived from ground water.

Delaware's ground water is a relatively unprotected resource due to generally high soil permeability and a shallow water table. Common causes of ground-water contamination include nitrates, iron, pH, salinity, trihalomethanes, and volatile organic carbons. Such impurities originate from many sources, including domestic on-site wastewater systems, landfills containing municipal and industrial wastes, chemical spills and leaks from tanks or lagoons, agricultural activities, and saltwater intrusion along the coast. The limits of natural treatment and standards of purity in ground water are now exceeded more frequently and over larger areas than in the past.

In 1985, Delaware implemented new regulations governing the design, installation, and operation of septic systems. These regulations are designed to protect ground-water quality. In addition, Delaware's Ground-Water Management Plan identifies a series of measures to protect ground water by relying on land use controls in critical ground-water resource areas. A ground-water monitoring strategy for Delaware was formulated in FY 1986; implementation began in FY 1987.

Delaware River Basin

To obtain a copy of the Delaware River Basin Commission's 1988 305(b) report, contact:

Delaware River Basin Commission
P.O. Box 7360
West Trenton, NJ 08628

Surface Water Quality

Delaware River and Bay comprise part of the boundary of four states: Delaware, New Jersey, New York, and Pennsylvania. From Hancock New York to the mouth of the Delaware Bay, the Delaware River flows 330 miles, draining 0.4 percent of the U.S. land area. Almost 10 pecent of the Nation's population rely on the waters of the Delaware River Basin for potable and industrial water.

In 1987, approximately 94 percent of the assessed river miles in the Delaware River Basin were found to be fully supporting their designated uses. In the Delaware Bay itself, approximately 99 percent of the assessed square miles were fully supporting their designated uses.

The Delaware River Basin Commission (DRBC) also conducted an assessment of its waters relative to their support of the fishable/swimmable goal of the Clean Water Act. This assessment revealed that 100 percent of the assessed river miles and 98 percent of assessed estuary square miles were meeting the fishable goal. Approximately 94 percent of the assessed river miles and 99 percent of the assessed estuary square miles were meeting the swimmable goal.

Two issues of concern to the DRBC are toxic substances and increased development along the upper Delaware River. The Delaware River flows through the world's largest freshwater port and the second largest U.S. petrochemical center. Small, pervasive, unnoticed spills from this large urban, industrialized area continue to have an unknown impact on the river system. The cleanup of this river system since 1972 has brought on a dramatic increase in recreation along the Delaware estuary. In the upper Delaware, growth and development threaten the water quality of two components of the National Wild and Scenic Rivers System.

The protection of water quality from growth-related impacts (both point and nonpoint) will be essential to maintain high quality reaches of the river and the water quality improvements achieved over the last 40 years. Recreational use of the Delaware River is intense and increasing in both the nontidal river and the estuary; this increased use makes the maintenance of water quality a key concern. An unanswered concern is the impact of the recreational use itself on the river's quality.

Ground-Water Quality

In December 1982, the Delaware River Basin Commission completed a 3-year study leading to the development of a ground-water management plan and implementation program for the Delaware River Basin. The study set forth 27 recommendations for improving the management of ground-water quality and quantity. Work continues on the implementation of these recommendations. One of the specific recommendations dealt with the implementation of a well registration program. This program, currently being implemented, will provide data essential for ground-water management and protection.

District of Columbia

To obtain a copy of the District of Columbia 1988 305(b) report, contact:

Department of Consumer & Regulatory Affairs
Water Hygiene Branch
5010 Overlook Avenue, S.W.
Washington, D.C. 20032
Attn: Hamid Karimi

Surface Water Quality

For 1988, the District of Columbia assessed 100 percent of its estuarine waters, 72 percent of its small streams, and 36 percent of its lakes and impoundments.

Most of the District's surface waters did not support all of their designated uses. The exception was the Potomac River estuary, where 83 percent of estuarine square miles partially supported designated uses. Most of the District's surface waters designated for use as raw water sources for industrial and public water supplies met these particular uses.

In the District, causes of nonsupport are typical for an urban area. Fecal coliform contamination is a principal cause of nonsupport of designated uses. In the Anacostia River, low dissolved oxygen levels is a leading cause of nonsupport of uses. High metal concentrations are also a concern, particularly in many of the District's smaller streams. Other causes of nonsupport include oil and grease, high pH, and high un-ionized ammonia levels.

Urban runoff, whether from storm sewers, combined sewer overflows (CSOs), or surface runoff, is a principal source of pollution to District surface waters. Presently, combined sewers serve 35 percent of Washington, D.C. Discharges of untreated sewage after a rainstorm results in high fecal coliform, high biological oxygen demand, and low dissolved oxygen. Storm sewers/runoff add sediment, heavy metals, road salts, oil, and other toxics to receiving waters.

Wastewater treatment plant effluent discharges are a major source of nutrients to

the Potomac estuary. Implementation of advanced wastewater treatment processes at the Blue Plains Wastewater Treatment Plant has significantly reduced nutrient loads to District waters. Still of concern are nutrient inputs from fall line points, particularly the upper Potomac watershed.

Other pollution sources are more site specific. These sources include leachate from landfills, runoff from industrial yards, leaks from underground storage tanks, and breaks in sanitary sewer lines.

Ground-Water Quality

Reliable information regarding the quality of the ground water in the District of Columbia is essentially nonexistent. This is because virtually all of the City's water supply needs have been satisfied by the Potomac River. To fill the void in ground-water data and management activities, the District has begun a program for the protection of ground-water resources. In 1987, the District submitted to EPA a draft ground-water protection strategy outlining plans for ground-water protection. Additionally, the District has funded a 3-year study of its ground-water resources.

Florida

To obtain a copy of the Florida 1988 305(b) report, contact:

Florida Department of
Environmental Regulation
Standards Monitoring
Section
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Surface Water Quality

Most of Florida's waters are of good quality; the distribution of problem areas closely follows the distribution of Florida's population. Water quality problems in the State are evident around the densely populated, major urban areas including Jacksonville, Orlando, Tampa, the Cape Kennedy area, and the southeastern Florida Coast. The sparsely populated northwest and west central sections of the State have very good water quality.

Florida has not historically been highly industrialized. Thus, difficult and persistent industrial types of pollution are not widespread. However, Florida has undergone an extensive population growth in the last two decades which has resulted in more pollution sources associated with development.

Florida reports that it assessed 90 percent of its stream miles, and of these, 67 percent fully supported designated uses. All but 1 percent of the State's lake acres were assessed. Thirty-three percent of assessed lakes were found to be fully supporting uses and 57 percent were partially meeting uses. (This lower degree of use support for lakes is attributed to the fact that two lakes—Lake Okeechobee and Lake George—account for almost half of the assessed lake area in the State and are partially meeting uses.)

Ninety-six percent of the State's estuarine area was reported as assessed, with 58 percent meeting uses. Of the State's ocean coastal area, 67 percent was reported as assessed and 91 percent of ocean square miles were found to meet uses.

In previous years, most water quality problems in the State were caused by point sources. Recently, however, nonpoint sources accounted for the majority of the State's water quality problems. This is because point source treatment processes have improved and there has been an increase in the acreage of agricultural and urban developed land. Major water quality problems in Florida include agricultural runoff, urban stormwater, domestic wastewater, pulp and paper mills, and hydrologic modification.

Ground-Water Quality

Because ground water supplies over 90 percent of Florida's drinking water, ground-water programs have traditionally focused on the monitoring of wells for contamination. Recently, a program has begun to monitor ground water as a system of contiguous reservoirs with connection to surface waters. Data from over 1,500 wells are being stored in a data base. Preliminary analysis of the data indicates generally excellent ground-water quality, particularly in the Floridan aquifer which underlies all but the westernmost and southernmost parts of Florida.

Major contamination sources in the State are underground storage tanks (primarily for gasoline) and agricultural activities. Other pollution sources include saltwater intrusion, septic tanks, landfills, phosphate mining, and hazardous waste sites. All community water systems are required to be tested periodically for 118 organic contaminants. The contaminants include most of the priority pollutants as well as certain pesticides known to be used in the State and suspected to be polluting ground water.

Major ground-water protection programs in Florida include a ground-water classification program; a permitting program to regulate underground injection of wastes; an underground storage tank program to monitor for leakage and provide cleanup procedures; a program to track pesticide use; a program to regulate hazardous waste storage, disposal, and cleanup; and septic tank and landfill regulations.

Georgia

To obtain a copy of the Georgia 1988 305(b) report, contact:

Water Quality Management Program
Georgia Environmental Protection Division
270 Washington Street, S.W.
Atlanta, GA 30334

Surface Water Quality

Water quality in Georgia's streams in 1986-1987 was good. An assessment of the State's 20,000 miles of streams and rivers indicates that the vast majority support designated water uses. In 1986-1987, 97 percent of stream miles assessed supported designated uses, 2 percent partially supported uses, and 1 percent did not support designated uses. This evaluation is based on predictive modeling, 20 years of trend monitoring, intensive surveys, and special studies, as well as the judgment of professional staff members.

Water quality in Georgia's publicly owned lakes/reservoirs in 1986-1987 was good. Of the 417,730 acres of lakes assessed, 98.7 percent fully supported uses, 1.3 percent partially supported uses, and 0.01 percent did not support designated uses. All publicly owned lakes were sampled in 1980 and 1981 as part of the Georgia Clean Lakes Program. Monitoring of major lakes and other selected lakes has continued on approximately an annual basis since 1982.

Water quality in Georgia's estuaries in 1986-1987 was also good. Of the 594 square miles of estuaries, 98 percent fully supported uses, 1 percent partially supported uses, and 1 percent did not support designated uses.

Municipal and industrial discharges, and storm sewers/runoff are cited as the most common sources of use impairment in Georgia rivers, lakes, and estuaries. Generally, the causes of most concern are dissolved oxygen, nutrients, toxic substances, turbidity, and fecal coliform bacteria.

Georgia continued its strong permitting and enforcement programs in 1986-1987. A total of 526 NPDES permits were reissued and Georgia's record of no permit issuance backlog was maintained. Ninety percent of major municipal discharges and 98 percent of major industrial discharges maintained consistent permit compliance in 1986-1987. However, improperly treated discharges, spills, and erosion/sedimentation problems resulted in monetary penalties totaling $542,763 being levied by the Georgia Environmental Protection Division.

Ground-Water Quality

Ground water is extremely important to the life, health, and economy of Georgia. For example, in 1987, ground water provided over 30 percent of the public water supply, 93 percent of the rural use, 65 percent of the irrigation use, and almost half of the industrial use of water in the State. For practical purposes, outside the larger cities of the Piedmont, ground water is the dominant source of water.

Except where they may become saline at lower depths, all of the aquifers can be considered as potential sources of drinking water. For the most part, these aquifers are underutilized and generally free of contamination. Water from most of the aquifers may be safely consumed without treatment, and, except for occasional curtailment of lawn sprinkling, water has not been rationed.

The most extensive contamination of Georgia's aquifers is from naturally occurring mineral salts (i.e., high total dissolved solids). Another natural source of contamination is from radioactive minerals that are common rock constituents in many Georgia aquifers. While naturally occurring radioactivity may occur anywhere in Georgia, the most significant problems have occurred at sporadic locations in a southwest-northeast trending zone extending from Tift County to Montgomery County. Manmade contamination can come from a number of sources, such as business and industry, agriculture, homes (e.g., septic systems), and hazardous waste facilities. In 1986, Georgia developed a comprehensive water management plan that addresses both surface water and groundwater availability as well as surface water and groundwater quality.

Hawaii

To obtain a copy of the Hawaii 1988 305(b) report, contact:

Hawaii Department of Health
P.O. Box 3378
Honolulu, HI 96801

Surface Water Quality

Located some 5,000 miles in the central and western Pacific Ocean, Hawaii has a coastal environment substantially different from that of the U.S. continental shelf. Hawaii assessed all of its river, estuarine, and coastal waters for this reporting period. Approximately 76 percent of river miles fully supported their designated uses, 30 percent of estuary square miles fully supported their designated uses, and 100 percent of ocean coastal miles supported their designated uses.

River and stream channel alterations are considered to be most damaging to aquatic freshwater ecosystems, causing modifications to natural habitats and changes in water quality due to flow restrictions, dissolved oxygen depletion, turbidity, and temperature increases. Large quantities of nonpoint source pollutants have a significant impact on stream ecosystems and nearshore coastal waters.

During heavy flooding, urban street contaminants and other debris wash into streams and drainage canal systems in urban areas. The silt-laden waters invariably discolor nearshore waters and cause elevated levels of coliform bacteria, nutrients, and turbidity.

Most estuaries in the State are within embayments that generally are not subject to rapid and efficient flushing. Therefore, embayments and nearshore waters in general may be significantly affected by nonpoint source pollution. Major nonpoint factors contributing to use impairment in estuarine waters include stormwater runoff, construction and agricultural activities, and natural erosion. Domestic and indusrial sources of pollution continually threaten fish and wildlife sanctuaries. The State also reports that wetlands and marshes near residential districts are threatened by habitat alterations due to urban growth and development.

Ground-Water Quality

Concerns about the quanity and quality of ground water and well water systems continue to be a major issue in both the public and private sectors. The 1987 Legislative Session finalized a State Water Code which addresses the crucial issue of ground-water quantity and use appropriations. Protection of the Southern Oahu Aquifer has been afforded by its designation by EPA as a sole source aquifer. The Pearl Harbor ground-water basin, which has been heavily used over the past years due to increased industrial and urban development, is included in this massive area aquifer.

The public's awareness of ground-water quality issues has increased in recent years. Two well surveys in 1987 included first-time analyses for some unregulated compounds that had been believed to be bound strongly to the soil and therefore not considered potential contaminants. The finding of compounds such as dieldrin and lindane, albeit at extremely low levels, has led the State to reevaluate which compounds should be classified as leachable.

Because of limited State funding and State laboratory resources, the Ground Water Protection Program has contracted out analyses for only 29 comprehensive screens in 1988. In order to ensure that the State's overall ground-water quality is assessed, the wells chosen will be from all the Hawaiian islands except Oahu, where data are already available.

Idaho

To obtain a copy of the Idaho 1988 305(b) report, contact:

Idaho Department of
the Environment
450 W. State Street
Boise, ID 83720

Surface Water Quality

The major focus of this report is the identification of waters that are not meeting water quality standards or are not supporting beneficial uses due to pollution from nonpoint sources.

Over 16,000 stream miles were assessed for nonpoint source pollution impacts; this amounts to approximately 50 percent of the total stream miles in the State. Over 12,000 miles of streams experience some type of nonpoint source impact; in half of these stream miles, at least one beneficial use is not fully supported.

The primary nonpoint source activity impacting beneficial uses in Idaho streams is agriculture. The second most significant nonpoint source impact is hydrologic or habitat modification. Other nonpoint source activities affecting Idaho waters are forest practices, construction, and mining. The extent of impacts from these activities varies by region. Agricultural activities affect more streams in the central and southern regions, while forest practices are more significant in the northern region.

Idaho has over 2,800 named freshwater lakes covering a total of more than 500,000 surface acres. Lake conditions vary from pristine to over productive. Most of the reservoirs in Idaho were created to provide agriculture irrigation water; many are experiencing eutrophication problems due to excessive nutrient and sediment loading from irrigation return flows and agricultural runoff. High alpine lakes are pristine and generally not affected by human activities. Signs of deteriorating water quality are most notable in lakes in the panhandle area. Although few are classified as eutrophic, there is a strong public perception of deteriorating water quality. Sources of impact are varied. Shoreline development results in impacts from construction, urban runoff, and subsurface sewage disposal. Watershed sources of impact include mining, agriculture, and forest practices.

A total of 727,202 lake acres were assessed for this report. Of the total lake acres assessed, 220,410 were classified as oligotrophic, 407,829 as mesotrophic, and 93,496 as eutrophic.

Ground-Water Quality

Limited monitoring data have indicated that most ground water in Idaho is of good quality. Where contamination has been found, it ranges from localized incidents in a few acres to more widespread nonpoint source pollution such as elevated nitrate levels.

