Section 319 National Monitoring Program: An Overview

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USEPA
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Cover: Water quality monitoring is essential in determining the health of our Nation's water resources.

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Clean water is one of our Nation's most vital resources. Since 1972, the Clean Water Act has successfully reduced many threats to our water resources by identifying and controlling distinct, or "point," sources of pollution.

But what about pollutants from everyday activities such as agriculture, residential development, and forestry? These pollutants are much harder to control because they come from not-so-easily identified, or "nonpoint," sources. According to the United States Environmental Protection Agency (USEPA), nonpoint sources include agricultural runoff, atmospheric deposition, contaminated sediments, and certain land-use activities that generate polluted runoff, such as logging, small construction sites, and on-site sewage disposal.

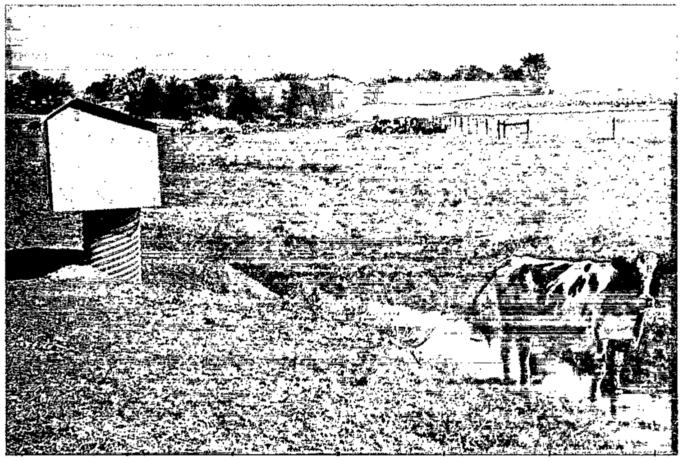
Nonpoint sources are reported to cause the majority of water pollution problems in the United States today. Nutrients, sediment, metals, pesticides, salts, pathogens, and organic matter are deposited into our rivers, lakes, and estuaries from nonpoint sources. Most of these pollutants also reach ground water. Without a clear understanding of how to control these nonpoint pollution sources, communities will be unable to change land-use practices and develop strategies to protect their water resources.

Section 319 National Monitoring Program: An Overview

Under Section 319 of the Clean Water Act, the USEPA has developed the Section 319 National Monitoring Program to address nonpoint source pollution specifically. Its objectives are twofold:

1) to scientifically evaluate the effectiveness of watershed technologies designed to control nonpoint source pollution; and
2) to improve our understanding of nonpoint source pollution.

To achieve these objectives, the Section 319 National Monitoring Program has selected watersheds across the country to be monitored over a 6- to 10-year period to evaluate how improved land management reduces water pollution. National Monitoring Program projects will help communities and citizens protect their local water resources by providing information on the effectiveness of tools and techniques for solving nonpoint source problems.



Stream degradation by lounging cows.

Nonpoint Source Water Pollution: An Emerging Threat

As the Clean Water Act brings point source pollution from municipalities and industries under control, the magnitude of nonpoint source pollution throughout the United States has become more apparent. Based on waters assessed by States in 1994, nonpoint sources are prominent among the Nation's five leading water pollution sources. Table 1 lists the top five sources by water resource type.

Table 1. Five leading sources of water pollution in the United States.

Rank	Rivers	Lakes	Estuaries
1	Agriculture	Agriculture	Urban Runoff/ Storm Sewers
2	Municipal Point Source	Municipal Point Source	Municipal Point Source
3	Hydrologic/Habitat Modification	Urban Runoff/ Storm Sewers	Agriculture
4	Urban Runoff/ Storm Sewers	Unspecified Nonpoint Source	Industrial Point Source
5	Resource Extraction	Hydrologic/Habitat Modification	Petroleum Activities/ Construction and Land Disposal

Source: *National Water Quality Inventory: 1994 Report to Congress.* 1995. United States Environmental Protection Agency (USEPA), EPA 841-R-95-005, Washington, D.C.

The Watershed Approach to Nonpoint Source Pollution Control

Watersheds are areas of land that drain to a stream or other water resource. Most nonpoint pollution control projects focus their activities around watersheds because watersheds integrate the effects that land use, climate, hydrology, drainage, and vegetation have on water quality. Focusing pollution control project activities around a watershed allows individuals living in that area to learn about the water resource they affect, and how to participate in its protection.

Stripcropping and contouring best management practices.

Monitoring the water resource(s) in a watershed is essential to detect and document pollution. Monitoring is also necessary to continually assess water quality and the health of the water resource. The most reliable way to determine if changes in land-based activities have affected water quality is to monitor the land and the water resource before, during, and after a change in land management or restoration occurs.

At the watershed scale, this relationship between changes in land management and water quality can only be determined by following a strict experimental plan, or monitoring protocol. Although not affordable in all cases, detailed tracking of both land management and water quality is essential to provide information to decision makers about the effectiveness of nonpoint source pollution control efforts.

Section 319 National Monitoring Program: Improving Our Understanding of Pollution Control

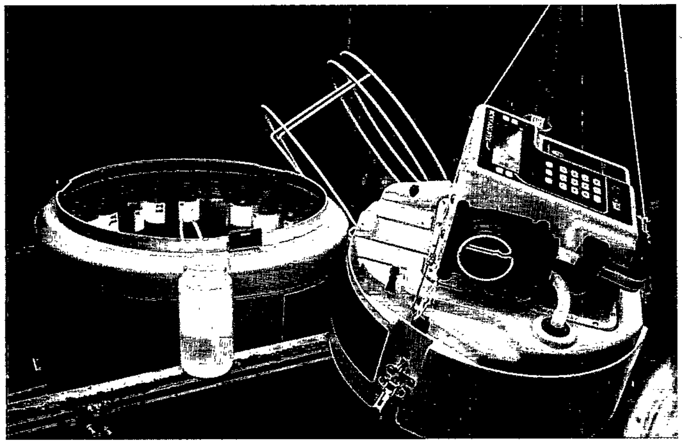
The Section 319 National Monitoring Program was established in 1991 to intensively monitor water quality and nonpoint source pollution controls in designated watershed projects. The projects are supported by USEPA funds authorized by Section 319 of the 1987 Amendments to the Clean Water Act, where Section 319 is the nonpoint source portion of this legislation. While the USEPA funding for these National Monitoring Program projects is used primarily for monitoring and evaluation, support from other funding sources and programs is leveraged to provide the needed land treatment. Coordination with other land management funding sources and programs is expected within the watershed project.

The monitoring program aims to scientifically evaluate the effectiveness of control technologies and to improve our understanding of nonpoint source pollution in these selected watersheds. To facilitate comparisons, each project follows a nationally consistent set of guidelines, including the use of an appropriate experimental design and water quality monitoring requirements. The National Monitoring Program can then use the information collected from the projects to develop a national monitoring database, and to provide information for adjusting nonpoint source pollution controls to improve water quality. The States and USEPA's Regions will use the findings from the National Monitoring Program to develop and select projects for future funding. Participating States will fine-tune their own monitoring efforts and programs based upon the results from this program.

While the National Monitoring Program may require a different monitoring design than other water quality assessment programs, the data collected are frequently complementary. In addition, sampling and analysis requirements are similar to those of other programs and agencies. For example, to assess the diversity of aquatic life, projects use USEPA's Rapid Bioassessment Protocols and follow quality assurance plans approved by the USEPA for physical and chemical analyses of water samples. The raw monitoring data are entered into the national databases, BIOS and STORET, to supplement data collected from other monitoring programs. To develop monitoring protocols for lakes, the National Monitoring Program intends to build from those developed under the Clean Lakes Program.

Nine National Monitoring Program projects are closely cooperating with the U.S. Geological Survey (USGS); USGS gauging stations monitor discharge and, in some cases, suspended sediment. At least two of these nine projects are located within drainage areas being intensively monitored by USGS as part of the National Water Quality Assessment (NAWQA). Personnel from the USGS manage one of the National Monitoring Program projects. This coordination enhances the value of the water quality data and adds expertise in analyzing water quality trends.

