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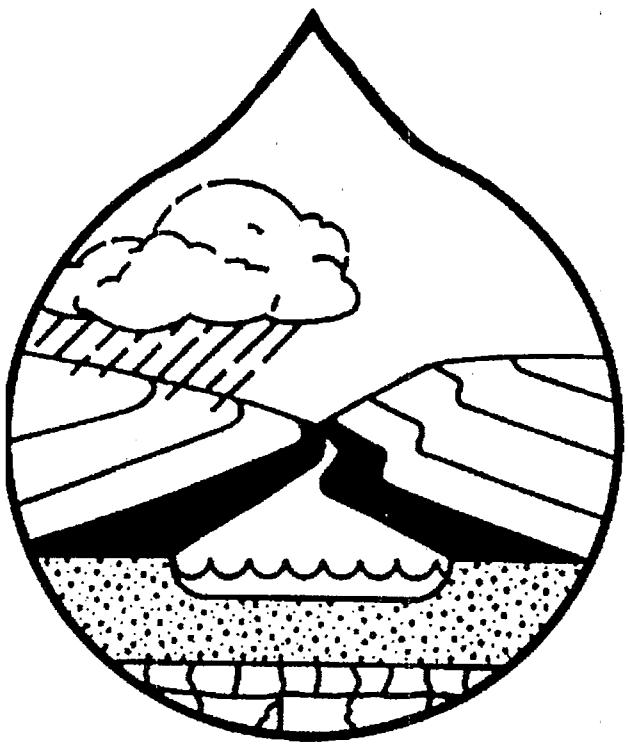
1997 Summary Report



1997 SUMMARY REPORT

SECTION 319 NATIONAL MONITORING PROGRAM PROJECTS

National Nonpoint Source Watershed Project Studies

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Disclaimer

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Table of Contents

List of Figures

List of Figures (Continued)

Chapter 1

Introduction

Monitoring of both land treatment and water quality is the best way to document the effectiveness of nonpoint source pollution control efforts. The purposes of the United States Environmental Protection Agency (USEPA) Section 319 National Monitoring Program (NMP) are to provide credible documentation of the feasibility of controlling nonpoint sources, and to improve the technical understanding of nonpoint source pollution and the effectiveness of nonpoint source control technology and approaches. These objectives are to be achieved through intensive monitoring and evaluation of a subset of watershed projects funded under Section 319 (USEPA, 1991).

The Section 319 NMP projects comprise a small subset of nonpoint source pollution control projects funded under Section 319 of the Clean Water Act as amended in 1987. The development of NMP projects has largely been accomplished through negotiations among States, USEPA Regions, and USEPA Headquarters.

The selection criteria used by USEPA for Section 319 NMP projects are primarily based on the components listed below. In addition to the specific criteria, emphasis is placed on projects that have a high probability of documenting water quality improvements from nonpoint source controls over a 5- to 10-year period.

- Documentation of the water quality problem, which includes identification of the pollutants of primary concern, the sources of those pollutants, and the impact on designated uses of the water resources.
- Comprehensive watershed description.
- Well-defined critical area that encompasses the major sources of pollution being delivered to the impaired water resource. Delineation of a critical area should be based on the primary pollutants causing the impairment, the sources of the pollutants, and the delivery system of the pollutants to the impaired water resource.
- A watershed implementation plan that uses appropriate best management practice (BMP) systems. A system of BMPs is a combination of individual BMPs designed to reduce a specific nonpoint source problem in a given location. These BMP systems should address the primary pollutants of concern and should be installed and utilized on the critical area.
- Quantitative and realistic water quality and land treatment objectives and goals.
- High level of expected implementation and landowner participation.
- Clearly defined nonpoint source monitoring program objectives.
- Water quality and land treatment monitoring designs that have a high probability of documenting changes in water quality that are associated with the implementation of land treatment.
- Well-established institutional arrangements and multi-year, up-front funding for project planning and implementation.
- Effective and ongoing information and education programs.
- Effective technology transfer mechanisms.

Minimum tracking and reporting requirements for land treatment and surface water quality monitoring have been established by USEPA for the NMP projects (USEPA, 1991). These requirements (see Appendix 1) were set forth based upon past efforts (e.g. Rural Clean Water Program) to evaluate the effectiveness of watershed projects.

USEPA developed a software package, the NonPoint Source Management System (NPSMS), to help the 319 National Monitoring Program projects track and report land management and water quality information (Dressing and Hill, 1996). NPSMS has three data files: 1) a Management File for information regarding water quality problems within the project area and plans to address those problems; 2) a Monitoring Plan File for the monitoring designs, stations, and parameters; and 3) an Annual Report File for annual implementation and water quality data. NPSMS version 3.01 is currently used by National Monitoring Program projects, operating in a DOS™ environment. USEPA has recently developed a beta-version 4.2 that runs under MS Windows™ Version 3.1 or better (USEPA, 1996a).

This publication is an annual report on 20 Section 319 NMP projects approved as of September 1, 1997. Project profiles (Chapter 2) were prepared by the North Carolina State University (NCSU) Water Quality Group under the USEPA grant entitled National Nonpoint Source Watershed Project Studies. Profiles have been reviewed and edited by personnel associated with each project.

The 19 surface water monitoring projects selected as Section 319 NMP projects are Lightwood Knot Creek (Alabama), Oak Creek Canyon (Arizona), Morro Bay (California), Jordan Cove Urban Watershed (Connecticut), Lake Pittsfield (Illinois), Waukegan River (Illinois), Sny Magill Watershed (Iowa), Walnut Creek (Iowa), Warner Creek Watershed (Maryland), Sycamore Creek Watershed (Michigan), Elm Creek Watershed (Nebraska), Long Creek Watershed (North Carolina), Peacheater Creek (Oklahoma), Upper Grande Ronde Basin (Oregon), Pequea and Mill Creek Watershed (Pennsylvania), Bad River (South Dakota), Lake Champlain Basin Watersheds (Vermont), Totten and Eld Inlet (Washington), and Otter Creek (Wisconsin). The 20th project, Snake River Plain, Idaho, is a pilot ground water project.

Two of the projects focus on urban sources, while the others primarily address agricultural sources. Nearly all of the projects address river or stream problems, while several projects are intended to directly benefit a lake, estuary, or bay. One of the projects is focused on ground water protection. The progress made by these projects will be showcased in this report.

Each project profile includes a project overview, project description, and maps showing the location of the project in the state and the location of water quality monitoring stations. In the project description section, water resources are identified, water quality and project area characteristics are described, and the water quality monitoring program is outlined. Project budgets and project contacts are also presented.

The Appendices include the minimum reporting requirements for Section 319 NMP projects (Appendix I), a list of abbreviations (Appendix II), and a glossary of terms (Appendix III) used in the project profiles. A list of project documents and other relevant publications for each project is included in Appendix IV. Appendix V contains a matrix for the Section 319 NMP Projects.

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Dressing, S.A. and J. Hill. 1996. Nonpoint Source Management System Software: A Tool for Tracking Water Quality and Land Treatment. IN: *Proceedings Watershed '96 Moving Ahead Together Technical Conference and Exposition.* Water Environment Federation, Alexandria, VA, p. 560-562.

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Chapter 2

Section 319 National Monitoring Program Project Profiles

This chapter contains a profile of each of the Section 319 National Monitoring Program projects approved as of September 1, 1997, arranged in alphabetical order by state.

Each profile begins with a brief project overview, followed by detailed information about the project, including water resource description; project area characteristics; information, education, and publicity; nonpoint source control strategy; water quality monitoring program information; total project budget; impact of other federal and state programs; other pertinent information; and project contacts.

Sources used in preparation of the profiles include project documents and review comments made by project coordinators and staff.

Project budgets have been compiled from the best and most recent information available.

Abbreviations used in the budget tables are as follows:

Proj Mgt ..... Project Management
I&E ..... Information and Education
LT ..... Land Treatment
WQ Monit ..... Water Quality Monitoring
NA ..... Information Not Available

A list of project documents and other relevant publications for each project may be found in Appendix IV.

Alabama

Lightwood Knot Creek
Section 319
National Monitoring Program Project

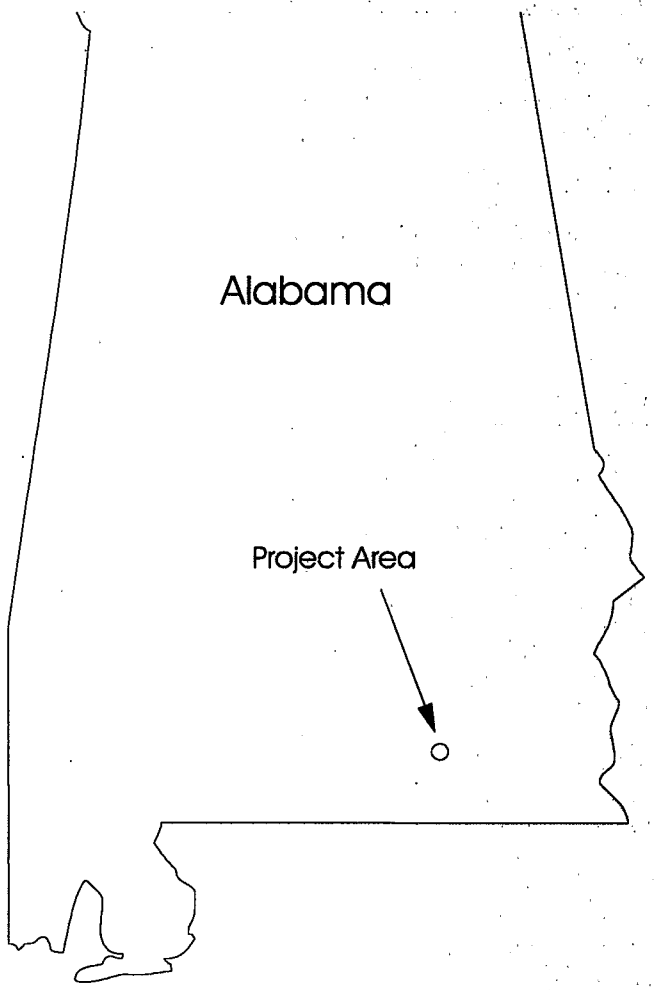

Figure 1: Lightwood Knot Creek (Alabama) Project Location

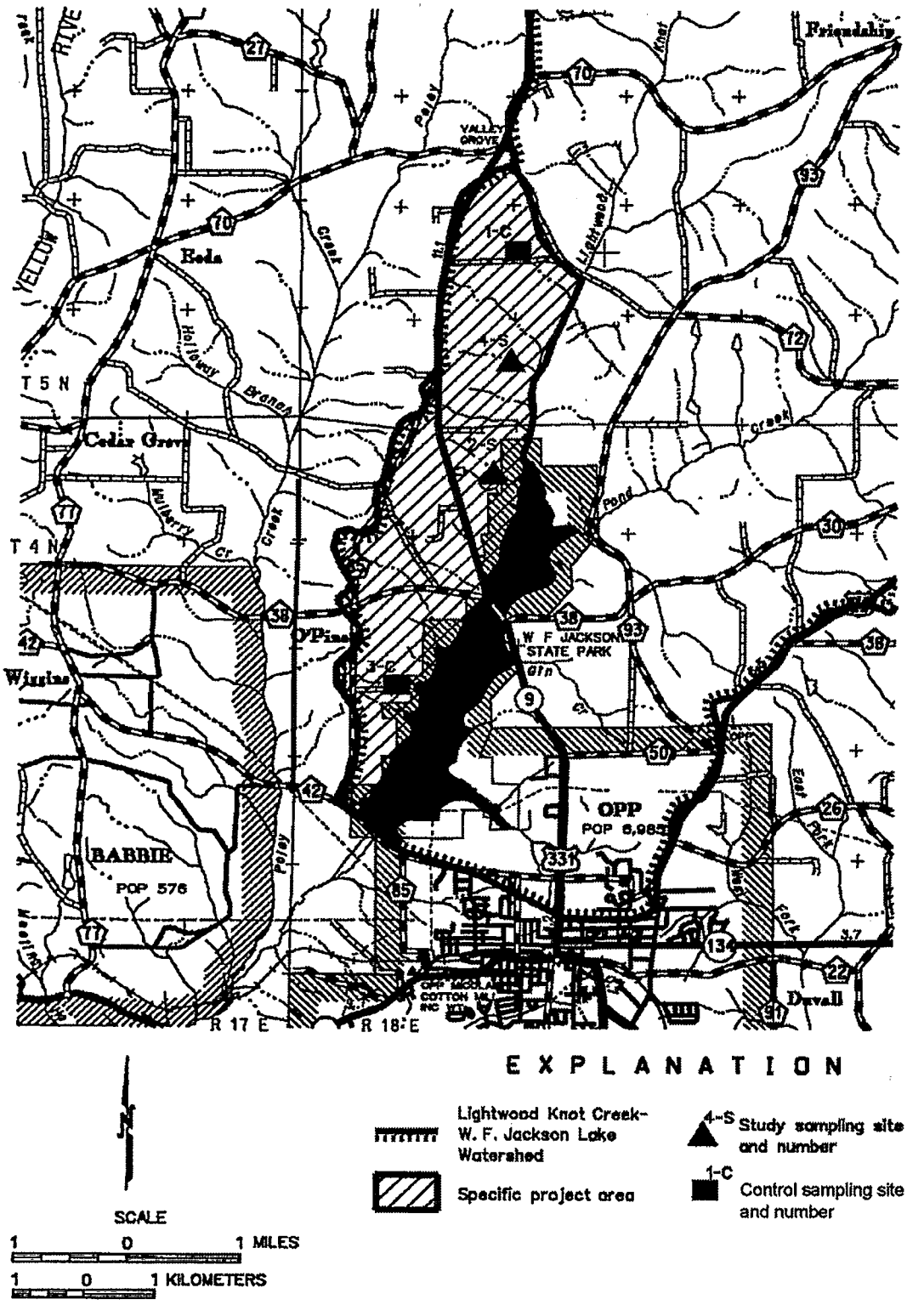

Figure 2: Water Quality Monitoring Stations for Lightwood Knot Creek (Alabama) Watershed