Idaho's principal aquifers have been evaluated for potential contamination by the U.S. Geological Survey and the Department of Water Resources. Both studies assessed a wide variety of potential contaminant sources, intensity of land use, and aquifer vulnerability resulting from geological and hydrologic factors.

Major land use practices in Idaho were ranked according to their contamination potential. Highest priority sources were petroleum handling and storage, feedlots and dairies, landfills and hazardous waste disposal sites, and land application of wastewater.

Nonpoint sources of impact to ground water are poorly understood in Idaho, principally because monitoring data are inadequate. Limited monitoring does indicate nonpoint source impacts from septic systems and agricultural activities. The relative importance of nonpoint source versus point source impacts, however, is not known.

Illinois

To obtain a copy of the Illinois 1988 305(b) report, contact:

Illinois Environmental Protection Agency
Division of Water Pollution Control
2200 Churchill Road
Springfield, IL 62706

Surface Water Quality

Rivers and streams in Illinois total 14,960 river miles (13,200 interior river miles; 1,760 border river miles). In this reporting period, 12,970 river miles were assessed for degree of use support. Of these assessed miles, 45 percent were fully supporting their designated uses. The major causes of use impairment include nutrients, siltation, habitat/flow alteration, organic enrichment/low dissolved oxygen, ammonia/chlorine, and metals. The major sources of use impairment include agriculture, point sources, hydrologic/habitat modification, construction/urban runoff, and resource extraction. Ninety-six percent of assessed stream miles were found to be meeting the fishable goal of the Clean Water Act (CWA), and 24 percent were meeting the swimmable goal.

The State assessed 382 lakes covering 183,572 acres and representing 74 percent of the acreage of inland lakes in Illinois. Twelve percent of assessed lake acres were found to support uses, 55 percent were partially supporting uses, and the remaining 33 percent were not supporting uses. Additionally, 91 percent and 42 percent of these assessed waters met the fishable and swimmable goals of the CWA, respectively.

The primary causes of use impairment for lakes are suspended solids, siltation, organic enrichment/dissolved oxygen deficiencies, and nutrients. Nuisance aquatic plants and taste and odor are the next most important causes affecting impaired lakes; toxics and other causes are of relatively minor importance statewide. Sources affecting the greatest number and acreage of lakes are agriculture (primarily row crops), in-place contaminants (deposited sediment with associated nutrients and pollutants), and lake/stream bank erosion.

Lake Michigan includes a total of 63 shoreline miles, forming the northeastern portion of Illinois' border. All 63 shoreline miles are assessed to be partially supporting designated uses with minor impairment. The causes for less than full support include total phosphate concentrations in water column samples and priority organics based on the lakewide sport fish advisory. Major sources include atmospheric deposition, urban runoff, and in-place contaminants. Due to a sport fish health advisory, Illinois' portion of Lake Michigan is considered to not be fully attaining the fishable goal of the CWA. All shoreline miles meet the swimmable goals of the Act.

Ground-Water Quality

Ground-water monitoring and assessment information to date indicate that statewide ground-water quality is generally good. However, many activities, past and present, contribute to ground-water contamination in Illinois. Major sources of identified contamination in the State include leaking underground storage tanks, abandoned hazardous waste sites, and municipal and industrial landfills. Substances identified as contaminants include organic and inorganic chemicals, metals, radioactive materials, pesticides and other agricultural chemicals, arsenic, brine, and petroleum products.

The Illinois Ground-Water Protection Act, signed into law September 24, 1987, will help direct new program initiatives through numerous agencies to protect the State's ground-water resources from future degradation and to avoid difficult and expensive remedial cleanup efforts.

Indiana

To obtain a copy of the Indiana 1988 305(b) report, contact:

Indiana Department
of Environmental
Management
105 South Meridian Street
Indianapolis, IN 46225

Surface Water Quality

During the reporting period, Indiana assessed 5,181 miles of streams, 104,540 acres of lakes, and 43 Great Lake shoreline miles. Of the waters assessed, 68 percent of the river and stream miles and over 99 percent of the total inland lake and reservoir acreage fully supported their designated uses. All of Indiana's portion of Lake Michigan was considered as partially supporting designated uses due to the lakewide fish consumption advisory for certain species.

Of the stream miles assessed, it was estimated that the swimmable goal was supported in 82 percent and the fishable goal was supported in 79 percent. Although both the fishable and swimmable goals were supported in over 99 percent of the total lake and reservoir acreas assessed, many are considered threatened by point and/or nonpoint sources of pollution. All of Lake Michigan governed by Indiana supported the "swimmable" goal but was not considered to support the "fishable" goal due to the lakewide fish consumption advisory.

The major causes of nonsupport of uses were fecal coliform bacteria, organic enrichment and dissolved oxygen problems, pesticides, priority organic compounds, and ammonia. There is also an indication that chlorine was moderately affecting uses. The sources of substances most often contributing to nonsupport of uses were: industrial and municipal/semi-public point sources, combined sewer overflows, and agricultural nonpoint sources. Nonpoint sources were most often considered to have only minor to moderate impacts.

One area of special concern for Indiana is toxics control and monitoring. Increased monitoring of fish tissue and sediments for toxic and bioconcentrating materials has occurred in Indiana over the last two years, and a considerable amount of data has been collected. However, little guidance is currently available to aid the State in interpreting this fish tissue and sediment data as to health effects and potential environmental impacts.

Ground-Water Quality

Indiana's plentiful ground water resource serves 60 percent of its population for drinking water and fills many of the water needs of businesses, industry, and agriculture. Although most of Indiana's ground water has not been shown to have been adversely affected by man's activities, over 200 sites of ground-water contamination have been documented. These problems affect over 900 individual wells and several hundred thousand people.

The substances most frequently detected as well water contaminants in the State are chlorinated volatile organic chemicals, petroleum products, and nitrate. Monitoring wells at waste disposal sites most often indicate ground-water pollution from inorganic chemicals. About 10 percent of the private wells and 2 percent of the noncommunity wells tested contain excessive nitrate levels. These are thought to be primarily of nonpoint source origin. The sources of ground-water contamination most commonly reported in the State are hazardous material spills, leaking underground storage tanks, and waste disposal activities.

The Indiana Inter-Agency Ground Water Task Force adopted a final version of the State Ground Water Protection Strategy and Draft Implementation Plan in early 1987. This document addresses 43 separate issues involving wells, ground water quality, and water quantity, and makes 160 recommendations for improved safeguards and management of the resource. The plan calls for new and revised laws and rules, new as well as modified agency programs, research and information management, coordination efforts within and among all levels of government, and continued public participation.

Iowa

To obtain a copy of the Iowa 1988 305(b) report, contact:

Iowa Department of Natural
Resources
Wallace State Office Building
Des Moines, IA 50319

Surface Water Quality

Of the 8,235 miles of streams assessed during 1986 and 1987, about 20 percent were described as not supporting the uses for which they were designated in the State's water quality standards. About 79 percent were partially supporting those uses. For lakes, 55 percent of the 48,549 assessed acres were found to be supporting designated uses, about 42 percent were partially supporting, and the remaining were not supporting uses. Thirty-two percent of 26,192 assessed wetland acres were found to be fully supporting designated uses, about 54 percent were partially supporting, and about 14 percent were not supporting.

Iowa also assessed attainment of the Clean Water Act goals for streams, lakes, and wetlands. Eighty-two percent of assessed stream miles, 99 percent of assessed lakes acres, and 86 percent of wetland acres were found to

be meeting the fishable goal. Due to naturally occurring physical limitations—primarily size and depth of water—the swimmable goal was not attainable in 73 percent of the stream miles and 76 percent of the wetland acres assessed. Of the waters in which the swimmable goal is attainable, 74 percent of the stream miles, 99 percent of the lake acres, and 73 percent of the wetland acres were found to meet the goal. The stream miles not meeting the swimmable goal were impaired by fecal coliform bacteria. The wetland acres not meeting the swimmable goal were impaired by sediment and nutrients.

Nonpoint sources contributing mainly sediment, nutrients, and pesticides were the primary reason for use impairment in Iowa's streams. Other major causes of pollution cited by the State include metals and pathogens. There are no direct discharges of wastewater to lakes in Iowa, so all lake pollution problems were attributed to nonpoint sources. The leading causes of nonsupport in lakes were nutrients, siltation, and to a lesser degree oil and grease.

Ground-Water Quality

Ground-water withdrawals account for nearly 85 percent of the total water uses in Iowa, with approximately 80 percent of all Iowa's drinking water coming from groundwater aquifers. The quality and quantity of Iowa aquifers vary throughout the State.

Major ground-water concerns in Iowa center around human activities and resultant ground-water contamination. Agricultural chemicals, landfills, underground storage tanks, agricultural drainage wells, livestock wastes, and improper management of hazardous substances all contribute to some degree to ground-water degradation. Several studies in northeastern Iowa have focused primarily on contamination involving nitrates, pesticides, and other manmade organic chemicals. High levels of nitrates have been detected in ground-water drinking water supplies throughout the State. Nitrogen fertilizer usage, animal wastes, and wastewater treatment all contribute to elevated nitrate levels in ground water. Studies in northeast Iowa's karst areas and statewide sampling during 1985, 1986, and 1987 have detected low levels of various pesticides in Iowa ground water. Runoff into agricultural drainage wells and sinkholes, as well as infiltration through soils, are believed to be the sources of pesticide contamination. Except for instances where contamination has been found in the vicinity of agchemical dealerships, the concentrations of pesticides found are thought to pose no immediate threat to public health. However, little is known about the effects of long-term exposure to low concentrations of many of these chemicals or their breakdown products.

Along with pesticides, synthetic organic compounds have also been detected in Iowa ground water. In several instances, concentrations have been detected that are high enough to be considered a health concern for long-term exposure.

In 1987, Iowa initiated ground-water protection legislation under the Ground-Water Protection Act. This Act combines regulatory and nonregulatory approaches to protect Iowa's ground-water sources. This law includes provisions relating to pesticide and fertilizer sales and use, as well as improved management practices relating to specific environmental concerns: solid waste disposal, underground storage tanks, agricultural drainage wells, and sinkholes.

Kansas

To obtain a copy of the Kansas 1988 305(b) report, contact:

Kansas Department of
Health and Environment
Water Quality Assessment
Section
Bureau of Water Protection
Forbes Field
Topeka, KS 66620

Surface Water Quality

During Water Years 1986-1987, Kansas assessed 6,888 miles of streams and 173,911 acres of lakes. Of the river miles assessed, 58 percent fully supported designated uses, 11 percent partially supported designated uses, and 31 percent did not support designated uses. Of the lake acres assessed, 67 percent fully supported designated uses, 28 percent partially supported designated uses, and 5 percent did not support designated uses.

Assessment of Kansas waters relative to their support of fishable/swimmable goal of the Clean Water Act revealed that 100 percent of assessed lake acres met both the fishable and swimmable goal. Ninety-five percent of the river miles assessed met the fishable goal and 79 percent met the swimmable goal.

The main causes of use impairment in rivers were determined to be pathogens and salinity. The leading sources are agriculture and municipal dischargers. For lakes, the main causes of use impairment appear to be siltation, salinity, and metals. Agriculture and hydrological/habitat modifications were the leading sources of use impairment in the lakes.

Ground-Water Quality

Kansans rely on groundwater resources for public, rural, industrial, and irrigation water supplies. Approximately 85 percent of all water used in Kansas is supplied from ground water. Irrigation continues to be the largest user of ground water. In rural areas, ground water supplies 85 percent of the drinking water.

Ground-water quality problems in Kansas are generally localized. About

300 isolated ground-water pollution problems are known and are generally the result of human activities. Pesticide contamination of ground water is a site-specific problem; more analysis is needed to determine the extent of contamination. The Kansas Department of Health and Environment (KDHE) has established a Bureau of Environmental Remediation to respond to State contamination cleanup needs.

Some Kansas ground water is not desirable for drinking because of inorganic chemicals and mineralization. Screening of Public Water Supply wells for volatile organic chemicals resulted in the removal of over 30 wells from service. Nitrate was found to exceed public Drinking Water Standards in several studies, including the Farmstead Well Contamination Study. The KDHE and the U.S. Geologic Survey maintain a ground-water monitoring network and conduct special investigations as warranted.

Kentucky

To obtain a copy of the Kentucky 1988 305(b) report, contact:

Kentucky Division of Water
Water Quality Branch
18 Reilly Road
Frankfort Office Park
Frankfort, KY 40601

Surface Water Quality

During the reporting period, Kentucky assessed 8,653 miles of streams and 214,483 acres of lakes. Approximately 71 percent of assessed river miles fully supported their designated uses, as did 84 percent of assessed lake acres.

The major causes of use nonsupport in rivers were fecal coliform contamination, affecting primary contact recreation use, and siltation, impairing warmwater aquatic habitat use. The major sources of the fecal coliform contamination were municipal wastewater treatment plant discharges. Nonpoint sources, primarily surface mining and unspecified other sources such as agriculture, were the major sources of siltation.

Iron and manganese were the greatest cause of use nonsupport in lakes. This was largely due to impacts on domestic water supplies from hypolimnetic water released from large reservoirs. Nutrients were the second greatest cause of use nonsupport and affected the largest number of lakes. Natural sources, surface mining, and unspecified nonpoint sources accounted for the greatest impacts to lakes.

The discharge of brines to Kentucky waters remains a serious problem, particularly in portions of the Licking and Kentucky River drainages. Significant improvements in water quality in parts of the Blaine Creek drainage resulted from the application of newly promulgated Federal chloride criteria to oil and gas permitting actions. Continuation of the permitting activities should significantly improve water quality in the other areas affected by brine pollution.

The loss of wetland resources and adverse impacts to remaining wetland areas are of concern to the State. It is estimated that half of Kentucky's original wetland acreage is gone. Nearly all of the remaining areas have been degraded by pesticides, acid mine drainage, siltation, oil brine, or domestic and industrial waste. A major threat to Kentucky wetlands is destruction by competing land use activities and poor land management practices.

Ground-Water Quality

With some exceptions, the quality of Kentucky's ground water is good. Special studies were conducted in 1987 on 199 wells in the Gateway Area Development District and the Calvert City area. Isolated occurrences of fecal coliform contamination were found and attributed to faulty well construction. No significant cases of organic contamination were found. While these studies point out the good quality of the ground water in these areas, other statewide problems remain to be solved. Impacts from sanitary landfills and domestic on-site sewage treatment, inconsistencies in Federal and State laws regarding ground water, and improperly abandoned wells are of concern.

Louisiana

To obtain a copy of the Louisiana 1988 305(b) report, contact:

Department of
Environmental Quality
Standards Development
& Implementation Section
Water Pollution Control
Division
P.O. Box 44091
Baton Rouge, LA 70804-4091

Surface Water Quality

Louisiana contains a plentiful supply of water resources comprising an estimated 290,000 river and stream miles, 715,812 lake/reservoir acres, and 7,656 square miles of estuaries. Of the 8,483 total river miles assessed, 68 percent are fully supporting designated uses, 25 percent are partially supporting designated uses, and 7 percent are not supporting designated uses. Seventy-

three percent of the State's 715,812 assessed lake acres are fully supporting their designated uses, and 27 percent are partially supporting their designated uses. Of the 7,656 square miles of estuaries which were assessed, 55 percent are fully supporting their designated uses, 42 percent are partially supporting designated uses, and 2 percent are not supporting designated uses.

The most frequently cited pollutants identified as causes of use are fecal coliform bacteria, oxygen-demanding substances, nutrients, oil, and inorganic impairment (specifically, chlorides and brine). The most commonly cited sources of pollutants are runoff from unsewered communities, inadequately treated sewage discharges from municipalities, discharges and spills from petroleum activities, agricultural runoff, and urban runoff. At this time, nonpoint sources appear to be the predominant sources contributing to water quality problems in the State.