Several of the projects are closely linked to, and dependent on, U.S. Department of Agriculture (USDA) projects and personnel. All projects rely, to some extent, on USDA personnel for technical assistance, implementation, and cost share of nonpoint source controls; however, the four projects that are coincident with USDA Hydrologic Unit Area and Water Quality Demonstration projects are particularly dependent on USDA personnel. Because the USDA projects are primarily concerned with implementing best management practices (BMPs), they make an excellent complement to the National Monitoring Program projects when the timing and placement of BMPs can be coordinated with water quality monitoring.



Automatic water quality sampler.

Section 319 National Monitoring Program: Project Selection

USEPA's regional offices nominate projects for the National Monitoring Program by forwarding State proposals to USEPA headquarters for review and concurrence. Before October 1, 1995, USEPA set aside a small portion of Section 319 funds for the National Monitoring Program. States have continued to propose projects for inclusion in the program, which underscores the merits of this effort to document the effectiveness of nonpoint source controls. USEPA works with project sponsors to develop approvable, 6- to 10-year projects. Proposed projects are assessed based on many factors including:

- Identification of water quality threats or problems, along with a listing of major pollutant(s) causing the problems, substantiated by previous water quality monitoring data;
- Nonpoint source control objectives, including the probability of adequately treating pollutant sources with the proposed best management practices;
- Watershed characterization, including project area size and a summary of existing land uses;
- Delineation of "critical areas" for pollutant(s);
- Land treatment implementation plan (including planned BMP location, amount of critical pollutant areas, and timing of implementation);
- Institutional roles and responsibilities for agency coordination;
- Land treatment and land-use monitoring design;
- Water quality monitoring design (including sampling locations, sample frequency, pollutants monitored, other variables monitored, such as stream flow and antecedent precipitation); and
- Evaluation and reporting plan.

Critical areas are areas of nonpoint source pollution within a watershed that are most likely to impair or threaten the designated beneficial use of the water. Designated beneficial uses are the desirable uses that water quality should support, such as drinking water supply, swimming, or fishing. Inherent in this determination is the identification of pollutants and pollutant transport. There is a higher probability of improving water quality if critical areas are clearly defined, and a large percent (usually greater than 75 percent) of the critical area is treated with nonpoint source controls or BMPs.

USEPA has reviewed proposals for approximately 60 projects under the National Monitoring Program, approving 20 to date (see Figure 1 on page 6). Nineteen of these involve monitoring surface water, particularly streams; one is a pilot ground water project.

The major pollutants of concern in the projects approved to date are sediment, nutrients, and fecal coliform. The pollutants are listed by project in Table 2.

Table 2. Primary and secondary pollutants.

Projects	Nutrients	Bacteria	Sediment	Organics	Riparian Area Degradation
Alabama	o	o	*		
Arizona	o	*	*	o	
California	o	o	*		
Connecticut	o	o	o		
Idaho[1]	*			o	
Illinois – LP	o		*	o	
Illinois – WR			*		*
Iowa – SM	o	o	*	o	
Iowa – WC	*	o	*	*	
Maryland	*		*		
Michigan	o		*	o	
Nebraska			*		
North Carolina	*	*	*		*
Oklahoma	*		*		*
Oregon					*
Pennsylvania	*	*	*		*
South Dakota			*		
Vermont	*	*	o		
Washington		*			
Wisconsin	*	*	*		o

[1] Pilot ground water monitoring project
* Primary pollutant
o Secondary pollutant

LP — Lake Pittsfield
WR — Waukegan River
SM — Sny Magill
WC — Walnut Creek

Projects can employ one of three study designs: paired watershed, upstream/downstream, or single-downstream station (Table 3). Overall, the 20 projects currently in the Section 319 National Monitoring Program are conducting 48 separate monitoring efforts.

The paired watershed design involves monitoring the outflow from two similar watersheds during a calibration period of two to three years within which both are managed the same (ideally). The calibration period is followed by a period when one of the watersheds is treated with BMPs. The watersheds continue to be monitored for two to three years after treatment is completed. The paired watershed design accounts for hydrologic variations so that the effect of the BMPs can be isolated.

In the upstream/downstream design, a monitoring station is installed directly upstream and downstream of an area where significant nonpoint source pollution controls will be implemented. Water quality and land-management monitoring should occur before, during, and after implementing controls.

The single-downstream station study design involves monitoring downstream of the entire study area. The quality of the water is compared between the initial project conditions and the conditions at project's end. This design is not recommended because of the difficulty in isolating the effects of nonpoint pollution controls from other variables, such as rainfall.

In each of the designs, monitoring data are analyzed to document that nonpoint pollution controls have significantly reduced pollutant delivery to the sampling station. The water quality monitoring designs of the current National Monitoring Program projects are listed in Table 3.

Table 3. Water quality monitoring design of Section 319 National Monitoring Program projects.

Project	Paired Watershed	Upstream/ Downstream	Single Downstream
Alabama	*		
Arizona		*	
California	*	*	*
Connecticut	*		
Idaho[1]	*		
Illinois – LP		*	*
Illinois – WR		*	
Iowa – SM	*		*
Iowa – WC	*	*	
Maryland	*	*	
Michigan	*		*
Nebraska		*	*
North Carolina	*	*	*
Oklahoma	*		
Oregon	*	*	*
Pennsylvania	*	*	
South Dakota	*		
Vermont	*		
Washington	*		*
Wisconsin	*	*	

[1] Pilot ground water monitoring project
LP — Lake Pittsfield
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Monitoring requirements for National Monitoring Program projects include pre-project sampling to establish baseline water quality; land management tracking; and options to collect at least 20 evenly spaced (in time) water chemistry samples during a season, to sample the aquatic community at least once per year, or to evaluate habitat conditions annually.

The aquatic community includes habitat and aquatic organisms (such as fish and insects) that indicate the health of water resources. Two projects (Oregon and Illinois–Waukegan) are only monitoring biological indicators such as fish and macroinvertebrates (water insects). Monitoring results are reported in a standard format using USEPA's NonPoint Source Management System (NPSMS) software to facilitate comparisons between projects and the development of a national database.

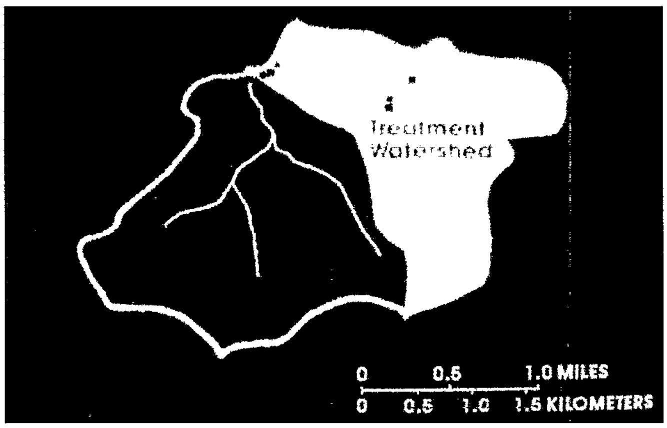

Diagram of paired watersheds in Pennsylvania.

Most projects are cooperative efforts between Federal, State, and Local agencies, and often between two or more Federal water quality programs (Table 4). Projects with a strong Local interest and highly valued water resources tend to be selected because participants in these projects often have greater incentive to improve water quality.

Funding for the different components of the National Monitoring Program comes from many cooperating Federal, State, and local government agencies, as well as the private sector. Funds provided to projects typically support both the basic monitoring requirements for National Monitoring Program projects, as well as monitoring activities that states include for their own purposes. For example, storm-event monitoring is not required, yet fifteen of the projects include such monitoring, which typically requires the purchase of automated sampling equipment. For this reason, the funding levels significantly exceed the true cost of required monitoring under the National Monitoring Program. The average funding levels are also skewed by the focus on the first few years of monitoring.

Table 4. The types and number of different agencies involved in the Section 319 National Monitoring Program projects.

