United States
Environmental Protection
Agency

Office of
Water Program Operations
Water Planning Division
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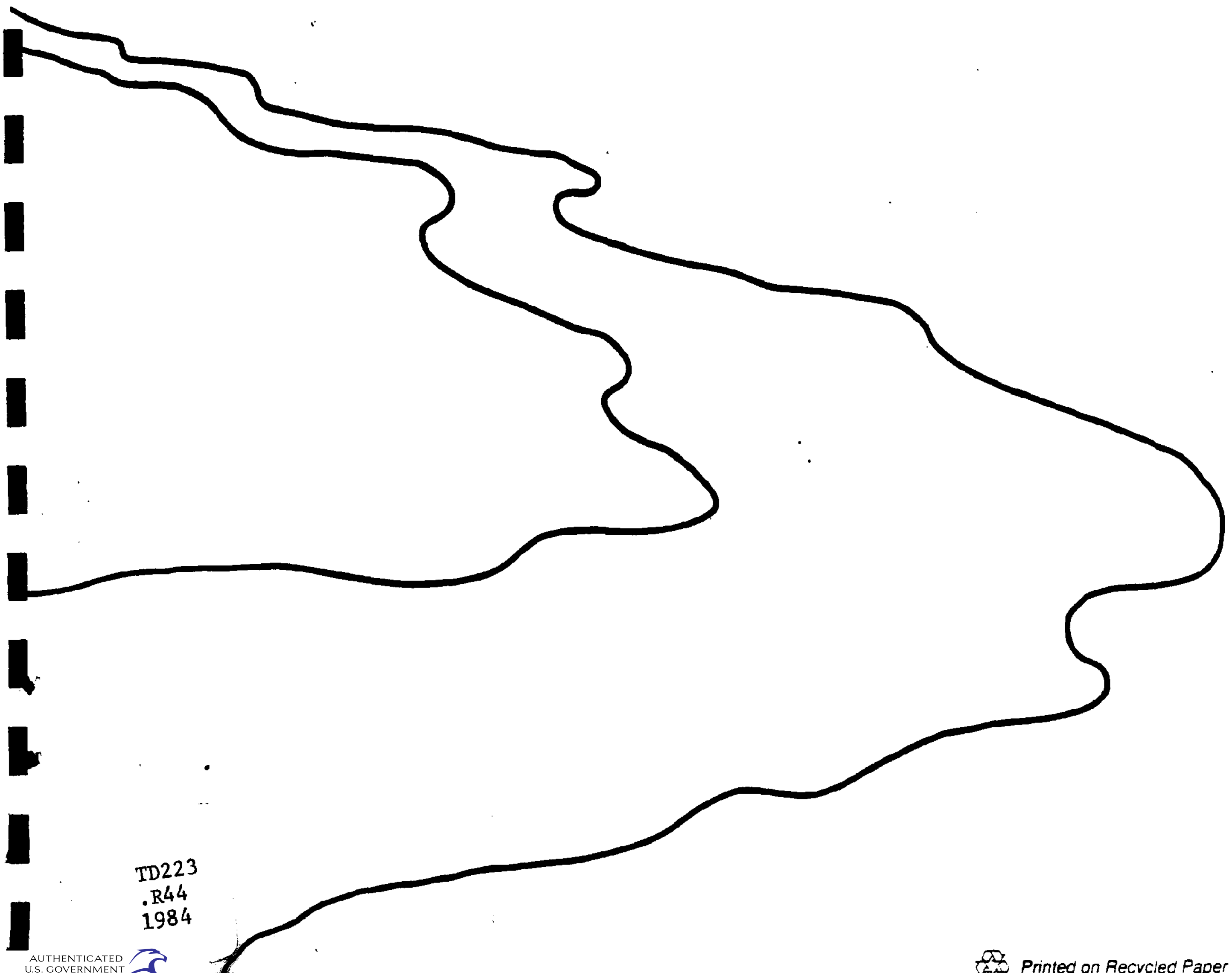
Water

EPA

Report to Congress:

Nonpoint Source Pollution in the U.S.



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REPORT TO CONGRESS:
NONPOINT SOURCE POLLUTION IN THE U.S.

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PREPARED BY THE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
WATER PLANNING DIVISION

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The information in this report was prepared with the assistance of The Synectics Group, Inc. under Contract No. 68-01-6629. To prepare this report, the existing body of literature and research studies on nonpoint source pollution was reviewed. Interviews were conducted with State water pollution staff, Federal agency personnel, research foundations, and national representatives of a variety of organizations. Preliminary findings were identified and presented to a workgroup for comment and revisions. The information presented in this final report reflects an attempt to present a balanced and representative analysis of current information available on the subject.

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PREFACE

PURPOSE OF THE REPORT

The U.S. Congress is addressing the problem of nonpoint source water pollution. The House Report No. 98-223 requested that the Environmental Protection Agency (EPA):

> "analyze the extensive body of past research in nonpoint source problems to identify and rank the highest payoff problem areas and submit a report by January 1, 1984, outlining specific strategies and approaches recommended for addressing nonpoint sources in a cost-effective manner."

In response to this Congressional request, the report that follows examines the nature and magnitude of nonpoint source water quality problems and outlines the key components of State strategies to prevent and control such pollution. The focus of the report is the identification of high-payoff approaches: i.e., approaches to nonpoint source control that are likely to result in the greatest water quality improvements.

Recently, many have identified the need to focus more attention on controlling nonpoint sources in specific areas in order to achieve water quality goals. This report is designed to respond to the Congressional request and to assist EPA, States, and local governments with their continuing efforts to develop nonpoint source control programs.

The report:

- Describes what is known (and not known) about the nature and extent of water quality problems caused by nonpoint source pollution and some available best management practices to address these problems (Chapters 1 and 2);
- Compares point and nonpoint source pollutant loadings nationally (Chapter 1);
- Identifies an approach for targeting high-payoff problem areas (Chapter 2);
- Examines the technical, institutional,* and economic factors and data gaps that affect the successful control of nonpoint source pollution (Chapters 1, 2 and 3);
- Identifies current Federal, State, and local programs that address the problem (Chapter 3);

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*For purposes of this report, "institutional" refers to the range of public and private entities that constitute the framework through which nonpoint source control programs are implemented.

- Highlights successful strategies for controlling nonpoint source pollution and identifies some innovative approaches (Chapters 2 and 3); and

- Outlines the key components of State strategies to prevent and control nonpoint source pollution (Chapter 4).

SCOPE OF THE REPORT

Nonpoint sources of water pollution are both diffuse in nature and difficult to define. In general, nonpoint source pollutants are carried over and through the ground by rainfall and snowmelt, but a variety of legal distinctions complicates the issue. When runoff is collected and discharged through a pipe (e.g., in combined storm and sanitary sewers, or in cases of runoff from active mines), it is usually considered to be a point source. There are exceptions, however, such as the Clean Water Act's definition of irrigation return flow as a nonpoint source, even though the water is collected and returned to the stream through a discrete channel or pipe.

Given the expansive definition of nonpoint sources, the potential scope of this report was tremendous. EPA, therefore, elected to limit its focus to those nonpoint source categories that are generally recognized as the major causes of nonpoint source pollution: agriculture, mining, urban runoff, silviculture, and construction. The categories addressed are both traditionally considered to be within the framework of a nonpoint source program and to present some of the most widespread and/or serious water quality problems.

Other sources which are sometimes considered nonpoint sources are not addressed for a variety of reasons. The management of leachate and runoff from solid and hazardous waste residuals is directly addressed under the legislative framework provided by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Combined sewer overflows are managed as point sources and handled within the context of EPA's Construction Grants Program. Pollution from individual, small-scale wastewater systems is addressed by a component of EPA's Construction Grants Program--the Small Alternative Waste System Program. Because of time constraints, water quality impacts due to instream hydrologic modifications such as dams, dredging, and channelization are not addressed in this report. The nature of these water quality problems and associated strategies and solutions is quite different from those arising from other nonpoint sources. With the exception of the Clean Water Act's Section 404 program (addressing the disposal or deposit of dredged or fill material in water bodies), programs to address pollution from hydrologic modification are largely experimental in nature. In addition, data gathering is hampered by the extremely diverse nature of research and program information.

Finally, the report focuses on surface water, although ground water concerns are identified and described where appropriate. The Agency is in the process of developing a comprehensive ground water strategy. This strategy will provide a central framework for ground water management.

FOLLOW-UP ACTIONS

The issue of nonpoint source pollution control and management has been identified by the Administrator and EPA's Regional Offices as a significant and national environmental concern for the 1980s. The Agency recognizes that pollution from nonpoint sources has adverse effects on water quality in certain areas across the country. EPA will continue to focus its efforts to:

- Coordinate its policies and activities with Federal agencies implementing programs related to nonpoint source control;
- Encourage States to implement nonpoint source control programs;
- Encourage States to use available funds under Sections 205(g), 205(j), 106, and 314 of the Clean Water Act for nonpoint source programs;
- Disseminate information to States to develop or update their nonpoint source programs for specific water bodies;
- Continue distributing information on methodologies for nonpoint source analysis gathered through its Nationwide Urban Runoff Program; and
- Evaluate, document, and distribute information on innovative, cost-effective techniques for controlling or mitigating nonpoint and point sources of pollution.

It is hoped that this report to Congress will provide data to assist ongoing and future nonpoint source control efforts. The report incorporates the latest information on nonpoint source pollution problems and their resolution that could be gathered from current literature and interviews with those knowledgeable in the field. Although gaps in problem assessment, control technology, and program approaches remain, many nonpoint source control efforts have been initiated at the State and local levels and provide a sound basis for intensified nonpoint source management activities.

EXECUTIVE SUMMARY

SOME REMAINING WATER QUALITY PROBLEMS ARE CAUSED BY NONPOINT SOURCES

Significant achievements toward attainment of water quality objectives have been accomplished by controlling point sources of pollution in the 11 years since the passage of the Clean Water Act. Reductions in point source pollution has illuminated the nonpoint source contribution to water quality problems. A variety of data gaps preclude the development of a consistent national summary of nonpoint-source-related water quality problems. Data-related difficulties reduce our ability to accurately quantify the nature and extent of water pollution caused by these sources. Nationally available reports, such as State 305(b) reports, are not consistent with each other and are not complete with respect to all nonpoint source types. Thus, this report presents what is known about nonpoint sources across the U.S., rather than providing a national summary of nonpoint source data into a single bottom line.

A review of information submitted by EPA Regions and the States on nonpoint sources is illuminating, however. Six out of the ten EPA Regions assert that nonpoint source pollution is the principal remaining cause of water quality problems. Half of the States report that nonpoint sources are a major or significant cause of their remaining water quality problems, and virtually every State reports some kind of water quality problem related to these sources. Additionally, 11 States identify nonpoint sources as the major cause of water quality problems.

Technical evidence from a variety of sources suggests that lakes, reservoirs, and estuaries may be particularly vulnerable to pollution from nonpoint sources.

STATE MANAGEMENT AND IMPLEMENTATION IS THE KEY TO IMPROVED WATER QUALITY

Managing nonpoint sources of pollution presents complex control problems. Nonetheless, effective steps can be taken to reduce pollutant loads from nonpoint sources. The localized nature of nonpoint source pollution makes a national strategy ineffective by not providing enough flexibility and specificity to solve local problems. State management of nonpoint source control programs is the key to achieving water quality objectives. As the central manager of the water quality program, the State must establish whether a water quality problem is related to nonpoint sources, and determine which of these problems will receive its priority attention. It is at the State level that local conditions can be properly weighed to determine what type of strategy is needed, whether progress toward achievement of objectives is being made, and what adjustments are needed for a more effective strategy.

FIVE SIGNIFICANT NONPOINT SOURCES ARE DISCUSSED IN THIS REPORT

The principal sources of nonpoint pollution vary between Regions and between States, but agricultural sources are identified as the most pervasive nonpoint source in every Region. Pollutant loadings caused by runoff from urban lands and by mining activities are the next most commonly reported nonpoint source problems. Urban runoff contributes to localized water quality problems and is a source of concern because it may contain toxic heavy metals. Where they occur, water quality problems from abandoned mines can cause particularly severe impacts, in some cases resulting in the devastation of stream life. For abandoned mines and densely developed urban areas, cost-effective remedial measures may be hard to implement. Additional nonpoint sources of localized concern include silvicultural activities and construction erosion. The water quality impacts from both of these sources are not as pervasive on a national level as the other sources described in this report.

TARGETING HIGH-PAYOFF NONPOINT SOURCE PROBLEMS HAS PRODUCED SUBSTANTIAL WATER QUALITY IMPROVEMENT

For most water quality problems caused by nonpoint sources, substantial water quality improvements can be--and have been--achieved cost effectively through careful targeting of control activities. Targeting high-payoff areas requires identifying both the priority water bodies for which the adoption of a nonpoint source control program will have significant benefits and the best management practices that will lead to the greatest improvements for the least cost. While general statements about problems and potential solutions are possible at the national level, the analysis and decision-making required for effective implementation of targeted controls must take place on a local level.

The key to careful targeting of control activities to maximize water quality benefits is a watershed-based analysis. A thorough watershed analysis will: (1) identify those use impairment problems that are caused specifically by nonpoint sources, (2) rank priority water bodies for concentrated attention, (3) pinpoint the specific land management practices giving rise to the problems, and (4) design a system of cost-effective management practices that can reduce the nonpoint source pollutant load to the watershed.

SITE-SPECIFIC DECISION-MAKING, NOT UNIFORM TECHNOLOGICAL CONTROLS, IS REQUIRED

The basic approach taken by the Clean Water Act for managing point sources--that is, the application of uniform technological controls to classes of dischargers--is not appropriate for the management of nonpoint sources. Flexible, site-specific, and source-specific decision-making is the key to effective control of nonpoint sources. Site-specific decisions must consider the nature of the watershed, the nature of the waterbody, the nature of the nonpoint source(s), the use impairment caused by the nonpoint source(s), and the range of management practices available to control nonpoint source pollution. The actual site-specific selection of particular management practices to control nonpoint source pollution (called Best Management Practices [BMPS]) will involve local environmental and economic considerations, as well as considerations of effectiveness and acceptability of the practice.

CURRENT ACTIVITIES ARE ADDRESSING THE NONPOINT SOURCE PROBLEM

Currently, some activities and resources are devoted to the identification and control of nonpoint source problems at the Federal, State, and local levels of government. Although most of these programs do not receive their impetus from a high-priority concern for water quality, many of these efforts, nevertheless, hold promise for significant improvements in water quality. For example:

- Agricultural pollutants are addressed by a variety of State programs containing educational, training, and cost-sharing components and are coordinated at the local level by soil and water conservation districts, with assistance from several branches of the U.S. Department of Agriculture. These programs are successfully encouraging the adoption of conservation practices that reduce erosion from farmland and pollution from other agricultural practices.

- Water quality problems caused by silviculture are being addressed in some areas by State regulatory and educational programs. Regulatory programs address nonpoint source pollution from forestry practices in 11 States. Various educational and training programs are being provided to small woodlot owners and operators to encourage better management practices that will reduce nonpoint source pollutant loads. Some of these programs were developed jointly by the U.S. Forest Service and EPA. In addition, national forest timber sale contracts require control of pollutants from forestry activities on Federal lands.

- Sixteen States have enacted construction erosion and sedimentation laws to control runoff of sediment from construction sites. In addition, many localities in other States have adopted local ordinances to control construction erosion.

ECONOMIC BENEFITS CAN BE ACHIEVED BY CONTROLLING NONPOINT SOURCES OF POLLUTION

Studies completed by EPA, the U.S. Department of Agriculture, and others show that it "pays to control nonpoint source pollution." For example, economic benefits can accrue to the farmer from reduced cultivation costs if conservation tillage is employed as a means of controlling erosion. Additionally, offsite benefits, both direct and indirect, can accrue to local communities. For example, improved recreational opportunities and reduced dredging costs can result from decreasing siltation caused by runoff from nonpoint sources.

GAPS EXIST IN MANAGEMENT APPROACHES TO NONPOINT SOURCE CONTROL

A variety of land management practices (BMPs) to control nonpoint source pollutants have already been shown to be effective. Additional research to identify and demonstrate the effectiveness of BMPs is not necessary for most nonpoint sources. Programs to ensure technical transfer of these proven management practices provide the means to fill the gaps.

Notwithstanding the demonstrated effectiveness of many BMPs, and despite the range of programs being mounted, significant gaps remain in the manner and extent to which specific nonpoint source problems are addressed. Although some of these gaps have to do with technical difficulties in identifying and characterizing the nonpoint source problem, many more relate to the management of these problems. For example, although agricultural nonpoint sources are thought to be the most pervasive type of nonpoint source pollution, only 19 States administer assistance programs for the implementation of BMPs. Additionally, most of these agricultural programs were originally established for the purpose of controlling soil erosion, not for achieving water quality goals. Recently, a few States have modified their programs to include water quality objectives.

INTERAGENCY COOPERATION HAS ADVANTAGES AND LIMITATIONS

Effective implementation of nonpoint source controls requires close coordination between State water quality agencies and those agencies with outreach programs that provide a network of services designed to reach landowners and operators and help them change the way they manage their land. These services are derived from Federal, State, and local programs oriented primarily toward other missions. Only EPA and State/local water resource agencies have undertaken protection of water quality as a primary goal. Although relying on the outreach capability of other agencies for implementation of nonpoint source controls works due to the record of mutual trust and effectiveness these agencies have forged in the field, there are also some drawbacks to such a dependency. For instance, the differing priorities and objectives of the parent agencies may slow efforts toward tackling nonpoint source pollution problems.

VOLUNTARY EDUCATION AND TRAINING PROGRAMS ARE NOT ALWAYS ENOUGH

State programs to manage certain nonpoint sources currently rely heavily on voluntary education and training programs to encourage adoption of controls. While we have had these voluntary programs for a long time, the results appear spotty because there has not been a focused approach that targets resources to meet water quality objectives. Additionally, improving management practices to control some nonpoint sources of pollution is sometimes beyond the economic interest of the people generating this pollution. In such cases, sole reliance on voluntary programs is not likely to accomplish adequate reductions in pollutant loads and, as a result, other approaches may be needed (e.g., economic incentives or regulations). Because of the diversity of options and the high public costs associated with implementing and enforcing nonpoint source control programs, supplements to voluntary programs must be carefully evaluated on the basis of need, social and economic equity, and effectiveness.

CONCLUSION

The development of carefully planned management strategies at the State level is the key to controlling nonpoint sources and achieving water quality goals. Targeting of specific areas is necessary to ensure that voluntarily-implemented controls will achieve water quality goals. Voluntary implementation of management practices can be successful but must be targeted to specific areas. Where they are not successful, problems could remain unaddressed until new approaches are tried, including effective State cost-sharing, incentive, and/or regulatory programs. While development of effective management strategies at the State level is key to achieving water quality objectives, implementation of appropriate control measures will require a coordinated effort on the part of all levels of government.

CHAPTER 1

Nature and Extent of the Nonpoint Source Problem

INTRODUCTION

Eleven years ago the United States made an unprecedented commitment to the restoration and enhancement of the physical, chemical, and biological integrity of its waters. The drafters of the Clean Water Act clearly recognized that achievement of its goals would be expensive; would require major commitments from all levels of government, industry, and private individuals; and would necessitate the reduction of pollutant loads being discharged from both point and nonpoint* sources.

Significant achievements have been made nationally in the protection and enhancement of water quality. Much of this progress, however, has been accomplished by controlling the many industrial and municipal point sources. In many parts of the country, pollutant loads from nonpoint sources present continuing problems for achieving water quality goals and maintaining designated uses.

WATER QUALITY: PROGRESS HAS BEEN MADE

In the face of mounting populations and pollution loads, the progress that has been made in water quality can be regarded as a substantial achievement. The population of the United States grew by 23 million between 1970 and 1980.[1] During this same period, a major indicator of economic activity--the gross national product--experienced a 36% increase. [2] Analysis of water quality data gathered from across the nation during that same decade shows that trends in water quality conditions have remained stable for most water bodies. Water quality data are aggregated nationally by the U.S. Geological Survey (USGS) in its National Stream Quality Accounting Network (NASQAN). For all water pollutants monitored nationally, most NASQAN stations show no change in levels (see Table 1.1). The National Fisheries Survey (also known as the Aquatic Life Survey) conducted jointly by EPA and the U.S. Fish and Wildlife Service (FWS) indicates the same stability in the condition of fisheries in rivers and streams.[3]

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*Nonpoint source pollution is generally carried over and through soil and ground cover via rainfall and snowmelt. Unlike "point" sources of pollution (mainly industrial and municipal effluent discharge pipes), nonpoint sources are extremely diffuse and can come from any land area. It must be kept in mind that these definitions are very general; legal and regulatory decisions have sometimes resulted in certain sources being assigned to either the point or nonpoint source categories because of considerations other than their manner of discharge (for example, irrigation return flows are designated as "nonpoint sources" by law, even though the discharge is through a discrete conveyance).

TABLE 1.1 SUMMARY OF TRENDS IN SELECTED WATER QUALITY CONSTITUENTS AND PROPERTIES AT NASQAN STATIONS 1974-81

Constituents and Properties	Number of Stations with: Increasing* Trends	No Change	Decreasing* Trends	Total Stations
Temperature	39	218	46	303
pH	74	174	56	304
Alkalinity	18	207	79	304
Sulfate	82	182	40	304
Nitrate-nitrite	76	203	25	304
Ammonia	31	221	30	282
Total organic carbon	36	230	13	279
Phosphorus	39	232	30	301
Calcium	23	198	83	304
Magnesium	50	208	46	304
Sodium	103	173	28	304
Potassium	69	193	42	304
Chloride	104	164	36	304
Silica	48	213	41	302
Dissolved solids	68	183	51	302
Suspended sediment	44	204	41	289
Conductivity	69	193	43	305
Turbidity	42	199	18	259
Fecal coliform bacteria	19	216	34	269
Fecal streptococcus bacteria	2	190	78	270
Phytoplankton	22	234	44	300
Dissolved trace metals				
Arsenic	68	228	11	307
Barium	4	81	1	86
Boron	2	15	3	20
Cadmium	32	264	7	303
Chromium	12	152	2	166
Copper	6	83	6	95
Iron	28	258	21	307
Lead	5	232	76	313
Manganese	30	250	19	299
Mercury	8	194	2	204
Selenium	2	201	21	224
Silver	1	32	0	33
Zinc	19	251	32	302

*The terms "increasing" and "decreasing" refer to the change in the recorded level of the constituent or property. For example, an increasing trend in pH is an improvement, but an increasing trend in dissolved solids indicates degradation.

Source: Unpublished data from USGS (Smith and Alexander, 1983, in press).

It must be noted, however, that both the NASQAN network data and the National Fisheries Survey information have significant limitations in terms of the scope of their coverage and the nature of the information gathered. Neither source, for example, addresses water quality in lakes or estuaries. Indeed, nationally aggregated data often fail to show the whole picture. The most extensive water quality data are generally collected at the State and local levels of government. These data are collected for the purpose of managing individual water quality programs, and are rarely recorded in a uniform manner. Thus, this valuable local information rarely can be statistically compared or even compiled to build a valid profile of the nation's water quality.* Although extensive State water quality data are stored in EPA's computerized STORET system, the lack of comparable monitoring systems and data across States makes national organization of this data difficult.

Individual reports from the States and from EPA Regional offices, however, suggest that pollution control investments by industry, by States and municipalities, and by the Federal government have paid off. The gross levels of water pollution common at the time the Clean Water Act was enacted, for the most part, have been abated. Improved water quality--including better biological health, fisheries, and recreational opportunities--has been noted in all parts of the country. In 1980, EPA documented achievements in pollution control for a variety of water bodies.[4] The list of improved water bodies is extensive: some major ones are the Savannah River (forming the border between Georgia and South Carolina), the Potomac River (between Maryland and Virginia, below Washington, D.C), the Willamette River (in Oregon), Escambia Bay (in Florida), and some of the Great Lakes.

NONPOINT SOURCE POLLUTION IS A PERVASIVE PROBLEM

Nonpoint Sources Are a Significant Cause of Remaining Water Quality Problems

Nonpoint sources play a major role in contributing to many of the water quality problems that remain. The NASQAN trends analysis indicates that many of the pollutants are showing worsening trends more often than improving trends.[5] Some of those pollutants that are showing worsening trends are contributed primarily by nonpoint rather than point sources. These pollutants are nitrate-nitrite, phosphorus, sodium, chloride, and sediment (measured as dissolved solids and turbidity). In the draft EPA/FWS National Fisheries Survey, State fishery biologists cited nonpoint sources more frequently as the cause of fair or poor quality fishery waters than point sources.

Evidence gathered under the Clean Water Act's Clean Lakes Program suggests that lakes and impoundments may be particularly affected by nonpoint source pollutants. In a recent survey conducted by the North American Lake Management Society, all but one of 38 States participating stated that nonpoint

*The EPA has provided a grant to the Association of State and Interstate Water Pollution Control Administrators to develop a system for aggregating State data on water quality. The result of this project--a comprehensive report on the status of water quality--is planned for presentation to Congress in 1984.

sources are seriously affecting lake water quality. More than three-quarters of all lakes in EPA Regions 2, 5, 6, 7, and 10 were reported by States to be seriously affected by nonpoint source pollution. Fourteen States with 24,000 lakes (and 7.3 million acres of water) reported that more than 75% of lakes were seriously affected.[6]

Virtually Every State Identifies Nonpoint Source Water Pollution Problems

The 1982 State Section 305(b) reports--water quality reports submitted biennially by the States to EPA pursuant to Section 305(b) of the Clean Water Act--indicate that virtually all States have some water quality problems caused by nonpoint sources. Approximately one-fifth of the States identify nonpoint sources as their major cause of water quality problems.[7] Half of the States say that nonpoint sources are a major or significant cause of remaining water quality problems. Table 1.2, which illustrates these findings, is derived primarily from the State Section 305(b) reports. Its detail is limited by the fact that reporting on nonpoint sources is neither complete nor consistent in these State reports.

Six out of the ten EPA Regions assert that pollution generated by nonpoint sources is the principal remaining cause of water quality problems in their Region.[8] On a national basis, the principal sources of nonpoint pollutants vary between Regions and between States and have been characterized in the following manner. Agricultural activities--including those resulting from tillage practices and animal waste management--constitute the most pervasive nonpoint source problem in every Region. Nonpoint source pollutant loadings caused by runoff from urban lands and from mining activities are the two next most commonly cited nonpoint source problems. Urban runoff contributes to localized water quality problems and is a source of concern because it is likely to contain heavy metals. Mining problems, where they occur, can present particularly severe water quality impacts (e.g., acid mine drainage).

Nonpoint source pollution due to silvicultural activities is primarily a local problem. Silvicultural activities can degrade the very high quality waters that flow through forested areas and support cold-water fisheries and drinking water supplies. The large amounts of sediment associated with construction runoff cause localized water quality problems in those parts of the country experiencing significant development pressure (e.g., the Southeast, mid-South, and Northwest).

Understanding the Nature of Nonpoint Source Pollution

Nonpoint sources may generate both conventional and toxic pollutants, just as point sources do. It is important to understand that, although nonpoint and point sources contribute many of the same kinds of pollutants, these pollutants are generated in different volumes, combinations, and concentrations during different flow regimes. Pollutants from nonpoint sources are mobilized primarily during storm events. Pollution episodes, therefore, occur with lower frequency and for shorter duration than occurs in the discharge of

TABLE 1.2 NONPOINT SOURCE PROBLEMS BY STATE

		Nonpoint Sources Cause A Problem?	Nonpoint Source Category: Agriculture (Including Feedlots)	Silviculture	Mining (Oil, Gas, Coal, and Noncoal)	Construction	Urban/ Suburban Runoff
REGION 1	CT	Yes	-	-	-	-	●
	ME	Yes	●	●	-	-	-
	MA	Yes	-	-	-	-	●
	NH	Yes	-	○	-	○	○
	RI	Yes	-	-	-	-	●
	VT	Major	▲	●	-	-	●
REGION 2	NJ	Major	●	●	-	●	●
	NY	Major	●	●	●	●	●
	PR	Major	▲	○	○	●	▲
	VI	Yes	●	-	-	○	○
REGION 3	DE	Yes	▲	-	-	○	●
	DC	Yes	-	-	-	●	●
	MD	Yes	●	○	●	●	▲
	PA	Major	●	-	▲	-	●
	VA	Yes	●	-	●	●	●
	WV	Major	●	●	▲	●	-
REGION 4	AL	Yes	●	●	●	-	-
	FL	Major	●	●	●	●	●
	GA	Major	●	●	○	○	●
	KY	Major	▲	●	▲	-	-
	MS	Major	▲	-	●	-	●
	NC	Yes	●	-	●	●	●
	SC	Yes	●	○	-	●	○
	TN	Major	●		●	●	●
REGION 5	IL	Yes	▲	○	●	●	●
	IN	Yes	▲	●	●	●	-
	MI	Yes	●	-	-	-	-
	MN	Major	▲	-	-	-	●
	OH	Major	▲	-	●	-	●
	WI	Major	●	-	-	-	○
REGION 6	AR	Major	●	●	●	-	●
	LA	Yes	●	●	●	●	●
	NM	Yes	●	-	●	●	-
	OK	Yes	●	○	○	○	○
	TX	Potential	○	-	○	○	○
REGION 7	IA	Major	▲	-	-	-	●
	KS	Major	▲	-	●	●	●
	MO	Yes	●	-	●	-	●
	NE	Yes	●	-	●	-	●
REGION 8	CO	Yes	●	-	●	-	-
	MT	Major	▲	●	●	●	●
	ND	Major	▲	-	-	-	●
	SD	Major	▲	●	●	●	●
	UT	Major	▲	●	●	●	●
	WY	Yes	●	-	●	-	●
REGION 9	AZ	Yes	●	-	●	-	●
	CA	Yes	●	●	●	●	●
	HI	Major	●	-	-	-	●
	NV	Yes	●	-	-	-	●
REGION 10	AK	Yes	○	●	●	-	-
	ID	Major	▲	●	●	●	●
	OR	Major	▲	●	-	●	●
	WA	Major	▲	▲	-	●	●

▲ Identified as a primary or major problem source ● Identified as a problem ○ Identified as a potential problem - Not reported upon

Source: State 305 (b) Reports as updated by EPA Regional Office personnel.

CASE EXAMPLES:
SPECIFIC NONPOINT SOURCE WATER QUALITY PROBLEMS FROM AROUND THE COUNTRY

Chesapeake Bay: Point and Nonpoint Source Controls are Necessary

The Chesapeake Bay has undergone degradation from both point and nonpoint sources of pollution. Nutrient levels have increased in many areas of the Bay, causing algal blooms in some parts. Low dissolved oxygen levels have been observed in large expanses of the Bay; the amount of Bay water exhibiting low or no dissolved oxygen has increased by a factor of 15 over the past 30 years. Heavy metals and toxic organic compounds have been detected at elevated levels in both the water column and sediment, and evidence of the bioaccumulation of some of these toxic contaminants has been observed. Harvests of shellfish and freshwater spawning fish have declined. Submerged aquatic vegetation has decreased throughout the Bay, and the diversity and abundance of benthic organisms have declined as a result of the polluted waters.