Waterbodies that experience frequent or chronic depressed levels of dissolved oxygen (DO) are of special concern to the State. Low DO levels can result from a combination of natural and man-induced sources which are frequently difficult to separate. Low DO levels can be attributed to partially or inadequately treated sewage and to natural conditions, especially in waterbodies surrounded by wetlands which contribute nutrients, organic matter, and other oxygen demanding substances. The DO levels in many of Louisiana's waterbodies reflect the impact of wetland drainage.

Ground-Water Quality

The quality of water in the State's major aquifer systems remains excellent. The deeper aquifers remain free from contamination. Of specific concern in Louisiana, however, are the shallow aquifers and the water bearing zones which are not used as major sources of water. These strata, which have been shown to contribute significantly to the water balance of the deeper aquifers, are becoming increasingly threatened. This threat is two-fold. Site-specific contamination of these shallow strata presents a direct threat to the major aquifers by means of leakage through well bores, stratigraphic interconnections, and fractures. In addition, individual wells are located in these shallow strata and may become directly contaminated.

To address this growing problem, the Department of Environmental Quality now has a Ground Water Protection Division within the Office of Water Resources. In addition to enforcing State and Federal ground-water protection programs, the new Division is working on the development of a State ground-water protection strategy. Although this strategy is still under development, the protection of all potential sources of drinking water will be a key goal.

Maine

To obtain a copy of the Maine 1988 305(b) report, contact:

Maine Department of
Environmental Protection
State House Station No. 17
Augusta, ME 04333

Surface Water Quality

During Water Years 1986-1987, 31,672 river miles, 994,560 lake acres, and 1,633 square miles of estuary were assessed. This represents 100 percent of the total size of waterbodies in the State. Of the assessed waters, 99 percent of river miles, 96 percent of lake acres, and 98 percent of estuary square miles fully supported their designated uses.

In the more populated areas of Maine, water quality is affected by a combination of point sources such as industrial and municipal effluents, and nonpoint sources such as urban and suburban stormwater runoff, combined sewer overflows, agriculture, construction-related runoff, and waste disposal practices. Most of the larger municipal and industrial effluents now receive the equivalent of best practicable treatment. This has led to improved water quality in the State's major rivers in the last 20 years. Given the difficulties of controlling nonpoint sources, the low number of remaining untreated point sources, and the emergence of ground-water quality and hydropower as major concerns, it is doubtful that future water quality improvements will continue at the same rate as in the past.

Ground-Water Quality

During the past 10 years, many wells in Maine have been abandoned due to contamination from nonpoint source pollution. Based on present knowledge of pollution sources affecting ground water, it is safe to assume that there are thousands of sites in Maine with unpotable ground water. The State is currently formulating a Ground Water Strategy to deal with the alarming degradation of this critical resource. Preventive rather than reactive measures will form the basis of this strategy.

Major sources of ground-water contamination in the State include septic systems, agricultural activities, improper storage, and disposal of hazardous substances, landfill leachate, leaking underground storage tanks, and salt storage/road deicing. Present trends indicate that more of Maine's ground water is becoming contaminated each year, and almost none is being restored to acceptable levels of quality. Migration and expansion of existing contamination plumes would be a continuing concern even if current pollution sources could be addressed.

Maryland

To obtain a copy of the Maryland 1988 305(b) report, contact:

Maryland Department of
the Environment
Chesapeake Bay & Special
Projects Program
2500 Broening Highway
Baltimore, MD 21224

Surface Water Quality

The State's surface waters are of good quality and exhibit stable trends even though many problems still exist and new ones have been identified. The most serious of these problems is the continuing accumulation of nutrients in estuaries and impoundments. Suspended sediments continue to be a problem in both free-flowing and tidal waters. Locally elevated bacterial levels are found throughout the State, and have resulted in some areas being closed to recreational bathing or shellfish harvesting. Acid mine drainage from many abandoned coal mines in Western Maryland remains a long standing, difficult problem to solve. The presence of the toxic pesticide chlordane in some sediments and fish tissues in Baltimore Harbor, Back River, and Lake Roland indicates a long-term pollution problem.

Of the 9,300 miles of rivers and streams assessed in Maryland, nearly 93 percent fully supported their designated uses, 5 percent partially supported uses, and about 2 percent did not support their designated uses. Of the 17,448 acres of large public lakes assessed in the State, 85 percent fully supported their intended uses, 15 percent partially supported uses, and less than 1 percent did not support their intended uses. None of the 1,981 square miles of the mainstem Chesapeake Bay estuary fully supported designated uses. No water quality impacts were noted along 32 miles of the open ocean coast.

Nutrients, sediments, and bacteria are the three major causes of use impairment in the State. These problems occur statewide and in most waterbody types. Regional causes of severe water quality impacts include organic enrichment in the Chesapeake Bay estuary and in the lower tidal rivers, and acidity in the State's western rivers and streams near abandoned coal mines. Other causes of severe water quality impacts include pesticide contamination (chlordane) and flow alteration. Leading sources of impairment include agricultural and urban runoff, mining, rural conditions, municipal discharge, land disposal (failing septic systems and raw sewage input), bottom sediment releases, and upstream sources.

Ground-Water Quality

Ground-water resources in Maryland are an abundant natural resource. Although it comprises only 13 percent of the total water used in the State, ground water is of substantial cultural and economic importance. For example, ground water constitutes up to 97 percent of the total water used in some Eastern Shore counties. Approximately 15 percent of the State's population use ground water as a drinking water supply; other major uses of ground water include livestock water supply, irrigation, and industrial uses.

On the whole, the State's ground waters are of acceptable quality. However, a number of localized instances of ground-water contamination exist. Locally serious impacts occur as a result of excess nitrates, bacteria, salt, toxic compounds, and petroleum products. In some cases, water supply wells have been closed.

Existing or potential sources of ground-water contamination in the State include septic systems, landfills and dumps, underground storage tanks, saltwater intrusion, agricultural activities, surface impoundments and injection wells, spills and improper storage, and land application of sewage sludge and wastewater.

Massachusetts

To obtain a copy of the Massachusetts 1988 305(b) report, contact:

Massachusetts Division of
Water Pollution Control
Westview Building
Lyman School Grounds
Westborough, MA 01581

Surface Water Quality

Water quality in Massachusetts has not changed significantly since 1986. The State reports that water quality impacts from point sources appear to be declining as a result of the construction and upgrading of wastewater treatment plants. Nonpoint sources, however, continue to degrade water quality and are more apparent now that control of point sources has improved.

Data for this reporting period indicate that 43 percent of the 1,646 river miles assessed fully support their designated uses, 36 percent partially support uses, and 20 percent do not support their uses. Of 171 estuarine square miles assessed, 32 percent support uses, 65 percent partially support uses, and 4 percent do not support uses.

In Massachusetts' rivers and estuaries, coliform bacteria are the leading cause of the impairment of designated uses. Combined sewer overflows and municipal sewage treatment plants are the major point source of fecal coliform bacteria, while urban runoff and failing

septic systems are its leading nonpoint source contributors. Nutrients, dissolved oxygen, and biochemical oxygen demanding substances are also significant causes of use impairment.

Monitoring data indicate that 91 percent of the State's river miles are fishable and 9 percent are posted with a fish consumption advisory. Of the State's estuarine waters, 68 percent are fishable, 31 percent have fish consumption advisories, and 1 percent are under fishing bans. PCB and heavy metal contamination are the cause of fish consumption advisories and bans in the State.

Ground-Water Quality

Ground-water supplies serve approximately 33 percent of the population in Massachusetts, with around 400,000 individuals relying on private on-site wells. Since 1960, 41 municipalities have been affected by chemical or bacterial contamination of municipal water supplies. This has resulted in temporary or permanent closures of 108 public wells, well fields, or reservoirs across the State. There are few statistics on private well closures.

Ground-water monitoring is conducted through routine testing, the State Purgeable Organic Testing (SPOT) Program, citizen requests, and special studies. This monitoring has resulted in well closures due to elevated levels of organics, iron and manganese, salt, petroleum products, coliform, and the pesticide EDB. Other contaminants cited include nitrates, MBAs, phenols, trihalomethanes, and calcium carbonate.

Contamination was traced to industrial sources, including leaking sewer lines and storage areas, discharges, and illegal dumping; leaking underground tanks; landfills; overdevelopment; septic systems; road salts; a sewage treatment plant; and natural conditions or unknown sources. Private water supplies are also threatened by pesticides from agricultural activities.

Much has been accomplished in the past 5 years to further ground-water protection and cleanup in Massachusetts. A 1983 Ground Water Protection Strategy set the organizational framework necessary to identify and effectively and efficiently address matters affecting ground-water quality and public health. Within the context of this strategy, new regulatory programs and financial and technical assistance programs have been developed and implemented. Closed and contaminated water supplies have been treated, local land use controls have been strengthened, and grants for the purchase of land to protect wells have been distributed. Because of these programs and grants, 26 percent of the closed municipal supplies have been brought back on line and an additional 17.6 percent are slated for reactivation.

Michigan

To obtain a copy of the Michigan 1988 305(b) report, contact:

Michigan Department of
Natural Resources
Surface Water Quality
Division
P.O. Box 30028
Lansing, MI 48909

Surface Water Quality

Water quality in Michigan's lakes and streams is generally quite good. The inland waters of the upper peninsula and the northern half of the lower peninsula are of excellent quality and generally contain diverse aquatic communities. In the southern part of the State, lakes and streams have been affected by surface water runoff from agricultural land and urban centers, and by municipal and industrial discharges.

During the reporting period, Michigan assessed 36,350 miles of streams, 424,021 acres of lakes, and 3,288 Great Lake shoreline miles. Designated uses were supported in 98 percent of the assessed river miles and 72 percent of assessed lake acres. Since all Michigan waters of the Great Lakes have public health fish consumption advisories in place for at least one species due to elevated levels of toxic materials in their tissue, the State's Great Lakes waters are considered to be not fully supporting their designated uses.

Four of the five Great Lakes border Michigan. Three of these lakes—Superior, Michigan, and Huron—are considered to be oligotrophic and of excellent quality. Water quality in Saginaw Bay of Lake Huron has improved considerably in recent years and has contributed to improved water quality conditions in Lake Huron. Conditions in Lake Erie have also improved. Lake Erie is still considered to be eutrophic, but biological communities are becoming more balanced and there are fewer problems with low dissolved oxygen levels. Michigan is currently preparing or implementing Remedial Action Plans for several Great Lakes nearshore Areas of Concern to improve water quality conditions in these historically degraded areas.

Over the past 20 years, pollution abatement efforts have reduced water quality problems in many Michigan waters. Eutrophication problems in particular have been substantially reduced due to major point source reductions in phosphorus and organic material loads. The State is now increasing its efforts at determining the magnitude of nonpoint source nutrient loads and formulating nonpoint source control programs.

Toxic contaminants continue to have a major impact on water resources in several areas of the State. Michigan has recently implemented an industrial pretreatment program, promulgated new rules on the discharge of toxic materials, and regulated hazardous

waste disposal facilities to control the discharge of these substances. However, many problems are due to in-place pollutants that have accumulated in bottom sediments from historical discharges. At present, little is known about the interaction of these materials with the aquatic environment, the extent of contamination in problem areas, the specific chemical compounds involved, or toxic material resuspension and transport rates.

Ground-Water Quality

Ground water is readily available at most locations in Michigan, although there are some places in the western upper peninsula and southern Michigan where yields are low. Most of the State's ground water is of exceptional quality and is used for a variety of purposes including domestic consumption, crop irrigation, food processing, and industrial processes. Approximately half of Michigan's residents, or about 4.6 million people, depend on ground water as their sole source of drinking water. The withdrawal of ground water for public consumption is the largest use of this resource in Michigan.

Certain aquifers have become contaminated by toxic materials leaking from waste disposal sites, businesses, or government facilities. Actual or potential ground-water contamination has been identified at 1,778 sites in Michigan. At this time, 69 of these sites are also on the Federal Superfund list.

As of January 1988, 35 Michigan municipal well systems were known to have been affected by toxic contaminants and over 950 private residential wells were known to be contaminated. Even greater numbers of public and private wells are potentially affected by known contamination sites.

Various steps are being taken to protect the State's ground water including the cleanup of hazardous waste sites and contaminated aquifers, the regulation of activities that could potentially impact ground-water supplies, and monitoring ground-water quality. An interagency ground-water management and protection program is being implemented.

Minnesota

To obtain a copy of the Minnesota 1988 305(b) report, contact:

Minnesota Pollution Control Agency
Water Monitoring and Data Management Unit
520 Lafayette Road
St. Paul, MN 55155

Surface Water Quality

Control of point source discharges has been vastly improved in Minnesota. However, as land use increases and intensifies, the adverse impact of nonpoint source pollution and toxic contamination presents an increasing challenge to the State's efforts to protect water quality.

During the reporting period, Minnesota assessed 4,443 miles of streams, 1,435,554 acres of lakes, and 272 Great Lake shoreline miles. Of the assessed waters, 35 percent of river miles, 84 percent of lake acres, and 100 percent of Great Lake shoreline miles were fully supporting their designated uses.

The major causes of use impairment in rivers were siltation, nutrients, pathogens, and organic enrichment. Seventy-three percent of impaired river miles were affected by nonpoint sources of pollution. The only cause of use impairment cited for lakes was nutrients, primarily from nonpoint sources.

Fish tissue analyses were used to identify waters contaminated with bioaccumulative toxics and to monitor heavily used water for potential problems. Mercury and PCBs were determined to be the leading causes of nonsupport of fish consumption uses in lakes; in rivers, PCBs were the leading cause, although mercury was also a factor. In rivers, toxic contamination of fish tissue generally occurred below major municipalities.

Ground-Water Quality

At least 75 percent of all Minnesotans rely on ground water for their drinking water supply. Water use within the State was divided into five major categories: public water supply; rural domestic and livestock water supply; irrigation; thermoelectric power generation; and self-supplied industrial use. Public and domestic water supply account for 55.7 percent of the ground water withdrawn, which was more than 140 billion gallons in 1985.

The Minnesota Pollution Control Agency (MPCA) has conducted a Ground Water Quality Monitoring Program since 1978. The monitoring network consists of approximately 400 wells and springs statewide, which are sampled in a 4-year rotation and analyzed for basic constituents and volatile organic compounds. Pesticides are also analyzed for a very limited basis.

The natural quality of Minnesota's ground water is generally quite good, with concentrations usually falling far below the primary drinking water standards. However, there is growing concern over increased nitrate and pesticide contamination. The influence of land use activities on ground-water quality can be seen in the chronic exceedances of the nitrate standard in the southwestern counties, where animal feedlots are concentrated. Nitrates are also frequently elevated in the karst areas of southeastern Minnesota, as well as in the shallow surficial unconsolidated sandplain aquifers which supply water in the central areas along the Mississippi River Basin.

Other recent ground-water monitoring programs of interest are the cooperative pesticide surveys conducted

by the Minnesota Departments of Agriculture and Health. The wells tested in the surveys were generally located in places where local hydrogeology indicates susceptibility to pesticide contamination. Approximately 500 samples were collected; about 38 percent of all samples had detectable levels of one or more pesticides.

The State is working to control and abate ground-water pollution through its ground-water protection strategy and development of municipal ground-water standards.

Mississippi

To obtain a copy of the Mississippi 1988 305(b) report, contact:

Mississippi Department of Natural Resources
Bureau of Pollution Control
Water Quality Management Section
P.O. Box 10385
Jackson, MS 39209

Surface Water Quality

Of Mississippi's 15,600 miles of rivers, about 89 percent fully support designated uses. Over 97 percent of these miles were rated as meeting the fishable goal of the Clean Water Act and 95 percent were rated as meeting the swimmable goal. The most significant impacts on impaired streams arose primarily from nutrients, siltation, and to a lesser extent pesticides, priority organics, metals, chlorine, organic enrichment/dissolved oxygen, and salinity. The major source of these pollutants is agricultural runoff. With implementation of Best Management Practices, all streams classified for Fish and Wildlife or higher uses could potentially attain support of the fishable/swimmable goal.

Over 96 percent of the State's 500,000 acres of lakes fully support designated uses, with the remainder partially supporting uses. All lakes were determined to be supporting the fishable/swimmable goal of the Clean Water Act. Lakes rated as partially supporting their use classification are affected by nonpoint sources, primarily agricultural runoff.