	Government Agencies							
State	Federal	State	Regional	Local	Tribal	University	Industry	Private
Alabama	2	2		1				
Arizona	5	10	1	4		4	4	9
California	2	2		1		1		2
Connecticut	2	1		1		2		1
Idaho[1]	6	5		4		4	1	
Illinois – LP	2	4		2				3
Illinois – WR		3		2		1		1
Iowa – SM	7	3		1		2		
Iowa – WC	5	3				1		
Maryland	1	1		1		1		
Michigan	2	1		4		1		
Nebraska	4	3	2	1				1
North Carolina	4	3		8		2		2
Oklahoma	2	1		3		1		
Oregon	1	1			1			
Pennsylvania	3	1		1		1		1
South Dakota	2	1		2				
Vermont	3	1	1	1		1		
Washington	1	1	1	2				
Wisconsin	3	2	1			1		2

[1]Pilot ground water monitoring project
LP — Lake Pittsfield
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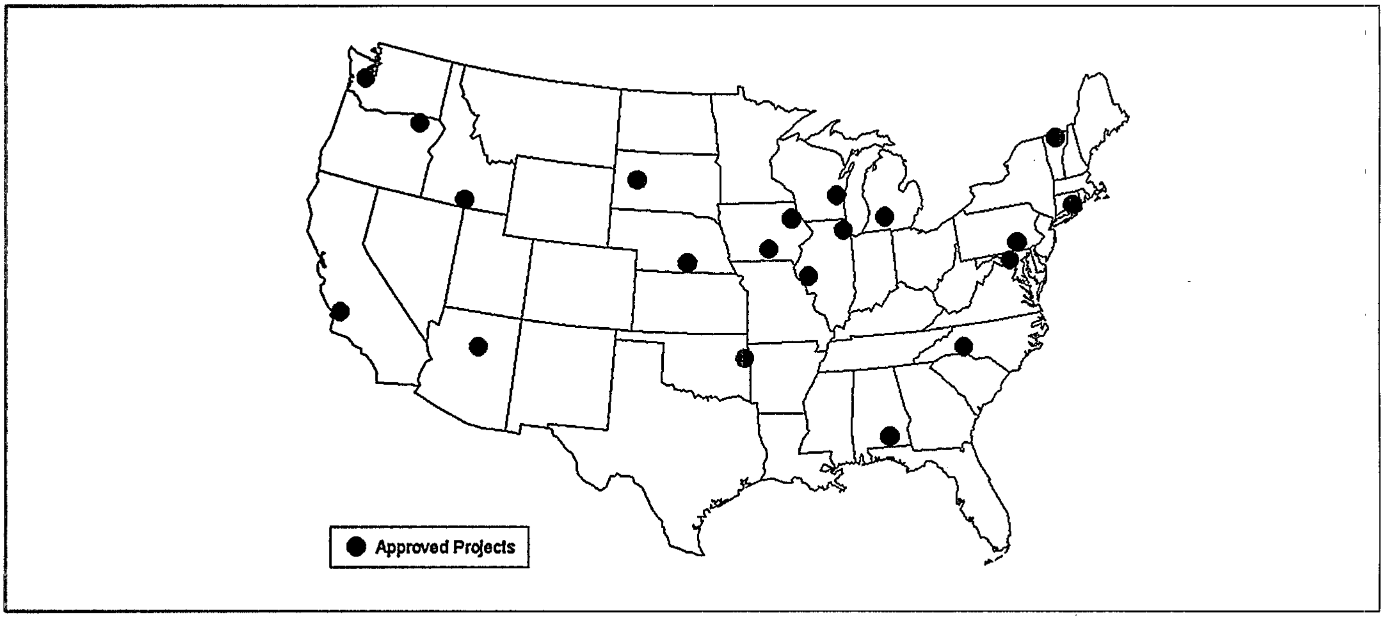


Figure 1. Locations of the 20 approved projects.

Section 319 National Monitoring Program: Projects

ALABAMA — Lightwood Knot Creek

The W.F. Jackson Lake (southeastern Alabama) was built for recreational uses. Excessive sedimentation of the lake, caused by agricultural activities in the watershed, is impairing aquatic life habitat, increasing bridge maintenance costs and flooding potential, and reducing the lake's water holding capacity.

Checking flow into bedload sediment pit sampler (Lightwood Knot Creek, Alabama).

Approximately 50% of the watershed is forested and 25% of the land is in pasture or hay; the remaining 25% is cropped. During the Lightwood Knot Creek 319 National Monitoring Program project, BMPs will be implemented on the cropland to reduce erosion and on the poultry farms to reduce nutrient and fecal coliform runoff. The water quality monitoring design is a three-way pair, with two treatment watersheds and one control watershed. BMPs will be implemented in the two treatment watersheds. No BMPs will be installed on the control watershed until the end of the project.

Water quality monitoring consists of weekly grab sampling from April through August for a number of different chemical constituents, including nitrogen, phosphorus, fecal coliform, and streptococcus. Total dissolved solids and total suspended solids will be monitored monthly.

ARIZONA — Oak Creek Canyon

Oak Creek, located in Oak Creek Canyon, Arizona, experiences an annual seasonal (summer) deterioration in water quality from fecal pollution. The Oak Creek project has determined that these impacts to water quality occur only when a reservoir of sediments containing fecal coliform becomes established in the creek (Table 5) and when the sediment is disturbed by recreational use of the waters, monsoon activity, or both. The sources of fecal pollution include recreational use (more than a quarter of a million visitors swim in Oak Creek each summer), septic systems, and wildlife.

Slide Rock Creek (Oak Creek Canyon, Arizona).

Table 5. Average fecal coliform counts in water and sediment at the downstream sample point at Slide Rock State Park (Arizona Project).

Month	Fecal Coliforms/ 100 ml Water	Fecal Coliforms/ 100 ml Suspended Sediment
January	0	0
February	1	5,700
March	0	6,080
April	10	0
May	78	4,826
June	138	70,879
July	1,820	1,052,626
August	1,810	1,014,333
September	109	37,555,556
October	16	44,286
November	4	37,037
December	1	14,286

The Oak Creek project is using an upstream/downstream water quality monitoring design to compare the effectiveness of BMPs at two recreational swimming areas, Slide Rock State Park (treatment) and Grasshopper Point (control), and at two campgrounds, Pine Flats campground (treatment) and Manzanita campground (control). Weekly grab samples are taken on Saturday afternoons (peak tourist time) from May 15 through September 15, and monthly samples are collected for the remainder of the year. BMPs that have been implemented at Slide Rock State Park and Pine Flats campground include enhanced restroom facilities and an educational program to promote visitor compliance with park and campground regulations on facility use and waste disposal. Upgrading septic systems and monitoring the proportion of human versus animal waste in Oak Creek water and sediment are also being pursued.

Another component of the Oak Creek project monitors the effect of storm water runoff from the parking lot at Slide Rock State Park. This parking lot is filled to capacity throughout the summer recreational season, since most users spend several hours at a time at the park. The result is that several hundred vehicles pass through the parking lot each day, depositing organic (oil and grease) and inorganic (from automobile exhaust) material onto the parking lot. Automatic remote water samplers were installed in the spring of 1997 to characterize parking lot runoff by collecting samples during typical monsoon summer thunderstorms. BMPs for effective parking lot management will be implemented over the next year to reduce the impact of parking lot runoff on Oak Creek water quality.

CALIFORNIA — Morro Bay

Morro Bay, one of the few intact natural estuaries on California's Pacific coast, is being harmed by sediment and to a lesser extent by bacteria, metals, nutrients and habitat loss. Brushland, rangeland, and streambank erosion contribute the largest portion of the sediment that is deposited in the Bay, and recent wildfire and floods have increased the sedimentation.

Sampling vegetation on rangeland (Morro Bay, California).

The Morro Bay Watershed Section 319 National Monitoring Program project is evaluating the effectiveness of different sediment-reducing BMP systems. A paired watershed study on tributaries of Chorro Creek (Chumash and Walters creeks) is evaluating the effectiveness of a rangeland BMP system — fencing the entire riparian corridor, creation of smaller pastures, installation of accessible water in each pasture, stabilization and revegetation of streambanks, and installation of water bars and culverts on farm roads. Another important part of this study is an analysis of whether event and regular-interval sampling are effective in detecting change. Three additional water quality monitoring sites have been established to evaluate the effectiveness of other BMP systems: sediment retention, cattle exclusion, and managed grazing. Water quality samples are also being taken throughout the watershed to document the changes in overall water quality during the life of the project.