A recent exhaustive study of the Chesapeake Bay has shown that point and non-point sources contribute significantly to nutrient loadings; point sources (primarily sewage treatment plants) are the major contributors of phosphorus, while nonpoint sources are the main contributors of nitrogen. Nonpoint sources of nitrogen include agricultural activities and urban runoff, the principal source being runoff from cropland. Like nitrogen and phosphorus, toxic organic compounds and heavy metals are also contributed by both point and nonpoint sources. Point sources of toxic metals and organic compounds include industrial facilities and sewage treatment plants; nonpoint sources include urban runoff, dredged material disposal, atmospheric deposition, and acid mine drainage. Many of these sources do not discharge directly into the Bay, but rather to tributaries which ultimately empty into the Bay.[9]

Nutrients in North Carolina Coastal Rivers Come From Nonpoint Sources

Several coastal rivers in eastern North Carolina have very serious water quality problems. The impacts include massive blooms of noxious algae, major fish kills, and declining commerical/sport fishing and other recreational opportunities. Catch reductions of 50 to 80% have been noted for herring, striped bass, and catfish. In response, an intensive investigation of point and nonpoint source nutrient loadings was conducted in the Chowan River. Results indicate that 97% of the nitrogen load and 94% of the phosphorus load for 1979 can be attributed to nonpoint sources, primarily those related to agriculture such as animal operations and cropland runoff.[10]

Erosion Problems in Tennessee Prove to be Costly

An area in western Tennessee located within the Mississippi Embayment is experiencing a severe erosion problem. More than 460,000 acres in an eight-county area are seriously affected by sheet and gully erosion. Soil losses in the more highly eroding areas are producing sediment at the rate of 200 tons per acre per year. These erosion rates are one of the greatest contributors to nonpoint source water pollution in the Tennessee Valley. As a result, many acres are subject to crop and timber kills from excessive flooding and loss of agricultural and timber lands from infertile sediment deposition and impaired drainage. A TVA study has estimated annual damages from excessive bottomland sedimentation at more than $11 million, including cropland, grassland, and timber production losses as well as losses in land values.[11]

Urban Runoff Can Affect Drinking Water Supplies

The Occoquan Reservoir located in the Virginia Piedmont is the major water source for the northern Virginia communities that surround Washington, D.C. By the late 1960s, this waterbody had begun to show significant signs of cultural eutrophication, including fish kills, algal blooms, oxygen depletion, and clogging of filters at the water treatment works. High levels of sewage treatment were implemented and existing treatment plants in the watershed were upgraded. Recent studies have shown that nonpoint sources (principally urban runoff) account for as much as 85% of the nitrogen load and 90% of the phosphorus load to streams entering the reservoir.[12]

Sediment Affects Recreation in the Tennessee Valley

Improperly managed surface mines and access roads have led to the washing away of massive amounts of soil or sediment. At a TVA public use area on the Nickajack Lake on the Tennessee River, siltation from unreclaimed strip mines entered an embayment to such a degree that dredging was required to keep a boat launch useable.[13]

Nonpoint Source Water Quality Problems are Severe in Pennsylvania

The primary nonpoint sources of pollution in the State of Pennsylvania are mine drainage and agricultural activities. In that State, nonpoint sources contribute the bulk of nutrient loads in the 17 lakes studied, and are responsible for many waters that do not meet bacteriological standards. In addition, the toxic properties of heavy metals and acid (from mining runoff), coupled with the smothering effects of iron precipitates, render many streams generally unsuitable for aquatic life. A 1982 report to EPA stated that 21% of stream miles would not meet 1983 water quality objectives; acid mine drainage is responsible for 85% of these stream miles.[14]

Montana Nonpoint Water Quality Problems Stem from Agricultural, Silvicultural, and Mining Activities

In the State of Montana, the three largest water quality problems are sediment, salinity, and water depletion. Most of these problems are the consequence of intensive agricultural practices on an erosive, salt-rich, and sometimes water-poor landscape. Acids and metals from coal and metal mining cause other serious water quality problems. Of the 209 stream segments with water quality problems, 84 are affected by agricultural practices, 29 by inactive mining, and 33 by forest practices.[15]

pollutants from point sources. The timing (intermittent discharge caused by rain or snow), concentration, and dilution of the pollution from nonpoint sources constitute only part of the picture when one considers the nature of associated water quality impacts; the transportation and ultimate fate of the pollutant constitute the other part.

The ultimate concentration of the pollutant, as well as the total load generated by the nonpoint source, depend upon the nature of the source and the climatic conditions transporting the contaminants. The potential dilution of pollutants during high flow must be considered against the velocity with which pollutants are dislodged and transported. Thus, it is difficult to make generalizations about the concentration of loads from nonpoint sources. Studies of sediment from agricultural sources, for example, have suggested that concentrations of sediment are at their highest during the continuing, long-lived, and heavy rainfalls that are typical of spring rains in the Midwest. On the other hand, concentrations of pollutants in urban runoff may be at their highest during a medium or intense rainfall of short duration. The initial downpour may "clean" city surfaces, and subsequent runoff may be cleaner and have lower pollutant concentrations.

A given pollutant loading may or may not have an impact on water quality. The measure of actual impact must come from examination of instream effects, as reflected in terms of impaired uses.

The movement of pollutants downstream may be a cause of further pollution problems. For example, sediment and the pollutants associated with it may move some distance from their original source, and may be a source of future contamination and turbidity when stirred up during subsequent storm events.

Important Pollutants from Nonpoint Sources

Sediment--that is, sand, silt, clay, and organic materials--is the largest contributor by volume to nonpoint source pollution. Many of the other pollutants contributed by nonpoint sources are associated with (bound to) sediments. The water quality impact of these sediment-bound pollutants may be different than the impact of the same pollutant dissolved in a free form via water runoff, or from a point source discharge. For example, phosphorus, nitrogen, many pesticides, and metals may be more biologically available when delivered unbound to the stream in water runoff than when delivered in association with sediment. One explanation for this observation is that the sediment binds--at least temporarily--other materials to it that mitigate the impact of the particular pollutant in question. In addition, as sediments settle out, they bury their associated pollutants so that they are less available. Whether or not sediments continue to mitigate the effects of contaminants depends on a number of factors, including how easily and quickly the pollutant will dissolve, as well as the degree to which future storm events stir up bottom sediments and stimulate the process releasing the material.

The impact of nonpoint-source-generated pollutants depends upon the nature of the water body to which they are delivered. Although it is difficult to generalize at the national level, it does appear that certain types of water bodies may be more vulnerable to pollutants from nonpoint sources than others. Streams that support cold-water fisheries, for example, may be particularly sensitive to the temperature alterations and habitat changes typically associated with sedimentation. Slow-flushing lakes, reservoirs, ponds, and estuaries retain the pollutants delivered to them for long periods of time. Such water bodies may be particularly vulnerable to sediment deposition. Sediment buildup, coupled with accumulating nutrient pollution, hastens the eutrophication of impounded waters. Table 1.3 describes nonpoint source water quality impacts.

Nonpoint Sources May Be an Important Cause of Ground Water Contamination

Although there is no national data base to confirm it, there are examples of the contamination of ground water by nonpoint sources. Pesticides and nutrients applied on agricultural lands seep into ground water, as does acid and metal drainage from deep mines.* In Arizona, for example, public wells containing a pesticide called dibromochloropropane (DBCP) have been closed due to contamination.[16] In Wisconsin, contamination of ground water by the pesticide aldicarb is being evaluated for possible public health concerns.[17] Iowa is concerned about the increased concentrations of nitrates in ground water in its karst regions.[18] Nitrate contamination of ground water presents important public health concerns when that ground water is a source of drinking water.

Where it occurs, ground water contamination is particularly troublesome. Once contaminated, ground water is difficult if not impossible to clean up. Natural cleansing processes may take decades or even centuries. The self-cleansing mechanisms common to surface waters generally do not exist underground. Because ground water generally moves very slowly (on a scale of only tens or hundreds of feet per year), very little dilution takes place, and pollution levels may remain high. The slow rate of movement, however, can also restrict contamination, leaving some parts of an aquifer safe for use while others remain polluted.[19]

A CONTINUING PROBLEM: NONPOINT SOURCE POLLUTION DEFIES GENERALIZATION NATIONALLY

A great deal is known about nonpoint source pollution. During the past 10 years, enormous volumes of data have been gathered and research has been conducted, but that information continues to be intractable to generalization. Little of it has been pulled together to create a national picture. Much more is known about nonpoint sources at the State and local levels of government than is available through national documents. More than 200 water quality management plans conducted under Section 208 of the Clean Water Act analyzed nonpoint source water quality problems in every part of the country. Numerous demonstration projects to control nonpoint source pollution have reported on the water quality problems to which they were directed and the results of the demonstration efforts.

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*Other important sources of contaminants, such as seeptic tanks, hazardous waste sites, and hydrologic modifications are outside the scope of this report.

TABLE 1.3 NONPOINT SOURCE WATER QUALITY IMPACTS

Pollutant	Nonpoint Source(s)	Water Quality and Associated Impacts
Sediment	Agriculture Silviculture Urban Runoff Construction Mining	● Decrease in transmission of light through water - Decrease in primary productivity (aquatic plants and phytoplankton) upon which other species feed, causing decrease in food supply. - Obscures sources of food, habitat, hiding places, nesting sites; also interferes with mating activities that rely on sight and delays reproductive timing. ● Direct effects on respiration and digestion of aquatic species (e.g., gill abrasion). ● Decrease in viability of aquatic life--decrease in survival rates of fish eggs and therefore in size of fish population; affects species composition. ● Increase in temperature of surface layer of water--increases stratification and reduces oxygen-mixing with lower layers, therefore decreasing oxygen supply for supporting aquatic life. ● Decrease in value for recreational and commercial activities: - Reduced aesthetic value. - Reduced sport and commercial fish populations. - Decreased boating and swimming activities. - Interference with navigation. ● Increases drinking water costs.
Salts	Agriculture Mining Urban Runoff	● Favors salt-tolerant aquatic species and affects the types and populations of fish and aquatic wildlife. Fluctuations in salinity may cause greater problem than absolute levels of salinity. ● Reduces crop yields. ● Destruction of habit and food source plants for fish species. ● Reduced suitability for recreation through higher salinity levels (skin/eye irritation) and higher evaporation rates. ● Affects quality of drinking water.
Pesticides and Herbicides	Agriculture Silviculture Urban Runoff Construction	● Hinders photosynthesis in aquatic plants. ● Sublethal effects lower organism's resistance and increase susceptibility to other environmental stresses. ● Can affect reproduction, respiration, growth and development in aquatic species as well as reduce food supply and destroy habitat for aquatic species. ● By definition these chemicals are poisons: if released to the aquatic environment before degradation, can kill non-target fish and other aquatic species. ● Some pesticides/herbicides can bioaccumulate in tissues of fish and other species. ● Some pesticides/herbicides are carcinogenic and mutagenic and/or teratogenic. ● Reduces commercial/sport fishing and other recreational values. ● Health hazard from human consumption of contaminated fish/water.

TABLE 1.3 NONPOINT SOURCE WATER QUALITY IMPACTS (CONTINUED)

Pollutant	Nonpoint Source(s)	Water Quality and Associated Impacts
Nutrients (Phosphorus, Nitrogen)	Agriculture Silviculture Urban Runoff Construction	● Promotion of premature aging of lakes and estuaries--eutrophication. - Algal blooms and decay of organic materials create turbid conditions that eliminate submerged aquatic vegetation and destroy habitat and food source for aquatic animals and waterfowl. - Blooms of toxic algae can affect health of swimmers and aesthetic qualities of waterbodies (odor and murkiness). - Favors survival of less desirable fish species over commercially/recreationally more desirable/sensitive species. - Interference with boating and fishing activities. - Reduced quality of water supplies. - Reduced dissolved oxygen levels can suffocate fish species. - Reduction of waterfront property values. - NO_3 (Nitrates) can cause infant health problems.
Metals	Urban Runoff Mining	● Accumulates in bottom sediments, posing risk to bottom-feeding organisms and their predators. ● Can bioaccumulate in animal tissues. ● Can affect reproduction rates and life spans of aquatic species. ● Disrupts food chain of aquatic environment. ● Can affect recreational and commercial fishing. ● Can affect water supplies.
Bacteria	Agriculture Urban Runoff	● Introduction of pathogens--disease-bearing organisms--to surface waters. ● Reduced recreational usage. ● Increase in treatment costs for drinking water. ● Human health hazard.
Sulfates	Mining	● Significant changes in acidity of streams. ● Leaching of toxic metals from soils and rock surfaces. ● Elevated levels of acidity and metals can be lethal to fish and eliminate entire aquatic communities. ● Severely limits domestic and industrial water use.

Compiling this information to show even the simplest national profile is fraught with difficulty. The State Section 305(b) reports, required to be submitted biennially by the States to EPA, are a case in point. These documents were analyzed for the present report and are summarized, in part, in Table 1.2. It soon became clear that the degree to which nonpoint source problems have been identified and summarized varies between States. Thus, differences between what the States choose to report make it difficult to compare States.

The information contained in this report represents the best information available at this time. Several States that reviewed the draft report said that Table 1.2 did not accurately reflect the nonpoint source problem in their States. The table has subsequently been updated by EPA Regional offices; Regional personnel were asked to review the results of the 305(b) analysis and add information that might more accurately reflect the nonpoint source problem in the States in their Region.

Other individuals wrote to help correct information derived from nationally summarized data sources such as the Department of Agriculture's Resource Conservation Act (RCA) Appraisal. These corrections provide further indication of the inadequacy of existing national data sources. Wisconsin, for example, informed us that animal waste is a priority nonpoint source of pollution. Again, EPA Regional office staff reviewed tables describing State problems and activities and updated information obtained from basic source documents.

COMPARING POINT AND NONPOINT SOURCES OF POLLUTION IS IMPORTANT TO DECISION-MAKING

Decision-makers are interested in comparing the pollutants generated by point and nonpoint sources, and in understanding the water quality impacts associated with them. The reason for the interest is the need to prioritize problems in order to achieve the most cost-effective approach for reaching water quality goals. Comparison of point and nonpoint source pollution is important for State governments and agencies that must identify priority actions.

Several factors make universal comparison of point and nonpoint sources of pollution difficult. For example, in many instances, point and nonpoint sources discharge into and affect different water bodies. Other difficulties of comparison have been discussed earlier. Some of them include differing flow conditions, uncertain knowledge of transport mechanisms, and technical difficulties in determining whether a particular water body is dominated by point or nonpoint sources of pollution or by natural conditions.

Decision-Making Must Have a Local Basis

A determination of whether specific water quality problems are caused by point or nonpoint sources must be based on an assessment of an individual receiving water body. States need to identify priority water bodies and make determinations of needed control measures for these waters by carefully analyzing water quality problems and the nature of the watershed. In many cases, controlling both point and nonpoint sources may be necessary to achieve water quality objectives. In other instances, point source discharges may already be controlled to such a degree that it is more cost effective to control pollutant loads from nonpoint sources. In the Lake Erie Basin, for example, implementation of point source controls has already resulted in high levels of phosphorus removal, and additional increments are now being sought through the control of agricultural nonpoint sources.

It is difficult to compare the impact of point and nonpoint sources on water quality at a national level. The Section 305(b) reports from the States, mentioned above, indicate that nonpoint sources are more important in some States than in others. Although States may generalize that nonpoint source pollution is a greater or lesser problem within their borders, evaluation of relative importance for the purpose of determining priority control measures must be made on the basis of a local evaluation that pinpoints specific sources of pollutants.

Data Are Appearing that Make Point/Nonpoint Source Comparisons Possible on a National Level

Resources for the Future (RFF) developed a national water transportion model of pollutant loadings (as opposed to water quality impacts) from point and nonpoint sources. Comparison of loading data offers information for understanding the relative amounts of pollutants generated by point and nonpoint sources. Of the 16 pollutants analyzed by RFF, 11 are discharged principally by nonpoint sources and four are discharged principally by point sources. Table 1.4 displays the relative national percentage of pollutant loadings generated by point sources and by nonpoint sources for 13 of the pollutants included in the RFF study.

Nonpoint sources contribute 95% of the average daily loading of sediment (measured as TSS--total suspended solids) and 90% of the nitrogen loading. Organic matter (measured as BOD--biological oxygen demand) and phosphorus are also more likely to be contributed by nonpoint sources (roughly two-thirds are from nonpoint sources). It is likely that the dominance of nonpoint sources as sources of nutrients and oxygen-demanding materials is a result of point source control measures implemented in recent years.[20] In addition, BOD loadings also reflect natural inputs such as debris from forests, leaf litter, etc.

Figure 1.1 shows the State-by-State dominance of point or nonpoint sources for three pollutants: phosphorus, lead, and copper. Although pollutant loadings cannot be equated with water quality problems (i.e., the impact of the pollutant load on the particular water body), these figures further support the possibility that certain States may experience pollution problems that are dominated by nonpoint sources. Climate, topography, soils, and the nature of water bodies may all play a role in this tendency. In other States, it is clear that a mixture of sources is the rule, and tradeoffs between point and nonpoint sources to achieve water quality goals may be possible. The possibility of such tradeoffs, however, can only be evaluated at the local level.

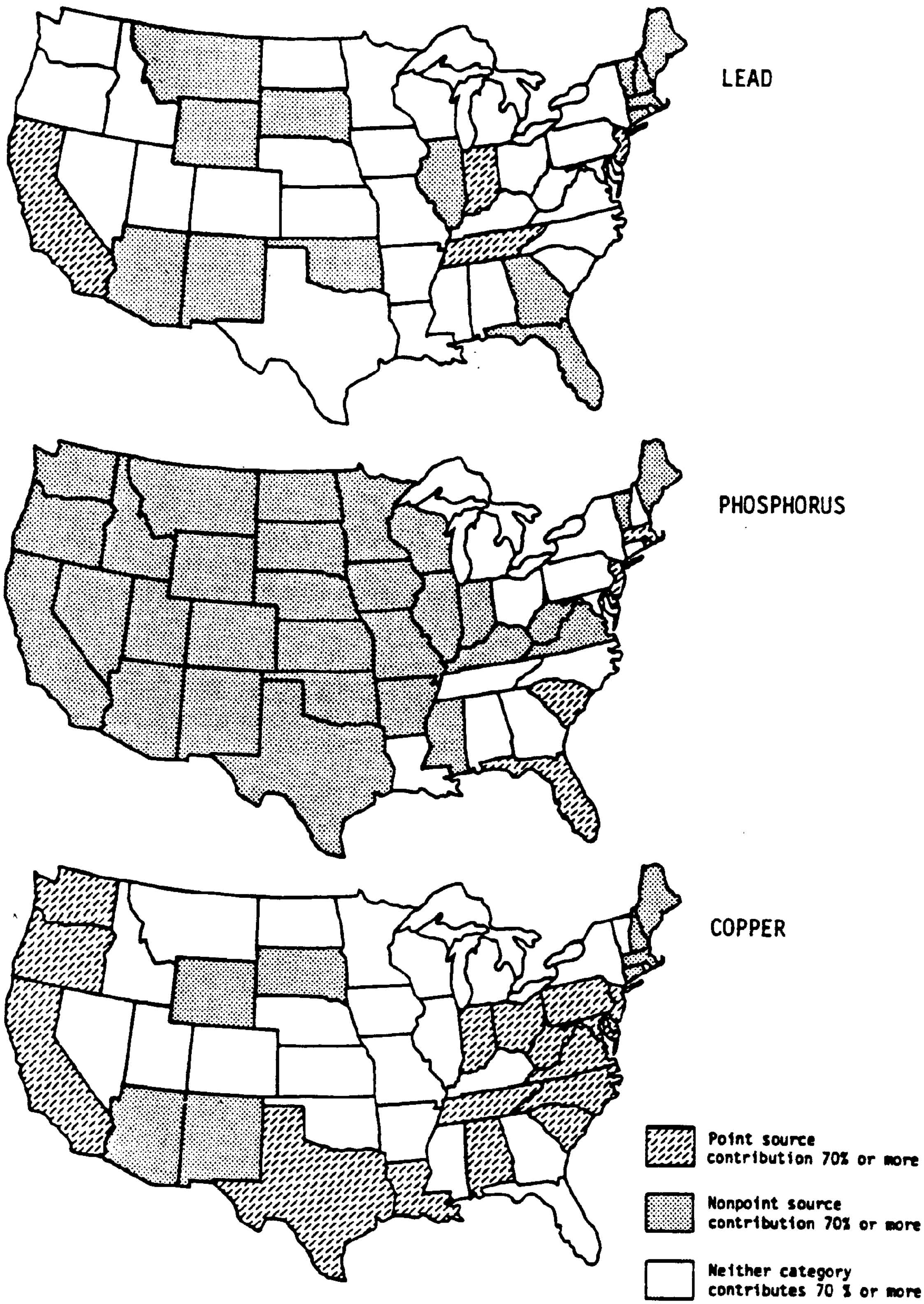
TABLE 1.4 POINT AND NONPOINT SOURCE CONTRIBUTIONS OF SPECIFIC POLLUTANTS (AVERAGE OF STATES' PERCENT CONTRIBUTIONS)*

Pollutant	% from Point Sources	% from Nonpoint Sources
Chemical Oxygen Demand (COD)	30	70
Total Phosphorus	34	66
Total Kjeldahl Nitrogen	10	90
Oil	30	70
Fecal Coliform	10	90
Lead	43	57
Copper	59	41
Cadmium	84	16
Chromium	50	50
Zinc	30	70
Arsenic	95	5
Iron	5	95
Mercury	98	2

*The data presented in this table represent the average of individual States' percent contributions, based upon average daily loading data for 50 States and the District of Columbia.

Source: Preliminary data developed by Resources for the Future under contract with USGS, the National Oceanic and Atmospheric Administration, and EPA.

FIGURE 1.1 RELATIVE CONTRIBUTIONS OF POINT AND NONPOINT SOURCE LOADINGS BY STATE



Source: Preliminary data developed by Resources for the Future under contract with USGS, National Oceanic and Atmospheric Administration, and EPA.

NONPOINT SOURCES ARE DIFFICULT TO MANAGE

Despite improvements in our knowledge and understanding of nonpoint source water quality problems, gaps still exist that complicate their management. Some aspects regarding the extent and magnitude of the problem remain to be clarified. These gaps can frustrate the control of nonpoint sources. Economic, legal, and institutional* problems can further complicate our ability to manage nonpoint source pollution.

The First Challenge: Defining a Nonpoint Source Problem

As part of their water quality planning and management programs, States are identifying and updating the identification of priority water bodies. After this identification process is complete, the initial challenge faced by the State water quality manager is to determine whether or not an identified water quality problem is caused by nonpoint sources. The manager's ability to define a nonpoint source problem is made more difficult by the following factors:

- A certain portion of nonpoint source runoff is due to natural conditions. Separating natural background conditions from nonpoint source pollution generated by people is an essential step toward determining future management actions.

- It is difficult to segregate the impacts of point and nonpoint sources. Both sources may contribute to a use impairment or a criteria violation. Separating the effects of each source is a complex technical issue.

- Baseline information is lacking. State water quality programs have been historically guided by point source concerns. As a result, both the numerical criteria that support water quality standards (and establish the levels of a particular pollutant that support or fail to support designated uses) and water quality monitoring programs are designed for the low-flow conditions under which the impact of point sources is of greatest concern. Use of numerical water quality criteria may not be appropriate for the management of nonpoint sources. However, alternative baseline approaches are lacking and there is a general lack of monitoring programs oriented toward nonpoint source controls.

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*For purposes of this report, "institutional" refers to the range of public and private entities that constitute the framework through which nonpoint source control programs are implemented.

Other Difficulties

Nonpoint sources are difficult to manage for various other reasons: physical, historical, and institutional. First, it is hard to establish cause-and-effect relationships between many nonpoint sources and particular water quality problems. Nonpoint sources are by nature diffuse and result from many different land management activities within a watershed. In addition, alterations to the landscape of a given watershed may change the manner and the amount of water moving through it. Such hydrologic changes add to the difficulties in pinpointing sources of nonpoint pollutants.

Second, some streams appear to have been dominated by nonpoint sources for virtually as long as there are records available. The Missouri River, for example, has been called "The Big Muddy" throughout much of our nation's history. The carrying of eroded soil by streams is a natural phenomenon, and in some cases a reduction of loads from nonpoint sources may result in increases in naturally generated sediments. A related problem is the fact that the sediment load within a stream absorbs some of that stream's energy. The removal of sediment loads will release energy and some streams will seek a new equilibrium by taking fresh sediment loads from the streambank. [21]

Third, sediments and other pollutants released years ago and stored in water bodies may continue to act as sources of water contamination. In certain water bodies, for example, a significant source of sediment may be the sediment deposited during previous storm events, which is now a part of the stream bed. This sediment causes continuing water quality problems and complicates the evaluation of the impact of current activities generating nonpoint source pollutants.

Finally, management of nonpoint sources is complicated by the fact that decisions on appropriate management controls must be made on a site-specific and source-specific basis. Chapter 2 provides extensive discussion of the nature of these control measures. The complex nature of pollutants generated by nonpoint sources means that there is no single prescription that will provide an answer as to what control actions are needed. Site-specific decisions on control measures are made still more difficult by political elements. To the degree that decisions on appropriate nonpoint source controls affect the manner in which individuals manage their lands, these decisions can be very controversial.

ECONOMIC BENEFITS CAN BE ACHIEVED BY CONTROLLING NONPOINT SOURCES OF POLLUTION

Significant economic benefits can result from effectively managing nonpoint sources. These include onsite net benefits to the farmer such as reduced tillage costs (e.g., from conservation tillage) or increased crop yields (e.g., from controlling salinity on irrigated croplands). Offsite benefits of managing nonpoint sources of pollution can be substantial as well and can be categorized in the following manner: (1) protection of aquatic ecosystems, (2) enhanced recreational opportunities, (3) protection of water storage and navigation facilities, (4) protection of commercial fisheries, (5) reduced flooding, and (6) reduced damage to water conveyance and treatment facilities.

Several recent studies have estimated the offsite economic benefits of controlling nonpoint sources or the combination of point and nonpoint sources. The direct and indirect economic benefits of maintaining current water quality and reducing future (1988) eutrophication by controlling nonpoint source pollution in Dillon Reservoir (located in Summit County, Colorado) are estimated to be substantial.[22] Property values for seasonal residences adjacent to St. Albans Bay on Lake Champlain in Vermont have been reduced due to the degradation in water quality caused by both point and nonpoint sources.[23] It is estimated that significant dredging and spoil disposal costs could be saved in Michigan as a result of managing cropland erosion.[24]

Results are Possible

The fact that nonpoint sources of pollution are difficult to manage does not mean that control is hopeless. Much has been learned from research in the last decade. It is now known which BMPs will work and which will be the most cost effective under specific conditions. For example, while control of some nonpoint sources, such as urban runoff, can present technical challenges, evidence drawn from Federally sponsored demonstration projects indicates that many types of nonpoint sources of pollution can be controlled cost effectively.

There are State and local programs controlling runoff from agricultural, silvicultural, construction, and urban areas which are highly effective (see Chapter 3 for a more complete discussion). EPA, the U.S. Department of Agriculture (USDA), and others are exploring new management concepts for nonpoint sources of pollution which are proving to be very cost effective (e.g., risk sharing, trading of pollution control requirements between point and nonpoint sources, and conservation tillage). Substantial cost savings can be obtained by managing nonpoint sources rather than requiring further point source controls for achievement of water quality goals.

In summary, a great deal more is known today about controlling nonpoint source pollution than was known a few years ago. While all problems are not yet solved or even identified, initial steps can be taken by the States to determine if the management of nonpoint sources are warranted.

CHAPTER 1: NOTES

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CHAPTER 2

Identification of High-Payoff Problem Areas and Expected Results

SKILLFUL TARGETING LEADS TO HIGH PAYOFF

In the preceding chapter, we discussed in general terms what is known nationally about the water quality problems caused by nonpoint sources, and some of the difficulties in managing these sources. Chapter 2 describes how taking a well aimed approach to those problems can lead to high payoff in water quality improvements. We often use the term "targeting" in this discussion to refer to two components: water quality and management. Targeting for water quality involves identifying the priority water bodies for which the adoption of a nonpoint source control strategy will yield significant water quality benefits. Targeting for management means selecting those abatement activities that will lead to the greatest improvements for the least cost.

Once a priority water body is determined to have a nonpoint-source-related water quality problem, a most logical and effective way to address nonpoint source problems is to devise strategies for control within the confines of the surrounding watersheds. Then, within watersheds, particular land areas and activities giving rise to nonpoint source pollution can be identified and managed for control. Narrowing the focus yet again, decisionmakers must analyze the feasibility of implementing nonpoint source control measures. Abatement techniques must be selected that are the most suitable and effective for locations targeted for action. The institutional framework through which controls are to be implemented must be identified and, in some cases, designed.

This chapter examines both the water-related component and the management component of developing a targeted and "high-payoff" approach to managing nonpoint sources of pollutants. Because all of the decisions in this area are both site-specific and source-specific, much of this chapter addresses the differing nature and impacts of different nonpoint sources, and the kinds of management practices utilized to achieve water quality improvements.

TARGETING: A NARROWER FOCUS YIELDS RESULTS

The problem of pollution generated by nonpoint sources, when viewed from a nationwide perspective, can appear overwhelming. The sheer size of the land area involved, the vast number of activities that are and may contribute to nonpoint source pollution, and the institutional considerations that come into play in managing sources and solutions can lead to the feeling that the nonpoint source pollution problem is too big to address. However, as was pointed out in Chapter 1, such is not the case. The tools and knowledge for managing nonpoint source problems do exist.

What is required is a narrowing of focus on the problem. Recent research has shown that, for many nonpoint source pollutants and affected water bodies, a significant percentage of the pollution load and water quality problem comes from a limited portion of the watershed. Targeting management efforts to those land areas can clearly pay off. Water quality improvements can be maximized by implementing the most effective management practices on those key land areas.

FOUR BASIC ELEMENTS CREATE EFFECTIVE TARGETING

1. <u>Pinpoint those Water Quality Problems in Priority Water Bodies that Are Caused by Nonpoint Sources</u>

The State water quality agency must first determine in which of its priority water bodies are water quality problems caused by nonpoint sources. This determination is the first step in targeting a State's strategy for nonpoint source control. For a variety of reasons (discussed in Chapter 1), it can be difficult to determine the extent to which nonpoint sources degrade water quality. The task is not impossible, but nonpoint-source-related problems must be identified carefully. Statistical and biological monitoring procedures are under development for evaluating nonpoint source impacts on water quality.

2. <u>Rank Priority Water Bodies for Concentrated Attention</u>

To maximize the effectiveness of limited funds, it will probably be necessary for States to further narrow their focus on nonpoint source management in this second step. Two important considerations will be addressed at this point: the source of pollution (i.e., nonpoint, point, or natural background sources of pollution) and the need to prevent degradation of those water bodies that are now clean, but upon which planned land management activities will have an effect. One important question is whether the water body has the potential for improvement if nonpoint sources are controlled, or whether other sources will preclude such improvement. Another important question concerns whether new activities in a watershed will lead to deterioration of water quality if not managed properly.

States use a variety of approaches to establish priorities among problem water bodies. In general, the approaches chosen reflect a State's view not only of critical water values and public trust concerns, but also of how practicable available solutions may be in addressing the nonpoint source problem. For example, the State of Illinois establishes priorities for the control of nonpoint sources by assessing where the affected water resource is being used and where there is a public trust concern. The highest priorities for nonpoint source management are lakes that provide water supplies and recreational opportunities. Wisconsin's water quality priorities are oriented toward the protection of cold-water fisheries and lakes used for recreation. Its extensive nonpoint source water pollution abatement program identifies priority projects on a watershed basis--the natural hydrologic area within which nonpoint source problems occur--and then identifies priority management areas within the watershed--areas within the watershed containing the most significant sources.

3. Identify the Key Nonpoint Sources and Activities

A variety of land-use activities may be taking place within a given watershed. Any one of these may contribute to a water quality problem. A key step in targeting appropriate nonpoint source controls is the identification of the critical land-use activities that are the source of the water quality problem.

4. Choose Best Management Practices

Either explicitly or implicitly, virtually every State with a nonpoint source control program further targets its efforts by emphasizing the implementation of the most cost-effective "best management practices" (BMPs) available to control a specific source. BMPs are those methods, measures, or practices designed to prevent or reduce pollution. They include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. They are often used in varying combinations to prevent or control pollution from a given nonpoint source. One example of a BMP for pollutants generated by agricultural practices might be management of fertilizer application to ensure that no more fertilizer is applied than is absolutely necessary.