As in rivers and lakes, nonpoint sources are the primary reason for use impairment in Mississippi's estuaries and coastal waters.

Approximately 133 square miles of estuaries were assessed for this report. Of these, 126 square miles fully support designated uses, 6 square miles partially support uses, and only 1 square mile does not support designated uses. Of 81 coastal miles, 40 miles fully support designated uses but are threatened. Another 30 miles are partially supporting and 11 miles are nonsupporting. Except for periodic excursions of the bacteria standard for recreation, all of these coastal waters were found to support the fishable/swimmable goal of the Clean Water Act.

High fecal coliform levels along the Mississippi Gulf Coast are a serious concern in the State. This problem has been caused by rapid development on the Gulf Coast and the inability of existing sewage collection and treatment systems to keep up with population growth. Significant improvement is anticipated with the implementation of regional sewage treatment plants for the three-county area.

Another area of concern is the Mississippi Delta. This fertile farmland has been subjected to intense tillage and use of agricultural chemicals over many years; lakes and streams in the area have been affected. Although serious problems with DDT, its derivatives, and toxaphene have declined significantly since 1976, use of toxaphene as a herbicide is increasing. Improvements in the Delta should be gradually noted as less persistent chemicals are used at optimum spraying times. In addition, educational efforts through the 208 Program and other agricultural programs are resulting in use of Best Management Practices such as minimum tillage, filter strips, crop residue use, and safe pesticide container disposal.

Ground-Water Quality

Ground water in Mississippi is of good quality; however, in some areas natural problems such as low pH, excessive iron, excessive dissolved solids, and excessive color are noted.

Localized ground-water contamination problems have been found near a number of RCRA-regulated surface impoundments. Ground-water contamination has also been found near several wood preserving facilities and chemical companies. All of these contamination incidences involve shallow aquifers. The U.S. Geological Survey, in cooperation with the Mississippi Department of Natural Resources, has completed a study of ground-water and surface-water contamination in five areas of southern Mississippi. The study indicated that brine contamination in shallow aquifers has occurred in parts of the Pickens, Tinsley, Brookhaven, Little Creek, and Ryan oil fields. A number of areas in southwestern Mississippi were also found to be contaminated by brine. The study also indicates that parts of deeper aquifers may be contaminated in Tinsley and Brookhaven oil fields.

The Mississippi State Department of Health is responsible for administering the Federal Safe Drinking Water Act for the State. Approximately 96 wells serving 32 water supplies have been sampled for volatile organic chemicals (VOCs) in addition to primary drinking water parameters. Four of these public water supplies sampled contained VOCs. Two of these contamination instances were directly related to leaking underground storge tanks and the other two are unresolved. When contam-

ination of an underground source of drinking water occurs, the Department of Natural Resources works with the Department of Health to define a potential contaminant source.

Missouri

To obtain a copy of the Missouri 1988 305(b) report, contact:

Missouri Department of Natural Resources
Division of Environmental Quality
P.O. Box 176
Jefferson, MO 65102

Surface Water Quality

During 1986-1987, Missouri assessed 19,630 miles of rivers and 288,012 acres of lakes. Of the State's rivers and streams, 52 percent were fully supporting uses and all but 0.2 percent of the remainder were partially supporting their uses. Most impaired waters are affected by extensive land uses, especially row crop agriculture. Of the State's lakes and reservoirs, 99 percent were fully supporting their designated uses.

The number of stream miles affected by point sources in Missouri has been dropping since 1982 as the result of sewage treatment plant construction and a statewide assessment program that has targeted projects of greatest need. Nonpoint source control efforts, however, have lagged behind. A State-funded program to address soil erosion is under way on a watershed basis, and some improvements are expected from the reclamation of abandoned coal mines. Impacts from abandoned lead-zinc mining areas are not being addressed, and programs to abate agricultural erosion are of small scope compared to the size of the problem.

Another leading concern in the State is the continuing channelization (e.g., realignment, straightening) of streams, which reduces the quantity and quality of aquatic habitat, increases water temperature, and increases erosion and sedimentation. Also of concern is the presence of chlordane in fish tissue, which has resulted in fish consumption advisories in 683 stream miles and 700 lake acres. Chlordane was used in termite control and is believed to enter waterways as a result of storm sewers/runoff.

Ground-Water Quality

The State has identified 17 areas of known ground-water contamination. These areas have been contaminated by a variety of compounds such as organic chemicals, pesticides, heavy metals, and nitrates. Public and private wells are at risk or have been affected at a number of these sites. In addition, nitrates and bacteria from septic tanks and local surface contaminants are a problem statewide.

Missouri discusses its ground-water contamination sources as follows:

- Public supplies at Republic and Liberty, Missouri, have been contaminated and long-term water use may be a health risk from abandoned hazardous waste sites. Although unconfirmed, this source is probably also responsible for contamination and potential health risk with long-term water use for public supplies at Kirkwood and Valley Park, Missouri.

- Present documentation of Federal and State incident files established underground storage tanks as the most common sources of contamination requiring remediation. Industry awareness and new regulations should have a very strong input within 5 years.

- Septic tanks are responsible for bacterial, viral, and nitrate contamination of many improperly cased or uncased private wells through the State.

- Fertilizer and pesticides are causing localized ground-water contamination in agricultural areas. The extent and degree of the problem are still being assessed. Of greatest concern are areas where bulk quantities of these chemicals are routinely stored or mixed and areas where spills have occurred.

- Although no public water supplies have been contaminated or are believed to be seriously threatened by surface impoundments used to store liquid waste, these have probably been the largest source of hazardous waste in ground waters by volume.

Montana

To obtain a copy of the Montana 1988 305(b) report, contact:

Montana Water Quality Bureau
Department of Health and Environmental Sciences
Cogswell Building
Helena, MT 59620

Surface Water Quality

Natural waters in Montana range in quality from the almost distilled waters of some headwater lakes and streams in the west, to waters exceeding the salinity of seawater in parts of eastern Montana.

About 80 percent of Montana's stream miles have been evaluated for water quality conditions and about 15 percent are monitored on a regular basis. Of the stream miles that have been evaluated and monitored, 63 percent fully support designated uses, 34 percent partially support designated uses, and 3 percent do not support designated uses.

The major causes of use impairment in Montana's streams are siltation, nutrients, salinity, flow alteration, thermal modifica-

tion, habitat alteration, and metals. Major sources include agriculture, resource extraction, hydromodification, natural and unknown sources, forest practices, and construction.

About 70 percent of Montana's lake acres have been evaluated for water quality conditions and about 17 percent are monitored on a regular basis. Of the lake acres that have been evaluated and monitored, 52 percent fully support designated uses, 46 percent partially support designated uses, and 2 percent do not support designated uses.

The major causes of use impairment in Montana lakes are habitat alteration, salinity, siltation, and nutrients. Major sources in lakes include hydromodification and agriculture.

Ground-water Quality

The principal sources of ground-water contamination in Montana are underground storage tanks, spills, mineral processing, abandoned hazardous waste sites, septic tanks, and agricultural activities. Principal substances contaminating ground water are petroleum products, metals, cyanide, organic chemicals, nitrates, and pesticides.

Montana has a number of industry-specific ground-water pollution control programs as well as the umbrella Montana Ground-Water Pollution Control System (MGWPCS) administered by the Department of Health and Environmental Sciences. Potential sources of ground-water pollution, including those regulated by industry-specific programs, must satisfy the MGWPCS nondegradation policy and meet ground-water quality standards. The Department has agreements with several State agencies to assist in the review of permit applications and to ensure that water quality concerns are thoroughly addressed. Pollution sources that are not permitted by other federally mandated or State permitting systems are required to obtain a MGWPCS permit.

Nebraska

To obtain a copy of the Nebraska 1988 305(b) report, contact:

Nebraska Department of
Environmental Control
Box 94877
State House Station
Lincoln, NE 68509

Surface Water Quality

Very few significant water quality trends have been detected in Nebraska's streams over the past 10 years. Of Nebraska's 5,690 assessed stream miles, 57 percent fully supported designated uses, 21 percent partially supported uses, and 22 percent did not support designated uses.

Agricultural runoff is the principal source of use impairment in Nebraska. Other sources of use impairment include domestic point sources, industrial discharges, habitat modification and hydrologic modifications, and natural conditions. All of these sources have impacts on the biotic integrity of affected streams.

About 59 percent of all publicly owned lake surface acres in Nebraska were assessed for support of designated uses. Of those lake acres assessed, 96 percent fully supported all assigned uses. Aquatic life uses were impaired in those lakes not fully supporting their uses. Agricultural runoff and the inherent characteristics of the lakes appear to be responsible for the high producitivty and low dissolved oxygen levels in these lakes.

Data from 1978 through 1987 were available to determine water quality trends for 15 lakes representing 69,884 surface acres. Water quality showed no significaint changes in seven lakes covering 66,839 acres. These trends indicate that less than 1 percent improved, almost 96 percent maintained their water quality, and 4 percent showed degrading trends.

Nebraska notes a number of water quality related issues that are of concern. These include recreational use support, nonpoint source pollution, the lack of information regarding toxic pollutants, the need to fund and implement pollution control programs, the impact of agricultural chemicals on ground water, unlicensed landfills, and hazardous waste sites.

Ground-Water Quality

It is estimated that about 1,875,000,000 acre-feet of ground water lie in storage under Nebraska's surface. Ground water is an extremely important resource to Nebraska, supplying about 67 percent of the water used for irrigation and about 77 percent of the public water supplies.

Although Nebraska's natural ground-water quality is good, many areas have experienced degradation from human activities. Hundreds of cases of ground-water contamination have been documented, with numbers increasing each year. Major sources include agricultural activities; industrial facilities; leaking underground storage tanks; oil or hazardous substance spills; solid waste landfills; wastewater lagoons; brine disposal pits; septic systems; and other sources. Most commonly detected contaminants in Nebraska's ground water include nitrates; pesticides such as atrazine, alachlor, and dieldrin; and chlorides.

The Nebraska Ground-Water Quality Protection Strategy was recently updated. It puts forward a plan for ground-water quality protection that emhasizes the prevention of contamination. Many of the elements of this plan have been implemented.

Nevada

To obtain a copy of the Nevada 1988 305(b) report, contact:

Nevada Division of
Environmental Protection
Capitol Complex, Room 221
Carson City, NV 89710

Surface Water Quality

For its 1988 Section 305(b) report, Nevada assessed the quality of the Colorado, Truckee, Carson, Walker, and Humboldt River Systems, as well as Lake Tahoe. Agricultural and rangeland runoff were found to contribute large sediment and nutrient loads to waters of the State. Urban drainage systems contribute nutrients, heavy metals, and organic loads.

Las Vegas Bay/Lake Mead continues to experience water quality problems. Both the City of Las Vegas Wastewater Treatment Plant and Clark County Sanitation District discharge into effluent dominated Las Vegas Wash about 11 miles upstream from Las Vegas Bay. A large blue-green alga bloom occurred in Las Vegas Bay in the summer of 1986. Ammonia now enters Las Vegas Bay untreated and threatens this important fish nursery area.

The Truckee River continues to show improvement in aquatic life below Reno/Sparks Wastewater Treatment Plant. However, temperature values at control points downstream of Wadsworth approach the maximum tolerable temperature of cold water fishery. Previous problems with turbidity and siltation appear to have been resolved. These problems, along with the temperature problem, are traceable to gravel operations, channelization, urban projects within the river, watershed erosion, low flows and streambank vegetation removal.

Historically, the Carson River water quality standards for nutrients were frequently exceeded for most reaches. The greatest violations of standards occurred during the summer months at low flow in the lower reaches of the river. Carson City Sewage Treatment Plant ceased discharging to the Carson River in September 1987. Although it is too soon to observe the effects of removing this significant point source from the river, it is anticipated to aid in reversing the trend of deterioration which has been occurring over the past 17 years. However, as point sources have been removed, nonpoint sources in Carson Valley have now become a significant nutrient source. As a result of a special mercury study completed by Division of Environmental Protection staff in 1985, a fish consumption health advisory was issued. Selenium pollution has recently been shown to be a potential problem in the Stillwater Marsh area.

Elevated phosphates and nitrates have been consistent problems in the lower reaches of the East Fork and mainstem of the Walker River. However, 1986/1987 monitoring records show significant reduction in both total phosphorus and total nitrogen. Lower stream flows in 1986 and 1987 have led to a trend of increasing salinity.

The Humboldt River continues to have problems with violations of phosphorus, nitrate, turbidity, and total dissolved solids standards.

Lake Tahoe's pristine water quality continues to degrade. Primary productivity at the Tahoe Index Station has increased more than 140 percent since 1968. Annual algal productivity in 1986 was the highest on record. Recent data indicate a continuation of this increasing trend. Clarity also continues to degrade, with annual mean Secchi depths decreasing at a rate of 0.40 meter per year since 1967. While these parameters indicate decreasing water quality, they have not interfered with the lake's ability to support fish and wildlife and recreational uses.

Ground-Water Quality

Approximately 50 percent of Nevada's total population relies on ground water. Since surface waters are either fully allocated or over-allocated, Nevada's future growth must rely heavily on untapped ground-water aquifers. Thus, protecting present and potential (i.e., presently untapped) ground-water aquifers is a high priority of the State.

Nevada initiated this protection effort by completing the "Ground Water Protection Strategy for Nevada" in August of 1987. The Strategy delineated Nevada's short- and long-term goals, recognizing both the priorities and limited resources available.

Major sources of ground-water contamination in the State include mining, underground storage tanks, injection wells, septic tanks, and landfills. Substances contaminating ground water include volatile organic chemicals, nitrates, petroleum products, radioactive material, fluorides, arsenic, and brine/salinity.

New Hampshire

To obtain a copy of the New Hampshire 1988 305(b) report, contact:

Water Supply and Pollution
Control Division/DES
Water Quality Section
6 Hazen Drive
P.O. Box 95
Concord, NH 03301

Surface Water Quality

The water quality of New Hampshire's rivers and streams remains excellent overall. During 1986 and 1987, designated uses were fully supported in 71 percent of the 1,330 assessed miles. Sixteen percent partially supported designated uses and 13 percent did not support uses.

Point sources remain the major factor affecting uses in

New Hampshire's mainstem waterbodies. Predominant problems include inadequately treated municipal wastes from primary wastewater treatment facilities and existing untreated sources. However, nonpoint sources including bacterial contamination from individual septic system failures in rural areas are becoming more evident: as wastewater treatment facility upgrading and construction in the last 2 years have removed organic loadings to receiving waters, previously masked nonpoint source impacts have been found.

Of the nearly 150,000 acres of lakes assessed, approximately 87 percent fully support their designated uses. However, due to nonpoint pollution, about 13 percent of these waters only partially support designated uses and 0.5 percent do not support uses. Acidification and nutrient impacts are cited as the primary causes of nonattainment.

With only 18 miles of coastline, New Hampshire places high recreation value on every frontage foot. Only a small portion of the coastline does not fully support designated uses.

The protection of New Hampshire's valuable shellfish populations (clams, oysters, and mussels) in Great Bay/Little Bay, Hampton Harbor, and Rye Harbor remains a priority. Given the tremendous investment in wastewater treatment facilities in the seacoast region, the lack of a significant reduction in coliform bacteria levels in certain areas is of major concern. As a result of these concerns, a special Shellfish Committee was formed in March of 1988.

Ground-Water Quality

Approximately 60 percent of New Hampshire's population depends in whole or in part on ground water for water supply. The growing number of incidents of ground-water contamination, as well as competing demands for this renewable but finite resource, have made ground-water protection a priority issue in the 1980s and into the 1990s.

In general, the quality of New Hampshire's ground water is excellent. Because it is such a valuable resource, the State has designated all ground water as potentially drinkable. A comprehensive permit process was developed for any proposed discharge to ground water. An extensive inventory of potential point and nonpoint source pollution sources has been completed. Local communities are being encouraged to further protect fragile ground-water supplies through zoning, land use control and other aquifer protection strategies. The development of a statewide ground-water protection strategy will be completed during FY 1989.