PROJECT OVERVIEW

Lightwood Knot Creek is a tributary of the 1,100-acre W.F. Jackson Lake in Southeastern Alabama (Figure 1). Jackson Lake was constructed for recreational uses in 1987. The 47,300-acre watershed is approximately half forested and half in agriculture. Pasture, hayland, cropland, and poultry production are the dominant agricultural land uses.

Erosion in the Lightwood Knot Creek watershed and resulting sedimentation of Jackson Lake and disposal of animal wastes are major water quality problems. Numerous areas have been identified as sources of sediment. Types of erosion occurring include sheet, rill, ephemeral, and erosion along unpaved roads. Nutrients and bacteria from cattle and poultry operations are also sources of pollution.

Land treatment is scheduled to begin two years after the start of baseline monitoring. Erosion control practices to be implemented include runoff and sediment control structures, critical area planting, cover and green manure crops, and pasture and hayland management. For animal waste management, practices include poultry litter storage and waste utilization.

The Geological Survey of Alabama is conducting physical, chemical, and biological monitoring at two sets of paired watersheds. Each of the sets of watersheds has a control and treatment watershed. These watersheds are small, ranging from 75 to 240 acres. Monitoring is conducted weekly for all parameters (see Water Quality Monitoring section below) from April through August. Only inorganic and physical parameters are monitored for the remainder of the year.

A geographic information system (GIS) is used to map soil, land use practices, underlying geology, slope, monitoring site, and best management practice (BMP) implementation data for the two-paired watersheds that each consist of a control watershed and treatment watershed.

PROJECT DESCRIPTION

Water Resource Type and Size

Water resources of concern are Lightwood Knot Creek and other tributary streams to Jackson Lake, a reservoir created in 1987. Four branches of Lightwood Knot Creek are being monitored in this study. Median seven-day low flow of these branches, sustained by ground water seepage, is approximately 0.32 cubic feet per second per square mile of watershed.

Water Uses and Impairments

Lightwood Knot Creek and Jackson Lake are used for recreation. Disposal of animal wastes and sedimentation of tributaries and the lake are primary concerns. Excessive sediment impairs aquatic life habitat, increases bridge maintenance costs, increases flooding potential, and reduces the capacity of Jackson Lake. Elevated levels of nitrogen and phosphorus and elevated fecal bacteria counts have been found in Lightwood Knot tributaries.

Pre-Project Water Quality

Very little background water quality information is available; however, tributary sampling in July of 1994 provides some indication of pre-project water quality. Turbidity ranged from 41 to 55 NTU. Total nitrogen ranged from 0.8 to 5.0 mg/l and total phosphorus ranged from 0.03 to 0.51 mg/l. Fecal coliform and fecal streptococcus ranged from approximately 500 to nearly 9,000 counts per 100 ml.

Current Water Quality Objectives

The main objective of the project is to achieve and document water quality improvements in the treatment subwatersheds through the implementation of BMPs.

Modifications Since Project Initiated

None.

Project Time Frame

1996 to 2002

Project Approval

1996

PROJECT AREA CHARACTERISTICS

Project Area

The Lightwood Knot watershed draining into Jackson Lake covers 47,300 acres. Jackson Lake is 1,100 acres in size.

Relevant Hydrologic, Geologic, and Meteorological Factors

Soils consist of a thin sandy loam topsoil and a sandy clay subsoil with a depth of six feet. Coastal plain sediments of the tertiary aged lisbon and tallahatta formations outcrop in the project subwatersheds. Average annual rainfall is 56 inches and average annual runoff is 23 inches.

Land Use

Land Use	Percent
Crop	23
Pasture/hay	26
Forest	47
Residential	2
Lake	2
Total	100

Pollutant Sources

Pollutant sources vary from agricultural fields and roads to confined animal operations. Numerous areas have been identified for erosion control BMPs. There are 15 poultry operations that are potential sources of nonpoint source pollution.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

A program of educational outreach and information distribution was initiated in April, 1996.

Progress Towards Meeting Goals

A "water watch" citizens monitoring group is being established in the watershed. Numerous presentations, field tours, and demonstrations have occurred since initiation of the project.

NONPOINT SOURCE CONTROL STRATEGY

Description

Selected BMPs will be used for erosion control in the watershed, depending upon site conditions. Land treatment is scheduled to begin two years after the start of baseline monitoring. Erosion control practices include runoff and sediment control structures, critical area planting, cover and green manure crops, and pasture and hayland management.

Animal waste management practices include poultry litter storage, mortality composting, and water utilization.

Modifications Since Project Started

None.

WATER QUALITY MONITORING

Design

Two paired watershed studies are being conducted on tributaries of Lightwood Knot Creek (Figure 2). There are two control watersheds and two treatment watersheds. No additional BMPs will be installed in the treatment watersheds for two years. No additional BMPs will be installed in the control watersheds until the monitoring study has been completed (approximately seven years).

Modifications Since Project Started

None.

Parameters Measured

Biological

Aquatic habitat assessment and biotic indexing
Fecal coliform (FC)
Fecal streptococcus (FS)

Chemical

Aluminum (Al)
Ammonia (NH_3)
Antimony (Sb)
Arsenic (As)
Barium (Ba)
Beryllium (Be)
Biochemical oxygen demand (BOD)
Boron (B)
Cadmium (Cd)
Calcium (Ca)
Chemical oxygen demand (COD)
Chloride (Cl)
Chromium (Cr)
Copper (Cu)
Iron (Fe)
Lead (Pb)
Magnesium (Mg)
Manganese (Ma)
Nickel (Ni)
Nitrite (NO_2)
Nitrate + nitrite ($N0_3$ + $N0_2$)
Orthophosphate (OP)

pH
Selenium (Se)
Silica (Si)
Silver (Ag)
Sulfate (SO_4^-)
Tin (Sn)
Total dissolved phosphorus (TDP)
Total dissolved solids (TDS)
Total Kjeldahl nitrogen (TKN)
Total suspended solids (TSS)
Turbidity
Zinc (Zn)

Covariates

Bedload sediment
Flow
Precipitation
Specific conductance

Monitoring Scheme for the Lightwood Knot Creek Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Two paired watersheds	Tributary subwatersheds	P NH_3 NO_2 $NO_3 + NO_2$ DO TDS Turbidity TSS FC FS pH Conductivity	Discharge Precipitation	Variable Weekly Daily 15-minute event	2 times per year	7 years

Sampling Scheme

Samples are taken weekly for all parameters from April through August. Total dissolved solids, total suspended solids, and covariates are monitored monthly during the remainder of the year.

Modifications Since Project Started

Surface water quality monitoring at four project sites was initiated on April 1, 1996. Stream discharge, water level, specific conductance, and temperature data are recorded at 15-minute intervals. Water samples are collected every 36 hours from April to September and every 18 hours from to six storm event samples per week. Water samples are analyzed for more than 30 constituents including metals and nutrients. Continuous bedload sediment volumes are monitored for all four streams and continuous rainfall data are collected at two sites. Because of the required short holding time for samples used for bacteria and biochemical oxygen demand analyses, these samples are collected as weekly grab samples from April to September. Best management practices will be implemented in the two treatment watersheds. No additional BMPs will be installed in the control watersheds until the monitoring study has been completed (approximately seven years).

Water Quality Data Management and Analysis

All chemical monitoring results collected during the Lightwood Knot Creek 319 National Monitoring project are entered into the USEPA STORET database and the Alabama Department of Environmental Management's database. Biological data are stored in the USEPA BIOS database.

NPSMS Data Summary

The project intends to track water quality parameters and land use activities with the NonPoint Source Management System (NPSMS).

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Average concentrations of nitrate from April, 1996 through June, 1997, were 0.28 mg/L at site 1-C, 0.29 mg/L at site 2-S, 2.29 mg/L at site 3-C, and 2.00 mg/L at site 4-S. Average concentrations of phosphorus for the same period were 0.03 mg/L at site 1-C, 0.07 mg/L at site 2-S, 0.08 mg/L at site 3-C, and 0.07 mg/L at site 4-S.

Maximum fecal coliform counts during the same period varied from 2,200 colonies per 100 milliliters (col./100 ml) to 14,300 col./100 ml. Maximum fecal streptococcus counts varied from 12,500 col./100 ml to more than 200,000 col./100 ml.

TOTAL PROJECT BUDGET

The estimated budget for the Lightwood Knot Creek Section 319 National Monitoring Program project for the life of the project is:

Project Element	Funding Source ($)			
	Federal	State	Local	Sum
Proj Mgt	120,693	59,305	NA	179,998
I & E	NA	NA	NA	NA
L T	100,000	NA	NA	100,000
WQ Monit	544,307	715,695	NA	1,270,002
TOTALS	775,000	775,000	NA	1,550,000

Source: Geological Survey of Alabama, 1995

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

In 1994, a Water Quality Incentive Project (WQIP) was approved for the Yellow River basin. The project includes funding for BMPs in the Lightwood Knot Creek watershed to improve erosion control and implementation of animal waste management practices.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

None.