In practice, the targeting of reasonably available BMPs sometimes affects the selection of priority water bodies. For example, although water quality problems caused by acid drainage from abandoned mines present some of the most severe problems in a number of States, high cost and feasibility of technology have limited the BMPs for their control. Thus, these problems often do not receive high priority: energy and money are being directed toward problems that have more straightforward solutions.

THE SELECTION OF BEST MANAGEMENT PRACTICES INVOLVES KEY CHOICES

The basic approach taken by the Clean Water Act for managing point sources--that is, the application of uniform technological controls to classes of dischargers--is not appropriate for the management of nonpoint sources. Flexible, site-specific, and source-specific decision-making is the key to effective control of nonpoint sources.

Any given category of nonpoint sources of pollution--agriculture, silviculture, construction, etc.--is composed of a variety of sources. Many different activities are associated with each type of nonpoint source. In the agricultural category, for example, animal waste pollution can come from small, confined animal feeding areas; barnyards; application of animal waste to fields as fertilizer; or animal grazing activities. The first "site-specific" question to ask is: "What are the major nonpoint sources affecting the water body?" For any source within a particular category, a variety of BMPs may be available. The selection of the appropriate BMP or system of BMPs for any one site will depend upon a variety of factors, including:

- Environmental Considerations--Climate, nature of the water body, nature of the aquifer and surrounding strata (if ground water is involved);

- Land Considerations--Soils, slopes, permeability of soils, depth to ground water;

- Effectiveness--The portion of the pollutants of concern that can be expected to be effectively managed by the selected practice;

- Economic Considerations--Cost of the BMP, short-term and long-term benefits and costs to the landowner, size and nature of the land holding (and associated benefits and cost considerations), and cost effectiveness with respect to achieving water quality goals. (In this discussion, cost effectiveness means the consideration of alternative approaches and selection of least-cost approach to control or mitigate nonpoint pollution.); and

- Implementation Considerations--Acceptability of the practice, need for training and education, need for incentives, etc.

Effective nonpoint source control programs select BMPs that are designed to meet specific watershed and site-specific needs, rather than applying a single BMP to all "similar" nonpoint sources.

TIMING AFFECTS IMPLEMENTATION OF BMPS

The implementation of BMPs takes time. The amount of time needed to implement control strategies depends upon the nature of the BMP. Even the simplest BMPs--such as changing crop rotations to reduce sediment loads--require reaching individuals with education and training. Some BMPs may require the phasing out of old equipment and the purchase of new. The speed with which this takes place depends upon a number of economic considerations.

Other timing issues include the amount of time needed for adoption of regulatory and/or cost-sharing programs. In urban areas, for example, it may be necessary to develop and adopt construction erosion and stormwater management ordinances, a process that may be quite time consuming.

TARGETING STRATEGIES: A SUMMARY

Targeting as a means of achieving relatively high-payoff returns on nonpoint source control efforts relies upon highly flexible approaches at the State and local levels. It requires both the willingness and the capability:

- To identify specific areas where nonpoint sources are clearly the cause of water quality problems, either alone or in combination with point sources;

- To establish clear priorities for water bodies and stream segments with demonstrated water quality problems; and

- To identify site-specific BMPs or systems of BMPs that will provide the most pollution abatement at the least cost and have the greatest likelihood of being implemented.

Such an approach makes it possible to focus resources upon the worst and/or most solvable problems first. Of course, targeting is also likely to highlight certain unwelcome realities: for example, the conclusion that some severe water quality problems caused by nonpoint sources currently have no acceptable BMPs that can reasonably be implemented at the State or local levels. A number of States do not target water quality problems due to acid mine drainage because of the lack of practicably available solutions to these problems.

Although general identification of nonpoint sources and associated problems can be accomplished at a national level, the targeting of critical areas and practices must be based upon more detailed analysis and evaluation done at the Regional and State levels. Those specific water bodies that have been brought to public attention for nonpoint source control (e.g., the Chesapeake Bay and Lake Erie) achieved this status only after extensive field study and regional identification as a high priority water body.

INTRODUCTION TO THE NONPOINT SOURCE CATEGORIES

The discussions that follow address five nonpoint source categories:

- Agriculture
- Silviculture
- Mining
- Construction, and
- Urban Runoff.

The kinds of problems caused by each activity are described, as are some of the considerations involved in selecting BMPs for their control. Although it is clear that the targeting of land areas and priority water bodies for control of pollutants mobilized via nonpoint sources must take place at a very localized level, policymakers must have a good grasp of the source-specific concepts related to such targeting.

NATURE OF THE PROBLEM

Agriculture: The Most Pervasive Cause of Nonpoint Source Water Quality Problems

As is the case with most types of nonpoint source pollution, the nature and extent of the agricultural nonpoint source problem is directly related to the way in which the land is used. The agricultural sector generally manages land resources very intensively. Row cropping, for example, usually involves not only a good deal of land disruption, but also the application of chemicals such as fertilizers and pesticides. About 63% of the non-Federal land in the United States is used for agricultural purposes, including crop and livestock production.[1] It is not surprising, therefore, that agricultural activities constitute the most pervasive cause of water quality problems from nonpoint sources. Indeed, it is considered the most serious cause in most of the EPA Regions.[2] National studies suggest that agricultural nonpoint source pollution adversely affects portions of over two-thirds of the nation's river basins.[3]

Nonpoint source pollution from agriculture actually has several different sources with different associated impacts. These sources are:

- Nonirrigated croplands, both row (e.g., corn and soybeans) and field (e.g., wheat),
- Irrigated croplands,
- Animal production on rangeland and pastureland, and
- Livestock facilities.

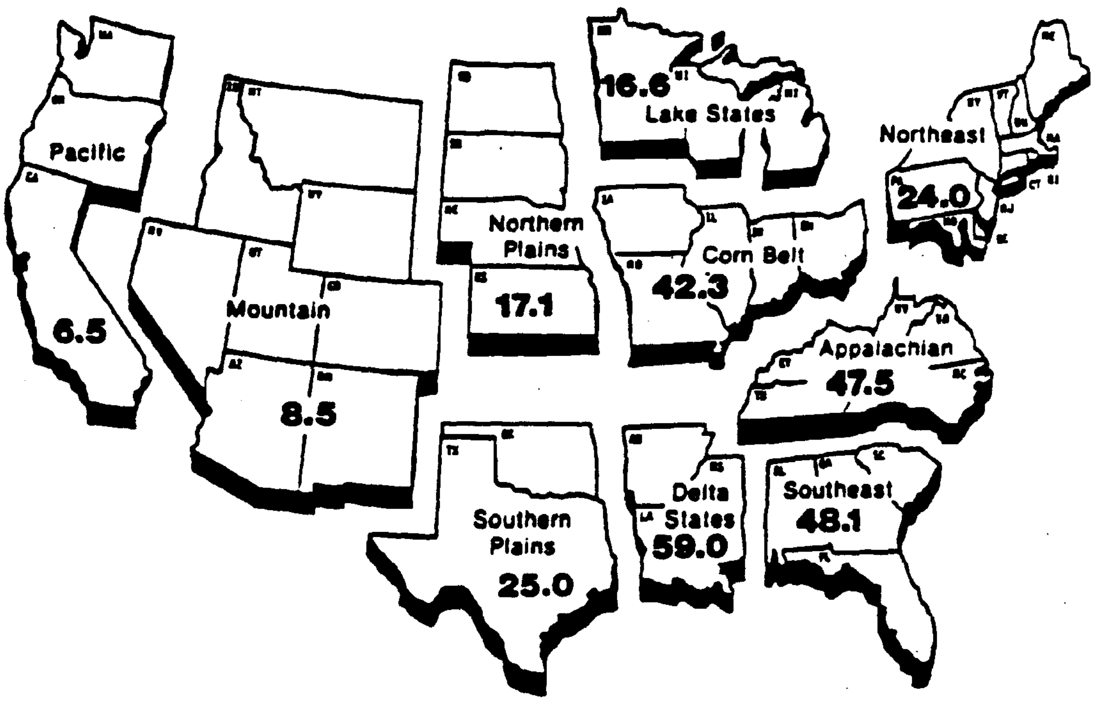
This range of sources indicates that the agricultural nonpoint source problem is not only pervasive, but also multifaceted. The primary pollutants from nonirrigated cropland are sediment, nutrients, and pesticides. While irrigated farming is a source of these pollutants, too, it is also the major agricultural source of polluting salts and other minerals. Runoff from barnyards and feedlots primarily contributes nutrients, organic matter, ammonia, fecal bacteria, and other microorganisms to receiving water bodies. Overgrazing of rangelands and pasturelands often contributes sediment and nutrient pollution through runoff. The related surface disruption and reduction in natural cover increases the erodibility of these lands. Livestock grazing freely along streambanks compact and damage them, thus increasing erosion and sedimentation problems. Livestock wastes also contribute to stream pollution.

Sediment from Cropland is a Major Potential Cause of Water Pollution

The most obvious cause of surface water contamination from cropland is sediment, which is carried off eroding lands via rainfall, snowmelt, or heavy wind. Research suggests that 25 to 40% of the soil that runs off a field reaches a water body.[4] Because of this disparity between gross erosion and sediment delivery, calculated erosion rates may not be directly correlated with water quality problems. A look at erosion rates, however, gives a relative indication of the parts of the country most likely to have sediment problems.

The National Resource Inventories conducted by USDA in 1977 (to be updated in 1984) indicated that most of the 413 million cropland acres are eroding at an annual rate of 5 tons per acre or less. However, about 68 million acres are losing 5 to 14 tons per acre per year, and 26 million acres have erosion rates exceeding 14 tons.[5] As a result, it has been estimated that 10% of the nation's cropland is responsible for 54% of all U.S. soil loss due to sheet and rill erosion.[6] Figure 2.1 provides, for each of the nation's crop production regions, the percentage of cropland eroding at levels exceeding 5 tons per acre per year. The actual potential for sediment delivery depends upon a site's soil characteristics, slope, climate, and proximity to surface waters. The pollution generated is also directly related to crop type, tillage practice, and other factors tied to management techniques. For instance, wheat cultivation generally produces less erosion than row cropping.

FIGURE 2.1 PERCENTAGE OF CROPLAND ON WHICH THE RATE OF SHEET AND RILL EROSION EXCEEDS THE SOIL LOSS TOLERANCE LEVEL (1977)



Sources: Sandra S. Batie and Robert G. Healy, editors, The Future of American Agriculture as a Strategic Resource, The Conservation Foundation, 1980, p. 90.

Unpublished data from EPA, Water Planning Division.

The potential water quality impacts caused by sediment are numerous. Sedimentation directly affects aquatic habitat and spawning areas and indirectly affects temperature and turbidity. In addition, chemicals attached to the sediment--such as pesticides and nutrients--cause other water quality problems.

Additional Problems are Caused by Nutrients, Pesticides, and Salts

Many nutrients ultimately delivered to surface and ground water result from the excessive application of fertilizers or manure to cropland. These additives contain nitrogen, phosphorus, and potassium. Nitrogen and phosphorus are the major contributors to the accelerated eutrophication of water bodies, and the former may cause high nitrate levels in ground water. Cropland, pastureland, and rangeland contribute over 6.8 million tons of nitrogen and 2.6 million tons of phosphorus to U.S. surface waters each year, accounting for 68% of the total loads of these pollutants.[7] The Corn Belt (Illinois, Indiana, Iowa, Missouri, and Ohio) uses 39% of the nation's phosphorus fertilizer and 32% of its nitrogen fertilizer.[8]

Pesticides are usually present in streams, rivers, and lakes at quite low concentrations. Delivery of pesticides to water bodies varies, depending on crop adsorption rates, the propensity of the chemical toward water or sediment-attached transport, rainfall, slope, soil type, and the proximity of the land to a waterway. Over time, pesticide delivery averages only about 5% of total pesticides applied; however, when more than an inch of rainfall occurs within one week of pesticide application, delivery rates increase substantially and may result in fish kills.[9]

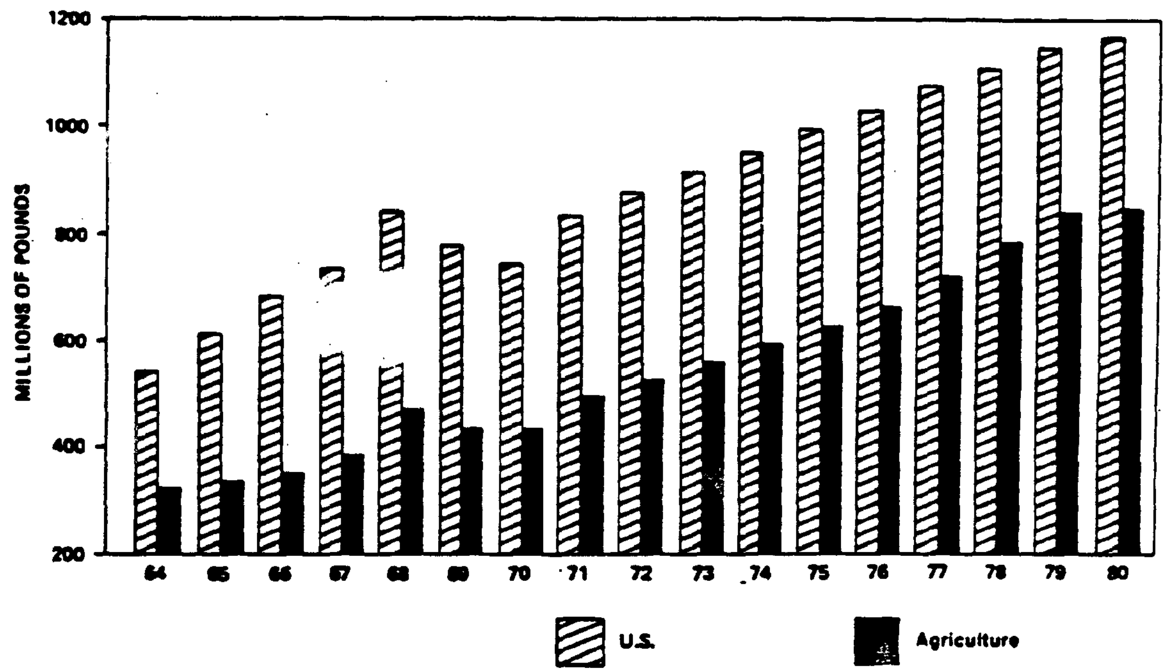
The characteristics of pesticides used in agricultural production have undergone changes in recent years, tending to reduce environmental impacts. Also, application requirements mandated by EPA regulations are designed to minimize problems. Newer pesticides are less persistent in the environment and therefore have fewer long-term impacts, but these pesticides are also more likely to be water soluble.[10] Thus, water (rather than sediment) is the vehicle by which these chemicals enter water bodies. While sediment control measures also control runoff water, concern remains as to whether they provide adequate protection. In addition, toxic water-soluble chemicals in pesticides may be more biologically available when freely waterborne than they are when bound to sediment. Thus, they may cause acute short-term surface water impacts and eventually have serious effects on ground water resources through percolation.

Herbicides are the most commonly used pesticides. In 1980, farmers used 445 million pounds of herbicides, and 306 million pounds of insecticides. Total agricultural use of pesticides in 1980 is estimated at 846 million pounds--72% of the total national consumption[11], and this usage continues to increase. Projections made in 1979 indicate that by 1985 annual use will reach 2.5 billion pounds.[12] Figure 2.2 provides an illustration of the growth in American pesticide use.

While irrigated farming, too, is a source of sediment, nutrients, and pesticides, it also causes special agricultural pollution problems. Salts and other minerals are carried to water courses by irrigation return flows and to ground water resources by percolation through soil and rock layers. The Soil Conservation Service (SCS) estimates that half of the 90 to 100 million tons of salt delivered annually to streams is from agriculture.[13] This can make a significant contribution to salinity downstream, which affects aquatic habitat and downstream water users at great cost.

Table 2.1 indicates those States for which control of specific agricultural nonpoint source pollutants is a high priority.

FIGURE 2.2 UNITED STATES PESTICIDE USAGE:
TOTAL AND ESTIMATED AGRICULTURAL SECTOR SHARE (1964-1980)



Source: Nonpoint Source Runoff: Information Transfer System, EPA, Office of Water, July 1983, p.2.7.

Rangeland and Pastureland Contribute to the Problem

Rangeland and pastureland, although usually not used as intensively as cropland, can contribute significant amounts of sediment and nutrients to water bodies, especially where overgrazing is taking place. Sheet and rill erosion is known to exceed 3 tons per acre per year in some rangeland in western and southern States. Wind erosion in New Mexico and Texas exceeds 2 tons per acre per year.[14] Shallow soils (themselves often the result of erosion) and insufficient plant cover are among the factors that contribute most frequently to erosion. Erosion rates are thus closely correlated to the condition of the

TABLE 2.1 PRIORITY AGRICULTURAL POLLUTION PROBLEMS BY STATE

	Salinity	Nutrients	Erosion/ Sedimentation	Fertilizers	Pesticides	Small Feedlots/ Animal Waste
AL			●			●
AK						
AZ	●	●	●		●	
AR	●		●		●	●
CA	●	●	●	●	●	
CO	●	●	●			
CT			●			●
DE		●		●		
FL		●	●		●	
GA			●		●	
HI			●		●	
ID		●	●		●	
IL			●	●	●	
IN			●	●		
IA		●	●	●	●	●
KS		●	●	●	●	
KY			●	●	●	
LA			●	●	●	
ME		●			●	●
MD		●	●	●		●
MA			●			
MI		●	●			●
MN			●			●
MS			●		●	
MO			●			
MT	●	●	●			
NE	●	●	●	●	●	
NV	●	●	●			●
NH			●			●
NJ		●	●	●		●
NM		●	●			
NY		●	●	●	●	●
NC		●	●	●	●	
ND		●	●			
OH		●	●			
OK			●	●	●	
OR		●	●			●
PA			●			●
RI			●			
SC			●			●
SD			●		●	●
TN			●		●	●
TX	●	●	●		●	
UT	●	●	●			
VT		●	●	●		●
VA		●			●	
WA			●			
WV		●	●			●
WI		●	●			
WY	●	●	●			
PR		●	●	●	●	●
VI			●			

* Blank spaces do not necessarily indicate the absence of a particular problem in a State; instead, they may reflect information in the two documents used as the basis for this table, and the priority problems identified in them. High priority problems are denoted by " ● ".

Sources:

1. Implementation Status of State 208 Agricultural Programs, Draft, EPA, Water Planning Division, September 1980, Appendix A.

2. RCA Potential Problem Area II Water Quality: Problem Statement and Objective Determination, USDA, July 1979, pp. 65-67.

3. Unpublished information from EPA Regional personnel.

lands. Management practices that maintain or improve the condition of range- and pastureland can therefore significantly reduce the erodibility of these lands.

The rates of sheet and rill erosion are slightly lower on pastureland than on rangelands. Rangeland and pastureland erosion is a problem in many Midwest and mid-Atlantic States and in Arkansas, Colorado, and New Mexico.[15] In addition, animal production on rangeland and pastureland results in runoff of animal wastes, which can seriously deplete dissolved oxygen in streams and lakes.

Livestock on American farms and ranches produce roughly 1.8 billion metric tons of wet manure each year. These solids contain about 7 million metric tons of nitrogen, 1.7 million metric tons of phosphorus, and 318 million metric tons of potassium.[16] This is a widely dispersed problem nationally, with sources scattered throughout agricultural areas. Runoff from more contained livestock areas (e.g., from feedlots and barnyards) contributes a great amount of nutrients, organic matter, ammonia, fecal bacteria, and other microorganisms that pollute receiving water bodies. The National Pollutant Discharge Elimination System (NPDES) permit program regulates only the concentrated feedlots which are large operations; it is the small operations that are of concern for nonpoint source management. In addition, NPDES permits regulate only the actual animal feedlot, not the disposal or land application of animal waste. Thus, the disposal of animal waste from all feedlots is of concern to nonpoint source managers.

Table 2.2 summarizes in general terms the distribution of agricultural nonpoint problems across the nation.

TABLE 2.2 GENERAL DISTRIBUTION OF AGRICULTURAL NONPOINT SOURCE PROBLEMS

Agricultural Activity	Location of Problem Areas
Cropland	Widespread, but worst problems are in Delta States, Southeast, Corn Belt, and in Appalachia.
Rangeland	Problems occur in the western half of the U.S. Wind erosion mostly in New Mexico and Texas.
Pastureland	Sheet and rill erosion is worst in the Midwest and mid-Atlantic States.
Irrigated Cropland	A problem primarily in the West. The effects of recent increases in irrigation in the Southeast have not been documented. Sediment from irrigated croplands is a problem in the Northwest.
Livestock Facilities	Widespread across U.S., highest concentration in the Midwest.

Socioeconomic Forces Affect the Agricultural Nonpoint Source Problem

Agricultural activities are changing in ways that are important to the management of nonpoint source problems. Economic trends have resulted in:

- Conversion of pastureland, rangeland, and forest land to cropland, which generates more profit, and

- Shifts from field to row cropping (e.g., from wheat to corn).

American farmers farmed 57 million more acres in 1980 than they did a decade earlier, an increase of nearly 20%.[17] In the Northern Plains States, the proportion of row crop acreage between 1974 and 1980 increased from 23% to 32%.[18]

Both of these trends are leading to increased total soil erosion and a growing amount of sediment and other pollutants. A recent study of increasing crop acreage in Georgia found that, compared to erosion rates on the pasture and rangelands prior to conversion, crop production increased the sediment yield by between 18 and 35 times.[19] Dramatic increases in phosphorus, nitrogen, and pesticides in runoff were also reported. Research has also shown that row cropping produces significantly more sediment than non-row cropping because row crops provide less natural cover to shield the soil from erosion-causing rainfall.

Another important trend is the consolidation of small farms into much larger ones, often absentee-owned and/or corporate-held. Recent research on the adoption of conservation tillage practices in an Iowa watershed found that the probability of adoption was inversely related to the size of the farm operation.[20] This suggests that the trend in increasing farm size will present difficulties for voluntary programs promoting the adoption of conservation tillage. The same study also found, however, that increases in energy prices have the effect of increasing conservation tillage adoption rates, even without encouragement from nonpoint source pollution policies.[21]

BEST MANAGEMENT PRACTICES FOR AGRICULTURE

The diversity of agricultural activities that result in nonpoint source pollution requires a variety of control techniques. Table A.1 in Appendix A provides an example of some agricultural BMPs, their costs, and their effectiveness. Some of these may provide immediate benefits to the farmers who adopt them, as well as to the downstream water users and society at large. For example, careful attention to the frequency and timing of fertilizer and pesticide use may act to reduce both the amount of these chemicals entering water bodies and the costs to farmers in terms of the amount of chemicals purchased. Management of quantity and timing of irrigation water can cut down both the runoff of salts and the costs to farmers of irrigation water.[22] As another example, in the mid-South some farmers are moving toward double cropping of winter wheat and no-till soybeans. This BMP provides almost continuous soil cover and an additional crop for the farmer.[23]

Other control techniques may yield a benefit to the farmer, but short-term costs, in some instances, may interfere with the farmer's ability to adopt these practices. Conservation tillage practices are a series of practices that retain crop residues on the land to reduce runoff of sediment. These practices are considered to be very effective and of direct benefit to farmers, but may require specialized equipment and additional costs.

Finally, a number of agriculturally related water quality problems can only be addressed by BMPs beyond the economic self-interest or means of the farmer. For example, reduction of some severe erosion problems may require terracing--a costly technique that breaks up a long slope into a series of shorter ones and reduces erosion by interrupting downhill water flow. Control of animal waste problems may require the fencing of streambanks to keep out animals.

SUMMARY: REDUCTION OF AGRICULTURAL NONPOINT SOURCE PROBLEMS IS ACHIEVABLE

Although agriculture presents the most pervasive nonpoint source pollution problems, the BMPs available for addressing agricultural nonpoint sources are generally well known. In addition, many--but not all--of the problems in this nonpoint source category can be ameliorated by adoption of BMPs within the economic self-interest of the landowner or farmer. In fact, management practices designed to stop erosion--and the movement of soil and associated pollutants from the land--may increase the long-term productivity of the land.

Substantial achievements in water quality can be made by targeting resources, education, and training programs to the land areas and activities that are the source of agriculturally generated pollution problems. Effective delivery systems for many of these programs are already in place as a result of the excellent outreach agencies developed by the USDA. The Experimental Rural Clean Water Program, for example, has demonstrated the effectiveness of targeting and training in a number of watersheds throughout the country (see Chapter 3). Barriers to widespread adoption of agricultural BMPs, in general, are not technical. These barriers include: educational ones (farmers lack knowledge about BMPs); economic ones (adoption of certain BMPs is beyond the farmer's economic interest); and programmatic ones (programs that specifically address nonpoint sources and that provide technical and financial assistance and/or an appropriate regulatory framework are often lacking at the State and local levels).

SILVICULTURAL NONPOINT SOURCES

NATURE OF THE PROBLEM

The smaller areal extent of forest management activities, less intensive site preparation, infrequent harvest, and lower frequency of pesticide and nutrient applications in a given year all result in silviculture generating a smaller volume of total nonpoint source pollutants than agriculture nationwide.[24] However, 38 States addressed forestry impacts in their water quality management plans, and silvicultural management activities can generate major localized nonpoint source pollution problems.

One factor in understanding the nature of the silvicultural nonpoint problem is the frequency with which land disturbance takes place and the nature of that disturbance. The time intervals at which forests are cut is an important factor in the potential for nonpoint source pollution. Rotation periods vary from 20 to more than 100 years for different species of trees. Thus, harvest sites in the pulp and paper producing areas with shorter (20-year) cutting cycles have more frequent opportunities for contributing nonpoint source pollution.

Silvicultural activities are actually comprised of a number of different operations, each of which has a different potential for nonpoint source pollution. These activities include road building, pesticide and herbicide application, harvesting and logging operations, removal of trees from the harvesting site, and preparation of the site for revegetation. Poorly planned road building and poorly managed site preparation activities offer the greatest potential for pollution impacts. The likelihood of such impacts is dependent upon such factors as road design, extent of soil disturbance, and time required until cover is reestablished (generally 2 to 5 years, and, in certain terrains substantially longer).

A mature forest may experience extremely low soil erosion rates when undisturbed by the activities of people (0.5 tons per acre per year or less). While average erosion rates from carefully managed logging activities may be fairly low (less than an additional ton per acre) erosion rates from 10 to 15 tons per acre per year are not uncommon. Losses due to intensive site preparation (preparing soil for replanting) can exceed 100 tons per acre per year. [25, 26]

Nonpoint source impacts on water quality from silviculture depend on the characteristics of the forest land (e.g., soil type and slope), on climatic conditions, and on the type of forest practices and the care with which they are undertaken. As is the case with agriculture, sediment is the major pollutant by volume and, as was discussed more fully under "Agricultural Nonpoint Sources," the soil type, slope, and climate markedly alter the rates of erosion and sediment delivery to water courses. Although fertilizers and pesticides have been increasingly used in silviculture, they are typically applied only once or twice during a 20- to 35-year period, as compared to annual agricultural applications.[27]

In addition, there is evidence that forest chemical application results in little water degradation because chemicals are sprayed relatively infrequently in comparison to agricultural applications, and delivery rates to water bodies are low.[28] In years for which data are available, less than 1% of forest lands received chemical treatment nationally.[29] However, there is still concern about water quality where chemicals are aerially sprayed near the water course. In heavily drained watersheds, avoidance of water courses may be particularly difficult.[30] Thus, while the contribution of chemicals to lakes and streams is less frequently a problem for silviculture than agriculture, serious pollution problems can result at the local level in certain instances.

Other water quality problems associated with forestry practices include slash or debris from forest operations that contribute organic matter to water bodies and water temperature alterations resulting from removal of the vegetation that shades water bodies.

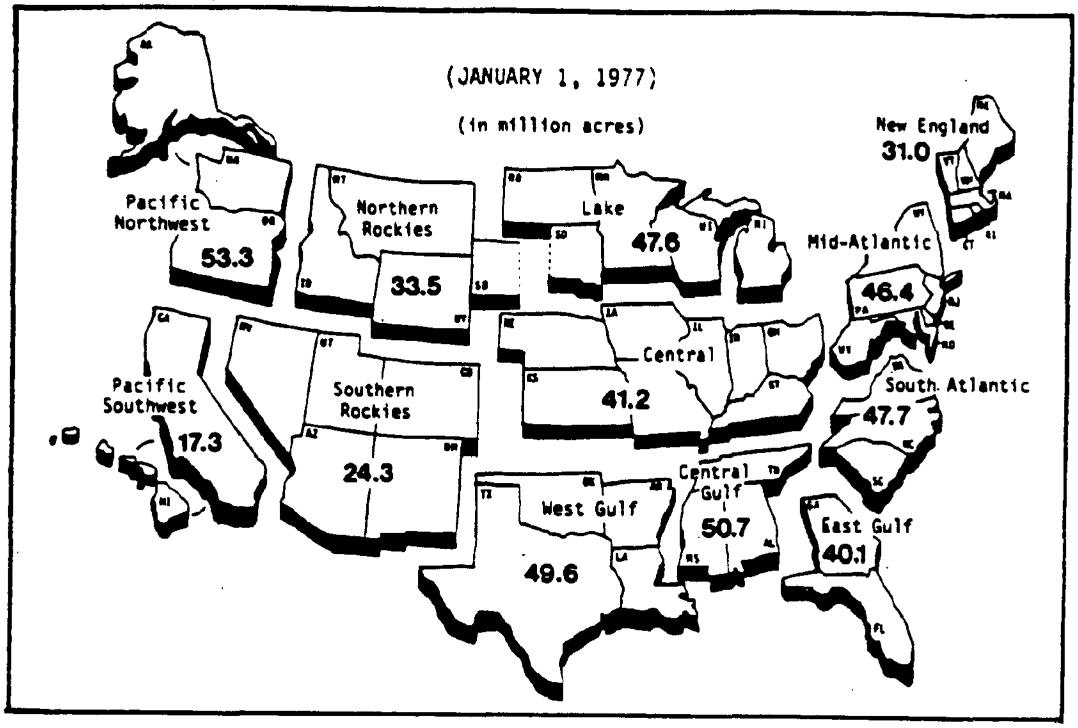
The significance of nonpoint source pollution from silviculture goes beyond the total pollutant load contributed by this source. Forested watersheds often have the nation's highest quality waters. These areas are the source of many municipal water supplies and are prized for cold-water fisheries, aesthetics, and other values.[31] Thus, maintenance and enhancement of these waters is a major goal.