The main issue that has concerned State and local officials is ground-water contamination from hazardous waste sites, leaking underground storage tanks, unregulated releases of hazardous wastes to septic tanks, and municipal landfills. Areas of significant contamination from these sources exist throughout the State.

In the long term, the key to protecting the State's ground-water resources is to prevent contamination by focusing limited State and local resources on the most sensitive or valuable geographic areas. This focus is difficult because of a lack of funding for the Wellhead Protection Program.

New Jersey

To obtain a copy of the New Jersey 1988 305(b) report, contact:

New Jersey Department of
Environmental Protection
Bureau of Water Resources
Management Planning
P.O. Box CN-029
Trenton, NJ 08625

Surface Water Quality

Approximately 31 percent of New Jersey's monitored river and stream miles meet both the fishable and swimmable goals of the Clean Water Act.

In New Jersey's estuaries, 77 percent were fully supporting uses, 20 percent were partially supporting uses, and 3 percent were not supporting uses. The State identifies ocean water quality and ocean litter as a special concern.

Pollutants commonly found in State waters include fecal coliform bacteria, nutrients, reduced dissolved oxygen levels, siltation, road salts, and oil and grease. Point sources affect every major waterway in the State. Nonpoint sources are also a major contributor to water-quality degradation, but very little monitoring data exist to quantify their extent. Impacts are suspected from stormwater outfalls, construction, urban and agricultural runoff, land disposal practices, and hydrologic/habitat modification.

Ground-Water Quality

Currently, about half of the State's population relies on ground water for drinking water. Of the 622 community public water systems in the State, 558 obtain all or part of their supplies from ground-water sources. There are also approximately 16,000 non-community wells and 400,000 private potable wells in the State.

Ambient ground-water quality is considered naturally good in the State although in many areas, iron removal is necessary for potability. There are ground-water problems, however: during the past 3 years, 218 wells were sealed due to ground-water pollution problems and the New Jersey Department of Environmental Protection (NJDEP) responded to 960 ground-water pollution cases.

From May 24, 1985 to December 1, 1987, well samples throughout the State were analyzed for volatile organic chemicals. The sampling results indicated

that 76 public wells and 139 private wells had unacceptable levels of volatile organic chemicals. It should be noted that the sampling did not focus on private wells, and the number of contaminated private wells only represent those that were brought to the NJDEP's attention.

Common sources of ground-water pollution in New Jersey include land disposal sites, accidental spills and leaks, underground storage tanks, and unknown sources. To protect regional ground-water supplies, the NJDEP has established two water supply critical areas.

New Mexico

To obtain a copy of the New Mexico 1988 305(b) report, contact:

New Mexico Environmental Information
Division Water Quality Planning Section
P.O. Box 968
Santa Fe, NM 87504-0968

Surface Water Quality

During the reporting period, New Mexico assessed 1,151 miles of rivers. Forty-eight percent of assessed rivers were determined to be partially supporting their uses, and 2 percent were not supporting uses.

A total of 119,666 acres of lakes were assessed. Of these, 40 percent are not fully supporting fishery uses. Water quality impairment of this acreage is the result of nonpoint sources.

Available data indicate that New Mexico has been largely successful in reducing point source impacts on the State's rivers. Nonpoint sources now predominate. Habitat alteration, siltation, toxic metals, and flow alteration are the predominant causes of use impairment in New Mexico's rivers and streams.

In the State's lakes, dissolved oxygen deficiencies, plant nutrients, siltation and habitat alterations are major causes of use impairment. Agriculture and recreation are the major sources of these impacts, silviculture, construction activities and miscellaneous activities have lesser impacts.

New Mexico notes three issues of special concern: nonpoint source pollution, toxic substances, and protection of mountain streams. As mentioned above, nonpoint sources of pollution are quantitatively the largest known cause of surface water quality impairment in New Mexico. In addition a need exists for further investigation of surface water quality impacts of toxic substances.

In mountain streams, home and recreational development, mining and milling, overgrazing, and community wastewater discharges have resulted in standards violations and in fishery and habitat degradation. Known and potential water quality impairment has been documented on 37 mountain stream reaches. The Environmental Improvement Division is exploring management approaches to better protect mountain streams; both regulatory and nonregulatory approaches are being considered.

Ground-Water Quality

Ground-water contamination most frequently occurs in vulnerable aquifer areas where the water table is shallow. Since the mid-1970s the State has been inventorying incidents, causes, and sources of ground-water contamination around the State. At least 883 incidents of ground-water contamination have been documented. Slightly more than half of all cases have been caused by nonpoint source pollution, principally household septic tanks and cesspools.

Other sources of contamination include oil field sources such as pipelines, leaking well-casings and waste disposal pits, leaking underground storage tanks, ore-refining mills and mill tailings disposal sites, sewage treatment plants, dairies, slaughterhouses, industrial facilities, and public landfills.

Many population centers and mineral resource development areas have been established in vulnerable aquifer areas, with resultant ground-water quality problems. For example, two common types of ground-water contamination in the Albuquerque metropolitan area are (1) anoxic conditions or elevated salinity and hardness and (2) localized contamination cases involving constituents of health concern such as nitrate, gasoline, chlorinated solvents, and pesticides. Similarly, nitrate contamination, anoxic conditions and cases of contamination from leaking underground storage tanks have occurred in the rapidly developing Espanola area.

The Ogallala Formation, in Lea County, is the principal freshwater aquifer in the region. Numerous instances of contamination by oil-field activities have been identified since the early 1950s. Nitrate contamination from septic tanks has also occurred in several areas of the county.

The Grants Mineral Belt in Cibola and McKinley Counties has been a major uranium-producing region of the United States. Seepage from active and inactive mill tailings ponds, plus the long-term impacts of previously unregulated discharges and potential contamination from abandoned spoils piles, constitute a continuing ground-water quality problem.

The San Juan Basin is second only to southeastern New Mexico as a petroleum producing region and produces most of the State's natural gas. Ground-water quality in the Basin has been impacted by oil and gas production activities and by landfills.

In Dona Ana County, two sources—ponds used for the disposal of dairy wastes and septage disposal—are of concern. The septage disposal problem has become especially complex due to the closing of landfills to septage dumping. At present, there are no acceptable permanent septage disposal

sites in Dona Ana County. Federal, State, and local officials are working to find a solution.

New York

To obtain a copy of the New York 1988 305(b) report, contact:

New York State Department
of Environmental
Conservation
Bureau of Monitoring
& Assessment
Division of Water
50 Wolf Road
Albany, NY 12233-3503

Surface Water Quality

During Water Years 1986-1987, New York assessed 70,000 miles of streams, 750,000 acres of lakes, 1,564 square miles of estuaries, 577 Great Lake shore and 130 ocean coastal miles. Approximately 76 percent of its rivers and streams were found to fully support their designated use, along with 61 percent of lake, pond, and reservoir acres, 74 percent of estuary square miles, 17 percent of Great Lake shoreline miles, and 46 percent of ocean coastal miles.

Approximately 345 river miles, 131,000 lake acres, and 154 square miles of estuary are affected by toxic pollutants. An estimated 70 miles of ocean coastline and 492 miles of Great Lakes shoreline are affected by toxics as well. Contaminated sediments are responsible for virtually all of this use impairment; together with nonpoint sources, they constitute the major sources of water use impairment in the State. Industrial and municipal point sources are relatively minor contributors to use impairment.

New York lists eight special concerns: hazardous substance control; toxic sediments; PCB cleanup of the Hudson River; ground-water management; emergence of nonpoint source problems; effects of acid rain; Great Lakes water purity; and marine water purity, particularly in the Long Island Sound.

Ground-Water Quality

Approximately six million people in New York State use ground water as a source of water. Half of these people are on Long Island and the remainder are in upstate New York. The Department of Health has reported 130 public water supplies affected by toxic organic contamination of ground water. Of these, 33 water supplies on Long Island and 20 in upstate New York remain closed or abandoned.

Contamination by synthetic organic chemicals is the most significant threat to ground-water quality statewide. The three major categories of organic contaminants that are detected most frequently in ground water are:

- industrial/commercial synthetic organic solvents and degreasers, primarily trichloroethane, trichloroethylene, and tetrachloroethylene;
- gasoline and other petroleum products that contain the compounds benzene, toluene, and xylene; and
- agricultural pesticides and herbicides, primarily aldicarb and carbofuran.

The primary sources of ground-water contamination by organic chemicals are spills, leaks and improper handling at industrial and commercial facilities.

Pesticide contamination, primarily by aldicarb, is a particular problem on Long Island, where it is used on potato fields. It has also been detected in ground water in upstate New York. A sampling survey of 330 wells in eastern Long Island detected aldicarb in concentrations exceeding the Department of Health's recommended guideline in 23 percent of the wells.

Nitrate contamination has been noted in two upstate public water supply wells. It is a more serious problem on Long Island, where nitrate concentrations are increasing in the major public water supply aquifers for most of the developed and agricultural areas. Primary sources of nitrate are agricultural and domestic use of fertilizer, subsurface disposal of sewage, and leaking sewer lines.

North Carolina

To obtain a copy of the North Carolina 1988 305(b) report, contact:

North Carolina Department
of Natural Resources
& Community Development
Special Projects Group
Division of Environmental
Management
P.O. Box 27687
Raleigh, NC 27611-7687

Surface Water Quality

Of North Carolina's 33,275 assessed miles of freshwater streams and rivers, 67 percent support their uses, 28 percent partially support uses, and 5 percent do not support designated uses. River basins located in the mountains tend to have the highest percentage of high quality streams, while more heavily developed Piedmont or Coastal Plain basins have more stream mileage with use impairment.

Nonpoint sources account for use impairment in 92 percent of degraded streams. Major sources include agriculture, unknown nonpoint sources, municipal wastewater treatment plants (WWTPs), and urban runoff. Sediments are the leading causes of stream impact. In the past the State has emphasized control of point sources; while this emphasis has had great positive benefit, effective nonpoint source control is more difficult to implement and continued progress in pollution control will probably be slower.

Overall, 96 percent of the surface area of lakes and reservoirs in North Carolina support their designated uses, 3 percent partially support uses, and 1 percent do not support their uses. The largest cause of use nonsupport has been coal-fired power plant discharges to two lakes (Hyco and Belews), which have resulted in excessive selenium levels in these lakes. Belews Lake no longer receives coal ash basin effluent, and Hyco Lake will no longer be receiving effluent in the near future. These actions should restore biota in both lakes. In addition, extensive efforts are underway to control eutrophication in two relatively new lakes, Falls and Jordan. The major source of use impairment in lakes is in-place contaminants, industrial WWTP, and agriculture. Major causes of lake problems are metals (primarily selenium) and aquatic macrophytes.

Of the State's acreage of estuaries and sounds, 93 percent fully support their designated use while 7 percent partially support uses (because of closed shellfish areas or areas of excessive algae growth) and 0.1 percent do not support their designated uses. Major sources of impairment in estuarine waters are agriculture, municipal WWTPs, septic tanks, and urban runoff. Major causes of impacts in estuaries are chlorophyll *a* and nutrients, multiple causes, and bacteria. Several new or expanded efforts are underway to protect estuarine waters including expanded control of stormwater runoff to shellfish areas, nutrient control measures in several coastal watersheds, and protection of primary nursery areas.

Ground-Water Quality

About half of the people in North Carolina use ground water as their primary water supply. Ground-water quality is generally good statewide. The major source of ground-water contamination is leaking underground storage tanks; spills, lagoons, and septic tanks are also important sources. Comprehensive programs are underway to (1) assess potential contamination sites and (2) develop a comprehensive ground-water protection strategy for the State.

To prevent ground-water pollution, the State has classified ground waters, established ground-water quality standards, and implemented a permit system. All relevant State environmental permit applications are reviewed by the lead State ground-water agency to assure compliance with ground-water standards. Work was begun during 1987 to review ground-water standards to incorporate State ground-water quality permitting experience gained from the past several years.

The State responds to ground-water pollution incidents via an interagency emergency response program. This ground-water incident management program provides the mechanism for standardized pollution response procedures and a consolidated inventory of contaminated sites.

As a part of its ground-water planning effort, the Ground-Water Section is preparing an updated draft of its State Ground-Water Protection Strategy. Within the continuing ground-water management effort, the resource is monitored, trends documented, resource protection plans developed, and, where necessary, regulations imposed upon ground-water use. Ground-water data management is also an important element in the State's overall resource management program.

North Dakota

To obtain a copy of the North Dakota 1988 305(b) report, contact:

North Dakota Department of Health and Consolidated Laboratories
Division of Water Supply and Pollution Control
1200 Missouri Avenue
P.O. Box 5520
Bismarck, ND 58502-5520

Surface Water Quality

Of the 9,850 miles of assessed rivers and streams in North Dakota, 1,350 miles were moderately to slightly impaired by point source pollution and all assessed miles were impacted to some degree by nonpoint source pollution. Of the assessed river miles, 69 percent were fully supporting their designated uses, and 31 percent were partially supporting uses. The major source of use impairment is nutrient and sediment transport from dry crop farmland. Runoff from range/pasture land and feedlots are moderate to minor sources of nonpoint pollution. These sources cause high nutrient, fecal coliform, and suspended solid concentrations and increase siltation. Discharges from municipal waste treatment facilities are considered a moderate to minor source of use impairment and periodically cause increased ammonia and fecal coliform concentrations.

Of the 619,333 lake acres assessed, 571,208 acres were fully supporting uses, and 48,125 acres were partially supporting designated uses. Partial support was largely manifested as fish kills and nuisance occurrences of blue-green algae impairing recreational activities such as swimming. Nutrients, siltation, and organic enrichment—mainly due to erosion and runoff from dry crop farmland—are the primary causes of lake use impairment.

The most critical water quality issue in North Dakota is nonpoint source pollution and, in particular, agricultural runoff. Wetland protection is another issue of growing concern to the State.

Ground-Water Quality

Ground water is one of North Dakota's most precious

resources. Nearly the entire rural population and most municipalities obtain their water from ground-water supplies. Sixty percent of the State's population relies on ground water for its drinking water source.

North Dakota is primarily an agricultural State with limited industrial development. As a result, it has experienced relatively minor ground-water contamination problems in comparison to heavily industrialized States. Leading sources of ground-water contamination include agricultural chemicals (e.g., pesticides and fertilizers), storage tanks and pipelines, wastewater impoundments, solid waste disposal sites, oil and gas exploration activity, and septic systems.

North Dakota's ground-water protection stragety is the core of its ground-water program. The strategy reviews current State and Federal ground-water protection programs and addresses issues such as standards, ground-water classification, monitoring, and data management.

Other programs that provide ground-water protection include the point and nonpoint source pollution control programs, the public water supply program, the underground injection control program, the construction grants program, the solid waste management program, and the hazardous waste management program.

Ohio

To obtain a copy of the Ohio 1988 305(b) report, contact:

Ohio Environmental
Protection Agency
Division of Water Quality
Monitoring and Assessment
P.O. Box 1049
Columbus, OH 43266-1049

Surface Water Quality

Of the total 7,045 assessed stream miles in Ohio, 32 percent are attaining their aquatic life use designations, 21 percent are partially attaining those uses, and 47 percent are not attaining aquatic like uses. Since the State's sampling program is necessarily biased toward stream segments in problem areas, the actual percentage of total stream miles attaining their aquatic life uses in Ohio is probably higher. Because of extensive coverage of larger streams and rivers, however, this assessment is probably a fair reflection of conditions in these waterbodies.

The proportion of stream and river miles not fully supporting aquatic life uses is less than reported in 1986, but not because of reductions in water quality. In fact, continued reductions are evident in point source loadings. Changes in use support are largely the result of the adoption of ecoregional biological criteria in Ohio, and a reassessment of all stream segments for which biological data were available. Two new indices and the use of reference sites to set biocriteria have resulted in more sensitive aquatic life criteria for Ohio's waters.