Suburban land uses that contribute to nonpoint source pollution (Jordan Cove, Connecticut).

CONNECTICUT — Jordan Cove

Jordan Cove, a small estuary fed by Jordan Brook, is part of the Long Island Sound. Water quality sampling has indicated that the cove does not meet bacteriological standards for safe shellfish collection. The watershed that drains Jordan Cove estuary is primarily forest and wetlands (74%) with increasing urban land use (19%). As urbanization continues, concern has increased about the impact of suburbanization on the estuary during and after construction. The pollutant of concern during construction is sediment, whereas the pollutants of concern after construction are phosphorus and nitrogen. This 319 National Monitoring Program project will help characterize polluted runoff from urbanized areas.

Runoff from three subdivisions is being monitored to assess the effects of construction and urban development. The three sites are: an established subdivision with 43 houses, a subdivision that is being built with generally accepted construction practices, and a subdivision being built using BMPs. Non-structural construction BMPs consist of phased grading, immediate seeding of stockpiled topsoil, maintenance of vegetation around the construction area, and immediate temporary seeding of proposed lawn areas. Structural practices include sediment detention basins and swales. Post-construction, non-structural BMPs will consist of street sweeping, implementation of fertilizer and pesticide management plans, pet waste management, and yard waste pickups. Structural BMPs will include grass swales, bioretention areas and a road of permeable concrete pavers (concrete blocks with holes in them), gravel pack shoulders on access roads, and the minimization of impervious surfaces.

Rainwater runoff from each subdivision is being collected and analyzed for sediment and nutrients. The paired watershed approach will allow comparison of the quality of the stormwater runoff from each of the three subdivisions.

IDAHO — Eastern Snake River Plain

The Idaho Eastern Snake River Plain is located in southcentral Idaho in an area dominated by irrigated agricultural land. The Eastern Snake River Plain aquifer system provides much of the drinking water for approximately 40,000 people living in the project area. The aquifer also serves as an important source of water for irrigation.

Excessive irrigation, a common practice in the area, creates the potential for nitrate and pesticide leaching into the aquifer below. Ground water monitoring has shown that nitrate levels in the shallow aquifer underlying the project area frequently exceed the drinking water standard of 10 mg/l (Table 6).

The Eastern Snake River Plain project is the only Section 319 National Monitoring Program project to evaluate the effects of agricultural BMPs on ground water quality. Two paired test fields are being evaluated. Twelve monitoring wells, 35 point ground water samplers, and 35 soil water samplers (lysimeters) are installed in one paired test field (Foregon); 12 monitoring wells and 25 soil water samplers are installed in the second paired test field (Moncur).

Lysimeter sampling for nitrate (Eastern Snake River Plain, Idaho).

Table 6. Ground water nitrate concentrations for 1992-1996 in the Eastern Snake River Plain project area (Idaho).

Field (each pair of fields contains 12 sample wells)	Mean Maximum Nitrate Conc. (mg/l)	Range of the Maximum Nitrate Conc. (mg/l)	Mean Minimum Nitrate Conc. (mg/l)	Range of the Minimum Nitrate Conc. (mg/l)
Moncur (2 paired fields)	25.5	8 – 59	3	02. – 9.8
Forgeon (2 paired fields)	69	34 – 130	2.7	8.6 – BDL[2]

[2]BDL = Below Detection Limit

Ground water quality is monitored monthly. The effects of irrigation water application rates on ground water quality in terms of nitrate, total dissolved solids, dissolved oxygen concentrations, electrical conductance, and pH are being evaluated for one paired field (Moncur). The effects of crop type on these same parameters are being evaluated for the other paired field (Forgeon). Nitrate is the key ground water indicator parameter for evaluation of BMP effectiveness for both paired test fields.

ILLINOIS — Lake Pittsfield

Lake Pittsfield was constructed in 1961 to serve as a flood control structure and as a public water supply for the city of Pittsfield, a western Illinois community of approximately 4,000 people. The 7,000-acre watershed (Blue Creek Watershed) that drains into Lake Pittsfield is agricultural, consisting primarily of corn and soybean cropland.

Sediment basin (Lake Pittsfield, Illinois).

Sedimentation is the major water quality problem in Lake Pittsfield. Sediment from farming operations, gullies, and shoreline erosion has decreased the capacity of Lake Pittsfield by 25 percent in the last 33 years.

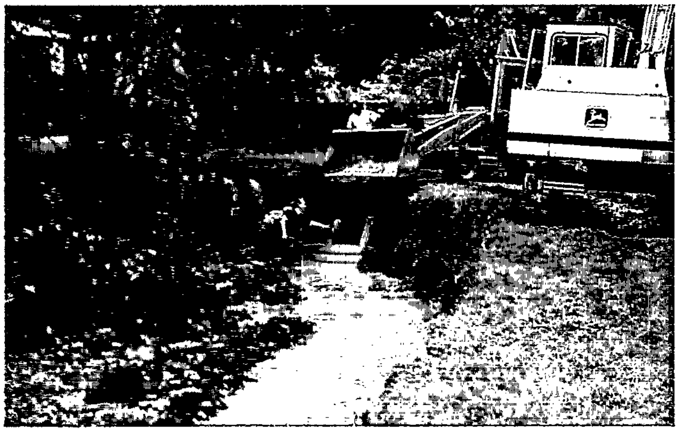
Based on a thorough analysis of lake problems and pollution control needs conducted under the Clean Lakes Program, project coordinators developed a strategy to reduce sediment transport into Lake Pittsfield. The keystone of the land management strategy is the construction of settling basins throughout the watershed, including a large basin at the upper end of Lake Pittsfield. USDA Water Quality Incentive Project funds have provided for installation of additional sediment-reducing practices such as conservation tillage, integrated crop management, livestock exclusion, filter strips, and wildlife habitat management. Land-based data and a geographical information system (GIS) are being used to develop watershed maps of sediment sources and sediment yields.

The objective of the Lake Pittsfield Section 319 National Monitoring Program project is to evaluate the effectiveness of the settling basins in reducing sedimentation into the lake. Water quality monitoring consists of tributary sampling after rainstorms (to determine sediment loads); monthly water quality monitoring at three lake sites (to determine trends in water quality); and lake sedimentation rate monitoring (to determine changes in sediment deposition rates and patterns).

ILLINOIS —Waukegan River

The Waukegan River 319 National Monitoring Program project is an urban stream restoration project located in a 6,700-acre watershed. High-volume runoff from impervious surfaces is degrading urban streams and reducing habitat due to low oxygen levels, low pool levels, and limited cobble substrate. The project, located in Waukegan, Illinois, uses biotechnical bank restoration (a combined vegetative and structural approach) to stabilize streambanks and low stone weirs to restore pool and riffle sequences. Several sites in Powell Park and Washington Park have been restored using a combination of lunkers (structures that stabilize banks and provide fish habitat), a-jacks (structures that look like playing jacks that stabilize streams), and riparian plants such as dogwood, arrowhead, and willow.

An upstream/downstream habitat monitoring design is being used to document water quality changes in the Waukegan River at the South Branch stations. With this design, urban water quality will affect both the control and the rehabilitated stations uniformly. Biological parameters, which include fish, macroinvertebrate, and habitat samples, will be measured three times per year from May through September. Flows are monitored continuously.



Urban streambank restoration (Waukegan River, Illinois).

IOWA — Sny Magill Creek

Sny Magill Creek, located in northeastern Iowa, is one of the more widely used streams for recreational trout fishing in Iowa. Sny Magill Creek, a coldwater stream, drains a 22,780-acre agricultural watershed consisting of land used for row crops, pasture, forest and forested pasture, and cover crops. There are approximately 98 dairy, beef, and swine producers in the watershed, with farm sizes averaging 275 acres.

Benthic macroinvertebrate sampling (Sny Magill Creek, Iowa).

Excess sediment deposition in the creek is harming the trout fishery. Consequently, a long-term goal of the project is to reduce sediment delivery to Sny Magill by one-half. To meet this goal, sediment control measures are planned. Because nitrogen, phosphorus, and pesticide levels are also concerns, planned land management includes reducing nutrient and pesticide use and implementing animal waste management systems.