When not properly planned, constructed, and maintained, roads, drainage ditches, and road cuts expose soil to erosion for long periods of time. Evidence suggests that as much as 60% of sediment generation comes from roads.[32] Improper road location and construction on less stable slopes can also cause landslides with accompanying erosion and sediment delivery.[33] Heavy equipment crossing streams without benefit of culverts or bridges can cause a loss of stream channel integrity and, in certain instances, increase stream erosion.[34]

As with agriculture, there are regional variations in the types of nonpoint source water quality problems caused by silviculture. In the Northwest, some of silviculture's effects on water quality can be severe. Characteristics like steep slopes, unstable and immature soils, and high rainfall can lead to significant silviculture-related problems.[35] The Northeast is characterized by the production of hardwood timber usually managed on an uneven-aged silvicultural system designed to regenerate the more valuable tree species. The terrain is relatively gentle, but new road construction will affect water quality unless precautions are taken. Disturbance from site preparation is the major issue in the Southeast, where softwoods harvested for pulp and paper are grown with shorter rotations.[36] The fewest problems are experienced in the Great Lakes States, where flat terrain and rapid revegetation assist in reducing the effects of site disturbance.[37]

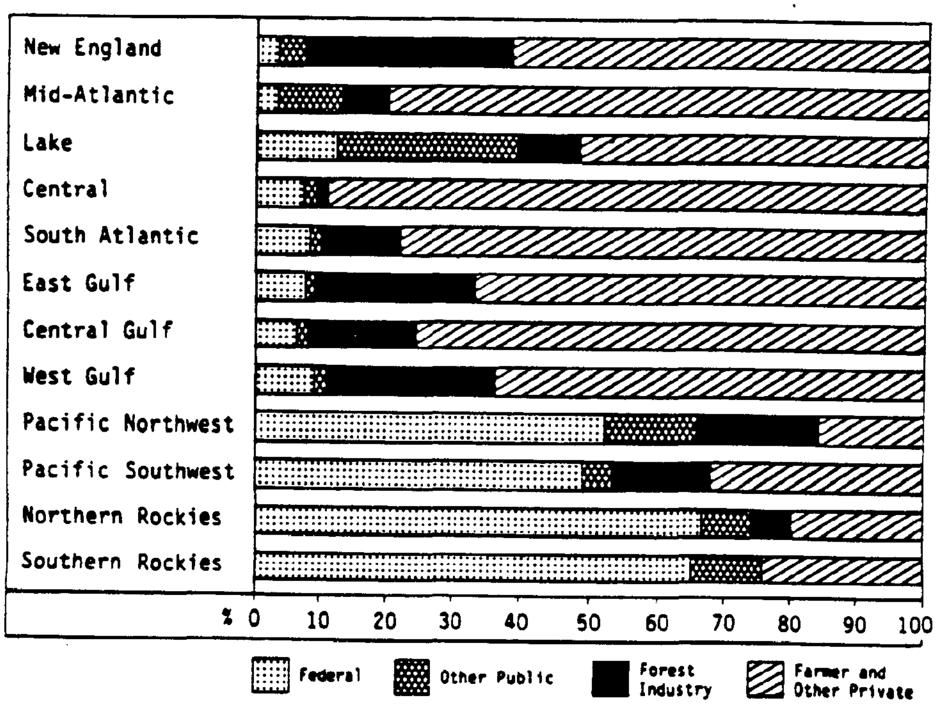
Some general trends are also discernable between Regions. In the Northwest, the level of pollution from timber operations may not increase as much as in other areas because of depletion of "old growth" timber inventories and reliance on existing access roads to harvest second and third growth stands. Expanded activity is expected in the Southeast.[38] As silvicultural activities intensify, there will be greater use of nonindustrial land, and more land is likely to be put into intensive production. Figure 2.3 shows the amount of

FIGURE 2.3 DISTRIBUTION OF COMMERCIAL FOREST LAND BY REGION



Source: An Analysis of the Timber Situation in the United States 1952-2030, Forest Service, USDA, December 1982, pp. 344-349.

FIGURE 2.4 OWNERSHIP OF COMMERCIAL FOREST LAND BY REGION (JANUARY 1, 1977)



Source: An Analysis of the Timber Situation in the United States 1952-2030, Forest Service, USDA, December 1982, pp. 344-349.

commercial forest land in major timber growing regions. Figure 2.4 shows the percentages of ownership of commercial forest land in each region of the country.

The future demand for forest and timber products is subject to debate. Recent estimates by the U.S. Forest Service predict an increase in demand of 32% by 2030.[39] Industry representatives are less optimistic and characterize growth potential as more moderate than Forest Service estimates.[40]

SILVICULTURAL BEST MANAGEMENT PRACTICES

As is the case with other nonpoint sources, no one mitigation approach is appropriate for controlling all the sediment and other pollutants associated with silvicultural operations. Among the individual site characteristics that determine the effectiveness of a particular practice or combination of practices are slope, aspect, hydrology, elevation, weather patterns for rain and snow, and geological stability. Each site requires a combination of techniques best tailored to its particular characteristics.[41] The types of BMPs that are likely to prove effective include:

- Better pre-harvest planning;
- Better planned and constructed roads;
- Less soil-disturbing techniques for harvesting, storage, and hauling procedures;
- Less intensive site preparation;
- New logging techniques (balloon, high-lead, etc.);
- Revegetation and closing of roads after use; and
- Careful application of fertilizers and pesticides.[42]

Although the evidence is incomplete, less intensive site preparation may be beneficial at certain locations. Practices such as chopping (using a bladed roller), instead of shearing and windrowing, are not only less costly and less disturbing, but possibly may increase timber yields through soil conservation. Studies show that less intensive site preparation can actually decrease costs up to $100 to $400 per acre and increase timber yields.[43]

Economies of scale may be problematic for small tracts. On smaller acreages, it may be difficult to justify use of certain equipment that could reduce nonpoint source impacts. Good information on the sizes, types, and regional distribution of forest land holdings is limited, and would be useful in identifying regionally appropriate BMPs and in estimating resource needs for various types of program efforts. Table A.2 in Appendix A shows some examples of silvicultural BMPs.

It is estimated that there are over 4 million private owners of forest land. As detailed in Figure 2.4, 58% of all commercial forest land is held by private owners. Seventy-three percent of this is estimated to be in holdings of 500 acres or less, with an average size of about 70 acres.[44]

SUMMARY: METHODS FOR ADDRESSING SILVICULTURAL NONPOINT SOURCES ARE WELL UNDERSTOOD

Although silvicultural activities do not appear to cause nonpoint source pollution problems as pervasive as those caused by agriculture, or as severe as those related to mining, they can still lead to localized water quality problems in places where they are not well managed. Water quality impacts associated with excessive erosion can cause use impairment. The main nonpoint source pollutants from silvicultural activities are sediment, chemicals (from pesticides and herbicides), and organic debris. Principal sources are roads, logging activities, preparation of sites for revegetation, and aerial spraying of pesticides. Management practices to control these pollutants are well known and well understood. Major implementation concerns are institutional in nature.

As in agriculture, adoption of some BMPs will be both within the means and self-interest of the owner or operator. For example, proper construction of logging roads intended for long-term use may lower operation and maintenance costs. In many instances, however, adoption of BMPs will not be in the economic self-interest of the operator. Needs for specialized equipment may put some BMPs beyond the means of the small landowner or operator. Finally, certain BMPs may be unattractive because they result in lost timber sales (e.g., streambank management zones that leave a buffer strip in both sides of the stream).

As we will see in Chapter 3, in cases where the self-interest of the landowner or operator has not been enough to cause adoption of BMPs, many States have effectively encouraged compliance with regulatory or quasi-regulatory programs. In other States, educational and training programs are used.

MINING NONPOINT SOURCES

NATURE OF THE PROBLEM

Mining cannot be viewed as a homogeneous source of nonpoint pollution. Many different minerals are mined, each with its own set of nonpoint source problems. Coal and metal mining are the sources discussed here, because both are associated with serious water quality problems in large geographic regions.

For the purposes of this discussion, nonpoint sources of pollution from mining operations are considered to be those sources that are not designated as "point" sources. Mining nonpoint sources include discharge from inactive mining operations, as well as runoff from inactive road networks and old tailings and spoil piles. Although active mine sites may pose water quality problems, these are considered to be point source problems and are regulated under State and Federal National Pollutant Discharge Elimination System (NPDES) permits. In addition, the Surface Mining Control and Reclamation Act (SMCRA) of 1977 includes requirements for collection of runoff from active coal mines and treatment of such runoff to meet point source discharge requirements*.

The main nonpoint source problems at mining sites are:

- Runoff of sediment from haul roads at both active and inactive mine sites;
- Drainage of pollutants including acid, sediment, salts, and metals from inactive mines; and
- Drainage and leachate containing acid, metals, and sediment from the spoil and tailings piles generated both by active and inactive mines.

Sediments, Acids, and Heavy Metals Are the Pollutants of Concern from Mining Nonpoint Sources

Although mining is not as widespread as agriculture, the water quality effects resulting from mining are normally much more harmful. Sedimentation rates from mining can be extraordinarily high. Furthermore, whole streams may be biologically dead as a result of acid mine drainage. Other pollutants with potentially serious effects include heavy metals and radioactive materials.

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*Active coal mining sites and associated haul roads may continue to cause runoff-related water quality problems if, although required by law, all runoff is not collected and treated due to delays or technical problems in implementing SMCRA or NPDES requirements. These problems are not addressed in this report because the regulatory mechanisms are those associated with point source controls.

For mining, as for agriculture and silviculture, erosion and delivery of the resulting sediment to surface waters is a recurring problem. Because mining operations expose large areas of soil and rock to the elements, the erosion potential is great. Erosion and sedimentation are associated with almost every abandoned surface coal mine.[45] Haul roads are a significant source of sediment at both active and abandoned mining sites. In Kentucky, for example, erosion from abandoned coal roads, which average 65 feet wide, has been measured at between 2,000 and 4,000 tons per mile per year, depending on soil type.[46] Spoil and tailings piles are also easily eroded and contribute to sediment loadings. Most mineral extraction involves grinding the ore down to 200 to 300 mesh size; thus, mill tailings usually consist of fine dust in the 50 to 74 micron range that is easily eroded by water and wind processes and transported directly or indirectly into water courses.[47]

Other pollutants associated with mining operations can have even more serious water quality impacts than those associated with sediment. Acid drainage, for example, is associated with runoff from surface coal mines and drainage from deep coal mines[48] and a variety of noncoal mines, as well as runoff from spoil and tailings piles. Acid drainage results when sulfide-containing materials are disturbed and exposed to oxygen in the presence of water.[49] Acid water can devastate stream populations. Highly acidic water inhibits fish spawning, enhances the availability of toxic metals, and is an unsuitable habitat for many of the organisms upon which fish and other aquatic species depend.

Desirable metals such as gold, silver, copper, and vanadium are often found in conjunction with unrecoverable quantities of heavy metals, such as lead, arsenic, zinc, cadmium, mercury, and cobalt. When the desirable metals are separated from these heavy metals, the resulting waste piles are subject to erosion and acid leaching with subsequent delivery of waste metals to surface waters.

Mining activities can degrade ground water as well. Mine shafts and prospecting wells driven into underground strata provide pathways for contamination of aquifers that were previously protected by impermeable layers of rock and soil.[50] The destruction of geologic formations and the impact of precipitation on mine shafts releases minerals into ground water from both the bedrock and the mine shaft. Although mining has frequently been reported to cause water <u>quantity</u> problems by lowering water tables, the extent of ground water pollution impacts from mining is unknown.

Table 2.3 shows the amount of land disturbed by surface mining activities in 1977. Although this does not present a full picture of mining-related activities, it does give an indication of the distribution of surface mining problems.

Nonpoint Source Impacts from Metal Mines Occur in the West

Water quality problems associated with mining are found in many parts of the country. In the West, water quality impacts from metal and uranium mining are more serious than those from other types of mining. Although a great deal of coal mining is taking place, much of it began recently and is subject to NPDES

TABLE 2.3 ACRES OF LAND DISTURBED BY SURFACE MINING (JULY 1, 1977)*

	Land Needing Reclamation						Land Not Needing Reclamation	Total Land Disturbed
	Reclamation not required by any law			Reclamation required by law				
State	Coal Mines	Sand and Gravel	Other Mined Areas	Coal Mines	Sand and Gravel	Other Mined Areas		
AL	72,292	16,611	19,929	34,807	5,498	6,252	85,673	241,062
AK**	2,700	4,300	4,000	0	0	0	4,000	15,000
AZ**	400	6,400	60,900	0	0	0	121,800	189,500
AR	5,623	21,483	11,479	2,859	20	1,592	9,449	52,505
CA	10	7,970	80,998	500	17,642	51,316	59,061	217,497
CARIB.**	0	2,550	1,000	0	0	0	710	4,260
CO	7,089	8,334	15,861	1,195	11,672	6,513	14,023	64,687
CT**	0	16,740	787	0	0	0	4,590	22,117
DE**	0	2,912	63	0	0	0	1,498	4,473
FL	0	11,162	235,700	0	3,365	20,922	61,266	332,415
GA	1,680	3,353	24,008	764	4,623	13,772	23,247	71,447
HI	0	15	115	0	0	0	0	130
ID	0	5,100	1,600	0	18,200	3,500	2,500	30,800
IL	118,711	20,330	14,192	40,899	8,582	4,557	88,860	296,131
IN	25,882	11,875	6,522	74,581	4,176	1,894	64,711	189,641
IA	13,997	10,147	6,421	341	8,457	9,638	10,519	59,520
KS	41,256	11,150	10,159	815	3,634	3,978	20,117	91,109
KY	101,637	980	4,712	154,218	2,299	2,780	154,495	421,121
LA**	0	37,324	2,549	0	0	0	10,467	50,340
ME	0	28,833	2,075	0	2,293	923	6,794	40,918
MD	6,412	7,430	1,181	5,703	9,741	1,734	19,824	52,025
MA**	0	32,041	10,330	0	0	0	11,750	54,121
MI	142	39,424	23,422	0	15,662	4,072	27,600	110,322
MN	0	30,047	44,801	0	12,444	7,891	66,919	162,102
MS	0	45,966	7,821	0	0	0	14,415	68,202
MO	70,689	4,473	28,187	8,772	1,046	6,055	22,051	141,272
MT	1,955	4,655	18,340	4,766	4,492	6,598	12,528	53,334

*Based on information from Soil Conservation Service State offices.
**No state law when survey completed; therefore, no reclamation required by law.

TABLE 2.3 ACRES OF LAND DISTURBED BY SURFACE MINING (JULY 1,1977) (CONTINUED)

	Land Needing Reclamation						Land Not Needing Reclamation	Total Land Disturbed
	Reclamation not required by any law			Reclamation required by law				
State	Coal Mines	Sand and Gravel	Other Mined Areas	Coal Mines	Sand and Gravel	Other Mined Areas		
NE**	0	17,696	4,029	0	0	0	11,005	33,003
NV**	0	1,221	2,555	0	0	0	1,953	5,729
NH	0	12,725	417	0	0	0	547	13,689
NJ**	0	24,610	5,570	0	0	0	8,263	38,443
NM	22	11,860	1,806	3,709	1,057	26,072	2,207	46,733
NY	0	30,917	19,251	0	15,979	5,037	18,477	89,661
NC	0	11,908	4,792	0	7,096	3,909	7,000	34,705
ND	1,050	2,010	200	6,725	0	0	38,595	48,580
OH	196,709	22,621	18,923	77,050	16,659	8,427	190,578	530,967
OK	36,118	6,659	14,105	6,298	2,766	4,110	16,255	86,311
OR	0	3,521	17,568	3	6,814	1,538	7,387	36,831
PA	240,000	11,000	20,500	60,000	15,000	25,000	250,000	621,500
RI**	0	2,592	0	0	0	0	3,470	6,062
SC	0	9,065	7,128	0	4,395	3,194	9,815	28,597
SD	890	10,153	5,259	0	6,826	695	7,149	30,972
TN	29,583	4,950	2,305	3,127	810	1,135	104,596	146,506
TX	3,310	152,457	37,104	3,725	6,289	4,989	48,456	256,330
UT	635	3,999	4,414	133	4,637	10,216	7,521	31,555
VT	0	3,877	2,078	0	377	60	1,536	7,928
VA	23,724	3,788	1,251	8,222	3,929	2,003	70,060	112,977
WA	48	9,701	8,174	1,190	11,822	1,073	10,245	42,253
WV	84,868	4,554	995	7,658	0	0	137,105	235,180
WI	0	41,607	7,555	0	11,884	2,865	21,605	85,516
WY	9,657	3,673	12,376	62,028	7,665	12,787	5,511	113,697
Total	1,097,088	799,042	830,407	570,088	257,851	267,097	1,898,203	5,719,776

**No state law when survey completed; therefore, no reclamation required by law.

Source: Soil and Water Resources Conservation Act 1980 Appraisal, Part I, Soil, Water, and Related Resources in the United States: Status, Conditions, and Trends (RCA), USDA, 1981, pp. 181-182.

permit requirements and reclamation requirements under SMCRA.[51] Abandoned coal mine sites are also not a significant concern in the West. Noncoal mining is the primary concern; it has been estimated that 80% of water pollution from inactive noncoal mines occurs in four areas: Colorado, California, Idaho/Montana, and Missouri.[52] The impact of nonpoint source pollution caused by mining in the West is increased by the scarcity of surface and ground water resources.

Noncoal mining activities that generate heavy metal contaminants are second only to municipal treatment facilities as a source of toxics in water courses within EPA's Region 8 (consisting of Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming). Several streams in Colorado have very high levels of copper, zinc, and arsenic.[53] Contamination of water with heavy metals and other hazardous pollutants is viewed as an emerging problem in the West, due to the expansion of municipalities and the need for more water for domestic use; continued development will inevitably bring more people into contact with contaminated water in what have heretofore been remote areas.[54]

Acid Drainage from Coal Mines Occurs in the East and Midwest

The mid-Atlantic and Appalachian regions are severely affected by drainage from abandoned and inactive coal mines. EPA's Region 3 (consisting of Pennsylvania, Maryland, Delaware, Virginia, West Virginia, and the District of Columbia) reports that 49% of its streams--more than 3,000 stream miles--suffer severe water quality problems caused by acid mine drainage.[55] Two-thirds of these problem streams are in western Pennsylvania [56], with the remainder in West Virginia, parts of southwest Virginia, and western Maryland. Underground coal mining is not as widespread in the Midwest (or interior regions) as in the East. Abandoned coal mine lands are only a small percentage of the total land area, and water pollution problems are generally not as extensive in the Midwest as those in the East. Nonetheless, drainage from coal mines does affect waterways in the Midwest, and is considered to be serious where it occurs.

MINING BEST MANAGEMENT PRACTICES

Despite the fact that nonpoint source impacts from inactive mines are well understood, it is difficult to develop feasible control strategies because of the high cost of control measures, limited success of control techniques, and complexity of enforcement.[57] Techniques for control of mine runoff include:

- Sealing of abandoned mines to minimize oxygen contact and reduce acid formation, thus reducing contamination of drainage;
- Revegetation of eroding surfaces (which itself is inexpensive but often requires regrading of the mine site and replacement of top soil);
- Mixing of fine and coarse materials to help stabilize mill tailings;

- Addition of hypochlorite to gold tailings piles to render their cyanide component harmless;

- Alkaline treatment of uranium wastes to reduce their solubility;

- Compounding of highly hazardous material with asphalt or concrete or capping with clay to provide permanent storage and reduce leachate contamination;

- Removal of waste materials from streams and gulches that are subject to washing, and placement of these wastes on higher, impervious ground; and

- Containment of leached materials within ditches, dikes, and impoundments where hydrologic conditions permit.

Although many of the management issues are similar, there are significant differences in the technical and cost considerations associated with installing BMPs on different kinds of mining sites. In all cases, the most effective control of nonpoint source pollution from mining sites is prevention by proper planning of the site as it begins operation.

Abandoned underground mines pose some of the most challenging control problems. When mines were constructed below the water table and mine shafts were used for access, they were often reinforced with brick or stone linings. These shafts are resistant to natural closure by weathering and infilling, and are difficult to seal.[58] In fact, BMPs calling for sealing of mines (to prevent oxygen contact) and for alleviation of subsurface drainage problems are not only expensive, but have met with little success; their technical validity is currently considered questionable and plugs so emplaced often leak. The expert consensus is that such techniques generally require long-term (if not perpetual) maintenance, and that research and development efforts would be useful in developing effective technologies for abatement of pollution from underground mines.[59]

Abandoned surface coal mines pose a different challenge. Sedimentation and acid mine drainage result from road construction, removal of the overburden (the rock overlying the coal), topography, and the mining activity itself. BMPs involve a variety of land treatment techniques such as regrading and revegetating spoil and refuse, in combination with neutralization to control mine acid. Removal and burial or reprocessing of spoil and refuse banks can also alleviate mine drainage, as can covering toxic "spoils" with impermeable clay or capping them with synthetic material. A relatively recent innovation is the use of anionic detergent to control the bacteria that aid in the oxidation of pyrites.[60]

Reclamation practices for surface metal mining are diverse and must be chosen on the basis of the environment in which the mining is done, the physical nature of the mining operation (e.g., the use of quarries and large open pit mines), and the climate.[61] The ability to reclaim the mine and return it to its natural state may be severely limited. Most commonly, little overburden accompanies minerals that are excavated from flat-lying deposits.[61] Restoring the land to its original contour where massive ore bodies have been mined could require expenditures roughly equal to the costs of mining.[62] Location of metal mining in the arid West further inhibits revegetation possibilities.

SUMMARY: ABANDONED MINE PROBLEMS CONTINUE TO PRESENT SERIOUS WATER QUALITY CONCERNS

Mining-related nonpoint source water quality problems are found in many parts of the country. Because mining activities are typically concentrated in a limited area, water quality impacts are also localized in nature. Where they occur, however, the resulting impact can be quite serious.

Techniques for controlling pollution from operating mines are widely available. Proper site planning of a new mining operation is the key to preventing pollution, and is required by SMCRA for all new mines. In many parts of the country, however, it is the inactive and abandoned mines, the design and operation of which were completed a number of years ago, that pose serious water quality problems.

Techniques are available for solving many of the water quality problems associated with surface mining. In some instances, significant costs may be associated with regrading land areas and adding topsoil for revegetation in abandoned mines where improper planning for reclamation makes after-the-fact problem solving difficult. Correction of drainage problems from deep mines is both more technically difficult and more costly. In addition, correction of these drainage problems may not last, and will usually require long-term monitoring and maintenance.

Although techniques are available to address many abandoned surface mine problems, institutional issues and costs continue to present barriers to effective control. Mine owners are sometimes reluctant to cap or bury tailings piles, and to take other steps that might make future recovery of mineral values more difficult. Furthermore, ownership and responsibility for abandoned mines is often difficult or impossible to establish.

CONSTRUCTION NONPOINT SOURCES

NATURE OF THE PROBLEM

On a national basis, the water quality degradation caused by nonpoint source pollution from construction activities is not nearly as great as the amount caused by other major nonpoint sources. Sediment is the main construction site pollutant, but it represents only about 4 to 5% of nationwide sediment loads in receiving waters.[63]

Where construction activities are intensive, however, the localized impacts on water quality may be severe because of the high unit loads involved. Erosion rates from construction sites typically are 10 to 20 times that of agricultural lands, and runoff rates can be as high as 100 times that of agricultural lands.[64] Thus, even a small amount of construction may have a significant negative impact on water quality in localized areas.

Construction site erosion rates are highly variable because site characteristics are many and varied. Climate, soil type, slope, and the type of construction activity conducted are all involved. The characteristics associated with severe erosion problems can occur locally anywhere in the country.

Construction sites also generate pollutants other than sediment, including:

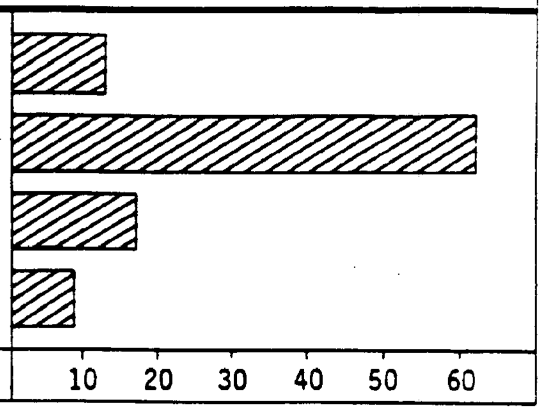
- Chemicals from fertilizer, such as phosphorus, nitrogen, and other nutrients, that can be attached to sediment particles or dissolved in solution;
- Pesticides, used to control weeds and insect pests at construction sites;
- Petroleum products and construction chemicals, such as cleaning solvents, paints, asphalt, acids, and salts; and
- Solid wastes, ranging from coffee cups to trees and other debris left at construction sites.

Pesticides, petroleum products, and construction chemicals can be toxic to aquatic organisms and seriously impair their fitness for human consumption. These pollutants can also degrade the water itself, impairing its use for drinking and water-contact recreation.

Projections by the U.S. Census Bureau indicate that population is growing most rapidly in the South Atlantic, South Central, and Southwest areas. Typically, these areas do not have State erosion control programs and, thus, construction erosion problems might be anticipated. Figure 2.5 shows the regional distribution of construction site sediment loss in the United States. In 1979, the U.S. Soil Conservation Service reported that 60% of the nationwide construction site erosion occurs in ten States, as shown in Figure 2.6. These figures are likely to change if growth patterns shift.

FIGURE 2.5 REGIONAL DISTRIBUTION OF CONSTRUCTION SITE SEDIMENT LOSS

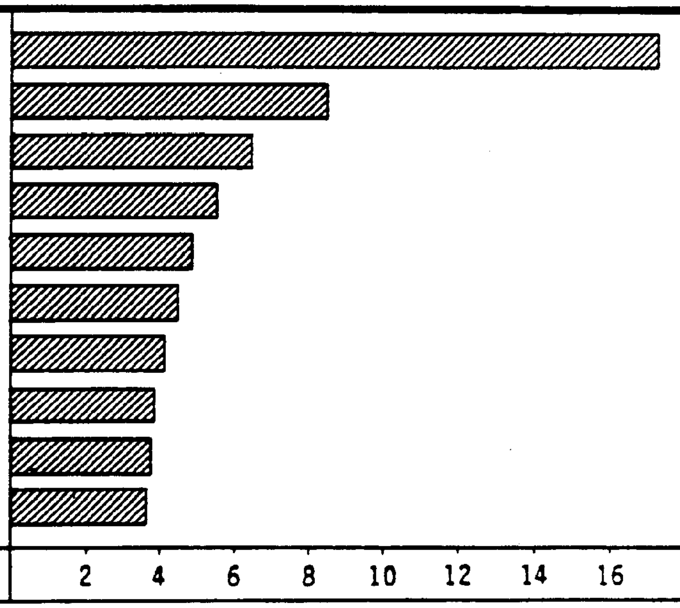
Regions	Tons of Erosion (in thousands)	Percentage of Total
Northeast (14 States)	9,798	
Southeast (12 States, Puerto Rico, Virgin Islands)	49,473	
Midwest (12 States)	13,679	
West (12 States)	6,990	
Total	79,940	



Source: Nonpoint Source Runoff: Information Transfer System, EPA, Office of Water, July 1983.

FIGURE 2.6 EROSION FROM CONSTRUCTION SITES

State	Tons of Erosion (in thousands)	Percent of National Total
Alabama	13,653	
North Carolina*	6,674	
Louisiana	5,071	
Oklahoma	4,231	
Georgia*	3,817	
Texas	3,528	
Tennessee	3,280	
Pennsylvania*	3,126	
Ohio*	3,004	
Kentucky	2,970	
Total	49,354	



*States with erosion and sediment control laws in effect.

Source: Nonpoint Source Runoff: Information Transfer System, EPA, Office of Water, July 1983.

It is estimated that a total of 1.6 million acres of land are disturbed annually by construction activities, with highway and other heavy development accounting for the vast majority of this acreage, and urban residential housing (84,000 acres) and urban nonresidential development (79,000 acres) representing the remainder.[65] However, fewer and fewer new highway miles are being and will be constructed as highway reconstruction and maintenance are now being emphasized.[66] The latter activities still cause some nonpoint source problems, but they are somewhat less severe than the problems caused by new highway construction. The effectiveness of highway construction erosion control is likely to reflect the availability of resources and varying levels of sensitivity to the problem in different States.

BEST MANAGEMENT PRACTICES FOR CONTROLLING CONSTRUCTION EROSION

Solutions to construction nonpoint source problems are well developed and understood. The various control alternatives involve protecting disturbed areas from rainfall and from flowing runoff water, dissipating the energy of the runoff, trapping sediment that is being transported, and using good housekeeping practices to prevent potential pollutants other than sediment from being transported by runoff.[67] It is particularly prudent to control this type of nonpoint source problem at the source--preventing pollution at each construction site--rather than trying to clean up receiving waters after they have been damaged. Proper planning to control construction site erosion, therefore, is crucial to the control process.

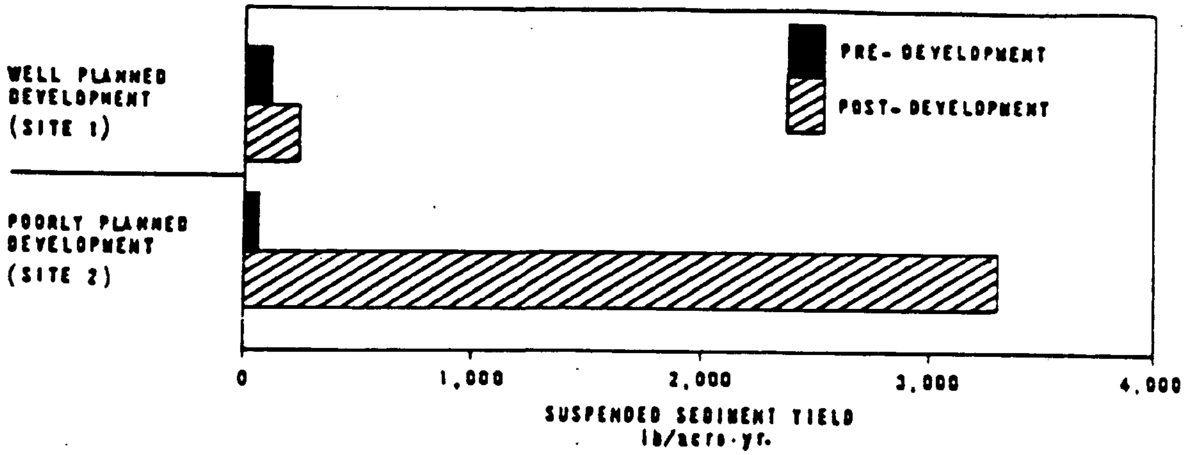
Each construction project should be planned with surface and ground water drainage problems in mind, avoiding critical areas on and adjacent to the site, and minimizing effects on natural drainage systems.[68] In addition, site planning means scheduling construction activities at the proper time and using phased construction stages that minimize the amount and duration of soil exposure. Figure 2.7 compares the sediment loads from well planned and poorly planned developments. This figure shows that, although a well planned development results in a small increase in sedimentation, a development that disregards proper planning can drastically increase sediment yields in runoff water.

A combination of nonstructural and structural BMPs are typically used on construction sites. Table A.4 in Appendix A lists examples of both nonstructural and structural BMPs. As noted above, good advance site planning can go a long way toward preventing construction erosion problems. Also, relatively inexpensive nonstructural vegetative controls (such as seeding and mulching) can also achieve a great deal. In some cases, however, more expensive structural BMPs may be necessary.

Examples of primary nonstructural BMPs include:

- <u>Soil stabilization practices, such as mulches, seeding, and other ground covers</u>--These can be very simple and effective methods for removing sediment from runoff and reducing the amount of runoff. They work by dissipating the energy of raindrops and absorbing moisture.

FIGURE 2.7 COMPARISON OF SEDIMENT YIELDS
FROM A WELL PLANNED AND A POORLY PLANNED DEVELOPMENT



Source: William G. Lynard, et. al., Urban Stormwater Management and Technology--Case Histories, EPA, Office of Research and Development, August 1980.

- Good housekeeping practices--These include proper use and application of pesticides, fertilizers, petroleum products, and chemicals. This BMP also includes proper solid and human waste disposal practices on construction sites.

Wet and dry detention basins are examples of structural BMPs. Wet retention basins have a constant pool of water in them and store runoff water even after rainstorms. Wet retention basins are very effective at removing sediment and other pollutants from runoff water and allowing water to percolate into the ground. These wet basins are often used for recreational activities such as boating. Conversely, dry detention basins remain dry between rainstorms and may be used for dry land recreational purposes. During rainstorms they detain runoff water for a short period of time and pollutants settle out. However, dry detention basins have been found to be less effective than wet ones at removing pollutants.