PROJECT CONTACTS

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Arizona

Oak Creek Canyon
Section 319
National Monitoring Program Project

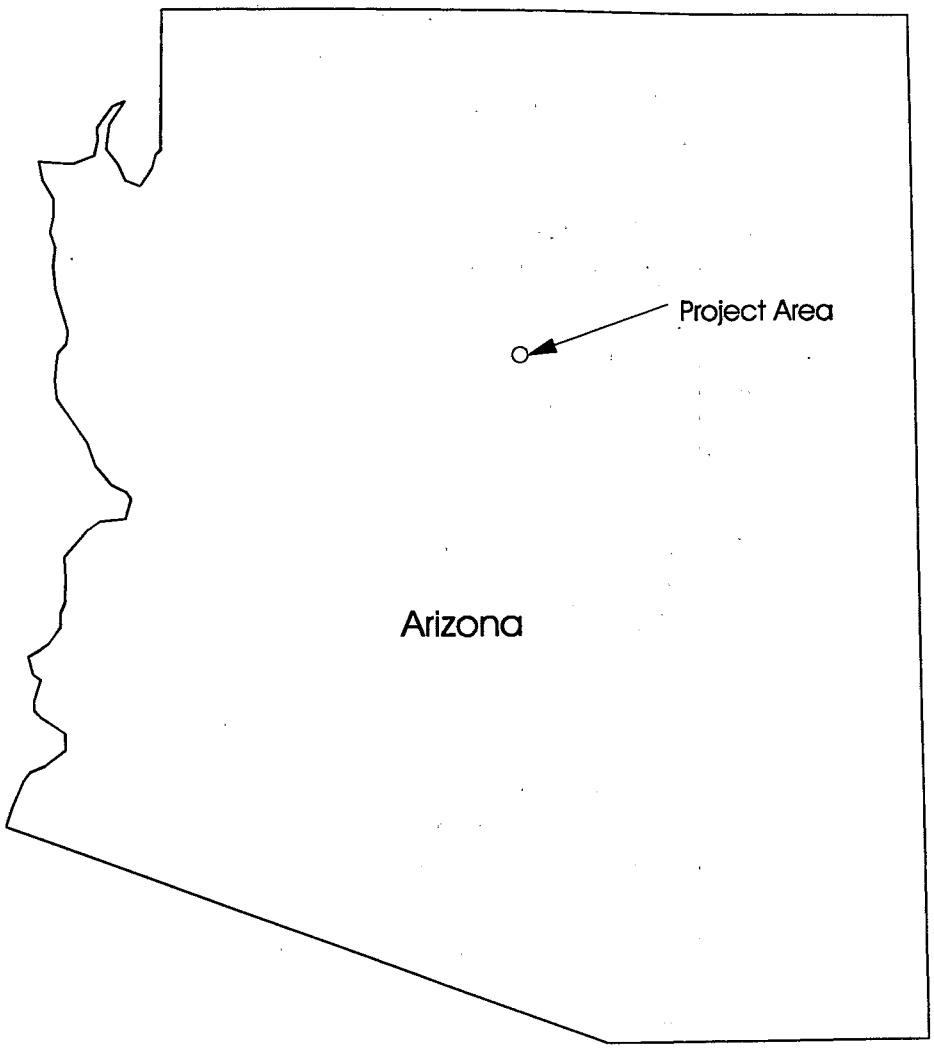

Figure 3: Oak Creek Canyon (Arizona) Project Location

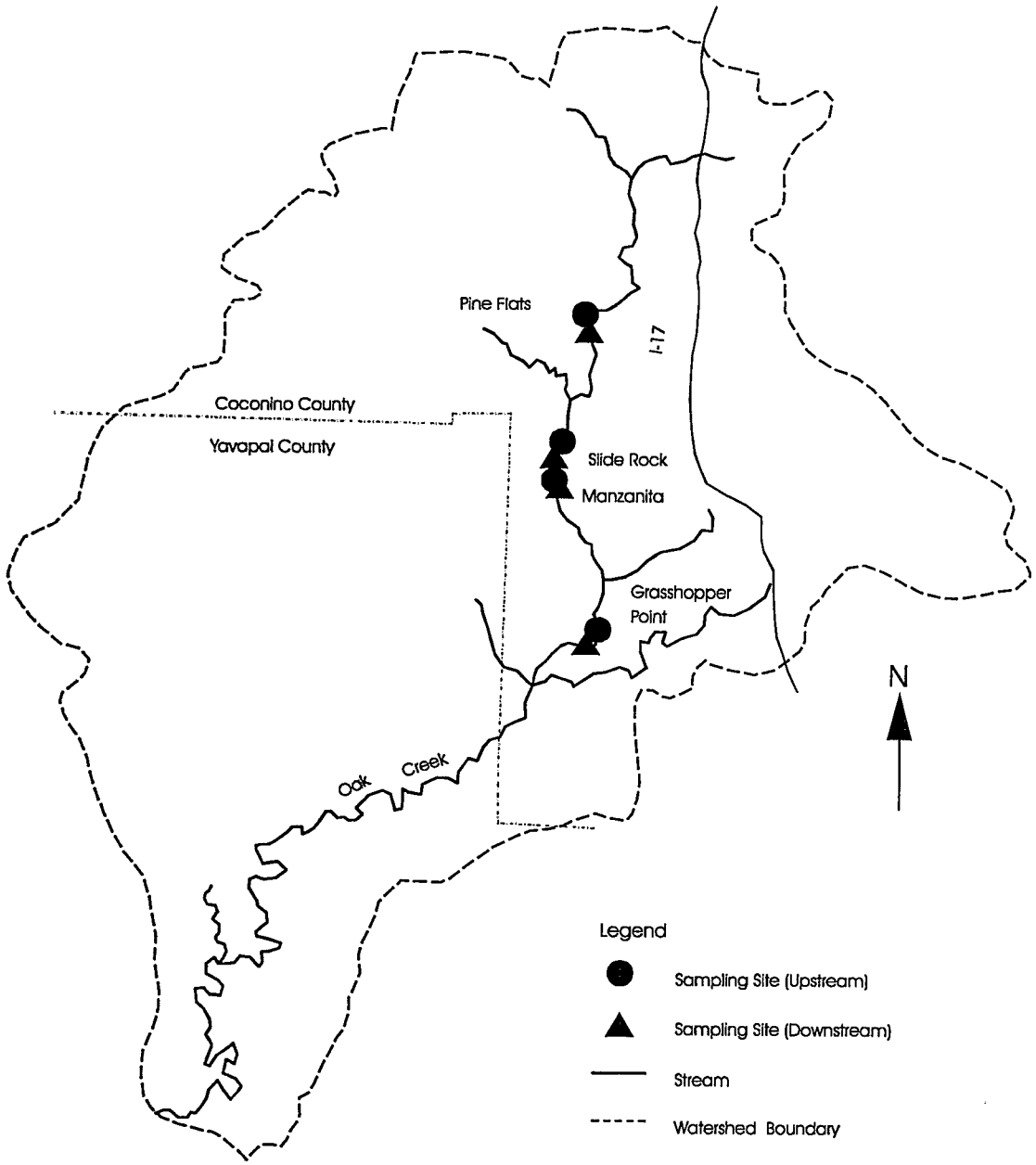

Figure 4: Water Quality Monitoring Stations for Oak Creek Canyon (Arizona)

PROJECT OVERVIEW

Oak Creek flows through the southern rim of the Colorado Plateau (Figure 3). The Oak Creek Canyon National Monitoring project focuses exclusively on that segment of water located in the canyon portion of Oak Creek, a 13-mile steep-walled area of the creek that extends from the Mogollon Rim to the city limits of Sedona, thirteen miles southward. Although Oak Creek Canyon watershed encompasses 5,833 acres, only 907 primarily recreational acres are considered to impact the water quality of Oak Creek Canyon water.

The Oak Creek Section 319 National Monitoring Program project focuses on the implementation and documentation of integrated best management practice (BMP) systems for two locations: Slide Rock State Park and Pine Flats Campground. The eleven-acre Slide Rock State Park is used by more than 350,000 swimmers and sunbathers each season and Pine Flats Campground accommodates approximately 10,000 campers each season. Such heavy use at both locations causes excess fecal coliform and nutrient levels in Oak Creek.

The BMPs implemented at Slide Rock State Park and Pine Flats Campground include enhanced restroom facilities, better litter control through more intense monitoring by state park officials of park visitors, and the promotion of visitor compliance with park and campground regulations on use of facilities, littering, and waste disposal.

A modified nested upstream/downstream water quality monitoring design is used to evaluate the effectiveness of BMPs for improving water quality at Slide Rock State Park. Grasshopper Point, a managed water recreation area similar to Slide Rock State Park, serves as the control. Water quality monitoring stations are located upstream and downstream of swimming areas at both Slide Rock (treatment) and Grasshopper Point (control). A modified nested upstream/downstream water quality monitoring design is also being used for Pine Flats Campground and Manzanita Campground. Pine Flats Campground is the treatment site, while Manzanita serves as the control site. Monitoring stations are upstream/downstream of campground sites. For these two studies, weekly grab samples are taken from May 15 through September 15 for four years.

PROJECT DESCRIPTION

Water Resource Type and Size

Oak Creek cuts deep into the southern rim of the Colorado Plateau. It drops approximately 2,700 feet from its source along the Mogollon Rim to its convergence with the Verde River. The Creek averages about 13 cubic feet per second (cfs) at the study area, but increases to 60 cfs downstream at its confluence with the Verde River.

The study sites for this project are located in Oak Creek Canyon. This portion of the watershed is characterized by steep canyons and rapid water flows with sharp drops forming waterfalls and deep, cold pools. Oak Creek Canyon is the primary recreational area in the watershed.

Water Uses and Impairments

Designated beneficial uses of Oak Creek include full body contact (primarily in Oak Creek Canyon), cold water fishery and wildlife habitat (primarily Oak Creek Canyon), drinking water (along the entire course), agriculture (the lower third), and livestock watering (lower third).

Oak Creek was designated as a Unique Water by the Arizona State Legislature in 1991 on the basis of 1) its popularity and accessibility as a water recreation resource; 2) its aesthetic, cultural, educational, and scientific importance; and 3) its importance as an agricultural and domestic drinking water resource in the Verde Valley. Two other criteria were considered in the designation: 1) Oak Creek Canyon is susceptible to irreparable or irretrievable loss due to the ecological fragility of its location and 2) it is a surface water segment that can be managed as a unique water. Management considerations must include technical feasibility and the availability of management resources.

Biological pathogens and excess nutrients pose the most serious and pressing current threats to Oak Creek water quality. Oak Creek water quality is impaired by high fecal coliform levels, probably resulting from the high usage of the campgrounds and day-use swimming areas by over 350,000 people from May through September, residential septic systems, and natural and grazing animal populations. Excessive nutrients, particularly phosphorus, which exceeds the 0.10 mg/l standard, threaten the water integrity of two impoundments located well below Oak Creek that provide a major source of drinking water for the City of Phoenix. These sources of pollution threaten all designated uses.

Pre-Project Water Quality

Water Recreation and Camping Areas

Human pathogens (protozoa, bacteria, and viruses) contaminate the Canyon segment of Oak Creek. Most of the attention has focused upon Slide Rock State Park and Grasshopper Point, the two managed "swimming holes" in the area. Fecal coliform counts peak in the summer during the height of the tourist season.

Fecal Coliform Levels During the Tourist Season (1993)

Date	Fecal Coliform Count (cfu/100 ml)
July	434
August	393
June	61
September	54

Nutrient levels, especially phosphorus, are also of concern, as shown below:

Phosphorus (P) Concentrations at Pine Flats Campground During 1993 (the annual average standard is 0.10 mg/l)

Date	P (mg/l)
February, 1993	0.12
March, 1993	0.20
April, 1993	0.12
June, 1993	0.14
July, 1993	0.28
August, 1993	0.41

Current Water Quality Objectives

Water Recreation Project Objectives

- A 50% reduction in fecal coliform
- A 20% reduction in nutrients, particularly ammonia

Camping Project Objectives

- A 50% reduction in fecal coliforms
- A 20% reduction in nutrients

Modifications Since Project Initiation

The Slide Rock State Park parking lot study has been discontinued.

Project Time Frame

1994 to 1998

Project Approval

1994

PROJECT AREA CHARACTERISTICS

Project Area

The entire Oak Creek watershed contains 300,000 acres. The project area, Oak Creek Canyon, encompasses 5,833 acres. However, the critical area comprises only 907 acres.

Relevant Hydrologic, Geologic, and Meteorologic Factors

Flow in Oak Creek ranges from an average 13 cfs, in the higher Oak Creek Canyon area, to 60 cfs at its confluence with the Verde River.

Annual precipitation in the Oak Creek watershed varies from a six-inch average in the Verde Valley to 20 inches per year on the higher elevations of the Mogollon rim. The majority of rainfall occurs during July and August of the monsoon season (July 4 to September 15). Summer rainfall storm events are short and intense in nature (rarely lasting for more than a half-hour) and are separated by long dry periods. In a normal summer season, over twenty rainfall events occur.

Perennial flow in Oak Creek is sustained by ground water, the main source of which is the regional Coconino Aquifer. The majority of aquifers in the Oak Creek watershed are confined or artesian. Within the Oak Creek watershed, ground water flow is generally to the south, paralleling topography toward the low-lying valley floor.

Land Use

Land Use	Acres	%
Road	55	6
Campground and Parking Lots	123	14
Business and Residential	245	27
Floodplain	290	32
Undeveloped	194	21
TOTAL	907	100

Source: *The Oak Creek 319(h) Demonstration Project National Monitoring Program Work Plan*, 1994

Pollutant Sources

Pollutants in Oak Creek addressed in this study originate mainly from swimmers and campers. DNA analyses are being performed to verify sources of bacteria contamination.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

Numerous organizations and individuals perceive themselves as "owners" of Oak Creek Canyon. It is in the best interest of the Oak Creek National Monitoring Program project to fully involve these groups and individuals in informational and educational activities.

The Oak Creek Advisory Committee, which was formed in 1992, involves federal, state, and local government agencies and private organizations such as Keep Sedona Beautiful and the Arizona River Coalition. The committee meets monthly to keep participants informed of current project activities and results, gain insights into areas of concern, and learn about the BMPs that are being implemented as part of the 319 National Monitoring Program.

Progress Towards Meeting Goals

With respect to the proposed Public Education Campaign for the Oak Creek Canyon Section 319 National Monitoring Program project, the following events have transpired:

- The U.S. Forest Service prepared a Public Education Plan for Slide Rock State Park and hired a public education specialist to continue and expand the public education effort.
- The Arizona State Parks staff have developed signs and a brochure aimed at educating Slide Rock visitors.