The adjacent 24,064-acre Bloody Run Creek watershed serves as the paired comparison watershed for water quality monitoring. Monitoring sites at the outlets of each watershed are documenting discharge and suspended sediment.

Water quality is monitored through bi-monthly sampling of the benthic organisms, an annual fisheries survey, and an annual aquatic habitat assessment. Monitoring of the benthic organisms suggests some improvement in the water quality of Sny Magill Creek; similar improvements are not seen in the comparison watershed, Bloody Run Creek (Figure 2).

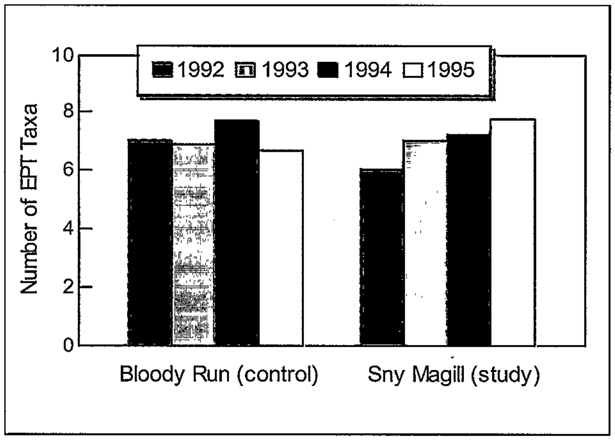
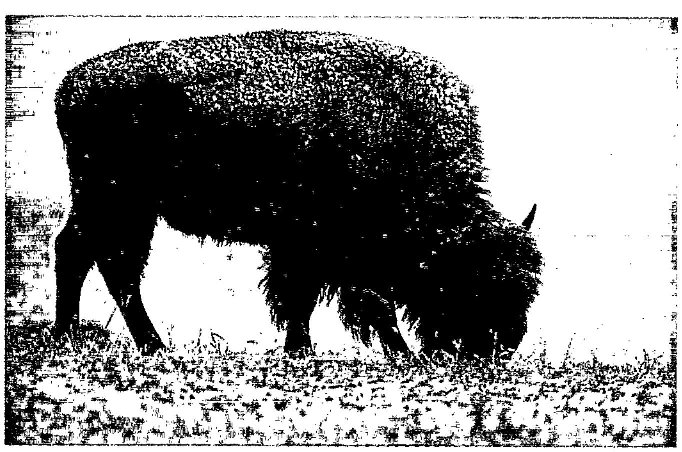


Figure 2. The EPT Index measures a specific group of pollution-sensitive organisms. An increasing value suggests improved water quality.

IOWA — Walnut Creek

The objective of the Walnut Creek project is to restore the area to pre-settlement conditions. The Walnut Creek 319 National Monitoring Program project uses a paired watershed design with upstream/downstream stations on both the Walnut Creek (treatment watershed) and Squaw Creek (the control watershed). Walnut Creek, which drains into the Des Moines River, does not support its designated uses and Squaw Creek only partially supports its uses. Primary biological productivity is low, and the condition of the fish community is poor. These streams are affected by agriculturally derived pollutants (sediment, nutrients, pesticides, and animal wastes) as well as sediment from streambank erosion.



Buffalo grazing on native prairie grasses (Walnut Creek, Iowa).

Corn and soybeans comprise 65.7% of the watershed acreage of Walnut Creek and 74.3% of Squaw Creek. The U.S. Fish and Wildlife Service, the agency in charge of the Walnut Creek National Wildlife Refuge and Prairie Learning Center, has decided to change land uses within the refuge. Approximately 5,000 acres of cropland will be removed from production by converting it to native tall grass prairie. Riparian and wetland zones will also be restored. For the portion of the watershed that remains in cropland agriculture, soil erosion control measures and pesticide and nutrient management BMPs will be implemented.

To document the changes in water quality, ten stations within the project drainage area are monitored biweekly to monthly in March through July. Four stations are monitored four times per year. Storm data is collected at the two watershed outlets and at the main stem of Walnut Creek, and habitat is assessed yearly.

MARYLAND — Warner Creek

Warner Creek is a small stream in northcentral Maryland that drains 830 acres. The creek is characteristic of many of the small streams that drain agricultural areas in the Piedmont area of Maryland. The major source of nonpoint source pollution in this stream is believed to be activities associated with dairy production. The effects of beef and dairy production on water quality will be compared by using a paired water quality monitoring design. Land use in the control watershed is primarily pasture for beef production, whereas land use in the treatment watershed is essentially dairy farming. An upstream/downstream monitoring program will be used to evaluate the effectiveness of fencing animals from streams, watering systems, and animal waste management systems.

Warner Creek (Maryland).

Water quality sampling is done weekly from February to June, with bi-weekly sampling during the remainder of the year for all monitoring stations. Storm-event sampling is conducted at the upstream and downstream monitoring stations. Samples are analyzed for nutrients and sediment to determine if changes in land treatment practices are affecting water quality. Monitoring results from the paired watershed indicate that mismanaged dairy operations are a major contributor to the water pollution in the watershed. Subsurface flow of water causes nitrate-nitrogen to enter Warner Creek.

MICHIGAN — Sycamore Creek

Sycamore Creek is located in southcentral Michigan (Ingham County). The creek has a drainage area of 67,740 acres, which includes the towns of Holt and Mason and part of the city of Lansing. The major commodities produced in this primarily agricultural county are corn, wheat, soybeans, and some livestock. Sycamore Creek is a tributary to the Red Cedar River, which flows into the Grand River. The Grand River discharges into Lake Michigan.

Soil sampling for nutrient management planning (Sycamore Creek, Michigan).

The major pollutants of Sycamore Creek are sediment, phosphorus, nitrogen, and agricultural pesticides. Sediment deposition is adversely affecting fish and macroinvertebrate habitat, and the decay of organic soils is depleting oxygen in the water column. Sycamore Creek has been selected for monitoring not because of any unique characteristics, but because it is representative of creeks throughout lower Michigan.

Streambank erosion control is being conducted under a Section 319 grant to the County Drain Commissioner. Land management consists primarily of sediment- and nutrient-reducing BMPs on cropland, pastureland, and hayland. These practices are funded as part of the USDA Sycamore Creek Hydrologic Unit Area (HUA) project.

Water quality monitoring is being conducted in three subwatersheds: Haines Drain, Willow Creek, and Marshall Drain. The Haines subwatershed, where BMPs have already been installed, serves as the control and is outside the Sycamore Creek watershed. Stormflow and baseflow water quality samples from each watershed are taken from March through July of each project year. Water is sampled for turbidity, total suspended solids, chemical oxygen demand, nitrogen, and phosphorus. A fourth station was added above the mouth of the creek in 1995 and sampled for the same parameters.

NEBRASKA — Elm Creek

Elm Creek is a spring-fed stream that drains 35,800 acres of rural land in southcentral Nebraska, near the Kansas border. Wheat and sorghum, pasture, range, and irrigated corn cover most of the land. High intensity, short duration thunderstorms common to this region produce peak flows that degrade water and habitat quality.

Trout productivity in Elm Creek is currently limited by inadequate in-stream habitat, elevated water temperatures, and deposition of fine sediments onto the stream substrate, mostly during runoff events. The project objectives are to reduce in-stream summer maximum temperatures, reduce in-stream sedimentation, reduce peak flows, and improve in-stream aquatic habitat.

Modeling and field surveys were initially conducted to identify critical erosion areas in need of nonpoint source control measures (BMPs). Conventional and non-conventional BMPs have been implemented extensively throughout Elm Creek's watershed since the project was initiated in 1992. In addition, a portion of Elm Creek was the focus of a 1996 lunker demonstration to improve in-stream habitat while stabilizing eroding streambanks. Implementation activities have been funded in part under the Elm Creek Hydrologic Unit Area Project, which is under the direction of the USDA, and by local cost-share dollars in conjunction with Section 319 funds.

Rural streambank restoration (Elm Creek, Nebraska).