Other examples of structural measures include diversion structures (e.g., dikes, ditches, level spreaders, and terraces) which route sediment-laden runoff water into sediment basins or other safe disposal areas. Where runoff velocities are slow, solids may settle out. Filter structures (e.g., stone and gravel piles, sandbags, and straw bales) are other structural BMPs that can be used to slow water velocities, thereby reducing further erosion. Filter structures are sometimes considered low structural or nonstructural controls when they do not entail much additional construction work. A roadside swale or depression directs runoff water to appropriate places and allows some or all of the water to percolate into the ground.

Usually, a combination of structural and nonstructural controls produces the most cost-effective answers to construction nonpoint source problems. For example, highway construction nonpoint source pollution can be decreased significantly by utilizing diversion and filter structures, mulches, and well planned excavation work.[69] Total costs are estimated at more than $1,000 per acre[70], but these costs are more than recaptured by the reduced expenditures for cleaning up sediment damage.

The costs for implementing construction site BMPs for private land development activities are typically borne by the developer and are usually passed on to the land purchasers. However, should the control requirement not be uniformly applied, a developer may have to absorb part or all of the costs of nonpoint source controls and reduce profit margins in order to stay competitive. In the case of highway or other public construction, any added costs to government agencies are borne by the general public.

The benefits of BMP implementation are received by anyone using the waters affected by construction erosion. In addition to improved water quality, some benefits of sediment control include:

- Reduced frequency and intensity of floods;
- Lowered costs for purifying drinking water obtained from surface water sources;
- Preserved wildlife and other natural areas for aesthetic, recreational, and commercial enjoyment, and increased tourist income;
- Reduced water cleaning and channel dredging costs; and
- Increased value of waterfront property resulting from a number of the other benefits.

SUMMARY: NONPOINT SOURCE POLLUTION FROM CONSTRUCTION CAN BE CONTROLLED

The major nonpoint source pollutant from construction sites is sediment. Although pollutant loads are small nationally, the volume of runoff from a particular construction activity--and its impact on a local water body--can be significant. BMPs are well understood technically. They are also recognized to be beyond the economic interest of the builder. Practices are typically instituted as a result of regulatory action on the part of the State and/or local government, and costs are passed on to the consumer.

Because the various solutions to this nonpoint source problem are quite clear, it is worth asking how BMPs can be implemented more effectively to achieve further results. In order to answer this, the failures in existing implementation programs need to be better understood so that appropriate steps can be taken to reduce this source of nonpoint pollution. Although precise data are not available, one of the apparent problems in many construction erosion control programs is the difficulty of inspecting and enforcing control measures at numerous sites scattered throughout a local jurisdiction. Weak inspection and enforcement point to the need for more emphasis on training and education to complement regulatory programs. Chapter 3 further describes the status of State construction erosion control activities.

URBAN NONPOINT SOURCES

NATURE OF THE PROBLEM

Rainwater running off roofs, lawns, streets, industrial sites, and other pervious and impervious areas washes a number of important constituents into urban lakes and streams. A large volume of the constituents in urban runoff is comprised of sediment and debris from decaying pavements and buildings that can clog sewers and waterways, reducing hydraulic capacity (and thus increasing the chance of flooding) and degrading aquatic habitat. Heavy metals and inorganic chemicals (including copper, lead, zinc, and cyanides) arising from transportation activities, building materials, and other sources are also significant pollutants. Nutrients are added to urban runoff from fertilizers applied around homes and in parks. Petroleum products from spills and leaks, particularly from service station storage tanks, and fecal bacteria from animal wastes and ineffective septic tanks are other important contaminants and may affect ground water as well as surface water. In short, many of the wastes from urban living make their way into urban runoff.[71]

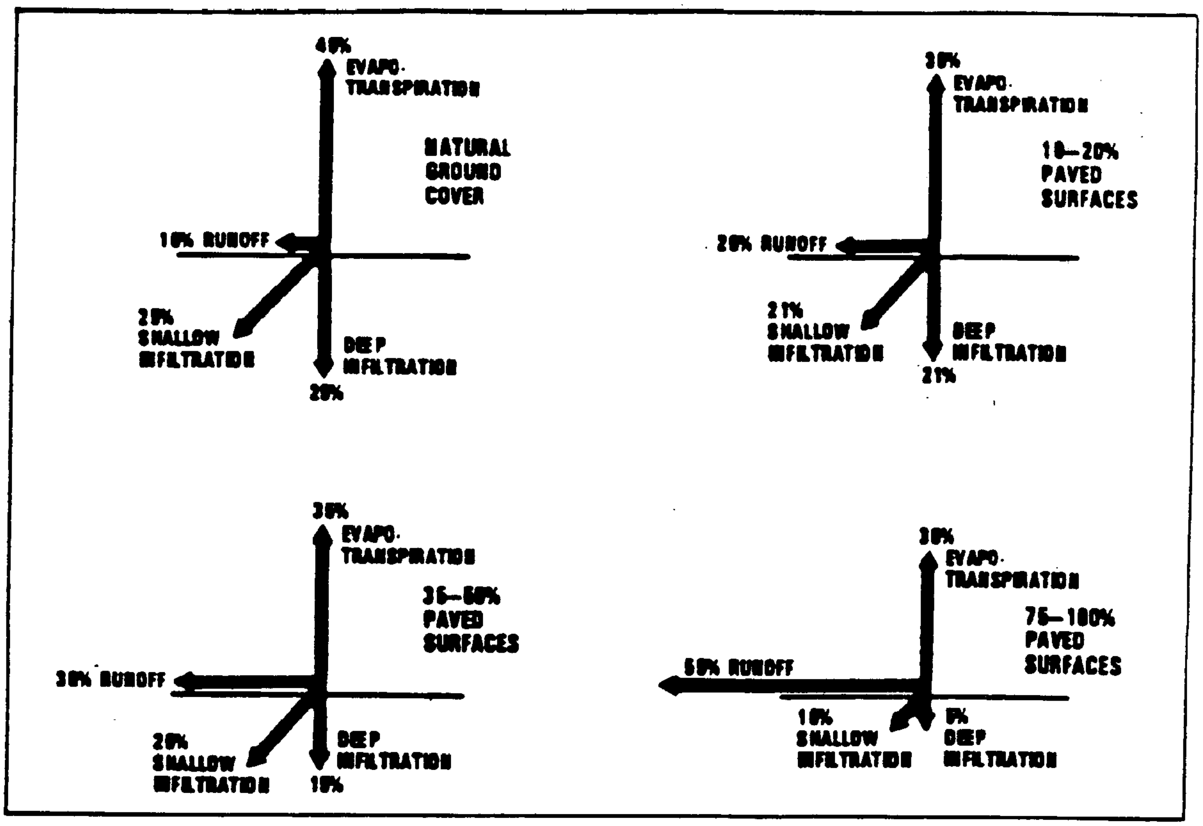
Of equal importance is the volume of stormwater runoff leaving urban areas. Figure 2.8 graphically illustrates the effects of paved surfaces on stormwater runoff volumes. When natural ground cover is present over an entire site, approximately 10% of the stormwater runs off the land into nearby creeks, rivers, and lakes. When paved surfaces account for 10 to 20% of the area of the site, 20% of all stormwater becomes surface runoff. As the percentage of paved surfaces increase, the volume and rate of runoff and the corresponding pollutant loads also increase.

Heavy metals are also carried this way in urban runoff. As shown in Table 2.4, results from the Nationwide Urban Runoff Program (NURP) indicate that metals and inorganics are the urban runoff contaminants having the greatest potential for long-term impacts on aquatic life, although they appear not to cause the immediately observable acute impacts of pesticides (e.g., fish kills). Some of these pollutants accumulate in the tissues of fish and other aquatic organisms. They also accumulate in the environment through continuing sedimentation and/or are resuspended in the water column during high flows associated with storm events.

These constituents may also have important effects on ground water, the extent of which is dependent on site-specific hydrologic and geologic conditions that determine the amount of runoff which percolates through to underground aquifers. Aquifers in limestone areas are particularly vulnerable because runoff flowing into sink holes and surface water is thus transmitted to ground water rapidly.

It is reported both in the literature and by EPA Regions that urban runoff causes significant local water quality effects. Several studies conducted as part of NURP indicate that the quantity of urban stormwater and the high velocity of its flow constitute a major cause of aquatic habitat disruption in urban areas through erosion, sedimentation, and scour.[72] NURP was unable to find extensive impairments or denials of approved water uses due to chemical pollutants borne by urban runoff.[73] However, only limited biological monitoring was conducted by the NURP projects, and concerns remain about the long-term impact of metals and other priority pollutants discharged during storm events and subsequently stored in bottom sediments.

FIGURE 2.8 EFFECT OF GROUND COVER ON URBAN RUNOFF



Source: Final Report of the Nationwide Urban Runoff Program, Final Draft, Vol. 1, EPA, Water Planning Division, December 1983, as cited in J.T. Tourbier and R. Westmacott, Water Resources Protection Technology: A Handbook of Measures to Protect Water Resources in Land Development, p. 3.

The urban nonpoint source problem is most acute in more heavily populated areas such as the Northeast or other major urban centers. It has been estimated that urban nonpoint source problems affect 20% of the nation's river miles and occur at some level in greater than 50% of the nation's drainage basins.[74] Cumulative impacts downstream can be significant even if use impairments at specific urban centers upstream have not been identified. If preventive measures are not taken, urban nonpoint source problems can be expected to increase anywhere that urbanization occurs.

TABLE 2.4 MOST FREQUENTLY DETECTED PRIORITY POLLUTANTS IN NURP URBAN RUNOFF SAMPLES*

Detection Rate**	Inorganics	Organics
Detected in 75% or more of the NURP samples	Lead (94%) Zinc (94%) Copper (91%)	None
Detected in 50% - 74% of the NURP samples	Chromium (58%) Arsenic (52%)	None
Detected in 20% - 49% of NURP samples	Cadmium (48%) Nickel (43%) Cyanides (23%)	Bis (2-ethylhexyl) phthalate (22%) α-Hexachlorocyclohexane (20%)
Detected in 10% - 19% of the NURP samples	Antimony (13%) Beryllium (12%) Selenium (11%)	α-Endosulfan (19%) Pentachlorophenol (19%) Chlordane (17%) γ-Hexachlorocyclohexane (Lindane) (15%) Pyrene (15%) Phenol (14%) Phenanthrene (12%) Dichloromethane (methylene chloride) (11%) 4-Nitrophenol (10%) Chrysene (10%) Fluoranthene (16%)

*Based on 121 sample results received as of September 30, 1983, adjusted for quality control review. Does not include special metals samples.

**Percentages indicate frequency of detection, not concentration. Analysis of concentration shows that concentrations of copper, lead, and zinc were the highest of any priority pollutant.

Source: Final Report of the Nationwide Urban Runoff Program, Final Draft, Vol. 1, EPA, Water Planning Division, December 1983.

BEST MANAGEMENT PRACTICES FOR URBAN AREAS

Both structural and nonstructural management practices are available to control urban runoff. The principal structural alternatives are runoff retention basins, in-line storage, and in-line screens. These methods retain water and/or solids within basins and/or conveyance systems, or allow water to percolate into the ground to reduce the peak flows and pollutants which reach streams.

Additional alternatives are being tested to perform similar functions. These include utilization of existing wetlands or creation of artificial wetlands to provide settling of solids and vegetative filtration, and "first flush diversion systems" that route some first increment of peak storm flows through treatment plants. Nonstructural BMPs include good housekeeping practices and land use planning. Table A.5 in Appendix A displays selected BMPs and ranges of effectiveness and associated costs. Figure A.1 in Appendix A summarizes the results of an Orange County, Florida demonstration program which studied the effectiveness of certain BMPs in removing specific pollutants.

The feasibility and cost of management alternatives must be evaluated in relation to whether an area is already built up or is just beginning to be developed. In established urban areas, structural control practices are very expensive to implement, and nonstructural controls are limited in their pollutant removal effectiveness. For instance, replacement of hard surfaces with porous pavement or redesign of existing in-line systems with accompanying road and property disturbance can be prohibitively costly, and land for retention basins is either prohibitively expensive or not available at all. On the other hand, in heavily developed areas of cities, it is sometimes possible to achieve limited reduction of some pollutants through good housekeeping practices. In general, however, land use planning and other urban runoff controls have limited utility in highly developed urban areas.

The greatest potential for utilizing the full range of structural and nonstructural BMPs is in developing urban areas, where the reduction of future pollutant loadings can be realized for the least cost. There is a great opportunity in such areas to employ land use planning to reduce future runoff volumes and corresponding pollutant loads. Developing communities can incorporate structural measures to reduce long-term urban runoff volumes and can also implement construction site erosion BMPs into their development plans.

The costs of urban BMPs are borne by the municipality and its residents. Benefits also accrue to this group and to society at large. Benefits of BMP implementation can include improved potable water supplies, restored recreational opportunities, restored or continued commercial fishing and shellfishing opportunities, and maintenance of land values due to the aesthetic appearance of receiving waters. In addition, damage to drainage systems, obstruction of navigation channels and harbors, and the frequency and severity of floods can be reduced. Good housekeeping practices often have additional benefits to the landowners who apply them. For example, educational programs on the proper use of fertilizers and pesticides frequently result in better lawns and gardens, and programs on proper streambank management not only minimize erosion but improve the appearance and value of property. In this regard, some local governments have developed video presentations for use at public meetings to instruct landowners on how they can control erosion on their property.

SUMMARY: CONTROL OF NONPOINT SOURCE RUNOFF FROM DEVELOPED URBAN AREAS WILL BE DIFFICULT

Water quality problems caused by urban nonpoint sources will be most acute in heavily populated, built-up areas such as the Northeast. The most effective control measures are structural, however, and opportunities for implementation of these measures will be very limited in such situations. Developing urban areas offer the greatest potential for utilizing the full range of structural and nonstructural BMPs. Adoption of these measures is an important means of reducing future urban nonpoint source pollutant loads.

Given the cost and other constraints of nonpoint source controls in developing urban areas, particularly close attention must be paid to the nature of the water quality problem in such areas. Results of the NURP study suggest that water quality impacts from urban runoff may be more limited in scope and geographical distribution than was previously suspected. Forthcoming EPA publications will make the NURP results available to indiviudal communities, and will include new methodologies to analyze water quality problems from urban nonpoint sources.

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CHAPTER 3

Current Programs Directed at Controlling Nonpoint Source Pollution

INTRODUCTION

In the preceding chapters, we examined the nature, magnitude, and extent of nonpoint source pollution problems, and the variety of approaches that can be used to reduce these problems. In Chapter 3, we will examine the kinds of programs being undertaken by Federal, State, and local governments to manage nonpoint sources of pollution and describe the manner in which the responsibility for such programs rests at the State and local levels.

EPA and Other Federal Agencies Have Been Active in Addressing Nonpoint Source Pollution

As part of the water quality management program, planning under Section 208 of the Clean Water Act required State and areawide agencies to identify water quality problems related to point and nonpoint sources. During the period from 1974 to 1981, the Federal government provided grants to States, Territories, and 176 areawide agencies for overall water quality management purposes under Sections 106 and 208. Portions of these funds were directed at identifying nonpoint source problems and developing strategies for their control. By 1982, 213 water quality management plans, which contained elements addressing nonpoint source pollution control, were approved by EPA. Continuing components of the EPA water quality management program that support State management of nonpoint sources include the basic water quality program support grants (Section 106) and grants to support planning (Section 205(j)).

During the 1970s, EPA also began a process of working with other Federal agencies to identify the manner in which their programs affect nonpoint sources of pollution, and, in some cases, to develop agreements ensuring that Federally funded projects minimize pollution from these sources. Other agreements negotiated with Federal agencies allowed the States and EPA to use the field resources available through programs such as those offered by the U.S. Department of Agriculture (USDA) to provide technical assistance on the management of nonpoint sources of pollution.

Now, 9 years after the initiation of this water quality management planning process, EPA can report that a significant amount of activity and resources is being devoted to identifying and controlling nonpoint source pollution problems at the Federal, State, and local levels of government. These activities are unevenly distributed, however, and vary in their effectiveness. In any case, it is essential to evaluate the nature and scope of these activities so that the needs that remain in the management of nonpoint sources can be perceived.

Structure of Chapter 3

The material that follows describes program activities currently being undertaken to control nonpoint source pollution at the State level, as well as the Federal actions that support to these efforts. The discussion is organized by the five nonpoint source categories analyzed in Chapter 2, and is preceded by overviews of activities at the State and Federal levels. Detailed tables summarizing State and Federal activities are presented in Appendix B. Although an effort has been made to be comprehensive, the State-by-State descriptions are limited by the amount of detailed information currently available about the nonpoint source control activities now being performed in each State. Table 3.1 summarizes State program information (otherwise found in Tables B.1, B.2, and B.4 in Appendix B) for three nonpoint sources: agriculture, silviculture, and construction. Local nonpoint source programs are too numerous and varied to either summarize or categorize. In order to present some flavor of the kinds of activities being undertaken by State and local governments, however, some brief case examples are included for several nonpoint source categories.

AN OVERVIEW OF STATE NONPOINT SOURCE PROGRAMS

States have undertaken a wide range of responses to nonpoint source pollution problems. These responses vary according to the source, and to the technical, institutional, and political difficulties inherent in managing it. Some general observations can be made, however, about State management of specific types of nonpoint sources.

Agriculture

Agricultural nonpoint source programs are usually voluntary, and a variety of agricultural agencies provides very localized technical support and assistance (e.g., USDA's Soil Conservation Service (SCS), Agricultural Stabilization and Conservation Service (ASCS), and Extension Service, and local soil and water conservation districts). Nineteen State programs provide cost sharing as an incentive to farmers to implement appropriate conservation measures or best management practices (BMPs). Enforcement measures are seldom used and are usually limited to situations where cause and effect relationships can be easily established, as in the case of many small feedlot operations.

Silviculture

In States where the forest industry has significant landholdings and is very active, silvicultural programs tend to be regulatory or quasi-regulatory* in nature. In States where small-lot silviculture is more commonly practiced, voluntary, educational, and sometimes incentive-oriented programs are aimed at private landowners.

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*Regulatory programs are those where silvicultural activities are directly controlled by way of a forest practices act. Quasi-regulatory programs use other laws such as sediment and erosion control laws to achieve control objectives.

TABLE 3.1 SUMMARY OF STATE NONPOINT SOURCE PROGRAMS

	AGRICULTURE			SILVICULTURE	CONSTRUCTION
	Current Program	Cost Share	Cost Share Funds ($ mill.)	Current Program	
AL	Voluntary			Voluntary	
AK	(Planned)			Regulatory	
AR	Voluntary			Voluntary	
AK	Voluntary			Voluntary	
CA	Voluntary			Regulatory	
CO	Voluntary			Voluntary	
CT	Voluntary	Yes	.03	Voluntary	Regulatory
DE	Voluntary				Regulatory
FL	Voluntary			Voluntary	
GA	Voluntary			Voluntary	Regulatory
HI	Voluntary			Quasi-Regulatory	Regulatory
ID	Voluntary/Regulatory	Yes	1.00	Regulatory	
IL	Voluntary/Regulatory	Yes	.50	Voluntary	Regulatory
IN	Voluntary	Yes	.40		
IA	Quasi-Regulatory	Yes	8.49		Regulatory
KS	Voluntary	Yes & loans	1.25		
KY	Voluntary			Voluntary	
LA	Voluntary			Voluntary	
ME	Voluntary/Regulatory			Quasi-Regulatory	Quasi-Regulatory
MD	Voluntary/Regulatory	Yes	5.00	Voluntary	Regulatory
MA	Voluntary			Quasi-Regulatory	
MI	Voluntary/Regulatory			Voluntary	Regulatory
MN	Voluntary	Yes	1.54	Voluntary	
MS	Voluntary			Voluntary	
MO	Voluntary	Yes	3.99		

*This table summarizes information from three tables in Appendix B. Information on this table is drawn from sources cited on these tables in the Appendix.

TABLE 3.1 SUMMARY OF STATE NONPOINT SOURCE PROGRAMS (CONTINUED)

	AGRICULTURE Current Program	Cost Share	Cost Share Funds ($ mill.)	SILVICULTURE Current Program	CONSTRUCTION
MT	Voluntary	Loans		Voluntary	Regulatory
NE	Voluntary	Yes	1.44		
NV	Voluntary/Regulatory			Quasi-Regulatory	
NH	Voluntary/Regulatory			Quasi-Regulatory	
NJ	Voluntary	Yes	50.00**	Voluntary	Regulatory
NM	Voluntary			Voluntary	
NY	Voluntary			Voluntary	
NC	Voluntary			Voluntary	Regulatory
ND	Voluntary	Yes	.45		
OH	Voluntary	Yes	.28		Regulatory
OK	Voluntary	Yes	.01	Voluntary	
OR	Voluntary			Regulatory	
PA	Voluntary/Regulatory			Quasi-Regulatory	Regulatory
RI	Voluntary				Regulatory
SC	Voluntary			Voluntary	
SD	Voluntary/Regulatory	Yes	.40	Voluntary	Regulatory
TN	Voluntary			Voluntary	
TX	Voluntary				
UT	Voluntary	Yes & loans		Voluntary	
VT	Voluntary			Voluntary	Quasi-Regulatory
VA	Voluntary	Yes	.10	Voluntary	Regulatory
WA	Voluntary			Regulatory	
WV	Voluntary			Voluntary	
WI	Voluntary	Yes	4.13	Voluntary	
WY	Voluntary	Yes	.02	Voluntary	
PR	Voluntary/Regulatory				Developing Program
VI					Developing Program
TOTALS:	39 Voluntary 10 Voluntary/Regulatory 1 Quasi-Regulatory 1 Planned	19 Cost Share		29 Voluntary 5 Regulatory 6 Quasi-Regulatory	16 Regulatory 2 Quasi-Regulatory 2 Developing Programs

**Total amount is for purchase of prime agricultural lands; a portion is available for water quality purposes.

Mining

Control programs that address currently operating coal mines are regulatory in nature and derive their authority from the Federal Surface Mining Control and Reclamation Act (SMCRA). Programs for abandoned mines usually involve the provision of financial assistance by State and Federal governments through the abandoned mines program of SMCRA, the Rural Abandoned Mines Program (USDA), or individual State programs.

Construction

Programs for the control of construction erosion are regulatory in nature, where they exist. Only about 16 States have effective regulatory programs. In States that do not have a Statewide regulatory mandate, some individual local governments regulate.

Urban Runoff

Urban runoff control programs are normally conducted by municipalities and, at present, are primarily directed at controlling the volume of urban runoff, although increasing attention is being given to incorporating water quality considerations as well.

AN OVERVIEW OF FEDERAL PROGRAMS

The activities of Federal agencies are important in the management of certain nonpoint sources because they concern either direct management of Federally owned land (Bureau of Land Management within the U. S. Department of the Interior), Forest Service within USDA, etc.) or are programs designed to assist private landowners. Nonpoint source problems are land management problems. Thus, agencies with programs that reach the land manager, or that affect the relationship between the State and the land manager, are key to the implementation of nonpoint source controls for agriculture, silviculture, construction, and mining.

- Various USDA programs provide not only technical assistance to individual landowners, but also a range of incentives that affect the manner in which the landowner chooses to manage the land. In addition, USDA manages significant amounts of public land. Its programs affect agricultural, silvicultural, and mining nonpoint sources.

- The Office of Surface Mining (U.S. Department of the Interior) implements SMCRA, which regulates the activities of operating and abandoned coal mines.

- The Federal Highway Administration within the U.S. Department of Transportation grants billions of dollars of Federal Highway Trust Fund monies to construct interstate and Federal highways, and conditions such grants on the application of appropriate BMPs.

The above programs are discussed in more detail in this chapter, and EPA's nonpoint-source-related programs are outlined at the end of the chapter.

Other Federal programs both affect and provide support for control of nonpoint sources. The U.S. Army Corps of Engineers, for example, conducts comprehensive watershed analysis programs that address water quality and water quantity concerns. In addition, the Corps issues permits for a variety of activities that take place in or affect navigable waters. The Tennessee Valley Authority provides technical assistance to landowners in its region. This technical assistance is directed toward a variety of purposes, including management of nonpoint sources of pollution. In addition, huge landholdings are managed by the Bureau of Land Management and the Forest Service for multiple-use purposes. Grazing, mining, and silvicultural activities may take place on these publicly owned lands. Elaborate planning processes are undertaken to ensure protection of the resource base and use of these lands for a variety of activities.

NONPOINT SOURCE PROGRAMS IN AGRICULTURE

Agricultural State Programs

Most State programs addressing agricultural nonpoint source control have recognized the need to take advantage of the existing network of Federal, State, and local agricultural agencies that routinely work directly with farmers and have already gained their trust. In many cases, the State agricultural or water quality agency has been given the authority to administer the State's nonpoint source control effort in relation to agricultural sources. Local soil and water conservation districts have been assigned a key role in the implementation of nonpoint source programs. This institutional arrangement has several strengths. First, it allows tapping an existing network of agricultural technicians capable of reaching local farmers and generating a positive response. Second, these individuals understand farming practices and are able to provide important technical assistance for the adoption and management of agricultural BMPs.

Merging Agricultural and Water Quality Programs at the State Level Has Advantages and Disadvantages

Most activities addressing the water quality aspects of agricultural nonpoint sources are part of programs having broader objectives. These include improvement of productivity, reduction of erosion, and delivery of information and education on agricultural practices. This situation offers advantages and problems. The advantages have already been described: the existence of an efficient and effective network of people and programs that has sought and gained the farmer's trust. Problems can be broadly characterized as a lack of targeting toward the achievement of priority water quality objectives and the absence of a clear definition regarding the relationship between conservation and water quality management.

Federal agricultural agencies use "T" (the rate of soil loss that allows for the maintenance of soil productivity) as a planning objective. While such goals can be complementary to water quality goals, the two are not always equivalent. Some of those lands eroding most heavily, and thus affecting productivity, do not deliver enough sediment and related pollutants to produce severe water quality problems. Conversely, other lands on which erosion is currently under "T" may be causing significant water quality problems. Differing sediment delivery rates (due to soil type, topography, and proximity to the water course) and other factors (such as nutrient delivery) cause the discrepancy. In a program managed primarily for productivity, a landowner would not continue to receive technical or financial assistance in this latter situation. Technical and financial support from agricultural agencies would flow to areas exceeding "T", directed by those institutional objectives oriented toward productivity.

Even where soils are eroding and sediment is being delivered at comparable rates from two different sites, the water quality impacts from each may be very different. The impacts will differ by the type of receiving water body, its sensitivity, and its existing condition. They will also differ in the type, volume, and toxicity of the other pollutants carried directly in the runoff water or associated with the migrating sediment. Water-quality-based decisions on the priority of controlling the nonpoint source pollution from each site are affected by the uses of the receiving water bodies as well. Agricultural agencies, on the other hand, generally have been inclined to treat eroding soils in different sites equally in terms of control priority. As a result, most agricultural cost-share programs for erosion control are distributed to farmers who volunteer their participation. USDA is beginning to target some of its resources to the most severely eroding cropland in the nation.

Targeting for soil erosion and managing for water quality are not antithetical objectives. In many instances, control of soil erosion may prevent future nonpoint-source-related water quality problems. In other instances, however, targeting for soil conservation may limit resources available to undertake needed remedial measures. In addition, as mentioned previously, targeting for soil erosion may miss some areas with relatively low erosion rates and high sediment delivery ratios.

Where local and State agricultural and water quality agencies are able to work together and integrate water quality and erosion control objectives, a combined program can be highly successful for water quality. In situations where State agricultural agencies disburse resources for erosion control purposes exclusively, the best results may not be achieved for water quality goals. Several States have adopted an approach of managing nonpoint source control on a watershed basis, rather than basing management on some other land area, or on a strictly source-specific foundation. This technique allows the effective targeting of land areas that are the most important sources of water quality problems.

State Agricultural Nonpoint Source Control Programs Are Widespread

Most State programs for control of agricultural nonpoint sources involve voluntary participation rather than regulation, and incorporate educational and technical assistance aspects. Many States now also offer financial incentives for the adoption of BMPs. Agricultural nonpoint source control

CASE EXAMPLE

A LOCAL PROGRAM: CONTROLLING AGRICULTURAL POLLUTION IN IOWA [1]

The Problem: Nutrients

Iowa has some significant erosion problems, particularly those arising from agricultural use of the land. In Shelby County, Iowa, Prairie Rose Lake has suffered severe water quality degradation as a result of excessive sediment, pesticide, and nutrient runoff from the watershed surrounding the lake. The extensive agricultural land use in the watershed has been primarily responsible for the high nutrient loads that stimulate algal growth and accelerate the lake's eutrophication. Concern developed regarding the poor condition of the man-made lake because it is an important recreational resource for west central Iowa; since 1971 alone, 10% of the usable boating and fishing area and 19% of the lake volume have been lost.

The Prairie Rose watershed has one of the highest erosion rates in Iowa, with an annual average soil loss of approximately 20 tons per acre. About 62% of the cropland has an annual soil loss rate of 30 tons per acre. The first step toward restoring the water quality of the lake was directed at reducing the erosion rate. By diminishing sediment delivery, the input of nutrients and pesticides to the lake should also be reduced.

The Approach: A Rural Clean Water Project

A Rural Clean Water Project (RCWP) was initiated on the watershed in 1980 by USDA and EPA with the objective of controlling soil erosion on 80% of the cropland area, with 75% of the landowners participating. Cost-share funds amounting to $700,000 became available through the RCWP in August 1980 for project implementation, and contracts with landowners will be developed by the Soil Conservation Service staff over a five-year period. As of October 1983, 32 of the 47 landowners approached had applied for RCWP contracts, and 28 contracts had been signed. The 28 signed contracts cover 75% of the cropland area.

The Success: Practices Have Been Implemented and Pollutant Loads Have Been Reduced

Various BMPs are being implemented in the Prairie Rose Lake RCWP for soil erosion control, pesticide management, and nutrient management. As of November 1982, conservation tillage was being employed on 560 acres, permanent vegetation had been applied to 48 acres, 50 miles of terraces had been built, eight sediment retention basins had been constructed, and 23 farms were employing both nutrient management and integrated pest management systems.

Due to the pollutant control measures applied to the watershed over the two years of RCWP implementation, a dramatic improvement in the water quality of Prairie Rose Lake has resulted. Between 1981 and 1982, a sediment delivery reduction of almost 50% occurred, along with a parallel reduction in sediment-associated pesticides and nutrients. Decreases in mean surface water turbidity of 33% and in mean bottom water turbidity of 50% have been recorded over this time period. Both algal productivity and phosphorus levels were also reduced.

programs approved under Section 208 have been established in 48 States, and 39 of these States are now involved in implementing programs. In addition, 19 States administer cost-sharing programs for the implementation of BMPs. These programs have annual budgets ranging from $10,000 to almost $8.5 million. Most of the agricultural cost-sharing programs were originally established for the purpose of controlling soil erosion. Several are now used to implement BMPs to achieve water quality goals. Two States are managing low-cost loan programs, and one State is fostering a tax credit program to promote the adoption of BMPs. Table B.1 in Appendix B provides a listing and description of State programmatic efforts. Demonstration projects have taken place in many States as a means of promoting specific management practices and usually involve the provision of technical and financial assistance to selected cooperators.

Federal Agricultural Programs

Federal agricultural programs may have a two-fold effect on water quality. First, specific commodities programs may provide incentives that lead to the adoption of agricultural cropping practices that increase the generation of nonpoint source pollutants. For example, it is widely believed that Federal policies encouraging the growing of grains in many cases provided the incentives for massive conversion to row crops, which took place during the mid-to-late 1970s.[2] Row crops foster more erosion than field crops do. (A specific examination of agricultural commodities programs is beyond the scope of this report.)

A second effect of the numerous USDA programs is more positive: the technical and financial assistance that they provide can be used to promote those agricultural BMPs that protect water quality. In most instances, water quality protection is a side effect of these programs, which usually focus on productivity and erosion control. Two examples of this type of program are described below:

- The Agricultural Conservation Program conducted by the Agricultural Stablization and Conservation Service provides up to $3,500 to individual farmers for erosion control and soil conservation measures. Funds for these purposes are distributed by local ASCS committees as widely as possible and are not routinely targeted for water quality improvement. ASCS special project funds have been used, however, to implement best management practices to achieve water quality goals in small watersheds.