NONPOINT SOURCE CONTROL STRATEGY

Slide Rock and Grasshopper Point (Water Recreation Project)

The access to and ambience of restroom facilities located at the Slide Rock swimming area are being enhanced. Park officials are attempting to reduce the amount of trash disposal in unauthorized areas. Finally, social strategies have been implemented to promote compliance with park regulations.

Pine Flats and Manzanita (Campgrounds Project)

The nonpoint source control strategy for the campground project targets the upstream site of Pine Flats. Best management practices implemented at Pine Flats are designed to reduce pollutants associated with human use of campground facilities. The BMPs implemented include enforcement of a clean zone between the creek and the campground and the promotion of the use of existing restroom facilities. Direct contact by park personnel with visitors and the addition of more visible signs help accomplish these goals.

Modifications Since Project Started

None.

Progress Towards Meeting Goals

The Oak Creek Task Force has implemented the following BMPs:

- Erecting nearly one mile of permanent barricades on State Highway 89A, reducing the number of visitors having access by approximately one-half
- Modernizing the single restroom located at the swimming area and maintaining a bridge to the facility

WATER QUALITY MONITORING

Design

The water recreation project, which is a modified nested upstream/downstream monitoring design (Figure 4), is designed to document the change in water quality as a result of the application of BMPs. The swimming sites at Slide Rock State Park (treatment site) and Grasshopper Point (the control site) are compared. Water quality monitoring stations are located above and below each swimming area.

The camping area project also uses an upstream/downstream monitoring design. Water quality monitoring stations have been installed above and below both the camping area at Pine Flats (treatment site) and the site at Manzanita (control site).

The two-year BMP implementation phase entails sampling protocols identical to those instituted in the calibration and project sampling phase. The objective of this monitoring phase is to demonstrate the extent to which land treatment has reduced nonpoint source pollution.

Modifications Since Project Started

None.

Parameters Measured

Slide Rock and Grasshopper Point (Water Recreation Project) and Pine Flats and Manzanita (Campgrounds Project)

Biological (Critical Parameters)

Fecal coliform (FC)

Chemical and Others (Critical Parameters)

Ammonia (NH_3)
Nitrate (NO_3)
Phosphate (PO_4^{3-})

Covariates (Noncritical Parameters)

Water temperature
Stream velocity and level
Number of users of the sites
Weekly precipitation
Alkalinity
Calcium (Ca^{2+})
Chloride (Cl^-)
Conductivity
Dissolved oxygen (DO)
Magnesium (Mg^{2+})
pH
Potassium (K^+)
Sodium (Na^+)
Turbidity

Sampling Scheme

Slide Rock/Grasshopper Point (Water Recreation Project) and Pine Flats/Manzanita (Campgrounds Project)

Grab samples are collected weekly from May 15 through September 15 and monthly from November through April. Samples are taken in the deepest part of the stream at each sampling site.

The monitoring scheme for the projects is presented as follows.

Monitoring Scheme for the Oak Creek Canyon Section 319 National Monitoring Program Project

Design	Activity/ Sites*	Critical Monitoring Parameters	Noncritical Covariates	Frequency	Time	Duration
Upstream/ downstream	Water Recreation Slide Rock (T)	FC NH_3/NH_4^+ NO_3^-	Alkalinity Ca^{2+} Cl^-	9/15-5/15 monthly 5/15-9/15 weekly	10 am - 5 pm Saturdays	2 years pre-BMP 2 years BMP
	Grasshopper Point (C)	PO_4^{3-} BOD	Conductivity DO Mg^{2+}			
	Camping Pine Flats (T)		pH K^+ Rainfall Na^+			
	Manzanita (C)		Streamflow Turbidity Visitor count Water temperature			

* T = the treatment site; C = the control site

Modifications Since Project Started

The Slide Rock Parking Lot study has been discontinued.

Water Quality Data Management and Analysis

The project team stores all raw data in STORET and reports the project results in USEPA's Nonpoint Source Management System (NPSMS) software.

NPSMS Data Summary

Currently unavailable.

Modifications Since Project Started

None.

Progress Towards Meeting Goals

The DOS SYSTAT for Windows program (Wilkinson, Leland. *SYSTAT: The System for Statistics,* Evanston, IL: SYSTAT, Inc., 1990) was used for statistical analysis. Multiple correlations for each factor were obtained. Sufficient data points (at least twenty for each factor) were available to provide valid and reliable data. Generally, analysis revealed extremely high correlations for most water quality parameters between treatment and control locations.

Project personnel have concluded that a significant amount (30.79%) of the ammonia recorded at the Slide Rock downstream is added into the water column between the upstream and downstream location. The ammonia source may result from visitors urinating in the water or on the terrain nearby or may be released into the water column from roiled sediments.

Approximately 98% of the time, fecal coliforms are added in significant amounts (88.2%) into the water column between upstream and downstream sites at Slide Rock.

Identifying fecal coliform sources is difficult. Slide Rock visitors are, undoubtedly, a source of pollution (i.e., discarding dirty diapers in the water and defecating in the water or on land nearby). However, visitor behavior cannot account for the cyclical nature of elevated fecals in this area. High levels of fecals (i.e., levels approaching the current water quality standard of 800 cfu/100 ml for a single measure) historically and during this project are typically detected during the "monsoon season" — roughly between July 15 and September 15 of each year. If visitors were the sole source of elevated fecal pollution, then high levels should have occurred between Memorial Day and July 4, when visitor counts are as high as during the monsoon season. This has not occurred; therefore, there must be one or more other sources of fecal coliform. Northern Arizona University is currently using restriction fragment length polymorphism to genotype *Escherichia coli* populations in Oak Creek to differentiate between human and animal sources of pollution.

Personnel from the Oak Creek Task Force continue to explore two possible sources of fecal pollution occurring at downstream Slide Rock: 1) visitors pollute the water directly by depositing excrement into the water or on the land nearby (which is washed into the water) and 2) visitors pollute the water indirectly by roiling fecal-laden sediments washed downstream to the Slide Rock area.

TOTAL PROJECT BUDGET

The estimated budget for the Oak Creek Canyon Section 319 National Monitoring Program project for the life of the project is:

Funding Source ($)			
Federal	**State**	**Local**	**Total**
330,000	87,000	288,000	705,000

Modifications Since Project Started

The Arizona Department of Environmental Quality has decided not to fund the Oak Creek Canyon National Monitoring Program project after the funding from Region IX of the U.S. Environmental Protection Agency is discontinued (spring, 1998).

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The Oak Creek Section 319 National Monitoring Program project complements several other programs (federal, state, and local) located in the Verde Valley:

- The U.S. Geological Survey has initiated a comprehensive water use/water quality study focusing on the northcentral Arizona region extending from the City of Phoenix to the Verde Valley.
- The Verde Watershed Watch Program, a 319(h)-funded program run by Northern Arizona University. The program is designed to train students and teachers from seven high schools (located within the river basin) in macroinvertebrate and water chemistry sampling to evaluate the effects of BMP implementation.
- The Arizona Department of Environmental Quality has established the Verde Nonpoint Source Management Zone in the state.

- The Colorado Plateau Biological Survey has established a major riparian study project focusing on the Beaver Creek/Montezuma Wells area of the Verde Valley.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

None.

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California

Morro Bay Watershed
Section 319
National Monitoring Program Project

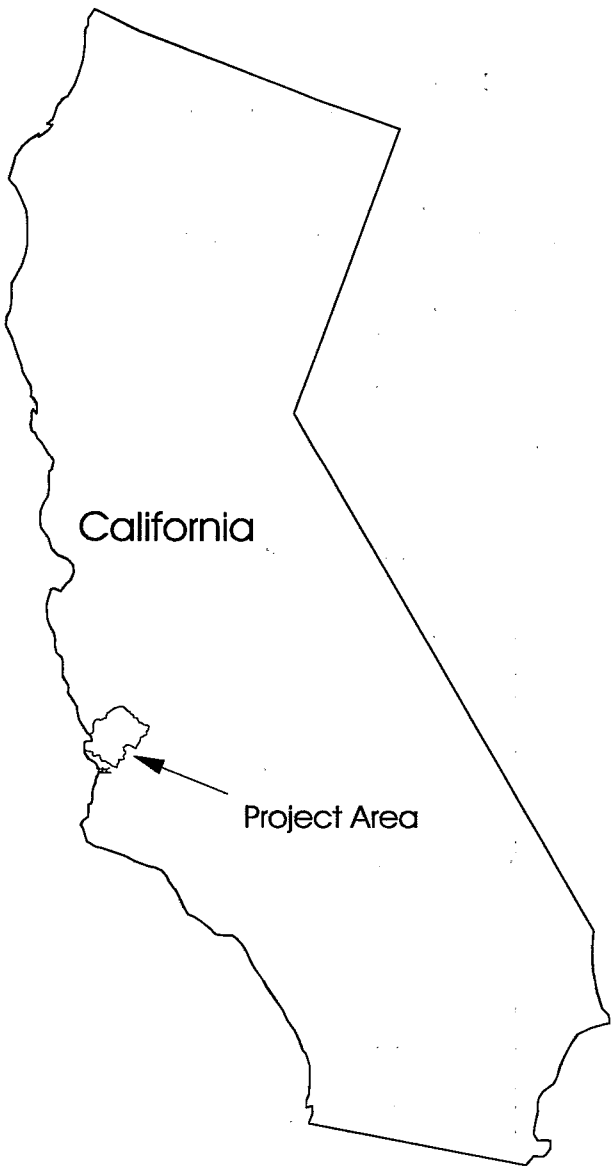

Figure 5: Morro Bay (California) Watershed Project Location

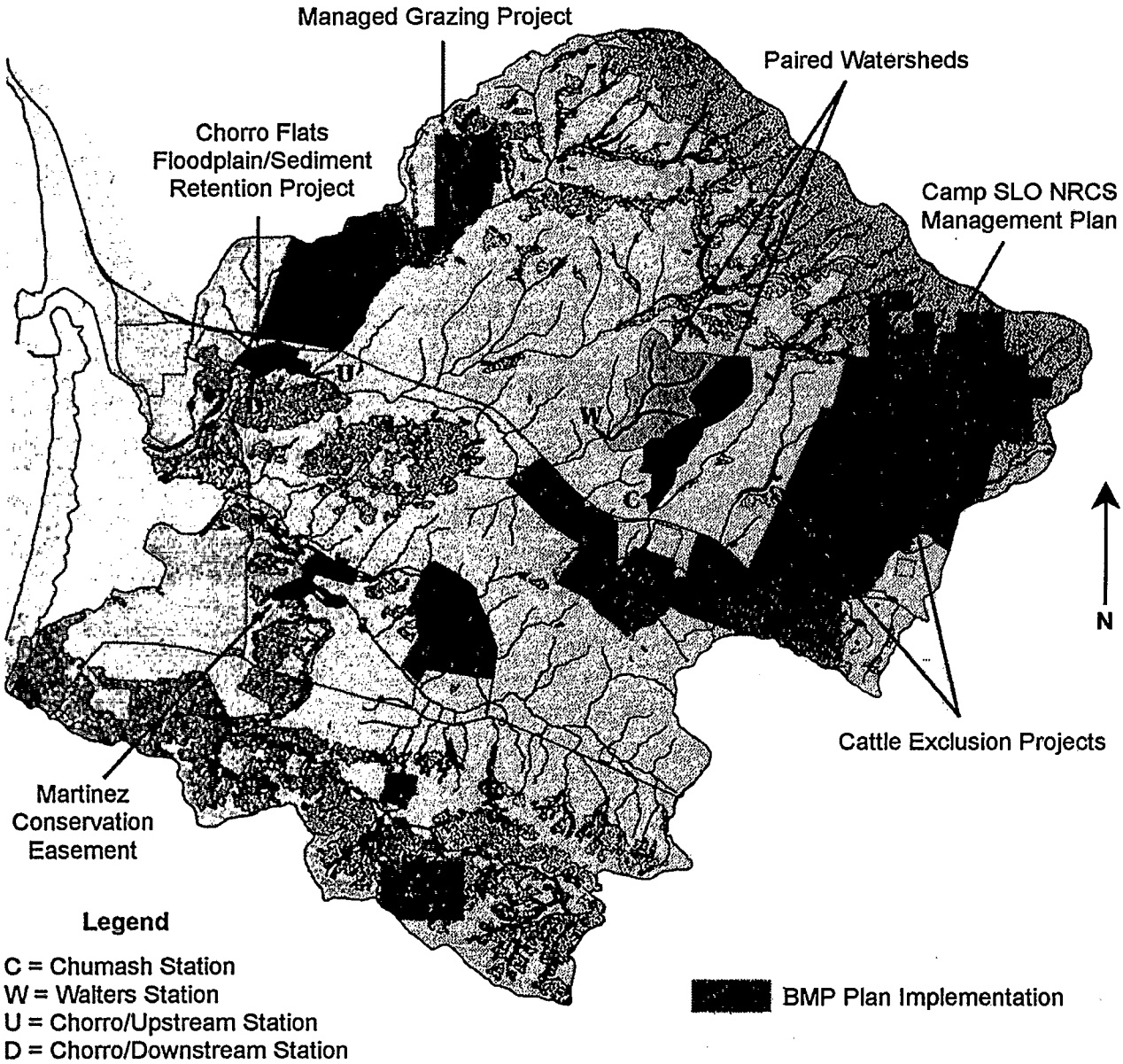

Figure 6: Paired Watersheds (Chorro Creek and Los Osos Creek) in Morro Bay (California)

PROJECT OVERVIEW

The Morro Bay watershed is located on the central coast of California, 237 miles south of San Francisco in San Luis Obispo County (Figure 5). This 76-square mile watershed is an important biological and economic resource. Two creeks, Los Osos and Chorro, drain the watershed into the Bay. Included within the watershed boundaries are two urban areas, prime agricultural and grazing lands, and a wide variety of natural habitats that support a diversity of animal and plant species. Morro Bay estuary is considered to be one of the least altered estuaries on the California coast. Heavy development activities, caused by an expanding population in San Luis Obispo County, have placed increased pressures on water resources in the watershed.