Physical, chemical, biological, and land management monitoring are conducted to determine if project water quality objectives are achieved. Both an upstream/downstream design as well as a single-downstream station study design are employed. Weekly monitoring of stream chemistry is conducted from March through September because nonpoint source impacts are greatest during this period. Biological and habitat data are typically collected in both spring and fall. Monitoring efforts will be continued for at least two years after BMP implementation activities cease.

NORTH CAROLINA — Long Creek

The Long Creek Watershed, situated in the southwestern Piedmont of North Carolina, is a 28,480-acre area of mixed agricultural and urban land uses. Long Creek is the primary water supply for Bessemer City, a small municipality with a population of about 4,900 people.

Water quality problems include high sediment, bacteria, and nutrient levels. The stream channel near the Bessemer City water supply intake in the headwaters area has historically required frequent dredging due to sediment accumulation. Downstream of the intake, Long Creek is listed as support-threatened by the North Carolina Nonpoint Source Management Program. Aquatic habitat is degraded in this section due to high levels of fecal coliform and excessive sediment and nutrient loading from agricultural and urban nonpoint sources.

Land management upstream of the water supply intake is reducing erosion from cropland and streambanks. Downstream of the intake, land management activities include fencing to exclude cows from streams, animal waste management, and implementation of sediment and rainwater runoff controls. Recently, a system of BMPs was installed at a dairy including: 1) livestock exclusion from perennial and ephemeral streams, 2) an alternative watering system, 3) streambank stabilization and riparian buffer establishment, 4) a waste management system, 5) heavy-use and feeding-area improvements, and 6) improved stream crossings. Water quality improvements have been monitored for nine months and are shown in Table 7.

Table 7. Water quality at selected sampling stations through November 1996 (North Carolina).

Station	Total Kjeldahl Nitrogen mg/l	Total Phosphorus mg/l	Fecal Coliform Bacteria mpn/100ml	Suspended Sediment mg/l
Water Supply Intake	NA	NA	550	4
Watershed Outlet	0.27	0.08	1,400	7
Upstream at Farm — Pre-BMP[1]	0.80	0.25	24,000	4
Upstream at Farm — Post-BMP[2]	0.48	0.12	26,000	2
Downstream at Farm — Pre-BMP[1]	2.20	0.72	110,000	11
Downstream at Farm — Post-BMP[2]	0.62	0.21	11,000	2

[1]Pre–BMP period was from April 1993 through January 1996.
[2]Post–BMP period was from February 1996 to November 1996.
Note: All values are the median for the period of monitoring.

Degradation before restoration (Long Creek, North Carolina).

Riparian area after livestock exclusion (Long Creek, North Carolina).

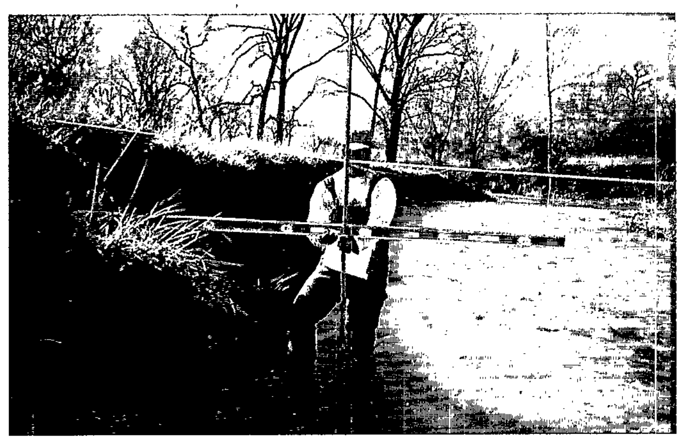
Water quality monitoring includes weekly grab sampling just upstream of the water supply intake before and after implementing erosion controls, water quality monitoring upstream and downstream of a dairy feeding and holding area on a tributary to Long Creek, and runoff sampling from two paired drainage areas on a cropland field. Water samples are being analyzed to provide the chemical, biological, and hydrologic data needed to assess the effectiveness of the nonpoint source controls.

OKLAHOMA — Peacheater Creek

The land use of the watershed that surrounds Peacheater Creek, a stream located in eastern Oklahoma, is agricultural, mainly pasture and forest. There are many livestock operations — 51 poultry houses, 9 dairies, and 1,200 beef cattle — in this watershed. The adjacent Tyner Creek Watershed is similar in size to Peacheater Creek for land use and number of livestock operations.

Fish and macroinvertebrate habitats are impaired by large gravel bars generated by streambank erosion caused by cattle traffic and past forestry activities. Elevated nitrogen and phosphorus levels, caused by animal waste runoff, contribute to the growth of algae in the Illinois River and eutrophication in Lake Tenkiller, both downstream of Peacheater Creek.

The water quality monitoring design is a paired watershed study. Nutrient management, animal waste management structures, mortality composters (dead chicken composters), and riparian area stabilization are the primary BMPs that will be implemented in the treatment watershed (Peacheater Creek). The control watershed (Tyner Creek) will not be treated. Water quality monitoring stations are located at the outlet of each watershed, whereas habitat and biological monitoring are conducted at several locations in each stream. Chemical monitoring is conducted weekly from February through June (monthly during the rest of the year) and during storm events. Macroinvertebrates and periphyton productivity are measured twice per year. Fish and intensive habitat assessments are done yearly. An extensive habitat assessment of the whole stream length will be done on alternate years with an assessment of streambank erosion.



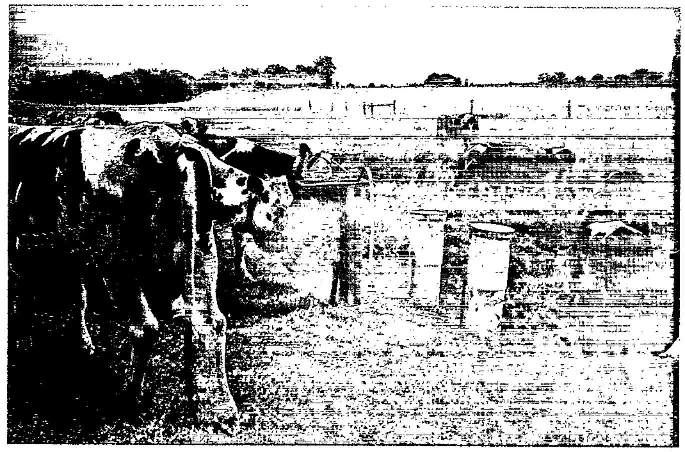
Measuring a channel cross-section (Peacheater Creek, Oklahoma).

OREGON — Upper Grande Ronde Basin

The streams of the Grande Ronde basin have historically provided a rich habitat for cold water fish, such as rainbow trout, salmon, summer steelhead, and bull trout. However, cold water fish production has been declining since 1970 as land use changes have reduced riparian vegetation by 75% and simplified in-stream habitat due to grazing practices and channel modifications. Stream temperatures have risen as riparian vegetation that once shaded the streams has been lost. Higher temperatures in the stream have resulted in reduced cold water fish populations. The project area, located in northeast Oregon, is within the Upper Grand Ronde Basin (695 square miles).

The objective of this project is to document the effects of habitat restoration on stream temperatures and aquatic communities. A paired watershed design is being used. Sampling for the Upper Grande Ronde Basin Section 319 National Monitoring Program project is unique in that water quality monitoring is focused primarily on biological indicators, such as fish, macroinvertebrates, and habitat. Water quality, habitat, and macroinvertebrate surveys are conducted three times per year and fish snorkel surveys are carried out once per year. The treatment stream, a segment of McCoy Creek, will be treated by stabilizing and revegetating riparian areas, restoring wet meadow conditions and restoring old channels that will allow the stream to naturally meander. Water quality data for the treatment area will be compared with data from the control stream, Dark Creek. Three other streams are monitored to provide background information.

Biological monitoring (Upper Grande Ronde Basin, Oregon).



Alternative pasture watering sites (Pequea and Mill Creek, Pennsylvania).

PENNSYLVANIA — Pequea and Mill Creek

The Big Spring Run is a spring-fed stream located in the Mill Creek Watershed of southcentral Pennsylvania. Its primary uses are livestock watering, aquatic life support, and fish and wildlife support. In addition, receiving streams drain to the Chesapeake Bay, which has well-documented water quality problems.