- Both the Soil Conservation Service and the Agricultural Extension Service (USDA) provide technical assistance for soil and water conservation activities. Again, much of this assistance is geared toward erosion control. However, in a number of locations, local Extension Service agents and SCS staff have been active in assisting States and localities in providing technical assistance to farmers in critical water quality areas.

In a few important instances, specific programs implemented by USDA demonstrate the potential effectiveness of merging water quality and erosion control objectives. Two examples of such programs follow:

- The Model Implementation Program (MIP), operated by ASCS, demonstrated effective management practices to control runoff from agricultural activities in a few demonstration projects around the country. This program was a forerunner of the Rural Clean Water Program (RCWP) (described below) and helped provide guidance for the implementation of that program.

- The Experimental Rural Clean Water Program, conducted by ASCS, is designed to provide incentives for the implementation of agricultural BMPs to solve nonpoint source water quality problems. This program provides long-term technical and financial assistance to farmers in 21 watersheds across the country.

Table B.2 in Appendix B summarizes major Federal programs addressing agricultural nonpoint sources.

NONPOINT SOURCE PROGRAMS IN SILVICULTURE

State Silvicultural Programs

The success of regulatory versus nonregulatory State programs is largely dependent on the number and size of silvicultural operations, and on political factors. Five western States have large forestry industries with major land holdings. Industrial landowners are easier to regulate, and the cost of BMPs can be more readily absorbed by these larger entities or passed on to buyers. These States regulate a wide range of silvicultural practices through individua forest practices acts. In other areas, such as the Southeast, holdings a generally smaller. BMP costs can be difficult for landowners to absorb, and effectively enforcing regulations for numerous small landowners is politically and institutionally difficult.

Some States rely instead on "quasi-regulatory" approaches to control forest lands by employing existing sediment and erosion control laws or water quality regulations. These programs are generally effective where technical assistance, local concern, education, and adequate enforcement are present. The most important step appears to be the integration of water quality concerns into normal forest management procedures. Some States also provide incentive programs for managing silvicultural nonpoint sources. These programs commonly feature technical assistance and targeted cost sharing to facilitate achievement of water quality goals. Table B.3 in Appendix B describes State vicultural programs.

Almost all State use voluntary educational programs with or without a regulatory program. se programs are targeted to reach landowners, land managers, timber operato , and others involved in silvicultural operations. A full assessment of e effectiveness of these programs is not available. There is utility in educational programs that seek to inform landowners of the link between benefits of reducing soil loss and possible increases in productivity. Short-term benefits are not likely to be perceived by small landowners for whom BMPs are costly and for whom long-term reforestation and reharvesting are not objectives. A forestry water quality training program has been jointly developed by the U.S. Forest Service and EPA and is being used in many State educational programs.

As shown in Table B.3, ten States have no control programs and are not planning any. Most, but not all, of these States lack significant forest lands or have not identified silviculture as a nonpoint source problem, and others maintain that existing management programs are adequate for the scope of the problem.

Federal Silvicultural Programs

The Federal government owns 26% of the commercial forest land in the country. In several regions of the country (the Pacific Northwest, the Northern Rockies, and the Southern Rockies), the majority of commercial forest land is Federally owned.

Forestry programs are conducted by USDA's Forest Service. Federal silvicultural activities on government-owned lands are controlled directly by the Forest Service under its own management schemes; the conduct of private operators on these lands is regulated by timber sales contracts. Some States report on lack of cooperation in implementing water-quality-related BMPs in certain forests.[3] Often the reason given is budget limitations.

State and private forestry programs are managed cooperatively by USDA and by the States, and provide technical assistance to State and private forest managers for a variety of purposes. Table B.4 in Appendix B describes significant Federal programs that support silvicultural nonpoint source management.

NONPOINT SOURCE PROGRAMS IN MINING

State Mining Programs

Operating coal mines are regulated as a point source by the States under authorities provided by the Surface Mining Control and Reclamation Act of 1977 (SMCRA). Although existing regulations require control of erosion from haul roads, sedimentation from these roads may be a source of nonpoint pollutants when they are improperly constructed or located beyond the perimeter of the permitted area. Delays in implementing final SMCRA regulations and in issuing permanent permits mean that operating mines continue to operate under interim permits which generally do not fully regulate the discharge of pollutants contributed by mining activities.

The Office of Surface Mining of the Department of the Interior continues to collect fees for each ton of coal mined. These monies are deposited in the Abandoned Mine Land Reclamation Fund, and are directed to a variety of priorities, including public health, safety, and environmental protection.

CASE EXAMPLE

A STATE PROGRAM:
A SILVICULTURAL INDUSTRY SELF-POLICING PROGRAM IN VERMONT[4]

The Plan

In 1977, the Secretary of Vermont's Agency of Environmental Conservation (AEC) appointed the Section 208 Forestry Runoff Committee to be responsible for developing a silvicultural nonpoint source plan. The committee was to identify problems, examine research data, review adequacy of existing laws and regulations, and recommend implementable solutions for controlling nonpoint source runoff from silvicultural activities. The recommendations developed by this study became the basis of the water quality management forestry plan. The final plan recommended a strong educational approach for forest landowners and timber harvesters, together with self-policing of logging sites by the forest industry.

Putting The Plan To Work

Under the certified forestry plan, the Vermont Timber Truckers and Producers Association (VTTPA) divided the State into three sections and elected a three-member committee in each section. All complaints concerning logging-related water quality problems are referred to the State agency. If the problem is sufficiently serious, the VTTPA committee visits the logger responsible to encourage him to resolve the problems with appropriate best management practices (BMPs). The State becomes involved in onsite visits to loggers only when the logging industry's self-policing effort fails to bring about a solution.

The rigorous educational and informational approach called for in the forestry plan has been developed. There are four projects involved, including a handbook, workshops, press coverage, and model timber sale contracts.

Results

Since the program began in July 1979, the committees have met with loggers on many occasions and satisfactorily resolved water quality problems by encouraging the use of BMPs. State water resource investigators have reported a new attitude and a higher level of responsibility on the part of loggers who have been contacted. Problems encountered have been resolved quickly and efficiently.

Workshops for loggers were held to provide technical information, demonstrations, a review of legislation, and assistance in the control of nonpoint source runoff. Evaluation forms completed by workshop participants revealed a high level of acceptance and impact.

Contributing to the success of the training sessions has been the cosponsorship of programs by industrial companies, including the St. Regis Corporation and International Paper Company.

Unfortunately, not enough money is available for all priorities and funds are now being directed principally toward safety-related measures such as mine fires. Water quality does not currently receive a high priority. The fees from surface and underground mining will raise an estimated $3 billion over its 15-year legislated life.[5]

There is not an adequate inventory of the nature, extent, and effectiveness of State programs that address noncoal mining. Mining operations in this category include metals mining, sand and gravel, phosphate mining, peat mining, etc. A 1979 report from the National Academy of Sciences noted that there are significant gaps for controlling the unwanted effects of noncoal mining. Many States have reclamation laws but provide no practical power for enforcement; specifically, they lack technical requirements for the mining of noncoal minerals.[6] Abandoned metal mines remain largely unaddressed by Federal and State laws.

Federal Mining Programs

Federal programs addressing coal-related nonpoint source problems are extensive and are derived from SMCRA. Programs relating to other kinds of mining are aimed primarily at those activities that take place on Federal lands. Both the Forest Service and the Bureau of Reclamation within the Department of the Interior (DOI) have extensive nonpoint source control requirements for these activities. Numerous unrelated Federal programs address the various environmental impacts from mining activities (e.g., solid waste disposal and water pollution). Several other DOI programs provide technical and financial assistance, as well as research on mine-related water quality programs. The USDA operates a small Rural Abandoned Mine program. Table B.5 in Appendix B summarizes major Federal programs related to mining.

NONPOINT SOURCE PROGRAMS IN CONSTRUCTION

State Construction Programs

Construction nonpoint source problems are normally dealt with by regulatory, permit-supported programs that require BMP implementation and site planning aimed at construction sites. Sixteen States and the District of Columbia have enacted erosion or sedimentation control laws, and several other State legislatures are considering similar bills. Table B.6 shows the State-by-State status of construction sediment control laws. Some of these laws are weakened by long lists of sediment control exemptions for various activities. However, many State and local governments have developed engineering guidelines that address nonpoint source pollution and are incorporated in contracts for construction of public buildings and roads.

Enforcement of regulations is critical to an effective program, but is often the weakest and most expensive link in the regulatory process. Another critical element involves the cooperative efforts of State and local agencies and private developers. Agreements between different entities, defining institutional and programmatic responsibilities, must be negotiated to implement laws and regulations properly. For example, coordination between State highway agencies, which receive Federal Highway Administration (FHA) funds to aid in highway construction, and agencies charged with the enforcement of erosion control laws is essential to achieving solutions to nonpoint source problems.

A LOCAL PROGRAM:

MONTGOMERY COUNTY, MARYLAND TAKES ACTION TO CONTROL CONSTRUCTION EROSION[7]

The regulatory program in Montgomery County, Maryland is an example of a local program that has been successful in reducing sediment loads 60 to 80%. This county, part of the Washington, D.C. metropolitan area, began to study its sediment problems in 1962. It collected data on land use, climate, and pollutant parameters throughout the 1960s. Montgomery County found that strictly enforced sediment controls would reduce suspended sediments in the Anacostia River basin by 50% at a cost of $1,030 per acre. In 1971, the county was the first in the nation to enact a mandatory sediment and erosion control ordinance. It requires that sediment, erosion, and stormwater control measures meeting State and local standards be implemented in subdivisions. Permit fees support the programmatic costs. The program is enforced via authority to withdraw permits for ordinance violations and stop-work orders that can be backed up by arrest.

Federal Construction Programs

Although various soil conservation programs of the USDA (e.g., the SCS and Extension Service) may provide technical assistance for site planning and related construction BMPs (see "Federal Agricultural Programs"), there are no Federal programs directly related to construction erosion.

The Federal Highway Administration, which provides funds to State highway agencies, has a Memorandum of Understanding with EPA concerning implementation of nonpoint source controls. The FHA has erosion control standards and requires implementation of control measures. FHA field staff in every State monitor implementation. In addition, the agency conducts ongoing research to improve construction erosion BMPs.[8]

NONPOINT SOURCE PROGRAMS FOR URBAN AREAS

State Urban Runoff Programs

In general, States do not control urban runoff by designing specific programs for the source as they do for agricultural or silvicultural runoff, for example. State agencies address urban runoff as part of their overall water quality program. States also frequently provide the enabling legislation that allows local governments to use techniques such as land use controls. In most instances, implementation of controls is left to local communities, and the effectiveness of programs is limited by the amount of State and local resources available for addressing urban runoff.

Institutional issues are significant considerations in the urban nonpoint source area. Problems of financing control measures and coordinating among different jurisdictions are key concerns. Many urban areas encompass several communities, and intergovernmental cooperation is an important institutional consideration.

Regulatory programs vary from State to State according to the enabling authorities available. The burden of implementing and enforcing regulations may fall on local, county, or State agencies. In addition, several States have reported that cost-share programs are in place.[9] The programmatic approaches used by urban communities include direct expenditures for structural or nonstructural controls, educational programs aimed at implementing good housekeeping practices, and regulatory programs to enforce good housekeeping practices and the proper maintenance of structural BMPs. Local regulations are also aimed at site planning and design requirements and management of land use. Some of the greatest opportunities for control of nonpoint source pollution from urban areas are found in the developing section of these areas. A notable amount of control activity is occurring at the local level and offers the potential for effective experience and information transfer.

A LOCAL PROGRAM:

CONTROLLING URBAN RUNOFF IN BELLEVUE, WASHINGTON [10]

One of the Nationwide Urban Runoff Program (NURP) projects that is examining institutional issues and various BMPs is in Bellevue, Washington. This suburban community has grown rapidly from 5,000 in 1954 to 80,000 in 1979. Seventy percent of its 19,000 acres is developed. To address the stormwater runoff problems that accompanied this growth, Bellevue established a city Storm and Surface Water Utility in 1974. The utility provides an organizational structure different from most public works departments and has proven to be an efficient enforcement and finance mechanism. Residential utility service charges, averaging $1.60 bimonthly, generate about $600,000 annually, an amount which just meets the costs of the utility. Erosion and sediment controls are required for construction sites as is post-development runoff management, including operation and maintenance requirements for permanent controls. Major drainage system improvements, such as storage/detention basins, channel lining and cleaning, and stormwater drains, are included in a drainage master plan. The costs for the master plan improvements average $1,000 per acre.

The two major impediments to instituting effective nonpoint source control programs are (1) problem identification and (2) the cost and difficulty of implementing BMPs, especially in established urban areas. In addition, the technical complexity of clearly establishing impacts on designated uses has made it difficult to agree on the appropriate level of financing for addressing the urban nonpoint source problem. It is difficult to persuade a community to burden itself with runoff controls when the consequences are imprecisely known, not immediately evident, or occur downstream.

Federal Urban Runoff Programs

The Nationwide Urban Runoff Program was established by EPA primarily to examine urban nonpoint source pollutant loadings and the effectiveness and costs of various management practices. Twenty-eight urban areas from different parts of the country (representing different climates, geographic areas, and hydrologic regimes) were selected for intensive study of the urban nonpoint source problem and associated control measures. The NURP projects were selected from among Section 208 projects and were designed to facilitate information transfer among the individual projects and with other urban areas across the county. The major findings of NURP are in the process of being summarized and will be released in final form in a final report now anticipated for release by July 1984. The data base provided by NURP is computerized on EPA's STORET system and will provide a source of additional insights for years to come.

PROGRAMS OF THE ENVIRONMENTAL PROTECTION AGENCY

The responsibilities of the EPA cut across nonpoint source categories and are directed toward the cleanup of any sources of pollutants that impede the achievement of water quality goals. Nonetheless, drafters of the Clean Water Act (CWA) recognized that control problems presented by nonpoint sources of pollution are inherently different from those posed by point sources, and that appropriate nonpoint source controls could only be implemented after careful planning and consideration of a variety of factors that can only be examined on a case-by-case basis at a very localized level. Sections 208 and 303 establish a planning and implementation framework that encourages integrated problem assessment and a comprehensive water quality management program within States. Section 208 of the CWA provided funds to States and areawide agencies to analyze the extent of nonpoint-source-related water quality problems and to develop implementation strategies for addressing these problems.

The Section 208-funded water quality management planning effort was largely completed by FY'81. EPA approved 213 water quality management plans generated by State and areawide agencies. The review of State programs incorporated in this report suggests that a number of States have developed varying levels of nonpoint source control programs as a direct result of Section 208 activity.

EPA has continued to support the States in their development of nonpoint source control programs through other funded sections of the CWA. Sections 106 and 205(j) have provided basic direction and support for State nonpoint source activities. While Section 205(g) funds are also eligible for nonpoint source activities, they are not in widespread use due to high demand to address point source program needs. These programs are summarized in Table 3.2.

In addition, EPA continues to support a variety of experimental and research-oriented programs, the results of which will provide technical

TABLE 3.2 EPA'S MAJOR NONPOINT-SOURCE-RELATED PROGRAMS

PROGRAM NAME	BASIC PURPOSE	RELATIONSHIP TO NPS CONTROL	CURRENT ACTIVITIES
WATER QUALITY PLANNING AND MANAGEMENT			
106	• Basic water quality program support. • Provision of grants to assist States and interstate agencies in establishing and maintaining adequate measures (other than the construction, operation, and maintenance of waste treatment plants) for prevention and control of water pollution.	Can be utilized to support State planning and implementation activities for nonpoint sources.	Activities funded include management of State pollution control programs. Control of nonpoint sources is a 106 program grant priority in FY 1984.
208			
Areawide Planning	Designated agencies were to develop and operate a continuing planning process for areawide waste treatment management. Federal grants provided.	• The principal nonpoint source control section of the Clean Water Act. • Provided financial assistance to State and areawide (Regional) agencies to identify nonpoint source problems and develop control strategies between 1974 and 1981.	• Over 200 water quality management plans completed and approved by FY 1981. • Appropriation of 208 planning related funds discontinued in FY 1980. • Since 1980, State updates of plans and implementation of ongoing activities have utilized State funds, 205(j) funds and 106 funds respectively.
Nationwide Urban Runoff Program	To provide credible information upon which to base policy decisions regarding Federal, State, and local involvement with urban stormwater runoff and its control. The principal focus of the NURP program has been identification of pollutant loadings from various urban environments and evaluation of the effectiveness of alternative control techniques.	Urban runoff is considered to be a significant nonpoint source of pollution. The NURP program was an offshoot of the 208 nonpoint source program. Twenty-eight projects were selected for the NURP program from urban 208 projects.	The 28 planning projects supported by NURP are essentially completed except for completion of final reports. The final NURP report is expected to be published in early 1984; a draft of this report was published in September, 1983.

TABLE 3.2 EPA'S MAJOR NONPOINT-SOURCE RELATED-PROGRAMS (CONTINUED)

PROGRAM NAME	BASIC PURPOSE	RELATIONSHIP TO NPS CONTROL	CURRENT ACTIVITIES
WATER QUALITY PLANNING AND MANAGEMENT (continued)			
205(j)	Provision of grants for water quality management planning designed to provide water quality protection beyond that already achieved or expected to be achieved by the imposition of technology-based controls. Activities funded under 205(j) should focus on priority water bodies where designated uses are not being met.	Water quality management planning activities funded under 205(j) include (but are not limited to): • identification of the nature extent and causes of water quality problems (including nonpoint sources) • identification of cost effective and locally acceptable nonpoint measures to meet and maintain water quality standards • determination of the relative contributions to water quality of point and nonpoint sources.	The top five tasks funded by 205(j) are: • water quality standards work • monitoring • groundwater • total maximum daily loads/waste load allocations • nonpoint source planning and coordination
Continuing Planning Process (303)	• Provides the basic authority of the CWA for establishment of State and interstate water quality standards. • Provides for an integrated framework for all water quality management planning programs. Section 303 provisions require that State agencies update and integrate all water quality management plans and establish priorities.	This program provides the central integrating mechanisms by which the State establishes its priorities for both point and nonpoint source controls.	Proposed rule changes will further integrate the basic components of the water quality management planning process and will focus State attention on the role of nonpoint sources in restoring or enhancing uses.
GREAT LAKES PROGRAM	To demonstrate new methods and techniques and to develop preliminary plans for the elimination or control of pollution within all or any part of the watersheds of the Great Lakes.	Demonstration projects are directed toward measures to control nonpoint sources of pollution, including urban runoff and rural runoff.	Section 108 (CWA) demonstration programs have studied the cause/effect relationship of various nonpoint source problems, and have demonstrated the effectiveness of a variety of nonpoint source control techniques. Recent projects have assisted local and State governments in technology transfer and integrating USDA resources to accelerate adoption of tillage practices supportive of phosphorus reductions called for in U.S. Canada water quality agreement.

TABLE 3.2 EPA'S MAJOR NONPOINT-SOURCE-RELATED PROGRAMS (CONTINUED)

PROGRAM NAME	BASIC PURPOSE	RELATIONSHIP TO NPS CONTROL	CURRENT ACTIVITIES
CLEAN LAKES PROGRAM	Provision of grants to States for the identification and classification, according to trophic conditions, of all publicly owned fresh water lakes, and the establishment and implementation of methods to control pollution sources and restore the quality of such lakes.	The Clean Lakes Program is an Agency program which can be used to cost-share with States for implementation of nonpoint source controls. A large portion of the program's attention has focused on nonpoint controls; funds are provided for a variety of watershed protection measures as well as for direct lake restoration.	Funding is provided for use in completing existing projects.
CHESAPEAKE BAY PROGRAM	To define the ecological conditions and water quality management needs of the Chesapeake Bay, and to evaluate the effectiveness of alternative pollutant controls on point and diffuse sources discharging to the Chesapeake drainage system.	The ecosystem approach of this program ensured that nonpoint as well as point sources would be examined. Relative loadings from point and nonpoint sources were identified, and the program's data base was designed to serve as a tool for targeting pollution controls for nonpoint sources as well as point discharges.	EPA has completed its Congressionally-mandated activities. The program is currently in transition from research and analysis to State determination of the actions to be taken.
DILLON RESERVOIR	A demonstration project designed to evaluate the cost-effectiveness of possible tradeoffs between point and nonpoint sources.	The Dillon Nonpoint Source Demonstration Project in Northwest Colorado analyzed the economic and technical viability of allowing four municipal treatment plants to forego improvements in exchange for implementation of nonpoint source controls in the Dillon Watershed.	Special Study

assistance to the States in implementing nonpoint source controls. One example is NURP, discussed above. This program investigated urban runoff problems and alternative control measures in 28 cities around the country. Methodologies developed by NURP will facilitate the transferability of NURP findings to other areas without the need for intensive data gathering efforts.

A second example is the Dillon Nonpoint Source Control Demonstration Project discussed in more detail in the following "Case Examples." The purpose of this project is to examine the efficacy of tradeoffs between point source and nonpoint source controls. An ongoing effort of the Northwest Colorado Council of Governments, with the assistance of the Colorado Department of Health and the U.S. EPA, this project estimated substantial cost savings from the implementation of a phosphorus control strategy that relies on nonpoint source controls rather than additional point source controls.

CASE EXAMPLES:
EPA-SUPPORTED NONPOINT SOURCE CONTROL EFFORTS

DILLON RESERVOIR: AN EXPERIMENT IN TRADING POINT AND NONPOINT SOURCE CONTROL MEASURES[11]

Dillon Reservoir is located in the Rocky Mountains about 100 miles from Denver. It is both a significant source of Denver's water supply and a location of a variety of recreational activities. In recent years, burgeoning vacation and permanent home development has led to water quality problems related to excessive algal production. The source of nutrient enrichment has been identified as phosphorus. Although phosphorus loadings are low in comparison to normal standards, algal growth in the Lake is particularly sensitive to the amount of phosphorus available.

The Dillon Reservoir project is an experimental project that analyzed nonpoint source control as an option for reducing phosphorus loadings to the reservoir. Four wastewater treatment plants have already achieved high levels of phosphorus reduction, and analysis showed that 72% of Dillon's total phosphorus load now comes from nonpoint sources. A tradeoff analysis was performed that compared the cost and removal efficiencies of additional wastewater treatment plant controls versus control of nonpoint source runoff.

The tradeoff analysis found that imposition of nonpoint source controls for phosphorus reduction, in place of additional point source controls, would provide considerable cost savings. Even if the effectiveness of nonpoint source controls is more limited than initially estimated, cost savings will remain substantial. The Northern Colorado Council of Governments is now proposing the use of point/nonpoint tradeoffs to meet new wasteload allocation requirements in Dillon Reservoir.

EPA CLEAN LAKES PROGRAM: LAKE RESTORATION IN COBBOSSEE WATERSHED[12]

The Cobbossee watershed drains 217 square miles in the State of Maine and contains 28 lakes, three of which are eutrophic due to phosphorus loadings from point and nonpoint sources. Despite the progress made from point source controls, additional controls were deemed necessary to restore lake water quality. The Clean Lakes Program (under Section 314 of the Clean Water Act) provided the funds for restoration of these lakes, a project that included alum treatment of one lake and implementation of agricultural nonpoint source controls in the watershed of all three lakes. Once considered one of the most polluted lakes in the State of Maine, Annabessacook Lake has undergone a 45% reduction in its total phosphorus level between 1975 and 1980. Significant water clarity improvements have already been documented for Annabessacook Lake, and further water quality improvements in all three lakes will continue to be carefully monitored.

CHAPTER 3: NOTES

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CHAPTER 4

Looking Ahead: Managing Nonpoint Sources

INTRODUCTION

In Chapter 1, we examined the nature and extent of nonpoint source problems nationwide. Chapter 2 discussed these problems at greater length within five source categories (agriculture, silviculture, mining, construction, and urban runoff) and mentioned that many management practices exist which can reduce nonpoint source pollutant runoff. A great number of these practices can be implemented with minimal difficulty and cost. Chapter 3 discussed the fact that many States now have programs underway that seek to address nonpoint source pollution problems, and the various Federal programs that provide technical assistance and support for nonpoint source programs at the State and local levels.

Chapter 4 seeks to outline the important components of a State program designed to manage nonpoint sources of pollution. As our technical understanding of nonpoint source pollution has grown, several gaps in our management of nonpoint sources have been identified. In most cases, these gaps are related to institutional and management issues rather than a lack of understanding about the causes of and solutions to the nonpoint source problem. For this reason, Chapter 4 primarily addresses the institutional and management considerations of a successful State nonpoint source control program.

WATER QUALITY MUST BE SYSTEMATICALLY MANAGED AT THE STATE LEVEL

State management of nonpoint source control programs is the key to achieving water quality objectives. As the central manager of the water quality program, the State must establish where water quality problems exist from both point and nonpoint source pollution, and determine which water quality problems will receive its priority attention. It is at the State level that comprehensive strategies can be adopted, progress toward achievement of objectives can be monitored, and necessary adjustments for a more effective strategy can be made.

For several reasons, dynamic leadership and management is vital to forging an effective nonpoint source control program. First, in many watersheds, implementing the voluntarily adopted best management practices (BMPs) may have no discernible impact on water quality unless the new approaches are targeted at critical land parcels from which nonpoint source pollutants are coming. Second, even when adoption of BMPs is within the means and economic interest of the landowner, education and training may be necessary to provide both the incentives and technical knowledge that will foster implementation of controls. Finally, the adoption of control measures for certain nonpoint sources will often remain beyond the economic interest of the landowner. In these instances, the adoption of BMPs may require regulatory action, the use of more powerful incentives, or both.

As has been discussed earlier, State programs that rely solely on voluntary adoption of BMPs by landowners will not always achieve significant improvements in water quality. Results require carefully managed implementation of a carefully designed program. Key elements of an effective State nonpoint source program involve:

- A sound management approach, headed by a responsible agency that can oversee implementation of the strategy(ies) and be held accountable for results;
- Careful targeting of nonpoint source controls, including site-specific selection and application of the BMPs that serve as these controls;
- Design of appropriate strategies to implement control measures; and
- Effective institutional arrangements for enforcement and delivery of appropriate assistance.

KEY COMPONENTS OF SUCCESSFUL STATE PROGRAMS: HIGH PAYOFF, CORRECT STRATEGY, AND COOPERATION

Nonpoint source control programs are being implemented in many States. However, in many cases, these programs do not take all aspects of the problem into account. More effective design of State strategies can go a long way toward gaining control over nonpoint sources of pollution. The key components of a successful State nonpoint source program are discussed briefly in the sections that follow.

Nonpoint Source Controls Must Be Targeted for High Payoff

When developing a high-payoff program to combat pollution from nonpoint sources, it is vital to aim the control strategy and supporting resources at those watersheds--and the land areas within them--where pollutants are most likely to be effectively and efficiently controlled. As was discussed in Chapter 2, this targeting has four basic aspects:

1. **Determine the priority water bodies within the State for which the source of the existing or potential water quality problem is "nonpoint."**

   The principal consideration is whether an existing or potential impairment of use is caused by nonpoint sources, point sources, or natural background levels.

2. **Of those priority water bodies identified in (1), decide which ones should receive concentrated attention.**

As was discussed in Chapter 2, issues of practicality (e.g., the availability of control techniques, local community interest or concern, and landowner cooperation) as well as consideration of relative water quality values within the State will affect the answer to this question.

3. **Establish which land-use activities within the watershed are responsible for delivering pollutants to the water body.**

4. **Design a system of BMPs that will best control the delivery of pollutants to the water bodies in the watershed.**

The first two targeting mechanisms identify the water bodies toward which efforts should be directed. The last two fine-tune the control approach, maximizing its payoff by focusing on the most effective controls and on the specific locations and activities at which they should be aimed. The outcome of these determinations will lay a good foundation for the institutional framework chosen for management of the program.

Two issues that have received inadequate attention in nonpoint source control programs should be carefully considered in future planning. These issues are (1) the need for nonpoint source water quality benchmarks and (2) ground water contamination by nonpoint source activities. These are discussed in more detail below.

Support Management with Water Quality Indicators Targeted to Nonpoint Source Controls

Before judgments can be made about the severity of a particular nonpoint source pollution problem, quantitative tools for assessing the problem must be available. Traditionally, numerical criteria have been used as benchmarks against which water quality problems can be managed and assessed. (Examples of these criteria are 5 mg/l for dissolved oxygen and 250 mg/l for chlorides and sulfates.) However, these tools are largely unsuited for managing nonpoint sources, as they are designed to protect water quality from point source impacts during low-flow conditions. Indicators should be established that address water quality problems related to the high-flow conditions that accompany nonpoint source pollution. This work calls for development of a different perspective on quantification of water pollution, and involves both complex and fundamental problems. For example, the flow conditions under which pollutants are mobilized from nonpoint sources are too variable to support the development of single-parameter criteria.

Nevertheless, benchmarks are necessary, and where they are lacking, management difficulties result. Identification of water quality problems cannot rely solely on violations of specific pollutant levels in ambient water. EPA is currently emphasizing the development of biological measures to support use designations and to encourage biological monitoring. Adoption of these biological measures by State agencies should help address the difficulties in nonpoint source problem identification.

In addition, analytical methodologies utilizing statistical approaches developed in the course of the Nationwide Urban Runoff Program (NURP) improve our ability to accurately estimate nonpoint source pollutant loadings that result from intermittent and highly variable nonpoint source pollution events.

Consider Ground Water in Identifying Priorities

State programs should consider ground water when identifying priority nonpoint source water quality problems. Most States traditionally have focused on the quality of surface waters in their pollution abatement programs. Ground water quality protection programs are in various stages of development in many States. Ground water monitoring is generally not conducted unless a specific problem has been identified. Yet there is increasing evidence that ground water can be--and, in many cases, is being--severely affected by land management practices. A carefully targeted nonpoint source control program should consider ground water as well as surface water problems. In some instances, the priority water body may be an underground aquifer.

An Effective Program Hinges on States Selecting the Right Strategy

States have access to a variety of approaches that can be used to encourage BMP implementation. These strategies include education, training, financial incentives, and regulation, alone or in combination. The selection of appropriate strategies depends upon the nature of the nonpoint source problem being tackled, the BMPs available to address that problem, and a variety of institutional considerations.

The choice of strategy often depends upon who receives the benefits from BMP implementation and the time frame over which those benefits are realized. The benefits of BMPs may or may not be immediately apparent to landowners. Where the BMPs used to control nonpoint sources have obvious short-term advantages for the landowner being asked to implement them, training programs to teach new management practices may constitute an appropriate and effective strategy. For example, better management of fertilizer usage on farmlands is a BMP for agricultural nutrient control that has short-term economic benefits to the farmer.

In other instances, direct benefits to the landowner may be delayed, or do not occur at all, and implementation of BMPs through education and training alone may not be successful. In such cases, financial incentives may be warranted. Financial or market incentives (e.g., low-interest loans, tax incentives, cost sharing, and trading) can often bridge the incentive gap associated with BMP implementation. In situations where benefits accrue not to the individual landowner, but rather to society at large, cost sharing and cash payments may be necessary. Risk-sharing, in the form of State equipment loan programs or insurance programs, has potential for cost-effectively controlling nonpoint sources of pollution. Trading of pollution control requirements between point and nonpoint sources is another approach which, in one instance, is proving to be cost effective.[1]

WISCONSIN STATE PROGRAM[2]

Nonpoint Source Water Quality Problems Are A Significant Concern

As a result of the implementation of long-standing control programs for point sources in Wisconsin, the major remaining water quality problems in the State are primarily due to nonpoint sources of pollution. Nonpoint sources are suspected of impairing designated uses in nearly every lake and stream in the southern two-thirds of the State. The affected area includes approximately 130 of the total 330 watersheds found in Wisconsin, including a large number of trout and bass streams and deep, high quality lakes, many of which are valued as recreational and commercial resources. The major nonpoint source problems are animal wastes, cropland erosion, woodland grazing by livestock, construction activities, and urban runoff.