Various nonpoint source pollutants, including sediment, bacteria, metals, nutrients, and organic chemicals, are entering streams in the area and threatening beneficial uses of the streams and estuary. The primary pollutant of concern is sediment. Brushland and rangeland contribute the largest portion of this sediment, and Chorro Creek contributes twice as much sediment to the Bay as does Los Osos Creek. At present rates of sedimentation, Morro Bay could be lost as an open water estuary within 300 years unless remedial action is undertaken. The main objective of the Morro Bay Nonpoint Source Pollution and Treatment Measure Evaluation Program, of which the Morro Bay Watershed Section 319 National Monitoring Program project is a subset, is to reduce the quantity of sediment entering Morro Bay.

The U.S. Environmental Protection Agency (USEPA) Section 319 National Monitoring Program project for the Morro Bay watershed was developed to characterize the sedimentation rate and other water quality conditions in a portion of Chorro Creek, to evaluate the effectiveness of several best management practice (BMP) systems in improving water quality and habitat quality, and to evaluate the overall water quality at select sites in the Morro Bay watershed.

The Morro Bay Watershed Section 319 National Monitoring Program project is a paired watershed study on two subwatersheds of Chorro Creek (Chumash and Walters Creeks). The purpose of the project is to evaluate the effectiveness of a BMP system in improving water quality (Figure 6). BMP system effectiveness is being evaluated for sites outside the paired watershed. These projects include a managed grazing system, cattle exclusion projects, and a flood plain sediment retention project. In addition, water quality samples taken throughout the watershed will document the changes in water quality during the life of the project.

PROJECT DESCRIPTION

Water Resource Type and Size

The total drainage basin of the Morro Bay watershed is approximately 48,450 acres. The 319 project monitoring effort is focused on the Chorro Creek watershed. Chorro Creek and its tributaries originate along the southern flank of Cuesta Ridge, at elevations of approximately 2,700 feet. Currently three stream gauges are present in the Chorro Creek watershed: one each on the San Luisito, San Bernardo, and Chorro creeks. The San Bernardo gauge became inoperable in 1996; a new gauge has yet to be installed. Annual discharge is highly variable, ranging from approximately 2,000 to over 20,000 acre-feet, and averaging about 5,600 acre-feet. Flow in tributaries is intermittent in dry years and may disappear in all but the uppermost areas of the watershed. In spite of the intermittent nature of these creeks, both Chorro and Los Osos creeks are considered cold-water resources, supporting anadromous fisheries (steelhead trout).

Morro Bay is one of the few relatively intact natural estuaries on the Pacific Coast of North America. The beneficial uses of Morro Bay include recreation, industry, navigation, marine life habitat, shellfish harvesting, commercial and sport fishing, wildlife habitat, and rare and endangered species habitat.

A number of fish species (including anadromous fish, which use the Bay during a part of their life cycle) have been negatively affected by the increased amount of sediment in the streams and the Bay. Sedimentation in anadromous fish streams reduces the carrying capacity of the stream for steelhead and other fish species by reducing macroinvertebrate productivity, spawning habitat, and egg and larval survival rates, and increasing gill abrasion and stress on adult fish. Trout are still found in both streams, but ocean-run fish have been greatly reduced. However, several reports of sitings have occurred in the past two years. The Tidewater Goby, a federally endangered brackish-water fish, has been eliminated from the mouths of both Chorro and Los Osos creeks, most likely as a result of sedimentation of pool habitat in combination with excessive water diversion.

Accelerated sedimentation has also resulted in significant economic losses to the oyster industry in the Bay. Approximately 100 acres of oyster beds have been lost due to excessive sedimentation. Additionally, fecal coliform bacteria carried by streams to the Bay have had a negative impact on the shellfish industry, resulting in periodic closures of the area to shellfish harvesting (NRCS, 1992). Due to continually elevated levels of total and fecal coliform, the California Department of Health Services has reclassified the Bay from "conditional" to "restricted." Reclassification to "restricted" requires changes in harvesting practices, which have cost prohibitive for existing operations and have resulted in closure of a significant portion of the growing area. Elevated fecal coliform counts have been detected in water quality samples taken from several locations in the watershed and the Bay. Elevated fecal coliform detections, exceeding 1,600 Most Probable Number/100 ml, have generally been found in streams in areas where cattle impact is heavy. The most probable sources of year round coliform pollution to the Bay, however, are failing septic systems and boater discharges.

Pre-Project Water Quality

The two creeks that flow into the estuary (Chorro Creek and Los Osos Creek) are listed as impaired by sedimentation, metals, temperature, and agricultural nonpoint source pollution by the State of California (Central Coast Regional Water Quality Control Board, 1993). Nutrients are also a pollutant of concern in both drainages.

Studies conducted within the watershed have identified sedimentation as a serious threat in the watershed and estuary. Results of a U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Hydrologic Unit Areas (HUA) project study show that the rate of sedimentation has increased tenfold during the last 100 years (NRCS, 1989b). Recent studies indicate that the estuary has lost 25% of its tidal volume in the last century as a result of accelerated sedimentation, and has filled in with an average of two feet of sediment since 1935 (Haltiner, 1988). NRCS estimated the current quantity of sediment delivered to Morro Bay to be 45,500 tons per year (NRCS, 1989b).

Current Water Quality Objectives

The overall goal of the Section 319 National Monitoring Program project is to evaluate improvements in water quality resulting from implementation of BMPs. The following objectives have been identified for this project:

- Identify sources, types, and amounts of nonpoint source pollutants (see the list of parameters that will be monitored under Water Quality Monitoring), originating in paired watersheds in the Chorro Creek watershed (Chumash and Walters creeks).
- Determine stream flow/sediment load relationships in the paired watersheds.

- Evaluate the effectiveness of improving water quality in one of the paired subwatersheds (Chumash Creek) of a BMP system.
- Evaluate the effectiveness of several BMP systems in improving water or habitat quality at selected Morro Bay watershed locations, including a managed grazing project, cattle exclusion projects, and a flood plain sediment retention project.
- Monitor overall water quality in the Morro Bay watershed to identify problem areas for future work, detect improvements or changes, and contribute to the water quality database for watershed locations.
- Develop a geographic information system (GIS) database to be used for this project and in future water quality monitoring efforts.

Modifications Since Project Initiation

None.

Project Time Frame

August 1, 1993 to June 30, 2003

Project Approval

1993

PROJECT AREA CHARACTERISTICS

Project Area

The Morro Bay watershed drains an area of 48,450 acres into the Morro Bay estuary on the central coast of California. The Bay is approximately 4 miles long and 1.75 miles wide at its maximum width. The project area is located in the northeast portion of the Morro Bay watershed.

Relevant Hydrologic, Geologic, and Meteorologic Factors

Morro Bay was formed during the last 10,000 to 15,000 years (NRCS, 1989a). A post-glacial rise in sea level of several hundred feet resulted in a submergence of the confluence of Chorro and Los Osos creeks (Haltiner, 1988). A series of creeks that originate in the steeper hillslopes to the east of the Bay drain westward into Chorro and Los Osos creeks, which drain into the Bay. The 400-acre salt marsh has developed in the central portion of the Bay in the delta of the two creeks. A shallow ground water system is also present underneath the project area.

The geology of the watershed is highly varied, consisting of complex igneous, sedimentary, and metamorphic rock. Over fifty diverse soils, ranging from fine sands to heavy clays, have been mapped in the area. Soils in the upper watershed are predominantly coarse-textured, shallow, and weakly developed. Deeper medium- or fine-textured soils are typically found in valley bottoms or on gently rolling hills. Earthquake activity and intense rain events increase landslide potential and severity in sensitive areas.

The climate of the watershed is Mediterranean: cool, wet winters and warm, dry summers. The area receives about 95% of its 18-inch average annual precipitation between the months of November and April. The mean air temperatures range from lows around 45 degrees F in January to highs of 75 degrees F in October, with prevailing winds from the northwest averaging about 15 to 20 miles per hour.

Land Use

Approximately 60% of the land in the watershed is classified as rangeland. Typical rangeland operations consist of approximately 1,000 acres of highly productive grasslands supporting cow-calf enterprises. Brushlands make up another 19% of the watershed area. Agricultural crops (truck, field, and grain crops), woodlands, and urban areas encompass approximately equal amounts of the landscape in the watershed.

Land Use	Acres	%
Agricultural Crops	3,149	7
Woodland	3,093	7
Urban	3,389	8
Brushland	8,319	19
Rangeland	26,162	59
Total	44,112	100

Source: NRCS, 1989a

Pollutant Sources

It has been estimated that 50% or more of the sediment entering the Bay results from human activities. Sheet and rill erosion account for over 63% of the sediment reaching Morro Bay (NRCS, 1989b). An NRCS *Erosion and Sediment Study* identified sources of sediment to the Bay, which include activities on rangeland, cropland, and urban lands (NRCS, 1989b). The greatest contribution of sediment to the Bay originates from upland brushlands (37%) because of the land's steepness, parent material, lack of undercover, and wildfire potential. Rangelands are the second largest source of sediment entering into streams (12%). Cattle grazing has damaged riparian areas by stripping the land of vegetation and breaking down bank stability. The unvegetated streambanks, as well as overgrazed uplands, have resulted in accelerated erosion. Other watershed sources that contribute to sediment transport into Morro Bay include abandoned mines, poorly maintained roads, agricultural croplands, streambank erosion, and urban activities.

Modifications Since Project Started

In August, 1994, the "Highway 41 Fire" burned a significant portion (7,524 acres) of the upper Chorro Creek watershed and its tributaries. The paired watersheds, Chorro, Chumash, and Walters, were not burned. Above average precipitation and several periods of widespread flooding during the 1994-95 winter, following the wildfires, resulted in significant erosion and sediment loading throughout the watershed.

INFORMATION, EDUCATION, AND PUBLICITY

Many formal and informal educational programs conveying information about the 319 National Monitoring Program project and the watershed are conducted each year. Information and education programs include field tours, lectures, and workshops about the water quality problems within the watershed (for landowners and local agency personnel).

Progress Towards Meeting Goals

Public presentations about the Morro Bay 319 National Monitoring Program project are regularly made to groups such as Friends of the Estuary, Cal Poly State University (Cal Poly), Cuesta Community College, and the Morro Bay Task Force. Presentations on the monitoring program were also made at a Regional Water Quality Control Board public hearing and at the annual Soil and Water Conservation Society Conference (California Chapter). A paper will be given on the program at the International Symposium on Soil Erosion and Dryland Farming in Xi'an, China, in September of 1997.