Municipal (including combined sewers) and industrial point source discharges accounted for impacts in 56 percent of stream miles. Nonpoint sources were contributors in 20 percent, habitat/flow modification in 17 percent, natural conditions in 2 percent, in-place pollutants in 2 percent, and other or unknown in the remainder. Most waterbody segments were affected by multiple sources. Leading causes of nonattainment include low dissolved oxygen/organic enrichment, toxics, and habitat modification/flow alteration.

Trend analyses of data from 11 Ohio rivers indicate a sharp improvement where the biota had been affected by municipal discharges and less improvement where toxic discharges or urban runoff have been affecting the biological community. Overall, Ohio has made dramatic improvements in rivers that were grossly polluted by municipal sewage plants 20 to 30 years ago. Many miles are still not fully attaining aquatic life uses, but it is estimated that their impairment is not nearly as severe as in the past. This progress should not be overrated in light of the high percentage of monitored miles with impaired aquatic life uses.

In Ohio's inland lakes and reservoirs, 6 percent of assessed acres fully supported uses, 56 percent partially supported uses, and 10 percent did not support uses. The remaining 28 percent was considered to be attaining, but threatened. Nonpoint sources, point sources, and habitat modification were major sources of use impairment in lakes. Leading causes were identified as algal/nutrients, organic enrichment/low dissolved oxygen, metals/inorganics, and pathogens.

All 23 of Ohio's Lake Erie shoreline miles were evaluated for aquatic life support and were considered partially supporting due to a lakewide fishing advisory for carp and channel catfish, and to criteria exceedances for copper and cadmium.

Ground-Water Quality

Protecting ground water is essential in safeguarding the health of Ohioans. More than four million people depend on ground water as their primary source of drinking water in the State. Ground water supplies some 1,200 of Ohio's 1,600 community water systems, including systems serving three of its ten largest cities.

Ohio's large population and diverse economy generate a wide range of potential ground-water contaminants, ranging from bacteria to toxic chemicals. The most serious sources or potential sources of contamination include hazardous waste generation, solid waste landfills, leaks and spills, agriculture, septic tanks, mineral extraction, and improperly constructed or maintained wells.

To manage its ground water properly, Ohio developed a Ground-Water Protection and Management Strategy in 1986. An important initiative of this strategy was the creation of an Inter-Agency Ground-Water Advisory Council to monitor State ground-water related programs and to comment in all rulemaking processes. This group was established during 1987 and will be important in assisting the State with the implementation of its Ground-Water Strategy.

The State's ground-water strategy implementation plan addresses priorities for identifying and remediating sources of ground-water contamination. Sources of contamination from hazardous waste and material, treatment, storage and disposal activities pose the greatest potential threat to human health, although other sources may be more numerous. The strategy is directed at controlling all sources of ground-water contamination using a variety of Federal, State, and local authorities.

Ohio River

To obtain a copy of the Ohio River 1988 305(b) report, contact:

Ohio River Valley Water Sanitation Commission
49 East Fourth Street
Suite 815
Cincinnati, OH 45202

Surface Water Quality

The Ohio River Valley Water Sanitation Commission (ORSANCO) coordinates water pollution control efforts for the 981 river miles of the Ohio River. All river miles were assessed, and all were partially supporting their designated uses.

The fishable goal of the Federal Clean Water Act was met in 941 miles and not met in 40; the swimmable goal was met in 819 miles and not met in 162. Compared to the previous reporting period, exceedances of stream criteria increased for heavy metals, especially lead and mercury. This is primarily due to the adoption of more stringent water quality criteria in 1982.

Major causes of designated use impairment include major municipal discharges, industrial discharges, nonpoint sources, and tributary contributions. Municipal discharges, privately owned sewage treatment facilities, and combined sewers contributed impairment of recreational uses.

The water quality problems cited above will provide the major emphasis for water pollution control efforts of the Commission and its member States on the Ohio River in the coming years. In addition, the following special concerns must be addressed:

- In establishing permit levels for dischargers, the limits that must be met by downstream water supply utilities must be considered.

- Spills and accidental discharges will continue to be a potential problem given the number of facilities treating, storing, and handling various chemicals along the Ohio River.

- Wastewater treatment facility operation must continue to receive attention to assure that facilities achieve the degree of water quality improvement for which they were designed.

- Hydroelectric power development at Ohio River navigation dams could reduce the degree of aeration at the dams, thereby lowering dissolved oxygen levels.

Ground-Water Quality

The Commission's major concern is protecting and improving surface waters in the Ohio River Basin. As part of this effort, the Commission will be assessing the impact of ground-water contamination as a nonpoint source of pollution to the Ohio River. The alluvial aquifer associated with the main stem of the Ohio River is vulnerable to contamination due to extensive industrial development along the Ohio River. This issue will be addressed as part of the Commission's Toxic Substance Control Program.

Oklahoma

To obtain a copy of the Oklahoma 1988 305(b) report, contact:

Oklahoma Department of Pollution Control
P.O. Box 53504
Oklahoma City, OK 73152

Surface Water Quality

The overall quality of Oklahoma's waters remains good; designated uses and the Clean Water Act are being met in a majority of waters. Oklahoma assessed 9,248 miles of streams. Of these, 36 percent fully supported their designated uses, 38 percent partially supported uses, and 26 percent did not support their designated uses. Major causes contributing to nonsupport include; siltation, nutrients, pesticides, suspended solids, pathogens, and salinity. Major sources of nonsupport include agriculture, resource extraction, and hydrological/habitat modifications.

Currently, Oklahoma is concerned about the extent of animal waste contributions to streams in northeast Oklahoma. In combination with inadequately treated municipal wastewater,

animal wastes have caused serious degradation of the Illinois River Basin in Oklahoma and Arkansas. This problem does not appear to be correctable without improved coordination of point and nonpoint source management actions. Further, this management must be interstate in nature to ensure that effective controls will result. In other words, an integrated management approach involving both States appears to be the only course of action that is likely to succeed. This problem and water quality issues raised by a proposed reservoir on Lee Creek, highlight inconsistencies on the part of EPA in the arbitration of quality standards issues between States.

Ground-Water Quality

In December of 1983, the Oklahoma agencies with ground-water responsibilities joined in a cooperative effort to establish a program development strategy for ground-water protection. From this effort a framework agreement was developed. Under the provisions of this agreement, the Corporation Commission, the Department of Agriculture, the Department of Health, and the Water Resources Board adopted goals and principles for program development.

Oklahoma has also adopted statewide ground-water standards that identify beneficial uses for 21 aquifers. Under its ground-water sampling program, 506 wells are monitored for 22 parameters. The results of the initial monitoring are being evaluated and summarized into an assessment report.

Oregon

To obtain a copy of the Oregon 1988 305(b) report, contact:

Oregon Department of
Environmental Quality
Water Quality Division
811 Southwest Sixth Avenue
Portland, OR 97204

Surface Water Quality

During the reporting period, Oregon assessed 27,738 miles of streams, and 504,928 acres of lakes. Of the assessed river miles, 45 percent fully supported designated beneficial uses, 31 percent partially supported uses, and 24 percent did not support their designated uses. Of the assessed lake acres, 74 percent fully supported uses, 12 percent partially supported uses, and 14 percent did not support their designated uses.

Major causes of nonsupport in rivers include habitat modifications, flow alterations, thermal modifications, and siltation. Major sources of impairment in rivers include agriculture, silviculture, resource extraction, combined sewers, construction, municipal discharges, bacteria and excessive nutrients. In lakes, major causes of nonsupport include nutrients, pH, and organic enrichment (low oxygen). Major sources of impairment for lakes include agriculture, land disposal, and storm sewers/runoff.

The State is in the process of establishing Total Maximum Daily Loads (TMDLs) for eleven "water quality limited" stream segments where water quality standards are not being met. This process reflects a major program change from technology-based to water quality-based permitting with a greater emphasis on the receiving waterbody.

The cultivation of nursery stock in containers is a growing industry in Oregon. Certain container industry practices can create water quality problems. These include application of fertilizers and pesticides; construction of dams to capture and reuse irrigation return water; poor construction of irrigation ponds; and the setting of containers on gravel over packed earth or plastic with drainage to surface waters. The State is currently reviewing these practices to develop best management practices and to determine if permits should be used to regulate runoff.

Ground-Water Quality

In Oregon an estimated 1.6 million persons (about 60 percent of Oregon's population) depend on ground water for all or part of their daily water needs. An average of 1.1 billion gallons per day of ground water were withdrawn in Oregon during 1980. Of this amount, 75 percent was for irrigation use, 12 percent for rural domestic and livestock use, 7 percent for industrial use, and 6 percent for public water use. Ground-water use is expected to increase in the future because the State's population is growing and because summertime flow in many streams is inadequate to meet present and future demand.

The number of known ground-water contamination sites in the State has increased to over 200, and is rising steadily, in part due to increased assessment activities. To date, ground-water contamination resulting from industrial activities has been discovered at approximately 75 sites in Oregon. The types of industries that have been found to be causing ground-water pollution include chemical manufacturing, metals plating, wood treatment, oil/gas storage and refueling areas, electronics, food processing, aluminum plants, and pulp and paper mills. Among the contaminants from these industries are organic chemicals, dissolved metals, nitrates, cyanide, and total dissolved solids. Other sources of ground-water contamination in Oregon include landfills, on-site sewage disposal, municipal sewage treatment facilities, and agricultural activities.

The Oregon Environmental Quality Commission adopted a statewide Ground-Water Quality Protection Policy in August 1981. Since that time, the State has worked with a citizen's advisory committee to assist in the development

of proposed amendments to the policy including point source control rules, nonpoint source control procedures, a classification system, and ground-water quality standards. Three new programs were approved by the Oregon Legislature in 1987 to clean up hazardous waste sites; establish permitting, monitoring, and cleanup requirements for underground storage tanks; and prepare interagency management plans for the Ontario and Boring aquifers. The Department of Environmental Quality is working with other State agencies to develop a comprehensive statewide plan for groundwater management.

Pennsylvania

To obtain a copy of the Pennsylvania 1988 305(b) report, contact:

Pennsylvania Department of Environmental Resources
Bureau of Water Quality Management
P.O. Box 2063
Harrisburg, PA 17120

Surface Water Quality

A total of about 13,242 miles out of approximately 50,000 total miles of rivers and streams were assessed for this report, based on monitoring or evaluations conducted between July 1970 and December 1987. This represents an increase of about 7,016 miles assessed over the 1986 report. Approximately 73 percent of the miles assessed fully supported designated stream uses, 13 percent were partially supporting, and 14 percent were not supporting uses.

The most extensive causes of water quality degradation in Pennsylvania streams are acidity and metals from abandoned coal mine drainage. While some funding is available for abatement of abandoned mine drainage, the immensity of the problem and difficulties associated with control have severely hampered abatement and treatment projects. These difficulties are expected to continue. Other major causes of use impairment are siltation, nutrients, organic enrichment, pathogens, and pesticides. These pollutants are primarily the result of agricultural runoff, municipal and industrial discharges, individual septic discharges, and oil and gas extraction activities. Oil and gas production is takes place in over 30 counties in Pennsylvania.

The environmental impacts of this industry have been significant, particularly in western Pennsylvania: about 2,000 unpermitted discharges of brine and produced fluids have been inventoried by EPA in the State's western counties. These discharges are to be permitted or eliminated as required by Federal law.

Pennsylvania assessed trophic status in 37 significant publicly owned lakes. Of these, 29 were classified as mesotrophic, 7 as eutrophic, and 1 as oligotrophic. Out of the State's total 340 significant lakes, 28 were considered to have impaired uses, and 11 were classified as threatened.

Ground-Water Quality

On a statewide basis, ground water contributes approximately 70 percent of all stream flow under average conditions and up to 100 percent during low flow periods. More than two-thirds of public water supplies and almost all private supplies in the State come from ground water. Shallow ground-water conditions normally prevail throughout Pennsylvania; consequently, the entire State is vulnerable to man's activities.

Ground-water quality is believed to be generally acceptable for drinking with only minor treatment. However, in portions of western Pennsylvania, excessively high iron, sulfate, hardness, total dissolved solids, and manganese concentrations limit ground-water use in varying degrees. Extensive mining and oil and gas production activities are contributing to major ground-water quality problems in western counties, and nitrate-nitrogen problems are present in south-central and southeastern counties. Leaking underground storage tanks and less extensive mining have contributed to local ground-water problems statewide.

Major sources of ground-water contamination include underground storage tanks, surface impoundments, industrial landfills, septic tanks, and abandoned hazardous waste sites. The major pollutant cause statewide is petroleum and/or its by-products. Other causes include organic and inorganic chemicals, metals, and pesticides.

Since 1963, Pennsylvania's Ground-Water Quality Management Program has included review of permit applications, pollution investigations, enforcement actions, and advisory activities which affect ground-water quality. New initiatives being implemented include a ground-water quality protection strategy, a ground-water quality monitoring strategy, an underground storage tanks program, and implementation of soil-dependent treatment systems for on-lot disposal of sewage.

Puerto Rico

To obtain a copy of the Puerto Rico 1988 305(b) report, contact:

Puerto Rico Environmental Quality Board
Water Quality Area
P.O. Box 11488
Santurce, PR 00910-1488

Surface Water Quality

Puerto Rico has approximately 5,373 stream miles. Of these, 46 percent were fully supporting designated uses during the reporting period. Pathogens, nutrients, and suspended solids were the leading causes of use

impairment in streams; leading sources included agricultural activities (feedlots and crops), land disposal (landfills and wastewaters from communities), and urban runoff.

Thirty-four percent of Puerto Rico's 11,146 acres of lakes and lagoons were found to support designated uses. Principal causes of nonsupport in lakes included organic enrichment/reduced dissolved oxygen levels, suspended solids, and pathogens, primarily from nonpoint sources.

Of 434 coastal shoreline miles, 58 percent fully supported designated uses. Major causes of impairment included nutrients, suspended solids, and unknown toxicity. Sources of impairment in coastal waters included land disposal and municipal and industrial dischargers.

Only 17 percent of 173 estuarine miles were reported to be fully supporting designated uses. Habitat alterations from natural sources, such as mangrove areas, were cited as the principal cause of use impairment. Urban runoff and municipal point source dischargers were also cited.

Lakes, lagoons, estuaries, and wetlands were identified as special concerns because of their value as critical habitats. In order to more accurately assess their problems and water quality status, a need for better monitoring strategies for these waters was noted.

Ground-Water Quality

The principal uses of ground water in Puerto Rico include potable water supply, industrial processing, and agricultural activities. Ground water is extensively used and provides about 24 percent of the total water used islandwide. However, dependence on ground water varies throughout the island; a number of municipalities draw 50 percent or more of their public water supply from ground-water sources.

During 1986-1987, ground-water quality was assessed at 75 wells in the northeastern region of Puerto Rico. Volatile organic compounds such as methylene chloride and chloroform have been identified in at least five wells, based upon preliminary evaluations. This study is as yet incomplete. Major sources of ground-water contamination included injection wells, abandoned hazardous waste sites, and underground storage tanks.

Rhode Island

To obtain a copy of the Rhode Island 1988 305(b) report, contact:

Rhode Island Department
of Environmental
Management
Division of Water Resources
291 Promenade Street
Providence, RI 02908-5767

Surface Water Quality

During the reporting period, Rhode Island assessed 581 river miles, 16,089 lake acres, and 192 estuary square miles. An assessment of overall surface water quality in Rhode Island indicates that 84 percent of the State's rivers and streams, 91 percent of lakes, and 80 percent of estuaries/oceans support designated uses.

Of those waters assessed for support of Clean Water Act goals, 80 percent of river and stream miles are fishable/swimmable, as are 90 percent of lakes and 93 percent of estuaries/oceans.

The most significant causes of nonsupport in rivers and streams are heavy metals, coliforms, low dissolved oxygen, and nutrients. In lakes and ponds, the major causes of nonsupport are coliforms, nutrients, and siltation. In estuaries and coastal waters, the major causes of nonsupport are coliforms, heavy metals, nutrients, and low dissolved oxygen. In rivers and estuaries, major sources include industrial and municipal point sources and nonpoint sources such as urban runoff, failed septic systems, while lakes/ponds are affected by nonpoint sources, primarily septic systems.