Intergovernmental Cooperation and Clear Management Responsibility Are Key

The Wisconsin Department of Natural Resources (DNR) has overall responsibility for administration of the nonpoint source control program and disburses cost-sharing and local assistance funds for implementation of the program. The Wisconsin program relies heavily on a cooperative arrangement with Statewide and local agricultural agencies. The water quality agency (the DNR) has clear implementation and management responsibility for the program. A State nonpoint source coordinating committee plays a significant role in the selection of priority watersheds. Membership on this committee includes representatives of Federal, State, and local governments. With the help of the committee, the DNR selects priority projects and develops detailed watershed implementation plans.

Local implementation of watershed plans takes place through a Designated Management Agency (DMA)--usually the local Land Conservation Committee. Soil Conservation Service staff and Extension Agents provide additional technical support and assistance to local farmers. Specifically, these staff provide technical assistance to landowers for the design and implementation of BMPs.

Targeting Critical Areas Ensures a High Payoff

An underlying concept of the nonpoint source control program in Wisconsin is the concentration of available financial and technical resources on critical areas which will maximize the water quality benefits of the investment. Priority projects of two types are targeted by the program--priority watershed projects and local priority projects. Priority watershed projects are hydrologic units in which nonpoint source problems occur over large areas (on the order of 100,000 acres) and major portions of the watershed require implementation of BMPs. Those areas within the watershed that contain the most significant sources are identified as priority management areas, and are the only areas eligible for cost sharing. The DMA negotiates cost-sharing agreements for BMP implementation that require implementation and installation within five years. Cost-sharing rates vary from 50 to 70% per BMP, with no limitation on maximum amounts except for animal waste storage facilities. Supplemental county funds may raise the cost-sharing rate to as much as 90% on certain practices. Currently there are 19 ongoing priority watershed projects, and typical projects follow an 8- to 9-year progression from initial selection to completion of BMP implementation.

Local priority projects are for smaller areas, typically less than 6,400 acres, and address nonpoint source problem areas that do not require a total watershed approach. Many individual lakes and streams can be protected in this way. Between 1979 and 1980, 27 local priority projects were funded, 24 of which are already complete. Local priority projects are selected by the State from applications submitted by the DMA's. Cost-sharing agreements are signed by project participants, and implementation generally occurs within 2 years.

Preliminary Results Show Program is Meeting Water Quality Goals

Nonpoint sources are a significant water quality problem in Wisconsin, and, in response, the State has developed a very innovative program to address this problem. A recent evaluation of the program concludes that "the priority watershed project approach has proven to be a very effective way to integrate land management and water resource programs."[3] This evaluation was based on a preliminary assessment of the program's achievements in two priority watersheds--the Elk and Hay River Priority Watershed Projects. Specifically, preliminary results in the two watersheds show that approximately 70% of the pollutants associated with barnyard runoff will be brought under control. In addition, the evaluation reports that significant water quality improvements have been achieved in the Hay River Priority Watershed Project.[4]

Implementation Takes Time

Wisconsin's recent program evaluation clearly illustrates that it takes time to implement nonpoint source controls and to evaluate their effects. It was only possible for Wisconsin to do this preliminary evaluation 5 years after the initiation of the two watershed projects.[5] A number of time-consuming steps must be completed for all priority watershed projects. The key steps include: project selection, an assessment of the watershed and development of a detailed implementation plan, development of cost-sharing agreements with landowners for BMPs, and, finally, the installation of BMPs. Evaluation of the Hay and Elk River Priority Watershed Projects is possible because these projects are at the stage of having completed cost-sharing agreements with landowners. Many of the landowers are, in fact, in the process of installing BMPs.[6] Although implementation takes time, preliminary results in the Hay and Elk River Priority Watersheds indicate that the control efforts will result in some water quality improvements.

In instances where financial incentive programs, risk-sharing, and educational activities are neither sufficient nor appropriate tools for BMP implementation, it may be necessary to construct a regulatory program. The efficacy of a regulatory approach depends upon a variety of factors, including considerations of social equity, the ability of the landowner to absorb costs, and the enforcement capability of the State program. An example of a regulatory program is represented by the attempts of State and local governments to prevent construction erosion. When this regulation is applied consistently through a permit program, all developers and builders are treated equally, and costs are passed on to the consumer. However, when considering the application of a regulatory strategy for agricultural activities, policy-makers must recognize that it is likely that the farmer both operates on a lower profit margin and is less able to pass additional costs on to the consumer. In addition, it is difficult to conceive of an appropriate enforcement mechanism.

More specific issues regarding the choice of strategy for particular nonpoint source categories are discussed in the following sections.

Agriculture: Current Educational and Training Programs Are Not Always Enough

While most State programs to control agricultural nonpoint source pollution are largely voluntary in nature, it is clear that educational and voluntary programs may not do the whole job. A significant percentage (estimates are as high as 50%) of the agriculture-related sediment pollution can be controlled by conservation tillage which provides direct benefits to the farmer by keeping topsoil on the land. Even adoption of that practice, however, may require both technical assistance and a capital investment beyond the short-term capability (or economic interest) of the individual farmer. The more costly BMPs that cannot demonstrate significant direct benefits to the individual farmer (such as feedlot improvements and exclusion of livestock from streambanks) may require a different approach--e.g., financial incentives or regulation--in order to be adopted.

Conservation Tillage Practices: Apply with Care

Those BMPs known as "conservation tillage" practices have been shown to be highly effective in reducing erosion from farmland. However, they require that farmers manage their land in a very careful manner. Many experts feel that management training is necessary to implement conservation tillage successfully. Several of them have raised questions as to whether or not landowners initiating conservation tillage practices on their own may unwittingly contribute to environmental problems associated with pesticides and nutrients.

There are specific reasons for applying conservation tillage strategies with care. First, these practices are associated with increased amounts of herbicide use. A verdict has not yet been reached on whether BMPs such as no-till practices reduce runoff sufficiently to prevent increased herbicide loadings in surface water as a result of the increased herbicide use. Second, because conservation tillage techniques work by holding water (and soil) on the land, experts question whether or not these practices will increase nitrate levels in ground water. Because of these concerns, Wisconsin, for example, will not encourage the use of no-till practices, although it does promote a variety of other conservation tillage techniques. The extent of current and projected shifts to conservation tillage practices warrants a monitoring of side effects by State agencies.

Silviculture: A Greater Focus Is Needed on the Small Woodlot Owner

Water quality problems caused by silvicultural practices of the small non-industrial woodlot owner are not adequately addressed by many State programs. The strongest nonpoint source regulatory and quasi-regulatory programs exist in the Northwest, where industrial forestry landholdings are largest. The Southeast, where much of the growth in forestry production is taking place, relies on voluntary programs. This area is characterized by small landowners for which BMP implementation may reduce the immediate cash return on a harvest. Although there are a few silvicultural-related incentive programs (e.g., cost sharing) that address the financial needs of the small landowner, they are small and do not assist many landowners.

Training and educational programs for landowners and contract loggers have been demonstrated to increase adoption of BMPs. Additional research and monitoring on the productivity benefits and actual net costs of BMP application are required to provide foresters with additional information in the effort to promote BMP adoption.

Mining: Correction of Water Pollution from Abandoned Mines Remains a Difficult Control Issue

Some of the most severe sedimentation and toxic nonpoint source water quality problems are caused by abandoned surface and deep coal and metal mines.* The leaching of acids, heavy metals, and radioactive material from abandoned mines can severely degrade water quality and, in some instances, render affected water bodies biologically dead. It is generally less costly to address problems associated with sediment and erosion from surface sites than to combat acid mine drainage from deep mines or surface mines.

Proper site planning of operating mines is the key to preventing serious new water quality problems from mining activities. The cleanup of abandoned mines is often made more technically difficult by poorly designed mining operations in the past. Cleanup is complicated because former owners may be difficult to identify and liability hard to establish. In general, State strategies for addressing nonpoint source problems from abandoned mines should involve targeting the greatest opportunities for abatement of water quality problems, establishing authority to seek legal remedies against former owners, and providing technical assistance and money for cleanup.

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*Operating mines are considered to be a point source of pollution and are controlled through NPDES permits. An analysis of water quality problems associated with operating mines is beyond the scope of this report.

Construction: Public Building Projects May Present a Different Challenge

Implementation of construction BMPs is rarely considered to be in the economic interest of an individual builder. Therefore, there is widespread agreement that a regulatory approach to the control of nonpoint source pollutants from private construction sites might be necessary.

Sixteen States and the District of Columbia have sediment control laws covering a variety of construction activities. The remaining States--including some of the fastest growing ones--do not directly address erosion (and resulting sedimentation) from this source. Many of the existing State laws have exemptions for various construction activities. State and local engineering guidelines may fill gaps in State laws, but the degree to which they do so is varied.

Public construction projects may remain a source of concern even where sediment and erosion control laws are in place. Highways are the largest single source of construction erosion. The Federal Highway Administration monitors implementation of BMPs in Federally assisted highway construction, and State and local governments monitor projects constructed solely with State and local funds. Requirements for BMP application are typically made part of highway construction contracts. The effectiveness of this management approach varies from State to State and largely depends on State enforcement mechanisms. The fact remains that highway construction is still a significant source of sedimentation in some areas. Local road building is often unregulated, and can cause significant localized problems in the absence of Statewide sediment control laws.

Urban Runoff: Old and New Urban Areas Require Different Treatment

Urban runoff programs are generally considered to be a municipal responsibility. The efficacy of programs in older, highly developed sections of cities is limited by the expense and difficulty of implementing effective BMPs in these areas. Indeed, in most parts of the country, the expense and difficulty of implementing controls in built-up areas will always preclude effective "structural" actions. Certain techniques such as street sweeping or leaf pickup are applied in many such areas, but have limited effectiveness. Developing urban areas offer the greatest opportunities for addressing urban runoff problems through land use regulation and development planning. The great expanses of impermeable surface that promote runoff can be reduced by appropriate land use and stormwater management planning. Retention and/or detention basins can be incorporated into site preparation at relatively modest cost to reduce both runoff volumes and pollutant loadings. Land use and development planning is a local prerogative, however, and implementation of programs to reduce runoff in developing areas varies widely. Where developing areas address urban runoff in their land use and site planning at present, primary emphasis is upon preventing drainage and associated flooding problems. However, future approaches to urban runoff control can and should integrate both drainage and water quality objectives.

Cooperation Between the Water Quality Agency and the Operating Agency is Important

Regardless of the basic nature of the nonpoint source control program, effective implementation and enforcement of that program will require significant commitments by the States. Education and training of individual landowners and operators is an important component of regulatory programs as well as programs relying on voluntary implementation of BMPs. Because certain existing State and Federal programs regularly provide technical assistance and support to individual landowners and operators who may be the generators of nonpoint source pollutants, there is widespread agreement that involvement of Federal and State soil conservation, agricultural, and forestry programs is key to implementing nonpoint source control strategies.

As we have discussed, the differing missions of these agencies can lead to a lack of focus on water quality objectives. Effective management of nonpoint sources will require cooperative efforts between the water quality agency and the operating agency that routinely reaches the landowner. Respective roles in this cooperative arrangement might include:

- Gubernatorial designation of the lead agency responsible for implementation of a nonpoint source control program.
- State passage of the necessary legislative authority to implement the program.
- State water quality agency identification of priority water bodies needing nonpoint source controls.
- An inventory of land management activities likely to be a source of nonpoint pollutants conducted by the appropriate operating agency (e.g., USDA's Soil Conservation Service or the local soil and water conservation district).
- A watershed-based analysis and identification of the priority land management practices that must be controlled to manage nonpoint source pollutants performed by the water quality resource agency.
- Technical assistance at the field level provided by staff of the operating agency to assist in the identification, selection, and implementation of appropriate BMPs to address the nonpoint source problems.
- Education provided by the operating agency which is directed toward critical landowners and the general public to increase awareness of the need for and the benefits of controlling nonpoint source pollution.

Finally, cooperati arrangements with operating agencies can maximize the utility of the lim ted amounts of technical and financial assistance these agencies provide tc landowners: where possible, BMPs that satisfy the goals of the operating agency can be dovetailed with those that would promote water

CASE EXAMPLE: COOPERATIVE EFFORT TO REDUCE PHOSPHORUS LOADINGS TO LAKE ERIE [7]

THE PROBLEM

Lake Erie has received a great deal of attention since the late 1960s because of problems with accelerated eutrophication of its waters. As of the early 1970s, the primary cause of accelerated eutrophication was determined to be excessive phosphorus loadings. After additional study, the Western Basin of Lake Erie was identified as a significant source of these phosphorus loadings.

A COOPERATIVE EFFORT TO ADDRESS THE PROBLEM

The Tri-State Tillage Project is a cooperative effort to control the agricultural nonpoint sources which contribute to eutrophication of Lake Erie, and is being undertaken by a variety of agencies at the Federal, State, and local levels. The project is being conducted for the U.S. EPA Great Lakes National Program Office by numerous soil and water conservation districts, and is being coordinated through the National Association of Conservation Districts.

Soil and water conservation districts in Indiana and Michigan and two counties in Ohio have received grants directly from EPA under the Great Lakes (Section 108) Program. The Ohio Department of Natural Resources (Division of Soil and Water Districts) has received a grant for the remainder of the Ohio districts and has entered into subcontracts with them for implementing projects within their jurisdictions. A total of 31 districts have received funds for conservation tillage projects.

The primary objective of these projects is to provide interested farmers with no-till and ridge-till planting equipment for use on 10- to 20-acre demonstration plots on their farms. Technical assistance is also provided to these farmers by the Soil Conservation Service and Extension Service. In addition, cost-sharing incentives are available to farmers in some counties through the Agricultural Stabilization and Conservation Service. The goal of this effort is to have 20 to 40 farms with 3-year demonstration projects using the no-till or ridge-till system in each participating district.

RESULTS TO DATE

After little over one year of implementation, a total of 902 demonstration plots covering 11,379 acres in 18 counties were established. Preliminary data indicate that yields on no-till plots were better than or equivalent to yields on plots employing conventional tillage. As a result of the Tri-State Tillage Project, the adoption of conservation tillage practices will be accelerated and, consequently, phosphorus loadings to Lake Erie will be reduced.

quality through nonpoint source pollution control. For example, the U.S. Department of Agriculture's Agricultural Conservation Program (ACP) will provide up to $3,500 in matching funds for the implementation of conservation practices. If these funds are targeted to priority water quality problems, they can encourage the adoption of BMPs for effective nonpoint source controls and result in "high-payoff" water quality improvements.

FEDERAL NONPOINT SOURCE PROGRAMS PROVIDE IMPORTANT ASSISTANCE TO STATE PROGRAMS

Several Federal agencies address the nonpoint source pollution problem because they (1) have complementary programs in place, (2) have developed effective outreach mechansims, (3) manage activities on Federal lands, (4) have undertaken mandates which require that they address the problem, or (5) have technical expertise available. EPA, for example charged with the responsibility for protecting water quality, provides overview of State agencies that are developing programs to ameliorate nonpoint source pollution problems. Other Federal agencies have extensive outreach capabilities. For example, USDA has an extremely effective network of services and programs at the local level. These services reach out to local farmers and landowners with technical and financial assistance programs that can provide the necessary support for implementing nonpoint source control strategies.

Federal Programs Reflect Agency Priorities

The ability of different Federal agencies to support State nonpoint source control efforts depends upon the nature of their primary mission. Programs run by USDA and other Federal agencies with nonpoint-source-related programs often do not address water quality issues as the top priority problems. As is appropriate to its own mandate, USDA stresses erosion control and maintenance of land productivity. Some brief sketches of Federal programs that address the nonpoint source pollution problem in some way follow.

- USDA's National Conservation Program (which provides overall direction for USDA's soil conservation activities) makes water quality a component of erosion control. However, the agricultural priorities of erosion control and maintenance of productivity, rather than water quality, receive the major emphasis.

- The Abandoned Mines Fund operated by the Office of Surface Mining does not accord water quality a high priority for targeting reclamation efforts. Few projects targeted for cleanup efforts receive attention primarily due to their water quality impacts.

- In implementing a Memorandum of Understanding with EPA, the Department of Transportation's Federal Highway Administration delegates the responsibility for managing highway-generated sediment to the States. The FHA, however, is responsible for monitoring State activities, and grants are generally conditioned on the implementation of nonpoint source controls.

- The U.S. Forest Service (USDA) provides technical assistance and support to State forestry agencies through its State and Private Forestry Program. In addition, the Forest Service is itself a manager of vast amounts of commercial forest land. Forest Service efforts are not normally directed toward water quality as a top priority.

EPA is Developing a Coherent Policy on Nonpoint Source Pollution

EPA's nonpoint source control programs have, in the past, focused on providing guidance and financial assistance to States and areawide (regional) agencies as they developed the necessary plans to manage nonpoint sources. After completion of the initial water quality management planning process in 1981, the States began to implement nonpoint source management programs. Current EPA efforts focus on information transfer between and among States and localities.

Recent reports from EPA Regions and the States, however, have identified nonpoint sources as a significant water quality concern. EPA has identified nonpoint source issues as one of its priorities, and is in the process of developing a nonpoint source policy to guide the States' efforts. Among other things, this policy as proposed would direct that higher priority be given to use of resources from State water quality program grants (Section 106 of the Clean Water Act) and from Section 205(j) grants for State nonpoint source programs. In addition, the policy encourages States to identify those priority watersheds requiring nonpoint source controls and to consider implementing management programs in those areas.

CONCLUSION

Great strides have been made during the past decade by States and local governments in both identifying nonpoint source problems and determining what effective strategies should be implemented. A wide range of projects in virtually every part of the country has demonstrated the effectiveness of management practices to control nonpoint source pollution from such varied sources as croplands, rangelands, agricultural lands, surface mines, forest lands, construction sites, and urban areas. Experience over the past decade has also shown that improvements in water quality can be achieved by targeting the key land areas and activities that are most responsible for nonpoint-source-related water quality degradation.

State management of nonpoint source control programs is the key to achieving water quality objectives. As the central manager of the water quality program, the State must identify nonpoint-source-related problems, establish priorities, target key problem areas, and designate the agency to manage corrective and preventive actions, which often must be applied in a very site-specific manner. At the State level, comprehensive strategies can be adopted, progress toward achievement of objectives can be accurately monitored, and necessary adjustments for a more effective strategy and program can be made.

While voluntary implementation of management practices has achieved and can achieve even more significant water quality improvements, it is clear that certain problems will require more innovative, management approaches. Accountability, flexibility, and leadership are all vital elements. The effective State program will involve a responsible State agency held accountable for results, which has a sound management approach and is capable of leading a cooperative effort by a variety of State and local governmental entities. Effective control of nonpoint-source-caused water quality problems will not happen easily. Dynamic and creative leadership is required at the State level to forge effective nonpoint source programs.

While most of the planning, analysis, and implementation must take place at the State level, development of appropriate control measures will require a coordinated effort on the part of all levels of government--Federal, State, and local--working together in a mutually supportive partnership. Federal agencies play a variety of roles. They (1) provide invaluable technical assistance and other incentives, (2) support research and demonstration capability for the development and dissemination of needed methodologies and innovative management approaches, and (3) support important networks of services and programs at the local level. This assistance must continue to be focused and made available at the local level by field representatives of the parent agencies involved in nonpoint source research and control. Local water quality management agencies and decision-makers provide the necessary detailed knowledge of what are, by nature, highly site-specific problems and solutions. The key role, however, is played by the States, managing available resources and bringing them to bear upon identified problems in a way that ensures maximum water quality improvement for each dollar spent.

CHAPTER 4: NOTES

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APPENDIX A

Examples of Best Management Practices for Selected Nonpoint Sources

TABLE A.1 EXAMPLES OF MANAGEMENT PRACTICES FOR AGRICULTURE*

AGRICULTURAL PROBLEM	BMP	COSTS AND COST SAVINGS	EFFECTIVENESS
1. Sediment From Cropland	Conservation Tillage--retains crop residues on the field surface through practices ranging from a variety of reduced tillage approaches to no-tillage.	Compared with conventional tillage, conservation tillage total costs are an average of $31 per acre.[a] However, on some soils, yields are reduced and risk of lower yields is increased.	Reduces soil erosion (60-99%)[b,c,d], runoff (up to 61%), and loss of nutrients from the soil. The Conservation Tillage News reports the following results from certain experimental plots covered with corn residue in Iowa: ● Reduction of runoff--72% ● Soil loss reduction--90% ● Reduction of herbicide loss--99% ● Reduction of nutrient loss--76%.
	Contour-strip cropping--is farming gently sloping (2-8%) cropland along the contour, alternating strips of sod or close-growing grasses and legumes with row crops.	Implementation costs average $29 per acre.[a] Operating and maintenance costs range from $3-5 per acre per year.[e] Costs may be greater to the farmer if a lower profit crop is planted to accomodate terracing.	Reduces water erosion 40-60%.[e] Reduces wind erosion 40-50%.[e]
	Terracing--is a combination of embankments and channels across a slope of up to 12%, flattening and shortening the length of the slope and thereby reducing the volume of the runoff by retaining it longer for infiltration.	Installation costs are high, an average of $73 per acre[e], and maintenance costs per acre are $16 yearly.[b] Every ton of erosion reduction costs approximately $7.00.[a]	Can be very effective in reducing erosion--50-90% [b]; reduces suspended solids 30-50%.[d] Runoff water is also reduced.
	Grassed waterways--are natural or constructed vegetated depressions which carry surface runoff while preventing the formation of gullies.	Construction costs are $1-2 per foot or $72 per acre; maintenance costs are $1-14 per acre per year.[b,f] Costs are nominal for the expected yearly average of 1 ton of pollutant reduction per acre.[f]	Reduces sediment 5-40% phosphorus 5-40% pesticides 5-40%[e].
2. Excessive Pesticide Loadings Into Water	Integrated Pest Management--combines traditional pest control methods (such as crop rotation) with sophisticated measures such as insect traps and analyses of an insect's life cycle to determine how best to interrupt it.	Costs vary widely according to practices chosen.	Moderate to high reductions ranging from 20-40% in pollutant loadings, depending upon practices used.[g]
3. Water Quality Degradation from Animal Wastes	Livestock exclusion--ensures the inaccessibility of highly erodible areas, such as streams, by fencing these areas off.	Implementation costs average $1.10 per foot of fencing.[a] Average total cost is $4.00 for each ton of pollutant reduced.[f]	Pollutant reductions for both practices are half a ton per acre per year.[f] Reduces wind erosion 10-20%.[e] Reduces water erosion 20-30%.[e] Reduces total phosphorus and suspended solids 50-90%.[d]

*This table includes only a sample of the available BMPs that might be used. The costs and effectiveness columns are very brief and are only meant to be indicative of relative values. The information in this table was compiled from a number of studies, but does not represent a comprehensive summary.

TABLE A.1 EXAMPLES OF MANAGEMENT PRACTICES FOR AGRICULTURE (CONTINUED)

AGRICULTURAL PROBLEM	BMP	COSTS AND SAVINGS	EFFECTIVENESS
3. Water Quality Degradation from Animal Wastes (continued)	Feedlot waste management systems--including diversions, ponds, and scraping that control liquid and solid animal waste, particularly runoff from the feedlot.	Control of feedlot runoff costs approximately $7500 yearly for every 50 animals.[e,h] Manure storage is expensive, an average of $12,884 for each storage facility.[e]	Manure storage and feedlot runoff control are very effective at reducing runoff and total phosphorus (75-100%).[d]
4. Salinity from Irrigated Croplands	Irrigation scheduling--involves proper timing of and careful attention to the volume of water applied to the cropland.	Implementation costs are minimal, if any, and operation costs range from $3-15 per acre per year.[e,f] The monetary benefits (reduced costs and increased yields) can amount to $30 per acre per year, generating a net benefit of at least $15 per acre per year.[e] For every ton of pollutant reduction, this BMP costs $7.50 yearly.[e]	Reduces an estimated 2 tons of pollutants per acre per year.[f] Can reduce: ● total dissolved solids/ salinity-- 5-20% ● nitrates-- 5-20% ● sediment-- 0-10% ● phosphorus-- 0-10% ● pesticides-- 0-10%.[e]
5. Excessive Nutrient Loadings	Techniques to reduce sediment runoff may also reduce nutrient loadings.	See #1, Sediment.	See #1, Sediment.
	Nutrient use management--assures the retention of nutrients in the soils and minimizes losses through the use of soil testing to guard against over-fertilization, proper timing of nutrient application, and incorporation of fertilizers into the soil.	Costs are minimal and may result in savings to farmers through lower fertilizer expenses as a result of lower fertilizer applications and losses.	Moderate reductions in nutrient losses from the soil.

General Sources for Table A.1:

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d. Nonpoint Source Pollution Abatement in th[illegible]eat Lakes Basin: An Overview of Post-PLUARG Developments, Water Quality Board of the International Joint Commiss[illegible] August 1983, Table 3.1.

e. Nonpoint Source Pollution Control Strate[illegible] Colorado, Draft Report.

f. Implementation Planning for Control of Agricultural Pollution: Institutional and Financial Issues and Approaches (Draft), U.S. EPA Office of Water, 1982, pp. IV-8, 10, 11, 14.

g. Unpublished data from U.S. EPA Water Planning Division.

h. Lower Black River Priority Watershed Plan, Wisconsin Department of Natural Resources, USDA, p. 460.

TABLE A.2 EXAMPLES OF MANAGEMENT PRACTICES FOR SILVICULTURE*

PROBLEM	SAMPLE MANAGEMENT PRACTICE	COSTS	BENEFITS
1. Sedimentation construction and stream crossings	Harvest site pre-planning. Time should be spent laying out roads and loading areas on an enlarged segment of a topographic map, and then marking them on the ground prior to arrival of crews and equipment. Roads should follow contours, avoid steep slopes, and be slightly outsloped to disperse drainage. Sensitive soils at risk of severe erosion or landslides should be identified and avoided.	Low.	High. Planning road layout can reduce road miles and decrease construction maintenance costs; better layout can reduce erosion.
2. Concentration of water on roads	Waterbars and turnouts may be constructed to reduce volume and velocity of water on roads. Planning to minimize use can reduce rutting. Closing and reseeding of roads is also recommended.	Low to medium ($40-100).[a]	Medium.
3. Site preparation too intensive, causing erosion	Where applicable, chopping and burning is preferred over shearing and windrowing. Disking and root raking should be avoided.	Low ($120/acre).[a] Although site looks "messier," the cost is less.	Medium to high. Soil conservation gives higher wood yields.

*This table includes only a sample of the available BMPs that might be used. The costs and benefits columns are very brief and are only meant to be indicative of relative values. The information in this table was compiled from a couple of studies, but does not represent a comprehensive summary.

TABLE A.2 EXAMPLES OF MANAGEMENT PRACTICES FOR SILVICULTURE (CONTINUED)

PROBLEM	SAMPLE MANAGEMENT PRACTICE	COSTS	BENEFITS
4. Sediment generated at stream crossings	Use bridges and culverts over all live streams; cross streams only at right angles; keep equipmentment out of streams. Be sure to maintain culverts prior to wet weather periods to prevent clogging and [illegible]houts.	Bridges, high ($1,000 - $1 million); culverts, low ($100-150). [a]	Medium.
5. Thermal pollution; organic matter	Streamside Ma[illegible]ement Zones (SMZs). [illegible]eave a strip with enough trees and brush to provide adequate shading. Width depends on stream size and angle of adjacent slope. This zone can also be an effective barrier to keep slash and debris out of stream, although sediment may run through.	Medium to high. Loss of timber left in zone, but practice is reported to be "catching on" as a stream preservation technique.	High. Keeps stream temperatures down. Practice helps keep equipment out of streams.
6. Groundcover and soil disturbance from log removal	(a) Directional felling, to place logs nearer to skid trails and reduce turning while dragging.	$150/acre. [a]	Medium.
	(b) Aerial skidding methods, various techniques that eliminate the use of tractors, and partially or wholly lift logs off the ground for transport to loading site.	High to very high. Tractor skidding is commonly used, except for top grade timber on very steep slopes.	Medium to high.

TABLE A.2 EXAMPLES OF MANAGEMENT PRACTICES FOR SILVICULTURE* (CONTINUED)

PROBLEM	SAMPLE MANAGEMENT PRACTICE	COSTS	BENEFITS
6. Groundcover and soil disturbance from log removal (continued)	(c) Harvest Method:	Cost per 1,000 Board Feet:	
	Tractor	$ 15 - 25	
	High Lead	$ 20 - 35	
	Sky Line	$ 40 - 55	
	Balloon	$ 60 - 80	
	Helicopter	$120 -140.[b]	
	(Will vary according to volume of timber per acre)		
7. Chemical runoff	Mark streams prior to spraying; leave strips on both sides of stream. Avoid wet weather periods. Follow label directions. Use no more than necessary or economically justifiable.	None.	Not Quantified.

General Sources for Table A.2:

1. "Forest Management for Water Quality," U.S. Forest Service/EPA, August 1981 (Workbook to accompany the National Forestry Water Quality Training Program, Part B, Units 1-9 slide tape program).

2. A Review of Current Knowledge and Research on the Impact of Alternative Forest Management Practices on Receiving Water, National Council of the Paper Industry for Air and Stream Improvement, Technical Bulletin No. 322, May 1979, p. 38.

Sources of Cost Information:

a. Interviews, U.S. Forest Service.

b. National Water Quality Goals Cannot Be Obtained Without More Attention to Pollution from Diffuse or "Nonpoint" Sources, GAO, December 1977, p. 43.

TABLE A.3 EXAMPLES OF MANAGEMENT PRACTICES AND RECLAMATION TECHNIQUES FOR MINING

PROBLEM	EXAMPLE MANAGEMENT PRACTICE	COSTS	BENEFITS
1. Leaching of acid and metals from tailings and spoil.	(a) Replacement of hazardous materials in mine passages and sealing of mine.	High	High
	(b) Regrading and burial with soil that will support vegetation.	High	Variable; leaching may continue
	(c) Impoundment of waste materials with collection and treatment of runoff.	High; long-term treatment effort.	High
	(d) Placement on impervious surface with clay or concrete cap.	High	High
	(e) Compounding of hazardous substances with asphalt to prevent all contact with water and air.	High	High
	(f) Diversion of water from the mining area and from exposed acid-producing materials	Not Available*	Not Available
	(g) Placement of crushed limestone barriers in stream beds; addition of lime, soda ash, or other neutralizing agents to streams; construction of a treatment facility to neutralize mine water and remove precipitants.	Not Available	Not Available
2. Erosion of tailings and spoil piles.	(a) Revegetation. May be unfeasible due to levels of acid or toxic materials, lack of rainfall, or excessively fine-grained tailings.	Low	Variable
	(b) Collection of runoff in settling ponds.	High	High
	(c) Mixing of fine tailings with coarser materials to stabilize them.	High	Medium

*Not available from cited sources.

TABLE A.3 EXAMPLES OF MANAGEMENT PRACTICES AND RECLAMATION TECHNIQUES FOR MINING (CONTINUED)

PROBLEM	EXAMPLE MANAGEMENT PRACTICE	COSTS	BENEFITS
3. Acid drainage from underground mines.	(a) Plugging of shafts and drain tunnels to control the entrance of air into the mine and inhibit the oxidation of sulfide materials.	Very High	Variable; generally thought to to be unworkable except in special situations.
	(b) Use of wells to divert water from overlying aquifer around mine to an underlying one.	Very High	Not Available
	(c) Stripping coal from underground mines by standard surface mining methods, then reclaiming the area as a surface mine.	Not Available	Not Available
4. Leaching of uranium from tailings.	Mixing with limestone or other source of alkalinity to render the metal insoluble.	High	Medium
5. Leaching of cyanide residues from gold tailings.	Reaction with hypochlorite.	Not Available	Reported Effective

Sources:

1. Processes, Procedures and Methods to Control Pollution from Mining Activities. U.S. EPA, Office of Air and Water Programs, Water Quality and Nonpoint Source Control Division, October 1973.