In addition, educational outreach efforts have been made at several Cooperative Extension erosion control field tours and workshops, the Morro Bay Museum of Natural History, a 4-H watershed education day, the California Biodiversity Council, and Cal Poly Coastal Resources, Soil Science, Limnology, and Marine Biology classes. Publicity generated has included excellent articles in the local newspaper, a radio program, and a featured spot on the local evening news.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Paired Watershed

In the paired watershed, a BMP system is being used to reduce nonpoint source pollutants. Cal Poly is responsible for implementing the BMP system on Chumash Creek, which is one of the streams in the paired watershed, while Walters Creek serves as the control. The implemented BMPs include 1) fencing the riparian corridor, 2) creating smaller pastures for better management of cattle-grazing activities, 3) providing appropriate water distribution to each of these smaller pastures, 4) stabilizing and revegetating portions of the streambank, 5) installing water bars and culverts on farm roads where needed, and 6) removing and stabilizing a failed on-stream stock pond. During the project, riparian vegetation is expected to increase from essentially zero to at least 50% coverage. The project team has established a goal of a 50% reduction in sediment following BMP implementation.

BMP Systems at Sites within the Morro Bay Watershed

The NRCS has designed several BMP systems in the Morro Bay watershed. Three of these systems are being evaluated for their effect on water and habitat quality:

- A flood plain sediment retention project has been developed at Chorro Flats to retain sediment (sediment retention project)
- A riparian area along Dairy Creek, a tributary of Chorro Creek, has been fenced and revegetated (cattle exclusion project)
- Fences and watering systems have been installed to allow rotational grazing of pastures on the 1,400-acre Maino ranch (managed grazing project)

The goals for these projects during the next 10 years are to achieve:

- A 33.8% decrease in sediment yield from the sediment retention project
- A 66% reduction in sediment yield from the cattle exclusion project
- A 30% reduction in sediment as a result of the managed grazing project

Modifications Since Project Started

Modifications occurred at Chorro Flats due to emergency post-fire concerns. An existing level breech was widened so that the flood plain could serve as a sediment deposition area.

Progress Towards Meeting Goals

Paired Watershed Study: Funding was acquired through CWA 319(h) for implementation of improvements on the paired watershed. A Technical Advisory Committee was formed and has expanded its focus to include monitoring projects throughout the entire Morro Bay watershed. Implementation for land improvements on the Chumash Creek watershed is nearly complete. Implementation has included construction of riparian pastures, additional upland pastures, installation of watering troughs, culvert improvements, and revegetation and stabilization of portions of the corridor. Removal and stabilization of an on-stream stock pond will be completed in 1997.

Flood Plain Sediment Retention Project: The Chorro Flats project obtained funding ($960,000) for implementation of the Flood Plain Restoration Project. All environmental documents and engineering designs have been completed. Construction of the project and revegetation will be completed in 1997.

Cattle Exclusion Project: Dairy Creek fencing for riparian exclusion was completed in the summer of 1995.

Managed Grazing Project: In 1994, the Maino Ranch completed installation of watering devices and fencing, and the land is being managed as planned in a timed grazing project.

WATER QUALITY MONITORING

Design

Two watersheds have been selected for a paired watershed study. Chumash Creek (400 acres) and Walters Creek (480 acres) both drain into Chorro Creek. The watersheds of the two creeks have similar soils, vegetative cover, elevation, slope, and land use activities. The property surrounding the two creeks is under the management of Cal Poly. Because the rangeland being treated is owned by Cal Poly, project personnel will be able to ensure continuity and control of land management practices.

The paired watershed monitoring plan entails three specific monitoring techniques: stream flow/climatic monitoring, water quality monitoring, and biological/habitat monitoring. The calibration period (the period during which the two watersheds are monitored to establish statistical relationships between them) has been completed (1994/95 and 1995/96). Beginning in 1995/96, a BMP system of fences, watering troughs, and other improvements was installed in one of the watersheds (Chumash Creek). The other watershed, Walters Creek, serves as the control.

Other systems of BMPs have been established at different locations in the Morro Bay watershed. Water quality is monitored using upstream/downstream and single station designs to evaluate these systems. An upstream/downstream design has been adopted to monitor the water quality effect of a flood plain sediment retention project and a cattle exclusion project. A single station design on a subdrainage is being used to evaluate changes in water quality from implementation of a managed grazing program. Changes in channel profile rangeland composition and benthic invertebrate composition are also part of the monitoring design at these sites.

In addition to BMP effectiveness monitoring, ongoing water quality sampling is taking place at selected sites throughout the Morro Bay watershed to document long-term changes in overall water quality and to discern problem areas in need of further restoration efforts.

Modifications Since Project Started

Because of very limited runoff during the 1993-1994 sampling year, only one sampling event occurred. However, because of extreme wetness during the 1994-1995 rainy season, a number of sampling events were captured. Water quality and flow data were obtained in the 1995-1996 rainy season after the implementation of some BMPs. This year is characterized as a "during BMP implementation" year, but may be combined with baseline data due to minimal changes in land condition over this short time period.

Parameters Measured

Biological

Total and fecal coliform (FC)
Riparian vegetation
Upland rangeland vegetation
In-stream benthic invertebrates

Chemical and Other

Suspended solids (SS) (total filterable solids)
Turbidity
Nitrate (NO_3)
Phosphate (PO_4^{3-})
Conductivity
pH
Dissolved oxygen (DO)
Temperature

Physical

Cross-sectional stream profile

Covariates

Precipitation
Stream flow
Evaporation
Animal units

Sampling Scheme

Weekly grab samples are taken for at least 20 weeks during the rainy season, starting on November 15 of each year or after the first runoff event.

The samples from the paired watershed stations are analyzed for SS, turbidity, NO_3, PO_4^{3-}, total and fecal coliform, and other physical parameters.

The Dairy Creek cattle exclusion is being analyzed for SS, turbidity, nutrients, total and fecal coliform, and other physical parameters.

Suspended sediment and turbidity are being monitored at the Chorro Flats sediment retention area.

In addition, year-round samples for pH, DO, turbidity, temperature, and total and fecal coliform are conducted every two weeks at several additional sampling sites throughout the Morro Bay Watershed.

In the paired watershed, SS samples are collected during storm events using automated sampling equipment set at even intervals (30-minute). The water collected from each individual sample are analyzed for SS, turbidity, and conductivity. Streamflow and climatic data are also collected for hydrologic response of watersheds. Flow is measured at 5-minute intervals during events.

Vegetation is assessed via aerial photography conducted biannually in March and September during the first, fifth, and tenth years of the project. On both the paired watershed and the Maino property, four permanent vegetation transects are monitored two times each year to sample upland and riparian vegetation and document changes during the life of the project.

Cross-sectioned stream channel profiles are conducted once each year to document stream channel shape, substrate particle size, and streambank vegetation. Rapid BioAssessment (RBA) is used as a tool to assess water and habitat quality of sites throughout the Chorro and Los Osos Watersheds. Samples are collected during April and May at a number of sites, including several upstream-downstream pairs.

Monitoring Scheme for the Morro Bay Watershed Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency for WQ Sampling	Frequency for Vegetation Sampling	Duration
Paired	Chumash Creek[T] and Walters Creek [C]	Total & FC Riparian vegetation SS Turbidity NO_3 PO_4^{3-} Conductivity pH DO	Precipitation Stream flow Evaporation Animal units	Start after first run-off and weekly grab samples thereafter for 20 weeks. Storm event based monitoring (every 30 minutes).	March & Sept. aerial photography in 1st, 5th, & 10th year. Vegetation transects twice per year. RBA once per year. Cross-sectional profiles once per year (cross-sections).	2 yrs pre-BMP 2 yrs BMP 6 yrs post-BMP
Upstream/ downstream	Chorro Flats Sediment Retention Project	SS Turbidity Sediment deposition	Precipitation Stream flow Evaporation Animal units	Storm event monitoring (hourly)	March & Sept. aerial photography in 1st, 5th, & 10th year. RBA once per year. Cross-sections.	4 yrs pre-BMP 1 yr BMP 4 yrs post-BMP
Upstream/ downstream	Dairy Creeks Cattle Exclusion Project	SS Turbidity FC NO_3 PO_4^{3-} Physical parameters	Precipitation Stream flow Evaporation Animal units	Weekly during rainy season starting around Nov. 15.	March & Sept. aerial photography in 1st, 5th, & 10th year. RBA once per year. Cross-sections.	1 yr pre-BMP 1/2 yr BMP 7 yrs post-BMP
Single downstream	Maino Ranch Managed Grazing Project	SS Turbidity FC Riparian vegetation	Precipitation Stream flow Evaporation Animal units	Weekly during the rainy season.	March & Sept. aerial photography in 1st, 5th, & 10th year. Vegetation transects twice per year. RBA once per year. Cross-sections.	0-1 yr pre-BMP 8 yrs post-BMP

[T]Treatment watershed
[C]Control watershed

Modifications Since Project Started

Modifications have been made to sediment analysis techniques since project inception. During the first year, evaporation was used to process suspended sediment samples; however, dissolved solids are high in this watershed and contribute significantly to the total weight of the samples. Presently, analysis is for total filterable solids. A relationship between conductivity and dissolved solids has been developed to convert past years' data to filterable solids. Conductivity will no longer be measured for each suspended sediment sample during event monitoring as it has not proved to be of significant interest. Composite samples from event monitoring will no longer be analyzed for total N, total P, or pH. Grab sampling continues unchanged for nitrate, phosphate, conductivity, turbidity, dissolved oxygen, and water temperature.

The upper Chorro Flats station was moved downstream below the influence of the Chorro Flats Sediment Retention Project. Bedload sampling has been discontinued because of sampling difficulties. The Chorro Flats water quality stations were redesigned in October, 1995. The "top down" removable intake pipes facilitate improved functionality and accessibility. A continuously recording turbidimeter will be installed at Chorro Flats to provide additional data on storm events.

The winter of 1993-1994 was relatively dry, with only two runoff events. In contrast, the 1994-1995 rainy season was characterized by above average precipitation and periods of flooding. The 1995-1996 winter was more representative of normal rainfall events and streamflow levels in the watershed. Sediment, turbidity, and flow data from storm events are collected. Even interval grab sampling is obtained, with sampling conducted once every two weeks. During the rainy season (20 weeks beginning after the first runoff event), grab samples were collected once per week. Although the study design requires even-interval sampling year round, this is not feasible in several locations (including the paired watersheds) because the flow becomes intermittent or ceases entirely during summer months. The Coshocton sampler experienced continual inundation with sediment and was removed in 1995.

Water Quality Data Management and Analysis

Data Management

Data and BMP implementation information are handled by the project team. All data are now archived in a single repository. To ensure that data are archived in a consistent format and a chain of audit record on all data stream manipulations is maintained, a Master's student in Computer Science is developing additional programming aides for data management. A data management program has been developed in Excel format, which allows easy statistical manipulation and display of data files. A web site has been developed for the program, which includes copies of all annual reports, statistical and data management programs, raw data, and graphics (still in development at www.paradiesproductions.com).

A Quality Assurance Project Plan, for project water quality sampling and analysis, has been developed by the Central Coast Regional Water Quality Control Board. The plan is used to assure the reliability and accuracy of sampling, data recording, and analytical measurements.

Data Analysis

A statistician has recently been added to the team; therefore, a more detailed analysis of data is anticipated in the next year. The baseline sampling period has been completed and the first year of post-BMP data have been collected. Initial analysis of data has focused on determining minimum-detectable change and comparing even interval data results to event data. Even-interval data are found to best be utilized for examining pollutant parameters which are less directly tied to storm events, such as dissolved oxygen and temperature. Event interval data are most effective at examining sediment and turbidity relationships, as these parameters are most directly tied to storm events.

The data was examined in a variety of ways, including simple creek-to-creek regressions, regressions of flow-weighted pollutant parameters, double mass curves, regressions of flux- and time-weighted averages of event data, time-series plots, and flow-averaging.

Basic regressions of flow-weighted event data resulted in the following relationships:

Flow:	$y = 0.7177x + 0.060$; $r^2 = 0.9265$
Turbidity:	$y = 0.8332x + 0.6729$; $r^2 = 0.7321$
Sediment:	$y = 0.7274x + 0.9682$; $r^2 = 0.6333$

Minimum Detectable Change (MDC) was calculated using the following formula, where t is from a t-table, MSE is Mean Square Error, and n is sample size:

$$MDC = t_{2(n-1)}\ \mathrm{sqrt}(MSE_{95}/n_{95} + MSE_{96}/n_{96})$$

MDC was expressed as % decrease relative to initial concentration:

%Decrease = (1-10-MDC)* 100

When 1995 data were compared to 1996 data (log transformed), the following results were obtained:

MDC (flow) = 10.5%
MDC (turb) = 24.2%
MDC (sed) = 27.2%

Our goal for sediment reduction estimated during project planning was 30%. Our baseline data appears capable of detecting a change of this magnitude.