Ground water is clearly an important source of drinking water in Rhode Island. Twenty-four percent of the State's population is dependent on ground water for its water supply. This includes 151,620 people served by public water systems. In addition, private wells provide water for another 84,000 people, or 8.7 percent of the total population.

Rhode Island's principal aquifers are extremely vulnerable to contamination from a wide variety of pollution sources. Over 75 contaminants have been detected in Rhode Island's ground water, the most common being organic solvents, the pesticide aldicarb (Temik), and petroleum products. Most ground-water contamination problems occur on a localized basis. Significant pollution sources include landfills, hazardous and industrial waste disposal sites, leaking underground fuel storage tanks, chemical and oil spills, septic systems, road salt storage and application practices, fertilizer and pesticide applications, and surface impoundments. Resulting ground-water pollution has caused closure of at least 15 public wells and an estimated 300 private wells.

In 1985, the Rhode Island General Assembly passed the Ground-Water Protection Act of 1985, which established broad protection policies for the ground waters of the State. In turn, the Depart-

ment of Environmental Management created a Ground-Water Section in FY 1985 to coordinate departmental activities related to ground-water protection and to develop and implement a comprehensive program to protect the ground-water resources of the State. The Ground Water Section's responsibilities include Oil Spill Emergency Response activities, the Underground Storage Tank (UST) and Leaking UST programs, and the Underground Injection Control (UIC) program, as well as the development of a ground-water classification system and ground-water standards in accordance with the Ground-Water Protection Act.

South Carolina

To obtain a copy of the South Carolina 1988 305(b) report, contact:

South Carolina Department
of Health and Environmental Control
Bureau of Water Pollution Control
Division of Water Quality
2600 Bull Street
Columbia, SC 29201

Surface Water Quality

South Carolina has approximately 9,900 miles of rivers, 525,000 acres of lakes, and 2,155 square miles of tidal saltwaters. Physical, chemical, and biological data were available for 3,825 miles of rivers, 397,231 acres of lakes, and 663 square miles of tidal saltwaters. Of the assessed river miles, 75 percent fully supported their designated uses, 10 percent partially supported uses, and 15 percent did not support their designated uses. Of the assessed lake acres, almost all fully supported their designated uses. Of the assessed estuary square miles, 89 percent fully supported uses, 2 percent partially supported uses, and 9 percent did not support their designated uses.

Nonpoint sources were the leading contributors to use impairment in South Carolina's rivers and tidal saltwaters. In lakes, sources of pollution were largely unknown. Fecal coliform contamination was the most frequent cause of use impairment. Of the State's coastal waters classified for shellfish growing, about 86 percent are unconditionally approved for harvesting.

The State notes that industrial waste pretreatment programs have improved water quality by reducing toxic discharges. Most point source agricultural waste discharges have been eliminated through the issuance of State construction permits that require alternate non-discharging treatment systems.

Ground-Water Quality

The overall quality of ground water in South Carolina is excellent. Portions of a statewide network of monitoring wells for ambient ground-water quality have been recently established. Other available data sources are being used such as testing at public water supply systems, monitoring wells at sites where ground-water contamination has been confirmed or is suspected, and private wells. Data reported from these sources confirm the general high quality of ground water throughout the State.

Nevertheless, the State cites approximately 390 instances of localized ground-water contamination. Sources of contamination are diverse and include leaking underground petroleum storage tanks, industrial wastewater disposal, municipal and industrial landfills, and accidental spills and leaks.

These lagoons (including industrial pits and ponds), landfills (industrial and municipal), and underground storage tanks that are limited to ground-water contamination are not restricted to any particular areas of the State, but are more concentrated in the three major urban/industrial centers: Greenville/Spartanburg, Columbia, and Charleston. An additional concentration of ground-water contamination problems has been associated with high water-table recharge areas in Beaufort County.

South Dakota

To obtain a copy of the South Dakota 1988 305(b) report, contact:

South Dakota Department
of Water and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501

Surface Water Quality

South Dakota has a total of 9,937 miles of rivers and streams. Of these, 3,750 miles have been assessed for water quality. Currently, 37 percent of these assessed waters are fully supporting their assigned beneficial uses, 34 percent are partially supporting their uses, and 29 percent are not supporting their uses. Nonsupport of designated uses is primarily caused by agricultural nonpoint sources introducing suspended solids and pathogens (fecal coliforms). Other pollutant sources include inadequate municipal wastewater treatment, industrial discharges, and natural causes. Water quality trends in rivers were generally maintained.

South Dakota has 799 lakes and reservoirs (including Missouri River mainstem reservoirs) totalling 1,598,285 acres. Approximately 98 percent of use nonsupport for lakes can be attributed to nonpoint sources. Roughly 86 percent of the total lake acres assessed are considered to support their designated uses; almost all of these acres

are threatened. Only 3 percent of total lakes partially support uses, and 12 percent do not support uses.

Most lakes in the State are characterized as eutrophic to hypereutrophic. Runoff carrying sediments and nutrients from agricultural land is the major nonpoint pollution source. Smaller lakes are more severely affected by nonpoint sources than are larger lakes.

Ground-Water Quality

Approximately 453 million gallons of water are used daily by South Dakotans; of this, nearly 50 percent is from ground-water sources.

Ground-water quality is highly variable in South Dakota but is generally suitable for domestic, industrial, and agricultural uses. However, numerous localized incidents of ground-water degradation have occurred. Documented or suspected sources of ground-water contamination include leaking artesian wells; fertilizers and pesticides; wastewater treatment lagoons; landfills; septic systems; inadequate well design, construction, and placement; feedlots; and petroleum and other chemical spills or leaks. These pollution problems have remained consistent through the years, although reported spills or leaks of petroleum and other chemicals have increased. Many of these contamination problems result from improperly locating or constructing wells, septic systems, treatment lagoons, and other sources.

Generally, over the past ten years there has been an increase in reported incidents of potential ground-water contamination. This is primarily the result of increased public awareness and new reporting requirements under the underground storage tank (UST) regulation.

South Dakota is aggressively addressing ground-water pollution. Ongoing State ground-water projects include the Oakwood/Poinsett Rural Clean Water Project; assumption of the Underground Injection Control, RCRA, and UST programs; and cleanup activities from hazardous materials spills.

Tennessee

To obtain a copy of the Tennessee 1988 305(b) report, contact:

Tennessee Department of
Health and Environment
Office of Water Management
T.E.R.R.A. Building
150 Ninth Avenue, North
Nashville, TN 37219-5404

Surface Water Quality

Of the 11,081 stream miles in Tennessee, 9,408 were assessed for this report. Sixty-three percent of the assessed miles were fully supporting designated uses, 10 percent were not supporting designated uses, and 26 percent were partially supporting designated uses.

Of the 538,657 publicly owned lake acres in the State, 84 percent are fully supporting designated uses, 7 percent are not supporting designated uses, and 9 percent are partially supporting designated uses.

During the reporting period, Tennessee assessed 11,081 river miles, and 538,657 lake acres for the fishable/swimmable goal of the Clean Water Act. Of the assessed river miles, 98 percent met the fishable goal and 94 percent met the swimmable goal. Of the assessed lake acres, 92 percent met the fishable goal and 97 percent met the swimmable goal.

The largest causes of nonsupport in streams are siltation and suspended solids, fecal coliforms, low dissolved oxygen, nutrients, and flow alteration. Major sources of these causes are agriculture, upstream impoundment, hydrologic modification (channelization), municipal discharges, mining activities, urban runoff, industrial discharges, and construction activities.

In lakes, the largest causes of nonsupport are nutrients, low dissolved oxygen, siltation and priority organics. Major sources of these causes of use impairment are agricultural activities, upstream impoundments, municipal discharges, hydromodification, and mining activity.

Ground-Water Quality

More than one-half of the population of Tennessee relies on ground water for drinking water supplies. Ground-water comprises 21 percent of the water withdrawn in the State (exclusive of water withdrawn for thermoelectric use). In West Tennessee, nearly all public supplies, industries, and rural residents use ground water; Memphis, the largest city in Tennessee, is completely supplied by ground water.

Many pollutants are known or thought to be contaminating ground water. These pollutants include metals, petroleum products, pesticides and other agricultural chemicals, and radioactive materials. In addition, volatile or synthetic organic materials, plus inorganic chemicals such as nitrates, have been detected in some samples.

Leading sources of ground-water contamination include septic/sewage and water treatment plant sludge, illegal dumps, septic tanks, wastewater pits, ponds and lagoons, sanitary landfills, underground storage tanks and pipelines, and abandoned hazardous waste sites.

Ground-water protection in Tennessee has become a major concern. In an effort to define and protect this finite resource, the Tennessee Department of Health and Environment has developed a Ground-Water Management Strategy that would assemble the many pieces of relevant information into a comprehensive whole. Some of the recommendations contained in this Strategy will require legislative action by the General Assembly, while others can be accomplished by coordination of existing programs through

the establishment of the Ground Water Management Council.

Texas

To obtain a copy of the Texas 1988 305(b) report, contact:

Texas Water Commission
Water Quality Standards and Evaluation Section
P.O. Box 13087
Capitol Station
Austin, TX 78711-3087

Surface-Water Quality

Of the State's 13,998 assessed stream miles, 155 are not currently meeting fishable uses and 1,382 miles are presently not swimmable. Approximately 1,829 stream miles are currently not achieving individual designated water uses. The majority of impaired stream miles are affected by dissolved oxygen depletion and elevated fecal coliform levels caused by discharges of treated domestic wastewater. Approximately 65 percent of the 1,537 stream miles not suitable for fishing and swimming are affected by major metropolitan areas: Fort Worth-Dallas, San Antonio, Houston, and cities in the Lower Rio Grande Valley.

All of the State's 1,410,240 acres of reservoirs currently meet the fishable goal. In less than 1 percent of lake acres, the swimmable goal is not supported. The cause of nonsupport is elevated fecal coliform counts; the sources of this pollution include tributaries transporting treated domestic wastewater and urban runoff. All lake acres support their designated aquatic life habitat use.

Of Texas' 1,990 square miles of bays and estuaries, 458 are closed to shellfish harvesting due to fecal coliform bacteria contamination. Contact recreation and aquatic habitat uses are met throughout the State's estuarine area.

Eutrophication in reservoirs and estuaries may cause problems not specifically addressed by the designated uses and numerical criteria of the State's surface water quality standards. Estuaries exhibiting the highest degree of eutrophication are Clear Creek Tidal, Armand Bayou Tidal, and the Arroyo Colorado Tidal. The majority of bay segments experiencing eutrophication are located in the Galveston Bay system.

Ground-Water Quality

Approximately 61 percent of the total water used by Texans for domestic, municipal, industrial, and agricultural purposes is supplied by ground-water sources. A major form of ground-water contamination is saltwater intrusion from natural sources. Saline conditions are sometimes aggravated by ground-water withdrawals. In the past, oil and natural gas extraction activities were suspected of causing saline contamination in some areas. Improvements in brine disposal, well-plugging, and underground injection procedures have reduced these problems in recent petroleum operations.

Nevertheless, expanded development of the State's water resources and pressures to meet supply needs have created local, regional, and statewide problems of varying intensity. While surface water quality continues to be a major concern, ground-water overdraft and quality degradation are particularly troublesome because of expanding economic activities that are ground-water dependent.

Several State agencies are involved in the protection of ground-water resources. An interagency committee, funded by the EPA Ground-Water Grant, was established in 1985 to improve coordination of ground-water protection activities and develop a comprehensive ground-water protection strategy. A ground-water protection strategy was developed in 1987 and implementation began in 1988. The strategy addresses interagency coordination, improvement of existing programs, development of new program areas, and needs for funding and new legislation.

Utah

To obtain a copy of the Utah 1988 305(b) report, contact:

Bureau of Water Pollution Control Division of Environmental Health
P.O. Box 16700
Salt Lake City, UT 84145

Surface Water Quality

Data analyzed from October 1985 through September 1987 generally indicate that total phosphate levels are moderately exceeding the criteria for assigned beneficial uses statewide. Total phosphates come from natural, agricultural, construction, recreation, mining, and municipal sources.

Point sources of pollution can present water quality problems anywhere they are located, but are usually more significant in highly populated areas. Wastewater treatment facilities are often concentrated in certain drainages to meet the needs of increasing populations, and can seriously affect receiving streams. An example in Utah is the Jordan River in Salt Lake Valley. Regionalization of wastewater treatment facilities will provide high levels of treatment to maintain and improve downstream water quality in the Jordan River.

Many of the remaining water quality problems in Utah result from nonpoint sources rather than point source discharges. Nonpoint sources of pollutants include

natural geologic formations, failing individual wastewater disposal systems, urban sources, hydrologic modifications, agriculture, mining, recreation, construction, and silviculture.

Most of the water allocated in Utah is for agricultural use. Diversion of waters for irrigation tends to concentrate salts and solids in original stream channels. Return flow discharges add salts, nutrients, and sediments from croplands into stream channels. Overland runoff contributes salts, sediments, and nutrients from nonirrigated croplands and coliform bacteria from pasture land. Minimum-till and no-till conservation measures, implemented and supported by Utah agricultural agencies, reduce runoff and runoff-associated chemicals. Major nonpoint source control efforts are currently under way as Utah develops its nonpoint source assessment and management plan.

General ambient water quality conditions on Utah's lakes and reservoirs vary greatly. Nutrient concentrations and trophic states range from the oligotrophic conditions of many high mountain lakes to highly eutrophic downstream lakes and impoundments such as Utah Lake, Cutler Reservoir, Gunnison Bend Reservoir, and Minersville Reservoir. Other water chemistry characteristics vary from extremely soft water conditions of the high Uinta lakes to high total dissolved solids levels in reservoirs on the lower Sevier drainage.

Many lakes/reservoirs experience problems with thermal stratifications and subsequent dissolved oxygen (DO) depletion in the hypolimnion. Several lakes experience partial or complete fish kills each year due to DO depletion as a result of excessive algal production. Many lakes/reservoirs also have aesthetics and recreational use impairment because of severe annual drawdown which leaves expanses of exposed mud flats and insufficient waters to overwinter fish populations.

Ground-Water Quality

Ground water is one of the State's most valuable and necessary resources. It furnishes drinking water for two-thirds of the State's residents and comprises about 20 percent of the total water used in Utah. In rural areas of the State, it is commonly the only source of water for man and livestock.

Because of this dependence, a more diligent effort is required to protect Utah's ground-water resources.

The Ground-Water Quality Protection Strategy for the State of Utah reviews facts about ground water, describes government programs that affect ground water, and discusses potential sources of ground-water pollution. The strategy also provides management proposals for public consideration and comment. The purpose of these proposals is to generate discussion and provide a framework for a carefully derived protection program. The public's comments will be used in the development of this ground-water protection effort.

Vermont

To obtain a copy of the Vermont 1988 305(b) report, contact:

Vermont Department
of Environmental
Conservation
Water Resources Planning
103 S. Main Street
Waterbury, VT 05676

Surface Water Quality

The water quality of Vermont's rivers and lakes is generally excellent. Continued progress is noted in the cleanup or elimination of point source discharges, particularly from wastewater treatment plants. Of the 5,162 miles of rivers and streams in Vermont 88 percent fully supported the uses for which they are designated; uses are threatened in 20 percent of these river miles. Of the 229,146 acres of lakes and ponds in Vermont, 78 percent fully supported designated uses; 86 percent of these lake acres are threatened. The largest portion of this threat to lake use is associated with Lake Champlain, where toxic substances have been found in the tissue of a species of fish.

Vermont reports that nonpoint sources are the most widespread contributors to use impairment. The four most common water quality impairments due to nonpoint sources in rivers are siltation/turbidity, habitat alterations, nutrient enrichment, and flow alterations. Other common problems include thermal modifications and pathogens. The highest ranked sources of these impairments are agricultural runoff, hydromodifications below hydropower dams, and erosion from construction sites.