2. Tennessee Valley Authority, Coal Mining and Water Quality, September 1980.

3. Interviews with personnel within Bureau of Mines an Bureau of Land Management.

TABLE A.4 EXAMPLES OF MANAGEMENT PRACTICES FOR CONSTRUCTION

BMP	% EFFECTIVENESS FOR SEDIMENT CONTROL	COSTS
Structural:		
1. retention/detention basins	80-100% (wet) <60% (dry)	$300-2,000 for individual on-site basins [a,b,c]
2. diversion or filter structures; energy dissipators	40-60%	variable [a,c,d]
3. roadside swales	50-80%	medium to high ($2,000-4,000/ acre served) [b]
Nonstructural:		
4. good housekeeping practices	low (higher for other pollutants)	low [d,e]
5. site planning	variable	low to medium [a,b]
6. mulches; ground covers	50-95%	$200-1,500/acre served [a,c,d]

Sources of Cost Information:

a. Nonpoint Source Runoff: Information Transfer System, EPA, Office of Water, July 1983.

b. William G. Lynard, et al., Urban Stormwater Management and Technology--Case Histories, EPA, Office of Research and Development, August 1980.

c. Midwest Research Institute, Cost and Effectiveness of Control of Pollution From Selected Nonpoint Sources, Prepared for the National Commission on Water Quality, November 1975.

d. Toups Corporation, Nonpoint Source Pollution Control Strategy for Colorado, Draft , Prepared for State of Colorado, Section 208 Coordinating Unit, 1977.

e. Nonpoint Source Control Guidance Construction Activities, EPA, Office of Water Planning and Standards, 1976.

TABLE A.5 EXAMPLES OF MANAGEMENT PRACTICES FOR URBAN AREAS

BMP	% EFFECTIVENESS OF POLLUTANT CONTROLS	COSTS
Structural:		
1. retention basins	80-100% (wet)	low to high ($100-1,500/acre served) [a,b,c,d]
2. in-line storage	60-90%	medium to high ($1,000+/acre served) [b,c]
3. in-line screens	variable (sediment only; depends on screen size)	medium to high [e]
4. porous pavement	variable (depends on pore size)	high (where old pavement must be replaced) [b]
Nonstructural:		
5. streetsweeping	10-55% (sediment) 0-20% (other pollutants)	$1,000+/acre served (labor intensive) [c]
6. good housekeeping practices	low (sediment); medium (other pollutants) with effective enforcement	low [f]
7. land-use planning; site planning	variable	low to medium [b,c,f]

Sources of Cost Information:

a. Final Report of the Nationwide Urban Runoff Program, Final Draft, Vol. 1, EPA, Water Planning Division, December 1983.

b. Nonpoint Source Runoff: Information Transfer System, EPA, Office of Water, July 1983.

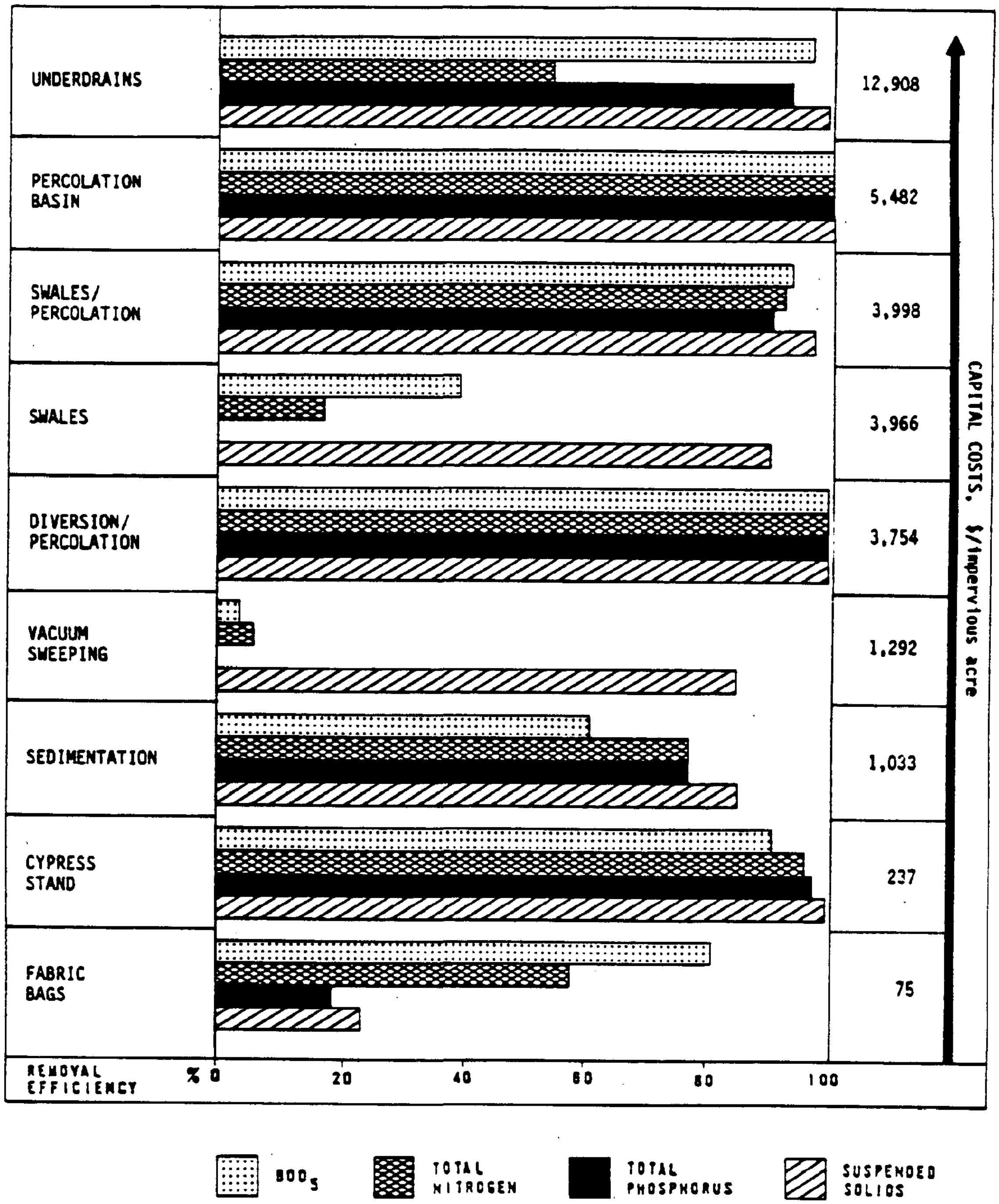
c. William G. Lynard, et al., Urban Stormwater Management and Technology--Case Histories, EPA, Office of Research and Development, August 1980.

d. Unpublished studies, EPA, Water Planning Division.

e. Urban Stormwater Management and Technologies: Update and Users' Guide, EPA, Office of Research and Development, September 1977.

f. Toups Corporation, Nonpoint Source Pollution Control Strategy for Colorado, Draft, Prepared for State of Colorado, Section 208 Coordinating Unit, 1977.

FIGURE A.1 COST EFFECTIVENESS OF URBAN BMPS
IN ORANGE COUNTY, FLORIDA



Source: William G. Lynard, et. al., Urban Stormwater Management and Technology--Case Histories, EPA, Office of Research and Development, August 1980.

APPENDIX B

Federal and State Programs

to Control Nonpoint Source Pollutants

TABLE B.1 STATE PROGRAMS ADDRESSING AGRICULTURAL NONPOINT SOURCES*

	Nature of Program			Yearly Amounts of Cost-Share Monies	Principal State Agency Responsible for Program	EPA-Approved 208 Program	Statutory Pollution Abatement Authority for Agriculture?
	Voluntary	Regulatory	Cost-Share				
AL	●				Department of Environmental Management	●	●
AK	(planned)				Department of Natural Resources		●
AZ	●				Department of Land, Water Commission	●	●
AR	●				Soil & Water Conservation Commission	●	●
CA	●				State Water Resources Control Board	●	●
CO	●				Soil Conservation Board	●	●
CT	●		●	1980 $30,000 - $60,000	Council of Soil and Water Conservation	●	●
DE	●				Department of Natural Resources and Environmental Control, Department of Agriculture	●	●
FL	●				Soil and Water Conservation Districts	●	●
GA	●				Environmental Protection Division, Department of Natural Resources	●	●
HI	●				15 Soil and Water Conservation Districts	●	●
ID	●		●	1983 $1 million	Soil Conservation Commission and Soil & Water Conservation Districts	●	●
IL	●	●	●	1981 $.5 million	Department of Agriculture, and Soil & Water Conservation Districts	●	●
IN	●		●	1981 $.4 million	Soil and Water Conservation Committee, Department of Natural Resources	●	●
IA	●		●	1983 $8.5 million	Department of Soil Conservation, Department of Water, Air, and Waste Management	●	●
KS	●		●	1983 $1.25 million	Department of Health and Environment	●	Authority Unclear
KY	●				Division of Conservation of Department of Natural Resources and Environmental Protection	●	●
LA	●				Water Pollution Division Department of Natural Resources	●	No Authority
ME	●	●			Bureau of Water Quality Control, Department of Environmental Protection	●	●
MD	●	●	●	1983 $5 million	Department of Agriculture, Department of Health, State Soil Conservation Committee, Office of Environmental Programs	●	●
MA	●				Department of Environmental Quality Engineering	●	●
MI	●	●			Soil Conservation Districts, Department of Natural Resources	●	●
MN	●		●	1983 $1.5 million	Soil & Water Conservation Board	●	●

*Some of these programs are designed for controlling soil erosion; others are designed for water quality.

TABLE B.1 STATE PROGRAMS ADDRESSING AGRICULTURAL NONPOINT SOURCES (CONTINUED)

	Nature of Program: Voluntary	Regulatory	Cost-Share	Yearly Amounts of Cost-Share Monies	Principal State Agency Responsible for Program	EPA-Approved 208 Program	Statutory Pollution Abatement Authority for Agriculture?
MS	●				Soil and Water Conservation Commission	●	●
MO	●		●	1983 $4 million	Soil and Water Conservation Program, Department of Natural Resources	●	●
NE	●			1983 $1.4 million	Natural Resources Commission	●	●
NV	●	●			Soil Conservation Districts	●	●
NH	●	●			State Conservation Committee	●	●
NJ	●		●	1982 $50 million**	State Soil Conservation Committee	●	●
NM	●				Soil and Water Division of Natural Resources	●	No Authority
NY	●				Department of Environmental Conservation		
NC	●		●	1982 $1.5 million	Soil and Water Conservation Committee	●	●
ND	●		●	1983 $450,000	Department of Health	●	●
OH	●		●	1980 $280,000	Division of Soil & Water Conservation Districts, Department of Natural Resources	●	●
OK	●		●	1983 $10,000	Oklahoma Conservation Commission	●	●
OR	●				Department of Agriculture	●	●
PA	●	●			Department of Environmental Resources	●	●
RI	●				State Conservation Committee	●	No Authority
SD	●	●	●	1980 $400,000	Department of Water and Natural Resources, Soil Conservation Districts	●	●
TN	●				Division of Water Management, Department of Public Health	●	●
TX	●				Texas State Soil and Water Conservation Board	●	●
UT	●		●		Soil Conservation Districts	●	●
VT	●				Agency of Environmental Conservation	●	●
VA	●		●	1983 $500,000	Soil and Water Conservation Commission	●	●
WA	●				Soil Conservation Districts	●	●
WV	●				Department of Natural Resources	●	●
WI	●		●	1983-84 $4.1 million	Department of Natural Resources	●	●
WY	●		●	1980 $23,500	State Conservation Commission	●	●
PR	●	●			Environmental Quality Board	●	●
VI	●				Department of Conservation and Cultural Affairs	●	

**NJ bond program for purchase of prime agricultural lands, a portion of which may be used for water quality purposes.

Sources: Implementation Status of State 208 Agricultural Programs (Draft), U.S. EPA Water Planning Division, September 1980, Appendix A.

Unpublished data from the National Association of Conservation Districts and U.S. EPA.

TABLE B.2 USDA PROGRAMS AFFECTING AGRICULTURAL NONPOINT SOURCES

Agency	Conservation Program	Date Enacted	Type of Program	Program Description
Agricultural Stabilization & Conservation	Agricultural Conservation Program (ACP)	1936	Cost-share	Assists farmers in shifting cropland from soil-depleting crops to soil-conserving crops, and in implementing soil-building or conserving practices. Special ACP funds are directed at achieving water quality goals.
		1978	Cost-share	Model Implementation Program was a demonstration program for implementation and maintenance of BMPs to solve agricultural water quality problems.
	Emergency Conservation Program	1978	Cost-share	Aids farmers in rehabilitating cropland damaged by floods or droughts.
	Experimental Rural Clean Water Program (RCWP)	1979	Cost-share	Obtains implementation and maintenance of BMPs on farms to control nonpoint water pollution.
Agricultural Research Service (ARS)	Agricultural	1935	Research	Performs and provides research on soil and water conservation and water quality.
Farmers Home Administration (FmHA)	Watershed Loans	1954	Loans	Deals with participants in Public Law 566 small watershed projects protecting, developing, and using the land and water resources from these watersheds.
	Soil and Water Loans to Individuals	1961	Loans	Assists farmers in carrying out projects for soil conservation and improvement, water development and conservation, and pollution abatement.
	Irrigation, Drainage and Other	1972	Loans	Aids organized associations of farmers in building or renovating water systems that serve several farms.
Extension Service (ES)	Land and Water Conservation	1978	Extention/ Education	Provides relevant, comprehensive education in each state to farmers on subjects important to agriculture, such as soil and water conservation.
Soil Conservation Service (SCS)	Technical Assistance	1935	Technical Assistance	Provides technical assistance to farmers, conservation districts, and urban areas regarding BMPs for soil and water conservation.
	Resource Conservation and Development	1962	Technical Assistance	Assists multi-county areas with plans for land conservation development to benefit rural communities, such as water quality management, controlling agricultural pollution, disposing of solid wastes, and developing wildlife habitat and recreational areas.
	Watershed Protection and Flood Protection Act (Public Law 566)	1954	Technical Assistance/ Project Grants	Provides technical assistance and funds to local organizations for protecting, developing, and utilizing small watersheds, particularly for purposes of flood prevention, agricultural-water management, municipal and industrial water supply, and recreation, fish and wildlife resource development and protection. In recent years, increasing emphasis has been placed on land treatment for water quality protection purposes.

Sources:

1. R. Neil Sampson, Farmland or Wasteland: A Time to Choose (Rodale Press; Emmaus, Pennsylvania, 1981), pp. 381-385.
2. Soil and Water Resources Conservation Act: 1980 Appraisal, Review Draft I, USDA, pp. 8-16, 8-18.
3. Catalogue of Federal Domestic Assistance, Executive Office of the President, Office of Management and Budget, 1983.

TABLE B.3 SUMMARY OF STATE SILVICULTURAL WATER QUALITY MANAGEMENT PROGRAMS

State	Regulatory	Quasi-Regulatory	Voluntary	Cost Sharing	No Program	Approx. State Program Cost ($) (FY'82)	Add-On Cost of BMP Compliance ($/1000 bd-ft.)
AL			●			$ 75,000	
AK	●					500,000	
AZ			●				
AR			●				
CA	●					3,900,000	55.00
CO			●				
CT			●			80,000	
DE					●		
FL			●			25,000	
GA			●			27,500	
HI		●					
ID	●					90,000	1.50
IL			●				
IN					●		
IA					●		
KS					●		
KY			●				
LA			●			-0-	
ME		●					
MD			●				
MA		●					
MI			●				
MN			●	●		125,000	
MS			●				
MO					●		
MT			●				
NE					●		
NV		●					
NH		●					
NJ			●				
NM			●				
NY			●				
NC			●			-0-	

TABLE B.3 SUMMARY OF STATE SILVICULTURAL WATER QUALITY MANAGEMENT PROGRAMS (CONTINUED)

State	Regulatory	Quasi-Regulatory	Voluntary	Cost Sharing	No Program	Approx. State Program Cost ($) (FY'82)	Add-On Cost of BMP Compliance ($/1000 bd-ft.)
ND					●		
OH					●		
OK			●			38,000	
OR	●					1,350,000	1.50
PA		●					
RI					●		
SC			●			-0-	
SD			●				
TN			●			2,500	
TX					●		
UT			●				
VT			●			-0-	
VA			●			40,000	
WA	●					1,400,000	10.00
WV			●			31,000	
WI			●	●			
WY			●				
Totals	5	6	29	2	10		

Source: Summary of Silvicultural Nonpoint Source Control Programs-1982, National Council of the Paper Industry for Air and Stream Improvement, Special Report No. 83-01, January 1983.

Agency and Program	Nature of Program	Primary Purpose	Priority Given to WQ* Objectives
USDA-Forest Service, Timber Sales	Auction sales of public timber resources.	Provision of timber for national needs.	Under current law and regs, WQ BMPs are incorporated into each contract. Cuts are limited in size to minimize local disturbance.**
USDA-Forest Service, Forestry Incentives Program (FIP) (C.F.D.A. No. 10.064)	Cost sharing up to 65%. Zero funding FY84	Tree planting and timber stand improvement for private nonindustrial forest lands of 1,000 acres or less.	Water quality not a priority, but some projects reported to have addressed WQ problems. (In general, reforestation does improve water quality.)
USDA-Agricultural Stabilization and Conservation Service (ASCS), Agricultural Conservation Program (CFDA No. 10.063)	Cost sharing up to 75%. FY84 funding $56 million (est). Average Payment: $764.	To control erosion and sedimentation, encourage voluntary compliance with Federal and State requirements to solve point and nonpoint source pollution, achieve priorities in the National Environmental Policy Act, improve water quality, encourage energy conservation measures, and assure a continued supply of necessary food and fiber. The program is directed toward the solution of critical soil, water, energy, and pollution abatement problems on farms and ranches.	Primarily addresses soil erosion on farms, as well as water quality. Some funds reported to go to silviculture. Applications processed by local ASCS committee at county level.
USDA-ASCS, Rural Clean Water Program (RCWP) (C.F.D.A. No. 10.068)	Three- to ten-year cost-sharing contracts up to 75%. FY84 funding $3 million (est). Max. project size: $50,000.	To develop and test methods for assisting agricultural landowners to reduce nonpoint source pollution. Projects involve installation of BMP's.	Directly addresses WQ, but forestry not a priority. Applications reviewed by local ASCS committee.

*Water Quality

**It is reported that budget cuts in some national forests have resulted in lack of implementation of WQ practices. (Source: Field interview, EPA Region 8).

TABLE B.5 FEDERAL PROGRAMS AFFECTING MINING NONPOINT SOURCES

AGENCY AND PROGRAM	NATURE OF PROGRAM	PRIMARY PURPOSE	PRIORITY GIVEN TO WATER QUALITY MANAGEMENT OBJECTIVES
Interior-Office of Surface Mining, Regulation of Surface Coal Mining and Surface Effects of Underground Mining (C.F.D.A. No. 15.250)	(a) Project grants to State for program development, administration and enforcement. Cost share: First year 80%, Second year 60%, thereafter 50%. Funding: FY'84 (est) $37,600,000. (b) Small Operator Assistance Program (SOAP). Payments to laboratories to conduct hydrologic surveys for small operators. Funding: FY'83 $7,400,000.	To assist coal States in developing and enforcing surface mine regulation programs, as authorized under SMCRA.	Water quality protection is a primary aspect of SMCRA, along with reclamation, soil conservation, etc. Water quality management requirements contained in SMCRA Section 515 require all surface mine runoff to be collected and treated.
Interior - Office of Surface Mining (OSM), Abandoned Mine Land Reclamation (AMLR) Program (C.F.D.A. No. 15.252)	Project grants, funded by tax on coal production. Funding: FY'84 (est) $209,400,000	To protect the public and correct the environmental damage caused by coal and noncoal mining occurring prior to 8-3-77, primarily at abandoned coal sites. At the request of a State governor, noncoal sites may be addressed (intended for those states without a long history of problem coal mines.)	Abatement of water pollution from abandoned mines is third priority, after projects to protect public health, safety and welfare. Top priority goes to extreme safety hazards, such as mine fires, open pits and shafts, subsidence problems, etc.
USDA - Soil Conservation Service, Rural Abandoned Mine Program (RAMP) (C.F.D.A. No. 10.910)	Cost sharing up to 80% Project grants for reclamation of sites under 320 acres. Funding: FY '84 (est) $2,282,000	Land stabilization; erosion and sediment control; development of soil, water (excluding stream channelization), woodland, wildlife, and recreation resources; and the agricultural productivity of such lands.	Water quality aspects tend to be addressed along with safety hazards or land restoration. Typical projects include filling of pits, removal of hazardous structures, regrading and reclamation of acid wastes, etc.
Interior - Bureau of Land Management, Inventory of Hazardous Materials	Proposed 8-10 year reseach project	To determine the extent and magnitude of the hazardous materials problem on BLM lands, including number of working mines, the degree of hazards posed, and level of effort needed for reclamation.	Undetermined.
Interior - U.S. Geological Survey, Water Resources Investigations (C.F.D.A. No. 15.803)	Federal assistance to States in the form of directed water resources research projects. 50% State matching share required. Funding: FY'84 (est) $47,113,000 (salaries and expenses)	To obtain physical data for program planning for resource development and management. (62 area reports are planned, of which about 20 have been published.)	Efforts are directed to both quality and quantity of surface and groundwaters. (Reports cover all major water quality issues for region studied.)

TABLE B.6 STATUS OF EFFECTIVE LEGISLATION FOR SEDIMENT CONTROL IN CONSTRUCTION

State	Law Drafted	Introduced to Legislature	Enacted
AL			
AK			
AZ			
AR	●		
CA			
CO			
CT	●		●
DE	●	●	●
FL			
GA	●	●	●
HA	●	●	●
ID	●	●	
IL	●	●	●
IN			
IA	●	●	●
KS	●		
KY			
LA	●	●	(1)
ME			
MD	●	●	●
MA			
MI	●	●	●
MN	●	●	
MS	●	●	
MO			
MT	●	●	●
NE			
NV			
NH			
NJ	●	●	●
NM			
NY	●	●	
NC	●	●	●
ND	●	●	
OH	●	●	●
OK			
OR	●	●	
PA	●	●	●
RI			●
SC	●	●	
SD	●	●	●
TN			
TX			
UT			
VT			
VA	●	●	●
WA	●		
WV	●	●	
WI	●	●	
WY			
PR			
VI	●	●	

(1) Governor's executive order assigns sediment control responsibility to conservation districts.

Sources: Nonpoint Source Runoff: Information Transfer System, EPA, Water Planning Division, July 1983.

Unpublished information from EPA.

APPENDIX C

Glossary

GLOSSARY

Acid Mine Drainage	A principal water pollutant from mining operations; acid water forms when water comes into contact with exposed mined wastes and ores.
Adsorption	The attachment of the molecules of a liquid or gaseous substance to the surface of a solid.
Algae	Primitive nonvascular plants, having one or many cells, usually aquatic and capable of fixing carbon dioxide by photosynthesis.
Aquatic	Plants or animal life living in, growing in, or adapted to water.
Aquifer	An underground bed or layer of earth, gravel, or porous stone that contains water.
Available Nutrient	That portion of any element or compound (such as phosphorus and nitrogen) in the soil that can be readily absorbed and assimilated by growing plants.
Bacteria	Microscopic organisms, generally free of pigment, which occur as single cells, chains, filaments, well-oriented groups, or amorphous masses.
Best Management Practices (BMPs)	Methods, measures, or practices to prevent or reduce water pollution, including, but not limited to, structural and nonstructural controls and operation and maintenance procedures. BMPs may be applied before, during, or after pollution-producing activities to reduce or eliminate the introduction of pollutants into water bodies.
Bioaccumulation	The process by which the concentration of a given chemical in body tissues increases exponentially through the food chain, as contaminated organisms are consumed by others, and the chemical becomes incorporated into the tissues of each consumer.
Buffer Strip	Strips of grass or other erosion-resistant vegetation between a waterway and an area of more intensive land use.

Conservation Tillage (Reduced Tillage)	Farming practices, such as reduced plowing, that cause less disruption of the land surface than does conventional tillage. Common practices include plow planting, double-disking, chisel-plowing, and strip tillage.
Contour Farming	Conducting field operations--such as plowing, planting, cultivating, and harvesting--across the slope and contour of hilly land.
Contour Strip Cropping	Farming operations performed on the contour with crops planted in narrow strips, alternating between row crops and close-growing forage crops.
Conventional Tillage	Standard method of preparing a seedbed by completely inverting the soil and incorporating all residue with a moldboard plow. This is done to the land more than once in order to prepare a smooth, fine surface.
Detention Basin	A structural BMP consisting of ponds constructed to temporarily store water so that settlement of some sediment may occur before water moves elsewhere.
Dissolved Oxygen (DO)	The amount of free oxygen dissolved in water and readily available to aquatic organisms. It is usually expressed in milligrams per liter or as the percent of saturation. Low concentrations can result from the decomposition of excessive amounts of organic matter, a process that consumes DO and therefore limits aquatic life.
Diversion Structures	Channels such as dikes, ditches, and terraces that route sediment-laden water at a nonerosive velocity into basins or other safe disposal areas.
Erosion	The wearing away of a land surface by wind or water. Erosion occurs naturally from weathering or runoff but can be intensified by land clearing practices. Sheet erosion occurs when water runs off in unbroken layers over the soil surface; rill erosion occurs when water runs off in incisions less than 12 inches deep through the soil; and gully erosion results in trenches deeper than 12 inches in the soil.

Eutrophication — The addition of nutrients to a body of water. This occurs naturally as part of the normal aging process of many lakes; however, the process may be accelerated by human activities that result in excessive nutrient inputs that promote abundant growth of algae and other aquatic plants. As these die and decompose, much of the dissolved oxygen in the water is consumed, making the lake uninhabitable for the previous diversity of fish and other aquatic life.

Fecal Bacteria — Intestinal bacteria that are associated with human and animal wastes; they are indicator organisms used to detect the presence of possible pathogens in water. They may enter water bodies from such nonpoint sources as manure runoff from fields, animal grazing near streambanks, or leaching from septic tanks.

Field Cropping — Farming practice that involves planting fields with grain plants (such as hay, wheat, or oats) that do not require seeded rows.

Filter Structures — Structural BMPs, such as stone and gravel piles, sandbags, and straw bales, that are used to slow water velocities in order to reduce erosion.

Grassed Waterway — A natural or constructed waterway (usually broad and shallow, covered with erosion-resistant grass) that is used to conduct surface water from cropland.

Groundwater — The supply of fresh water that forms a natural reservoir under the earth's surface.

Groundwater Recharge — The natural renewal of ground water supplies by infiltration through the soil of rain or other precipitation.

Heavy Metals — Metallic elements such as mercury, chromium, cadmium, arsenic, and lead, with high molecular weights. At low concentrations, they can damage organisms; heavy metals tend to bioaccumulate in the food chain.

Infiltration — The downward entry of water into the soil.

In-Line Screens — A structural BMP in which screens are placed within pipes and sewers in order to filter the particulate matter from the water.

In-Line Storage	A structural BMP that utilizes up-sized sewers and/or gates to control water flow directions so that runoff water can be stored within the sewer system to allow pollutants to settle out before it is gradually released.
Inorganic	Composed of chemical compounds not containing carbon.
Integrated Pest Management	Combining the best of all useful techniques--biological, chemical, cultural, physical, and mechanical--into a custom-made pest control system.
Irrigation Efficiency	The amount of water stored in the crop root zone compared to the amount of irrigation water applied to the soil.
Irrigation Return Flow	Surface and subsurface water that leaves the field following the application of irrigation water.
Leaching	The removal of nutrients, chemicals, or contaminants from the soil by water movement through the soil profile.
Livestock Exclusion	The removal or isolation of animals from streambanks or other highly erodible areas near water bodies.
Nitrogen	A chemical element, commonly used in fertilizer as a nutrient, which is also a component of animal wastes; as one of the major nutrients required for plant growth, it can promote algal blooms that cause water body eutrophication if it runs off or leaches out of the surface soil. Available nitrogen is a form which is immediately usable for plant growth (NO_3^- or NH_4^+).
Nonpoint Source	A diffuse source of water pollution that does not discharge through a pipe, such as agricultural or urban runoff, runoff from construction activities, etc.
Nonstructural BMPs	Practices which do not involve construction in order to be effective, such as site-planning, good housekeeping, and mulches and ground covers.

No-Till (Zero Till)	A soil management practice of planting a crop, without prior seedbed preparation, into an existing sod, cover crop, or crop residues; planting is done by punching a hole or slot in the soil in which to place the seed. Subsequent tillage operations are also eliminated, and chemical weed control is generally used.
Nutrients	Elements or substances such as nitrogen and phosphorus that are necessary for plant growth. In water bodies, large amounts promote excessive growth of aquatic plants and cause eutrophication of the water body.
Organic Materials	Carbon-containing substances in plant and animal matter. High concentrations of these are often found in industrial and municipal wastewaters and in surface runoff.
Pathogens	Disease-causing organisms.
Percolation	Downward flow or filtering of water through pores or spaces in rock or soil.
Pesticide	Any substance used to control pests ranging from rats, weeds, and insects to algae and fungi. Some pesticides bioaccumulate in the food chain and can contaminate the environment.
Phosphorus	One of the primary nutrients required for the growth of aquatic plants and algae. Phosphorus is often the "limiting" nutrient for the growth of these plants. (See Nitrogen)
Potassium	A component of fertilizer that can contribute to water body eutrophication from excessive nutrient loadings. See Nitrogen.
Retention Basin	A structural BMP that is an area with no outlet device and that stores runoff water in order to allow pollutants to settle out.
Revegetation	The planting of ground cover on highly erodible and marginal lands as a means of preventing further erosion.
Row Cropping	Farming practice that plows the land in straight rows, thus enhancing the erodibility of the land and promoting leaching.
Runoff	Water from rain, snow melt, or irrigation that flows over the ground surface and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

Salinity	The concentration of salt in water.
Sediment	Solid material (such as silt, sand, or organic matter) that has been moved from its site of origin and has settled to the bottom of a watercourse or water body. Excessive amounts of sediment can clog a watercourse and interfere with navigation, fish migration and spawning, etc. If disturbed, sediment can be resuspended in the water column, where it contributes to turbidity.
Silviculture	Management of forest land for timber. Some silvicultural practices, such as clear-cutting, may contribute to water pollution by enhancing the erodibility of the land.
Soil Stabilization	A nonstructural BMP that involves the use of mulches and ground covers, and effectively decreases the amount of sediment in runoff and reduces precipitation velocity (thus reducing the volume of runoff).
Structural BMPs	Devices constructed for pollution control purposes, such as detention/retention basins, diversion structures, or filter structures.
Suspended Solids	Solids floating in the water column which generally impart a cloudy appearance (turbidity) to water, sewage, or other liquids. Suspended solids are measured as the amount of material retained on standard filters.
"T"	The rate of soil loss that will still allow for soil productivity; a standard by which soil erosion control rather than water quality control is measured.
Tailings	Residue of raw materials or waste separated out during the processing of mineral ores.
Terraces	Embankments built along the contour of agricultural land to hold or divert runoff and sediment, thus reducing erosion.
Tillage	Plowing, seedbed preparation, and cultivat[illegible] practices.
Topography	The physical features of a land surface area, including relative elevations and the position of natural and man-made features.

Turbidity	Haziness or cloudiness in water due to suspended silt or organic matter.
Watershed	The area of land that drains into a particular watercourse or water body.

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