TOPMODEL is a physically-based hydrologic model which is being used to model periods of missing flow data, when equipment failures occurred. The model uses rainfall, stream flow, temperature, and a variety of soil and soil hydraulic parameters. Model calibration is being undertaken in 1997.

NPSMS Data Summary

Data will be entered into STORET and NPSMS as soon as upgraded software versions are available.

Modifications Since Project Started

None.

Progress Toward Meeting Goals

A revised Quality Assurance Plan has been developed, implemented, and submitted to USEPA for review. It is available at the Regional Water Quality Control Board office. GIS data layers entered this past year (using ARC/INFO) include sample site locations, streams, flood zones, ground water basins, geology, soils, vegetation, land use, and topography. Initial data analysis indicates that Chumash and Walters Creek are well paired and that sufficient baseline data have been collected.

The program has made significant progress in data management and analysis. Data handling has been greatly improved and streamlined, data storage has been provided for on a web site, and initial data analysis indicates that we should be able to detect changes resulting from BMPs if sediment reduction goals are achieved.

TOTAL PROJECT BUDGET

The estimated budget for the Morro Bay Watershed Section 319 National Monitoring Program project for the period of FY97 is:

Project Element	Funding Source ($)		
	Federal	State	Sum
Proj Mgt	20,000	N/A	20,000
I&E	25,000	N/A	25,000
* LT	130,000	1,593,500	1,723,500
WQ Monit	55,000	20,000	75,000
TOTALS	230,000	1,613,500	1,843,500

* Land Treatment dollars are largely to be used for permanent structures. These funds will be used for matching funds throughout the duration of the project, not just for the fiscal year. The amounts shown will be utilized over the entire project period.
Source: Karen Worcester (Personal Communication), 1997

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The California Assembly Bill 640 became law in January, 1995. The law establishes Morro Bay as the first "State Estuary," and mandates that a comprehensive management plan be developed for the bay and its watershed by locally involved agencies, organizations, and the general public.

On July 6, 1995, Morro Bay was accepted into the National Estuary Program (NEP). This "National Estuary" designation provides 1.3 million from USEPA dollars for planning over a three year period. Current efforts have been made by the Morro Bay State Estuary Watershed Council to create the foundation for this planning process. NEP issue groups have been meeting to discuss pollution sources in the watershed and estuary and to explore management measures which could be implemented. Action plans including strategies for reducing pollutants such as sediment and bacteria are being developed by NEP staff through input from the community and interested agencies.

In addition to the USEPA 319 National Monitoring Program project being led by the California Central Coast Regional Water Quality Control Board, several other agencies are involved in various water quality activities in the watershed. The California Coastal Conservancy contracted with the Coastal San Luis Resource Conservation District in 1987 to inventory the sediment sources to the estuary, to quantify the rates of sedimentation, and to develop a watershed enhancement plan to address these problems. The Coastal Conservancy then provided $400,000 for cost share for BMP implementation by landowners. USDA funding has been obtained for technical assistance in the watershed ($140,000/year), Cooperative Extension adult and youth watershed education programs ($100,000/year), and cost share for farmers and ranchers ($100,000/year) for five years. An NRCS range conservationist was hired with 319(h) funds ($163,000) to manage the range and farm land improvement program. Cooperative Extension has also received a grant to conduct detailed monitoring on a rangeland management project in the watershed. The California National Guard, a major landowner in the watershed, has contracted with the NRCS ($40,000) to develop a management plan for grazing and road management on the base. State funding from the Coastal Conservancy and the Department of Transportation has been used to purchase a $1.45 million parcel of agricultural land on Chorro Creek, just upstream of the Morro Bay delta, which is being restored as a functioning flood plain. Without the cooperation of these agencies and their financial resources, the Section 319 project would be unable to implement BMPs or educate landowners about nonpoint source pollution.

The Central Coast Regional Water Quality Board is conducting a study of the abandoned mines in the watershed with USEPA 205(j) funds. The Board has also obtained a USEPA Near Coastal Waters grant to develop a watershed work plan, incorporate new USEPA nonpoint source management measures into an overall basin plan, and develop guidance packages for the various agencies charged with responsibility for water quality in the watershed.

The Department of Fish and Game Wildlife Conservation Board provided funding ($48,000) for steelhead habitat enhancement on portions of Chorro Creek. The State Department of Parks and Recreation funded studies on exotic plant invasions in the delta as a result of sedimentation. The California Coastal Commission used Morro Bay as a model watershed in development of a pilot study for a nonpoint source management plan pursuant to Section 6217 of the Federal Coastal Zone Management Act Reauthorization Amendments of 1990.

Modifications Since Project Started

Twin Bridges, a major passage to Morro Bay which has undergone heavy sediment deposition and flooding, was replaced in conjunction with plans to reroute South Bay Boulevard over Chorro Creek. Construction began in May of 1996 and was completed in early winter. This bridge replacement will impact sediment deposition processes at the lower end of Chorro Flats.

OTHER PERTINENT INFORMATION

In addition to state and federal support, the Morro Bay watershed receives tremendous support from local citizen groups. The Friends of the Estuary, a citizen advocacy group, is invaluable in its political support of Morro Bay. The Bay Foundation, a nonprofit group dedicated to Bay research, funded a $45,000 study on the freshwater influences on Morro Bay, developed a library collection on the Bay and watershed at the local community college, and is actively cooperating with the Morro Bay Section 319 National Monitoring Program project to develop a watershed GIS database. The Bay Foundation also recently purchased satellite photographs of the watershed, which will prove useful for the monitoring program effort. The Bay Foundation co-wrote the nomination to the National Estuary Program along with the Regional Board. The National Estuary Program, Friends of the Estuary, and the Bay Foundation of Morro Bay are cooperating to develop a volunteer monitoring program for the Bay itself. Ongoing volunteer efforts include water quality and habitat monitoring.

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Connecticut

Jordan Cove Urban Watershed
Section 319
National Monitoring Program Project

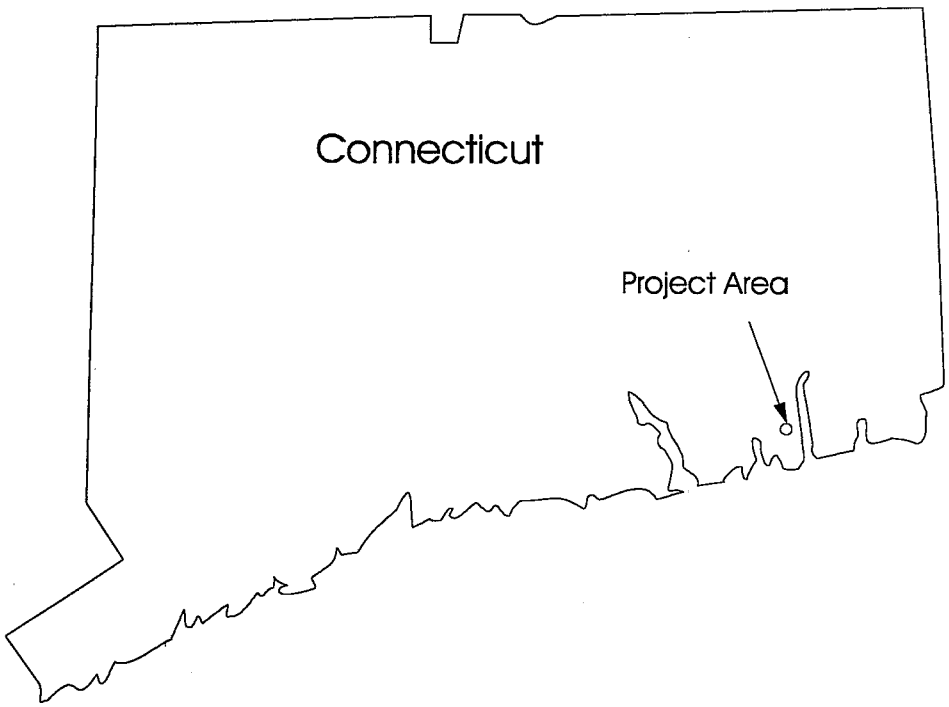
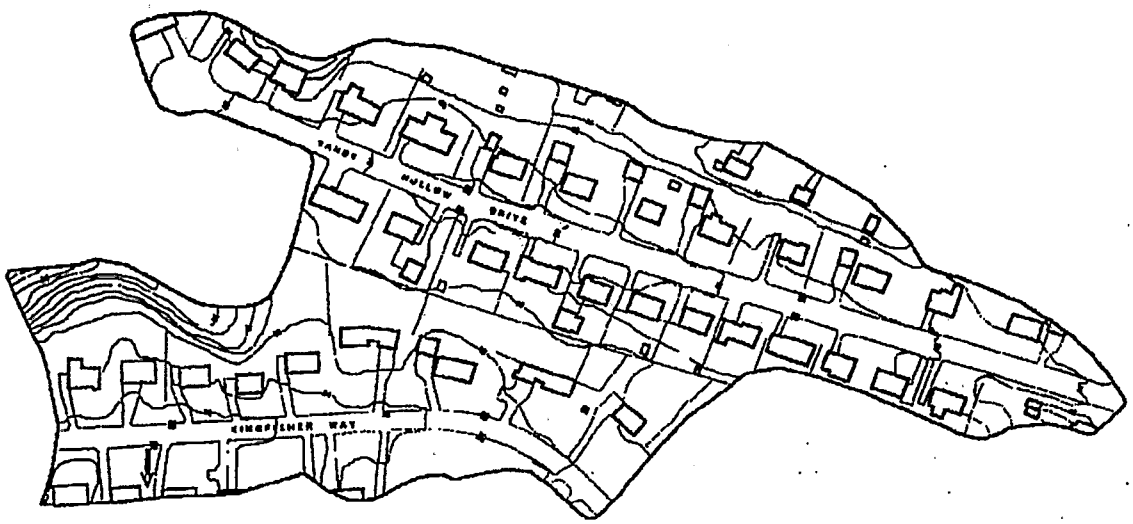
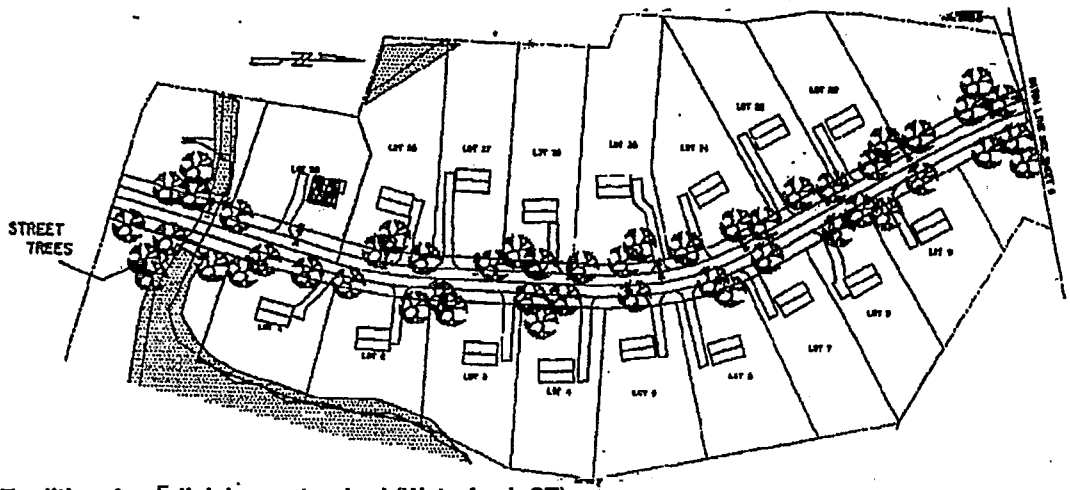


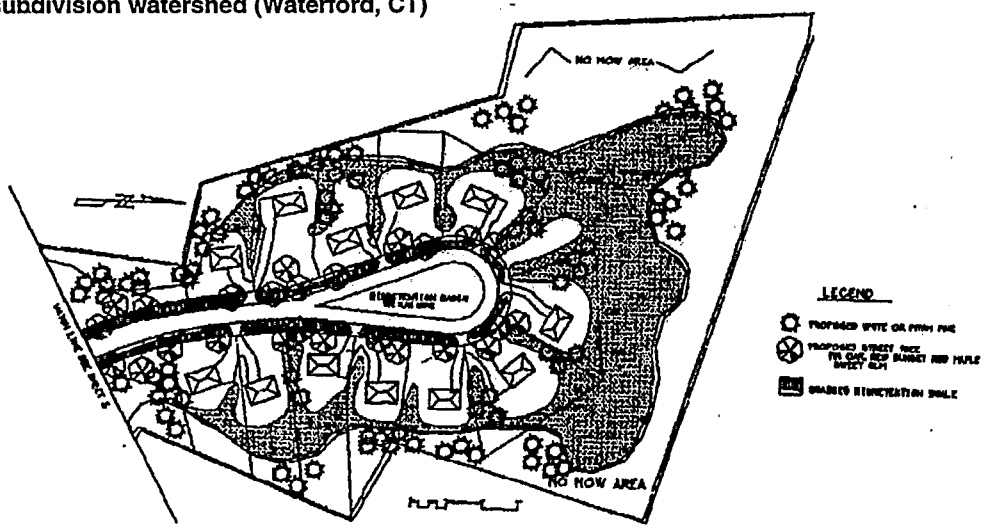
Figure 7: Jordan Cove Urban Watershed (Connecticut) Project Location



Existing residential control watershed with contours (Waterford, CT)



Traditional subdivision watershed (Waterford, CT)



BMP subdivision watershed (Waterford, CT)

Figure 8: Water Quality Monitoring Stations for Jordan Cove Urban Watershed (Connecticut) Watershed

PROJECT OVERVIEW

The Jordan Cove watershed is located along the north or Connecticut side of the Long Island Sound (Figure 7). Jordan Cove is a small estuary fed by Jordan Brook; the estuary empties into Long Island Sound. Water quality sampling has indicated that the Cove does not meet bacteriological standards for shellfish growing and sediment sampling has revealed high concentrations (>20 ppm) of arsenic. Also, short-term monitoring of bottom waters has documented depressed levels of dissolved oxygen.