The main source of pollutants in the area is cows lounging in the streams; therefore, the primary treatment is to fence cows out of streams. This allows grasses and shrubs to stabilize streambanks and potentially filter pollutants from pasture runoff.

The water quality monitoring effort employs a paired watershed study design which requires that the proposed nonpoint source control, fencing to exclude livestock from 100 percent of the stream miles, be implemented in an 896-acre watershed and leaving the other (1,152-acre) watershed untreated. Grab samples are collected every 10 days at the outlet of each paired watershed and at three upstream sites in the treatment basin from April through November. The monitoring plan also includes sampling the streams during rainstorms, and monitoring ground water.

Incised stream through rangeland (Bad River, South Dakota).

SOUTH DAKOTA — Bad River

The Bad River is located in westcentral South Dakota, where it converges with the Missouri River near Ft. Pierre. The section of the Missouri that the Bad River enters is located approximately 10 miles downstream of the Oahe Reservoir. The sediment load carried by the Bad River is filling in the channel in the Missouri river and impairing power generation at Oahe Dam. Also, the combination of ice jams and the silted-in channel on the Missouri river cause localized flooding in the city of Pierre during peak discharges in winter months.

Land use in the watershed consists primarily of livestock grazing with some dry-land wheat farming. Streambank erosion and improper grazing practices are the main causes of sedimentation in the watershed. To control erosion and reduce sedimentation, rotational grazing, riparian plantings, alternative water and feeding areas, and possibly some structural BMPs will be implemented in the treatment watersheds. The two-paired watershed design used in the Bad River 319 National Monitoring Program project includes four monitored watersheds: one pair in the eastern part and one pair in the western part of the Bad River Watershed.

Rangeland and riparian conditions will be monitored during the project. Water quality monitoring will be storm-event driven because the streams are ephemeral, flowing only during snow melt and intense summer thunderstorms. Sediment, rainfall, and discharge will be monitored.

VERMONT — Lake Champlain Basin

Lake Champlain fails to meet Vermont water quality standards for phosphorus, largely due to excessive nonpoint source loads. The Missisquoi River contributes the greatest share of phosphorus to Lake Champlain, and is itself impacted by phosphorus, bacteria, and organic matter from agricultural sources, primarily animal wastes from dairies, cropland, and livestock activity within streams and riparian areas.

The Lake Champlain Basin Watershed National Monitoring Program project is designed to implement and evaluate the effectiveness of livestock exclusion, riparian revegetation, and grazing management in reducing the concentrations and loads of nutrients, bacteria, and sediment from agricultural sources. One control watershed (Berry Brook — WS3) and two treatment watersheds will be monitored. Samsonville Brook watershed (WS1) will be used to evaluate the water quality benefits of intensive grazing management. Godin Brook watershed (WS2) will be used to assess the benefits of streambank protection and revegetation, controlled livestock access to streams, and improved livestock stream crossings.

Water quality data from May 1994 through September 1996 are summarized in Table 8. Average bacteria counts often exceed Vermont water quality standards, and maximum counts have exceeded 200,000 in each of the streams that are part of this project. Phosphorus and nitrogen levels indicate significant nutrient enrichment. Fish and macroinvertebrate data suggest moderate to severe impacts due to nutrients and organic matter.

Gathering rainfall data (Lake Champlain Basin, Vermont).

Table 8. Mean values for seven measured variables in three Lake Champlain Basin Watersheds (Vermont).

Variable	WS1	WS2	WS3
	Watersheds (anti-log of log mean)		
Total Phosphorus (mg/l)	0.108	0.107	0.980
Total Kjeldahl Nitrogen (mg/l)	0.97	0.90	0.78
Total Suspended Solids (mg/l)	31	18	16
E. Coli Bacteria (#/100 ml)	136	627	595
Fecal Coliform Bacteria (#/100 ml)	132	695	613
Fecal Strep Bacteria (#/100 ml)	447	486	442

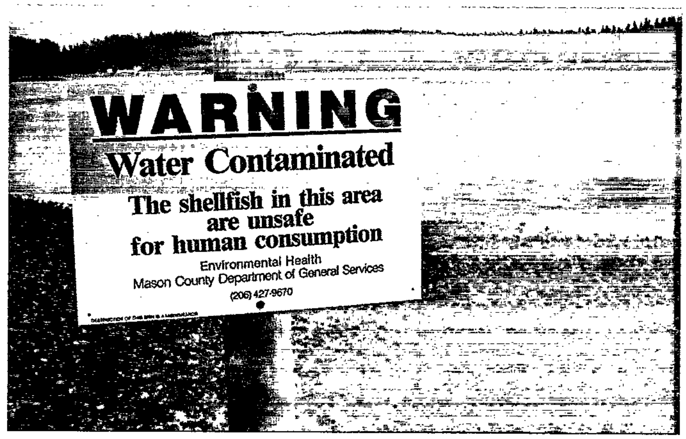
Monitoring will continue for at least six years, including a three-year calibration period before BMP implementation, one year during land-management implementation, and at least two years after BMP implementation. Streamflow is recorded continuously at all sites, and weekly composite samples are collected for analysis of nutrients and suspended solids. Bacterial analyses are performed twice weekly, macroinvertebrates are sampled annually at each site and at an additional reference site, and fish are evaluated twice each year by electroshocking. Land use, agricultural activity, and BMP implementation are monitored primarily through farmer records and interviews.

WASHINGTON — Totten and Eld Inlets

Totten and Eld Inlets, located in southern Puget Sound, contain some of the most productive shellfish areas in the world. The urban, suburban, and rural growth that has occurred within the last decade threatens the exceptional water quality of the inlets. To protect these natural resources, Local and State governments have combined their efforts to reduce nonpoint source pollution, particularly fecal coliform pollution, from failing septic systems and livestock-keeping practices.

The major BMPs being used to address the sources of the pollution problem are repairing failing septic systems and implementing farm plans and practices on the many small hobby farms. Best management practices recommended for animal keepers include pasture and grazing management, fencing, riparian area restoration, livestock density reduction, rainwater and runoff management, and animal waste management.

Like many 319 National Monitoring Program projects, the Totten and Eld Inlets project is using a paired watershed approach to document changes in water quality as a result of BMP implementation. The Kennedy watershed, which is sparsely populated and has few livestock, serves as the control watershed. Implementation of BMPs is occuring in the Schneider watershed (treatment). A single-monitoring-site approach is being used in four other watersheds (McLane, Perry, Pierre, and Burus). Fecal coliform is monitored weekly from early November through mid-April. Other variables such as conductivity, total suspended solids, turbidity, precipitation, and discharge are also being monitored.



Sign indicating bacterial contamination of shellfish beds (Totten and Eld Inlets, Washington).

WISCONSIN — Otter Creek

Biological monitoring within the Otter Creek watershed has shown that the fish community lacks fishable numbers of warmwater sport fish, largely due to inadequate fish habitat and polluted water. Dissolved oxygen concentrations occasionally drop below Wisconsin's State standard of 5.0 mg/l. In addition, bacteria levels exceed Wisconsin's recreational standard of 400 fecal coliforms per 100 ml in many samples.

This largely agricultural, 7,040-acre watershed drains to Lake Michigan via the Sheboygan River. Modeling and field inventories have identified critical areas needing treatment to achieve the National Monitoring Program project goals of improving the fishery, restoring the endangered striped shiner in Otter Creek, improving recreational uses by reducing bacteria levels, reducing pollutant loadings to the Sheboygan River and Lake Michigan, and restoring riparian vegetation.

Improved management of barnyard runoff and manure, nutrient management and reduced tillage on cropland, and shoreline and streambank stabilization are all being implemented to control sources of phosphorus, sediment, bacteria, and streambank erosion in the watershed. State cost-share funds have been used to install these BMPs.

Paired watershed and upstream/downstream monitoring studies covering eight monitoring sites are employed to evaluate the benefits of the BMPs. Meeme River serves as the control watershed and Otter Creek is the treatment watershed in the paired watershed study. Monitoring sites are located above and below a dairy with barnyard and streambank stabilization BMPs.