Point source discharges were responsible for repeated beach closures on Lake Champlain. Public beaches in the Burlington area were closed frequently during the summer of 1987, primarily as the result of combined sewer overflows which are now being corrected.

On other lakes, most of the water quality impairments are caused by nonpoint sources and excessive plant growth. Very few lakes receive point source discharges. The major impairments are nuisance aquatic plants such as Eurasion milfoil and algae; nutrient enrichment from nonpoint sources; pathogens; and siltation/turbidity. Threats to lake water quality include erosion from development, acid precipitation, and, in the case of Lake Champlain, a preliminary indication of the contamination of fish tissue by toxic substances.

Ground-Water Quality

Ground-water contamination in Vermont is a comparatively minor problem. However, from time to time, well interference problems do occur in more developed areas, although there is no evidence that ground-water withdrawals are exceeding recharge. The State relies on ground water to supply more than half of its drinking water needs; this is expected to continue, as there is no evidence of widespread water degradation or depletion.

The major sources of ground-water contamination in Vermont include petroleum pollution from leaking underground storage tanks and accidental spills; leachate from landfills; leachate from on-site sewage systems; road application and storage of salt and salted sand; and agricultural practices.

The ground-water protection program has made many significant accomplishments over the past 2 years. Current efforts to manage ground-water quality include coordinating various State agencies that participate in ground-water management programs, and completing the State's Ground-Water Protection Rule and Strategy. Other activities include a study of nitrate contamination, well driller licensing, and reviews, under the State's Act 250, of the impacts of proposed development on ground-water resources.

Virginia

To obtain a copy of the Virginia 1988 305(b) report, contact:

Virginia State Water Control Board Office of Water Resources Management
2111 North Hamilton Street
Richmond, VA 23230

Surface Water Quality

Water in Virginia is generally of good quality except in relatively few areas. During the reporting period, Virginia assessed 3,532 miles of streams, 161,089 lake acres, 1,800 estuary square miles, and 112 ocean coastal miles. Of the assessed river miles, 34 percent fully supported uses, 40 percent partially supported uses, and 26 percent did not support their designated uses. Of the State's assessed lake acres, 91 percent fully supported designated uses, and 9 percent partially supported uses. Of the assessed estuary square miles, 89 percent fully supported designated uses, 6 percent partially supported uses, and 5 percent did not support their designated uses. Lastly, all of the State's assessed ocean coastal miles fully supported their designated uses.

The major causes of nonsupport in Virginia's rivers include fecal coliform bacteria; major sources of these pollutants include agriculture and municipal point source discharges. Most of the mileage affected by domestic sewage is located in southwestern Virginia, where it is suspected that many individual homes discharge directly to streams.

In lakes, the major causes of nonsupport were nutrients, organic enrichment, pH, siltation, and metals. Major sources of use impairment in lakes include agriculture and storm sewers/runoff.

In estuaries, pathogens, organic enrichment, and pH are leading causes of use impairment; sources include municipal discharges, agriculture, and storm sewers/runoff.

Ground-Water Quality

Ground water accounts for approximately 22 percent of the water used in Virginia for purposes other than hydroelectric and thermoelectric uses. Eighty percent of Virginians used ground water either as their only water supply or as part of their supply.

Contamination of major aquifers in Virginia is not a serious problem. Most ground-water pollution incidents contaminate finite areas near the spill or accident. More than 800 cases of contamination have been documented; approximately 12 new cases are added per month. Most of these are due to leaking underground tanks and associated piping. The State lists underground storage tanks, landfills (municipal, on-site industrial, and others), surface impoundments, septic tanks, and agricultural activities as the major sources of ground-water contamination. Volatile and synthetic organic chemicals, pesticides, nitrates, fluorides, brine/salinity, and metals are the contaminants of concern.

Specific ground-water program activities in Virginia include formation of an interagency Ground-Water Protection Steering Committee, a Data Management Task Force, and an Antidegradation Advisory Group; implementation of an underground storage tank program; ground-water monitoring; and investigations of pollution complaints and proposed landfill sites.

Virgin Islands

To obtain a copy of the Virgin Islands 1988 305(b) report, contact:

Virgin Islands Department of Conservation and Cultural Affairs
Division of Natural Resource Management
P.O. Box 4340
Charlotte Amalie, St. Thomas
Virgin Islands 00801

Surface Water Quality

Water quality in the Virgin Islands is generally good but is worsening due to an increase in nonpoint source runoff such as vessel washes and uncontrolled runoff.

During the reporting period, the Virgin Islands assessed 29 square miles of estuary and 7 ocean coastal miles. Of the assessed

estuary square miles, 86 percent fully supported designated uses, 3 percent partially supported uses, and 20 percent did not support their designated uses. Of the assessed ocean coastal miles, 71 percent fully supported designated uses, 14 percent partially supported uses, and 14 percent did not support uses. Major sources of use impairment include municipal/domestic discharges, construction, and boating activities.

Lack of enforcement of permitting laws and unplanned development and growth are special State concerns. Without an effective management program, water pollution problems are sure to become worse.

There are little data available on toxic pollutants in the Virgin Islands marine environment. A survey completed in1986 examined water, sediments, and biota and concluded that there were few or no toxic organics in water or sediments in the Territory, although some trace metals were found at elevated levels.

Violations of water quality standards for fecal coliform bacteria have occurred in harbor areas where there are large numbers of boats and low natural flushing rates. Several Federal and Territorial laws prohibit sewage and waste discharge from vessels, but enforcement is limited. Land-based storm runoff and sewage leakage/infiltration have also been identified as sources of bacterial contamination.

The Virgin Islands is currently experiencing a building boom. This has brought about stress to the Territory's natural resources. Without the concomitant increase in environmental programs and planning, some of the Virgin Island's most valuable resources will be irreversibly damaged.

Ground-Water Quality

Some ground-water contamination occurs in the Virgin Islands, primarily in the form of elevated chloride concentrations caused by saltwater intrusion. Nitrate contaminants are also present in some areas as a result of sewage treatment plant malfunctions.

Other areas have been identified as being impacted by sewage pollution. There is also evidence of a new kind of contamination which previously was unknown in the Territory—organic pollution. Chlorinated solvents and petroleum products appear to be the main elements of this new contamination. At present, the extent and severity of the problem is not known, but efforts are being made to investigate the areas which have been identified.

The Government of the U.S. Virgin Islands has requested technical and legal assistance from the U.S. Environmental Protection Agency to investigate the matter, including a survey of water quality in island wells. The government is also exploring the possibility of the U.S. Geological Survey participation in a joint investigation of ground-water supply and quality as part of the implementation of the 1983 ground-water management plan. These actions are geared toward short- and long-term management for more efficient use and protection of this precious resource.

Washington

To obtain a copy of the Washington 1988 305(b) report, contact:

Washington Department
of Ecology
Water Quality Program
PV-11
Olympia, WA 98504

Surface Water Quality

During the reporting period, Washington assessed 4,621 river miles, 156,518 lake acres, 2,114 estuary square miles, and 163 ocean coastal miles. Of the assessed river miles, 50 percent fully supported designated uses, 35 percent partially supported uses, and 15 percent did not support their designated uses. Of the assessed lake acres, 78 percent fully supported designated uses, 21 percent partially supported uses, and less than 1 percent did not support their designated uses. Of the State's assessed estuary square miles, 92 percent fully supported designated uses, 4 percent partially supported uses, and 4 percent did not support their designated uses. All of the ocean assessed coastal miles fully supported their designated uses.

The primary causes of impaired surface waters in the State are fecal coliform bacteria, temperature problems, suspended solids, organic enrichment and dissolved oxygen problems, nutrients, and habitat/flow alterations. Contamination by metals, priority organics, and pesticides are serious problems in certain waterbodies. The primary sources of water quality impairment in Washington are runoff from pasture land and irrigated agricultural lands, municipal and industrial point sources, storm sewers, on-site wastewater disposal, urban runoff, and natural causes. Natural causes include such things as glacial runoff, poor circulation in estuaries, and low streamflow during summer months.

Ground-Water Quality

Washington lacks a comprehensive ground-water monitoring program, so it is difficult to assess the extent of existing contamination. Available data, however, suggest that contamination may be more widespread than previously believed. This is of concern because more than half of the State's population relies on ground water for drinking water; among rural residents, that figure is over 90 percent. In some counties, virtually all of the population relies on ground water for domestic use.

While existing data are limited, they do indicate the kinds of contamination problems the State faces. Concerns based on available data include: an increasing incidence of nitrates in ground water, especially in the irrigated regions of the Columbia Basin and in areas with high densities of residential on-site sewage systems; a potential for the presence of leachable pesticides in ground water, particularly in areas with irrigated agriculture; the possibility of transport of radioactivity from materials stored at Hanford Nuclear Reservation into ground water within and outside the reservation; leachate from landfills and other sites containing municipal and hazardous waste; leaks from underground storage tanks, both industrial and domestic; contamination from chemical spills; contamination by industrial waste through land disposal or discharge to ground water; saltwater intrusion in some coastal areas; arsenic contamination from apparently natural sources along the western foothills of the Cascade Mountains; and transport of pollutants by stormwater discharges to ground water via dry wells and other recharge devices.

West Virginia

To obtain a copy of the West Virginia 1988 305(b) report, contact:

West Virginia Department
of Natural Resources
Water Resources Division
694 Winfield Road
St. Albans, WV 25177

Surface-Water Quality

Well over half of West Virginia's population is rural. Because of the State's steeply dissected topography, a large portion of this rural population resides in small localized concentrations in narrow valleys. Along with localized unfavorable economic conditions and a limited amount of land available for residential development, this too often results in direct discharge of sewage and/or improperly installed and maintained on-lot sewage disposal systems.

Mining, oil and gas exploration, and timbering operations are also of major concern in the State due to nonpoint contributions to many streams. These problems are particularly acute in the Big Sandy/Tug Fork, Guyandotte, Coal, Kanawha, Elk, Pocatalico, and Little Kanawha watersheds.

Agriculture waste handling and runoff are of concern mainly in the Potomac watershed (in particular, the extreme eastern portion) due primarily to the area's large amount of agricultural operations and its limestone geology.

Concern over industrial discharges is confined, for the most part, to parts of the Ohio, Kanawha, and Monongahela watersheds where industry has tended to concentrate.

West Virginia reports that only 9 percent of its 14,301 assessed stream miles did not support their designated uses during the reporting period. Seventy-one percent partially supported their uses and 20 percent fully supported their uses. About 14,060 stream miles were not assessed. Of the 19,171 lake acres assessed, only 9 percent did not support designated uses. The remaining 91 percent of assessed lakes were partially supporting beneficial uses. Comparison of current data with that in earlier reports showed very little overall change in water quality during the reporting period.

Elevated levels of toxics were noted in 3,710 miles of total assessed streams. Mine drainage contributed to the problem in 2,427 of these stream miles. Elevated levels of toxics were also noted in 4,655 lake acres. Many of these reported elevated toxic levels are due to exceedances of the State water quality standard for iron.

Acid mine drainage from abandoned sources continues to present a major problem in the State's waters. Metals from mining activities were found to affect 2,852 of the assessed stream miles, while 1,897 miles were affected by a pH (acid) problem. Siltation from various nonpoint sources impaired 5,251 miles of stream, while organic enrichment and dissolved oxygen problems (mainly from sewage) were noted in 3,575 stream miles. Siltation and mine drainage (metals and pH) were the major causes of impact on lakes.

Ground-Water Quality

Although ground water in West Virginia is generally of good quality, in most parts of the State it was found to be naturally hard and to contain elevated levels of iron and manganese. Major contamination problems in the central and western parts of the State include acid mine drainage and saltwater intrusion caused by oil and gas well drilling operations. In the karst areas of the east, contamination from petroleum products and nonpoint sources such as animal feedlots, domestic septic tanks, pesticides, etc., are the principal concerns.

A ground-water protection strategy has recently been initiated and is currently in the development stage. The top priorities of this strategy are to establish legislation and regulation needed to protect and improve the State's ground water.

Wisconsin

To obtain a copy of the Wisconsin 1988 305(b) report, contact:

Wisconsin Department
of Natural Resources
Water Quality Evaluation
Section
P.O. Box 7921
Madison, WI 53707

Surface Water Quality

While siginificant point source impacts to Wisconsin's surface waters have been minimized, other water pollution problems remain. Toxic contamination of sediments and fish, ground-water contamination, and nonpoint source runoff into surface waters are continuing water pollution concerns.

Nonpoint sources are the predominant cause of water quality degradation in lakes and streams in Wisconsin. Of point source impacts in streams, less than half are due to industrial discharges, and slightly over half are due to municipal discharges. Approximately 9 percent of water quality degradation in lakes is due to natural causes. About 1 percent of the use impairment in lakes is due to point sources, primarily municipal wastewater treatment facility discharges. Nutrients, biochemical oxygen demand, and sediments primarily from nonpoint sources continue to adversely affect the State's surface waters.

Many surface water quality problems are localized, so nonsupport of designated uses may vary from region to region. The southwest corner of the State appears to have problems due to nonpoint source impacts, while the Fox Valley has both point and nonpoint source problems. Milwaukee and other Great Lakes harbor areas have large areas of contaminated sediments.

Ground-Water Quality

Sixty-seven percent of Wisconsin's residents use ground water for drinking water supplies. Many of the State's industrial and agricultural activities also depend on ground-water sources.

The five leading sources of ground-water contamination in Wisconsin are agricultural activities, solid waste landfills, abandoned waste sites, underground storage tanks, and spills. The application, storage, and handling of nitrogen-based chemical fertilizers and animal wastes has resulted in extensive nitrate contamination. Nitrate is the contaminant most often found to exceed ground-water quality standards.

Volatile organic compounds (VOCs) are the most significant contaminating substances associated with municipal landfills, underground storage tanks, abandoned hazardous waste disposal sites, and spills. Trichloroethylene is the VOC most often detected at levels exceeding ground-water quality enforcement standards.

In addition to VOCs, improper handling and storage of pesticides are sources of ground-water contamination. To date, 22 sites have been identified in the State where the improper storage or handling of pesticides has caused ground-water contamination.

Wyoming

To obtain a copy of the Wyoming 1988 305(b) report, contact:

Department of Environmental Quality
Water Quality Division
Herschler Building, 4th Floor
122 West 25th
Cheyenne, WY 82002

Surface Water Quality

Generally, Wyoming's water is of good to excellent quality. Significant improvements have been made in reducing impacts from municipal sources and most industries. Nonpoint sources, however, continue to have major impacts on water quality in the State. During the reporting period, Wyoming assessed all river miles and lake acres with the exception of those on the Wind River Indian Reservation. A total of 83 percent of river miles fully supported designated uses, and 17 percent partially supported uses. Of the State's lake acres, 93 percent fully supported designated uses and 7 percent partially supported uses.

The major causes of use impairment in Wyoming's rivers include suspended sediments, salinity, and habitat modifications. Major sources of these pollutants include agriculture (rangeland, riparian grazing, and irrigated agriculture), construction, hydrological/habitat modifications, and resource extraction.

The major causes of use impairment in lakes include nutrients, suspended sediments, and flow alterations. Sources of these pollutants include agriculture, hydrological/habitat modifications, construction, resource extraction, phosphate soils, and municipal discharges.

Ground-Water Quality

Ground water has been, and will continue to be, very important in Wyoming. Ground-water use in the State is estimated to be around 500,000 acre-feet per year. Domestic uses account for about 15 percent of the water withdrawn; agricultural uses account for about 51 percent; and the petroleum industry accounts for most of the remaining ground-water use.

Extensive ground-water contamination has been identified at refinery sites, mines, and leaking underground storage tanks. Many cleanup and restoration activities are currently

under way. The regulation of underground injection, the underground storage tanks program, and State permitting of facilities that have the potential to impact ground waters are under way to protect existing and potential uses of ground water. Despite these efforts, new problems continue to appear. At present, there are over 500 sites in Wyoming where ground-water monitoring, investigation, or remediation efforts are under way. The most common contaminants in ground water are petroleum products.

☆ U.S.GOVERNMENT PRINTING OFFICE : 1990 - 270-871