Habitat, fish, and macroinvertebrates are being sampled each year during the summer. Water chemistry is tracked through analysis of 30 weekly samples collected each year from April to October at the paired watershed and upstream/downstream sites. Runoff events are also sampled at the upstream/downstream sites and at the single-downstream station site at the outlet of Otter Creek.

Fishing in Otter Creek (Wisconsin).

Future Directions of the Section 319 National Monitoring Program

Landowners, taxpayers, and program administrators need to be confident that land-control practices installed to combat nonpoint source pollution will protect or improve water quality. Through the Section 319 National Monitoring Program, USEPA expects to gather data sufficient to demonstrate the types and extent of water quality improvements that can result from the installation of nonpoint source pollution control practices. The USEPA intends to have 20 to 30 projects included in the Section 319 National Monitoring Program that should provide between 40 and 100 separate evaluations of watershed-level and site-specific pollution-control efforts. The current mix of projects is skewed to agricultural sources, but USEPA continues to seek projects focused on other nonpoint source categories such as forestry and urban runoff.

States should benefit from the Section 319 National Monitoring Program, both because of the documentation of findings in the project areas, and due to the opportunity to transfer lessons learned into improved State monitoring efforts and more successful projects in other watersheds. Nonpoint source monitoring projects will be increasingly embodied within the integrated State monitoring assessments which USEPA and the States are working toward.

Local, State, and Federal governments, as well as private organizations, are working to educate citizens about nonpoint source pollution. Reducing it will require the concerted action of farmers and ranchers, homeowners, urban managers, construction and mining officials, and citizens — in other words, all of us. Each of us will have to learn how what we do affects water quality and how we can change our actions to protect one of our Nation's most vital resources: water. The National Monitoring Program is just one way in which these important lessons can be learned, demonstrated, and documented.

For more detailed information on the Section 319 National Monitoring Program projects highlighted in this document, please refer to: *1996 Summary Report: Section 319 National Monitoring Program Projects.* 1996. Osmond, D.L., D.E. Line, S.W. Coffey, J.B. Mullens, J.A. Gale, J. Saligoe-Simmel, and J. Spooner, NCSU Water Quality Group, North Carolina State University, Raleigh, NC. EPA-841-S-96-002. This report is also available on the World Wide Web at http://www.epa.gov/OWOW/NPS/Section319 *or* http://h2osparc.wq.ncsu.edu/96rept319/COVER-96.html.

Glossary

Animal waste management system — A best management practice designed to minimize pollution originating from livestock and poultry operations by providing facilities for the storage and handling of animal wastes.

Baseflow water quality sample — Water quality sample obtained during non-storm conditions.

Beneficial uses — Desirable uses of a water resource such as recreation (fishing, boating, swimming) and water supply.

Best management practices *(BMPs)* — Practices or structures designed to reduce the quantities of pollutants – such as sediment, nitrogen, phosphorus, and animal wastes – that enter surface or ground waters.

Chemical oxygen demand *(COD)* — Quantitative measure of the strength of contamination by organic and inorganic carbon materials.

Conservation tillage — Any tillage and planting system that maintains at least 30% of the soil surface covered by residue after planting to reduce soil erosion by water.

Control watershed — The watershed in which land management practices are not changed during the course of the paired watershed study.

Cost share — The practice of allocating project or other funds to pay a percentage of the cost of constructing or implementing a BMP. The remainder of the costs are paid by the producer.

Critical area — Area or source of nonpoint source pollutants identified in the project area as having the most significant impact on the impaired use of the receiving waters.

Culvert — Either a metal or concrete pipe or a constructed box-type conduit through which water is carried under roads.

Designated uses — Uses specified in terms of water quality standards for each water body or segment.

Detention basin — An area that accepts and retains stormwater runoff in order to protect downstream water resources from nonpoint source pollution.

Dissolved oxygen *(DO)* — The amount of oxygen available for biochemical activity in a given amount (liter) of water.

Drainage area — An area of land that drains to one point.

Electroshocking — A technique in which electricity is applied to the water, which stuns the fish and allows them to be collected, counted, and re-released.

Fecal coliform bacteria *(FC)* — Colon bacteria that are released in fecal material. Specifically, this group comprises all of the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation with 48 hours at 35 degrees Celsius.

Fecal streptococci *(FS)* — Indicate the presence of fecal contamination by warm-blooded animals. Although present in feces, they are not known to multiply in the environment.

Filter strip — A strip of varying width, left in permanent vegetation between waterways and land uses, to intercept and filter pollutants before they enter a water resource.

Grab samples — A volume of water collected, by hand or machine, during one short sampling period.

Geographic information systems *(GIS)* — Computer programs linking features commonly seen on maps (such as roads, town boundaries, water bodies) with related information not usually presented on maps, such as type of road surface, population, type of agriculture, type of vegetation, or water quality information. A GIS is a unique information system in which individual observations can be spatially referenced to each other.

Integrated crop management — A BMP system that combines a wide array of crop production practices so that agricultural nonpoint source pollution is minimized.

Land management — The management of land through the use of BMPs in order to reduce nonpoint source runoff.

Land management monitoring — The recording or tracking of land management activities.

Macroinvertebrate — Any non-vertebrate organism that is large enough to been seen without the aid of a microscope and lives in or on the bottom of a body of water.

National Water Quality Assessment — An ongoing U.S. Geologic Survey project designed to assess historical, current, and future water quality conditions in representative river basins and aquifers nationwide. Consistent and comparable water quality information is collected in 60 major river basins that drain 50% of the U.S. landbase.

Nitrate — A reduced form of nitrogen that is mobile in soils and can cause health problems for infants if the concentration exceeds 10 mg/l of nitrate-nitrogen.

Nonpoint source (NPS) pollution — Pollution originating from diffuse areas (land surface or atmosphere) having no well-defined source.

Nonpoint source pollution controls — General phrase used to refer to all methods employed to control or reduce nonpoint source pollution.

NonPoint Source Management System (NPSMS) — A software system designed to facilitate information tracking and reporting for the USEPA 319 National Monitoring Program projects.

Nutrient management — A BMP designed to minimize the amount of nutrients (usually nitrogen) applied to the soil to no more than the crop is expected to use. This may involve changing fertilizer application techniques, placement, rate, or timing.

Paired watershed design — In this design, two watersheds with similar physical characteristics and, ideally, land use are monitored for one to two years to establish pollutant-runoff response relationships for each watershed. Following this initial calibration period, one of the watersheds receives land treatment while the other (control) watershed does not. Monitoring of both watersheds continues for one to three years.

Peak flow — The maximum flow or maximum rate at which water runs off a site during a storm event.

Periphyton — Microscopic algae that attaches to submerged aquatic vegetation.

Pesticide management — A BMP designed to minimize contamination of soil, water, air, and nontarget organisms by optimizing the amount, type, placement, method, and timing of pesticide application for crop production.

Point source pollution — Water pollution that is generated from an industrial process or a sewage treatment facility.

Rapid Bioassessment Protocol — A standard method developed by USEPA to quickly assess aquatic health through fish and macroinvertebrate diversity.

Riparian corridor — The area of land adjacent to the bank or shoreline of a body of water.

Riparian vegetation — Vegetation that grows within the riparian corridor.

Single-downstream station design — A water quality monitoring design that uses one station at a point downstream from an area of BMP implementation to monitor changes in water quality.

Stormflow water quality samples — Samples of water collected during runoff caused by storm events.

Total suspended solids (TSS) — All solids dissolved and suspended.

Treatment watershed — The watershed that receives land management under the paired watershed monitoring design.

Turbidity — The measurement of the degree to which light travelling through a water column is scattered by the suspended organic (including algae) and inorganic particles.

USDA Hydrologic Unit Area and Demo Projects — Water quality projects, funded by the U.S. Department of Agriculture, that provide education and technical assistance to producers and conduct research with the goal of avoiding water quality degradation from agricultural practices.

Upstream/downstream design — A water quality monitoring design that uses two water quality monitoring sites. One station is placed directly upstream from the area where BMP implementation will occur and the second is placed directly downstream from that area.

Water quality variables — A water quality constituent (for example, total phosphorus pollutant concentration) or other measured factor (such as streamflow, rainfall).

Watershed — The area of land from which rainfall (and/or snow melt) drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins or drainage areas.

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