Land use in the 4,846-acre Jordan Brook watershed is mostly forests and wetlands (74%) along with some urban (19%), and agricultural (7%) uses. The project is located in a residential section of the watershed. The project plan is to develop a 10.6-acre area following traditional subdivision requirements and another 6.9-acre area of housing using best management practices (BMPs). A third drainage area consisting of 43 lots on 13.9 acres, which was developed in 1988, will be used as a control.

The project will incorporate the paired watershed monitoring design for the three study areas. Monitoring will include precipitation, air temperature, and grab and storm-event sampling for solids, nutrients, metals, fecal coliform, and biochemical oxygen demand (BOD). Additionally, monitoring of selected individual BMPs will also be conducted.

PROJECT DESCRIPTION

Water Resource Type and Size

Water resources of concern are Jordan Brook, Jordan Cove estuary, and Long Island Sound. The cove is a long and narrow estuary consisting of a 390-acre inner cove and an 100-acre outer cove. Because the project will sample only overland runoff, no water resource will be monitored.

Water Uses and Impairments

The Jordan Cove estuary does not meet bacteriological standards for shellfish growing. Sediment sampling has revealed high concentrations (>20 ppm) of arsenic.

Pre-Project Water Quality

Semi-annual sampling at eight locations along Jordan Brook has documented average concentrations of total phosphorus less than 0.03 mg/l and nitrate less than 1 mg/l. Water samples from inner Jordan Cove have had fecal coliform counts with a geometric mean ranging from 26 to 154 cfu/100ml.

Current Water Quality Objectives

Retain sediment on site during construction and reduce nitrogen, bacteria, and phosphorus export by 65, 85, and 40 percent, respectively. Maintain post-development runoff peak rate and volume and total suspended solids load to pre-development levels.

Modifications Since Project Initiation

None.

Project Time Frame

1996 to 2005

Project Approval

February, 1996

PROJECT AREA CHARACTERISTICS

Project Area

The two developments designated as treatment watersheds combined cover about 17.5 acres and the residential control watershed is approximately 13.9 acres.

Relevant Hydrologic, Geologic, and Meteorological Factors

The average annual precipitation is 49.8 inches, including 35 inches of snowfall. Soils on the study areas are mapped as Canton and Charlton, which are well-drained soils (hydrologic soil group B). The surficial geology is glacial till and stratified drift. Bedrock is composed of gneiss originating from Avelonia. Bedrock is typically at a depth greater than 60 inches and the water table is located below six feet.

Land Use

Land use in the area to be developed using traditional requirements is currently poultry farming; the area designated for development using BMPs is a closed-out gravel pit. The control drainage area of 13.9 acres has 43 residential lots, ranging in size from 15,000 square feet to 20,000 square feet, which were developed in 1988.

Pollutant Sources

Primary pollutant sources are expected to be construction and later urban runoff from residences.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

Each household in the three study watersheds will be visited annually for the purpose of obtaining survey information related to factors influencing nutrient and bacteria losses. Interaction during these visits will help answer questions about residents habits that affect nutrient and bacteria deposition and educate residents about reducing nonpoint source pollution.

NONPOINT SOURCE CONTROL STRATEGY

Description

The management practices will be applied to the BMP treatment drainage area only and will vary with two time phases. The first phase will be during construction (18 months). During this phase, nonstructural practices such as phased grading, immediate seeding of stockpiled topsoil, maintenance of a vegetated open space perimeter, and immediate temporary seeding of proposed lawn areas and structural practices, including sediment detention basins and sediment detention swales, will be employed.

Post-construction practices will include street sweeping, implementation of fertilizer and pesticide management plans, animal (pets) waste management, and plant waste pick-up. Structural practices such as grassed swales, detention basins, roof runoff dry wells, pervious concrete shoulders on access roads, and the minimization of impervious surfaces will be used. The goal is to implement BMPs on 100% of the lots in the BMP study area.

Modifications Since Project Started

None.

WATER QUALITY MONITORING

Design

The study design is the paired watershed approach using two treatment and one control watersheds. The calibration period will last for about one year during which time current land use management will be continued. The treatment period will include two phases: an 18-month construction phase and a long-term post implementation monitoring phase.

Modifications Since Project Started

None.

Parameters Measured

Biological

Fecal coliform (FC)

Chemical and Other

Total suspended solids (TSS)
Total phosphorus (TP)
Total Kjeldahl nitrogen (TKN)
Ammonia (NH_3)
Nitrate + nitrite ($N0_3$ + $N0_2$)
Biochemical oxygen demand (BOD)
Copper (Cu), lead (Pb), and zinc (Zn)

Covariates

Runoff
Precipitation
Air temperature

Sampling Scheme

Flow-weighted composite samples will be collected during storm-events and analyzed for solids and nutrients. Bacteria and BOD analyses will be conducted on grab samples collected manually when flow is occurring during a visit to the site. Portions of storm samples will be saved and combined into a monthly composite sample that will be analyzed for metals.

Monitoring Scheme for the Jordan Cove Urban Watershed 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired	BMP watershed Traditional watershed Control watershed	TSS TP TKN NH_3 NO_3+NO_2	Rainfall Air temperature Runoff	Storm-event		1 yr calibration 1.5 yr construction 7.5 yr post-BMP

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

Water quality and land treatment data will be entered into the NonPoint Source Management System (NPSMS) software. Quarterly and annual reports will be prepared and submitted according to Section 319 National Monitoring Program procedures. Raw water quality data will be entered into STORET.

NPSMS Data Summary

Unavailable.

Modifications Since Project Started

None.

TOTAL PROJECT BUDGET

The estimated budget for several elements of the Jordan Cove Urban Watershed National Monitoring Program project for the life of the project is:

Project Element	Funding Source ($)			
	Federal	State	Local	Sum
Proj Mgt	NA	NA	NA	NA
I & E	NA	NA	NA	NA
L T	NA	NA	15,000	15,000
WQ Monit	535,400	NA	NA	535,400
TOTALS	535,400	NA	15,000	550,400

Source: Jack Clausen, Personal Communication (1996)

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

Unknown.

OTHER PERTINENT INFORMATION

None.

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Idaho

Eastern Snake River Plain
Section 319
National Monitoring Program Project

Figure 9: Eastern Snake River Plain (Idaho) Demonstration Project Area Location

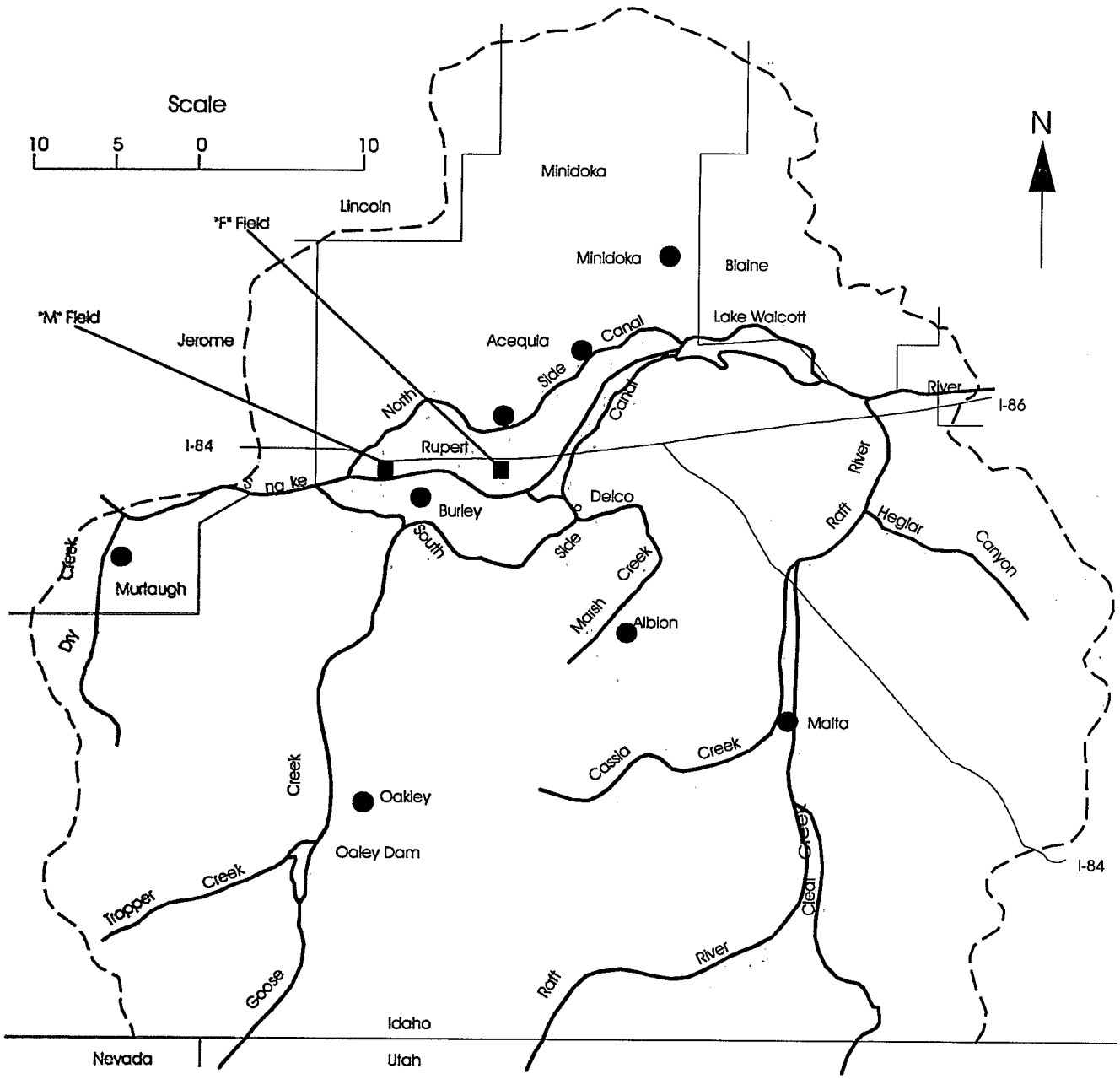

Figure 10: Eastern Snake River Plain (Idaho) USDA Demonstration Project Area

PROJECT OVERVIEW

The Idaho Eastern Snake River Plain is located in southcentral Idaho in an area dominated by irrigated agricultural land (Figure 9). The Eastern Snake River Plain aquifer system, which provides much of the drinking water for approximately 40,000 people living in the project area, underlies about 9,600 square miles of basaltic desert terrain. The aquifer also serves as an important source of irrigation water. In 1990, this aquifer was designated by the U.S. Environmental Protection Agency (USEPA) as a sole source aquifer.

Many diverse crops are produced throughout the Eastern Snake River Plain region. Excessive irrigation, a common practice in the area, creates the potential for nitrate and pesticide leaching and/or runoff. Ground water monitoring indicates the presence of elevated nitrate levels in the shallow aquifer underlying the project area.

The objective of a seven-year United States Department of Agriculture (USDA) Demonstration Project within the Eastern Snake River Plain (1,946,700 acres) (Figure 10) is to reduce adverse agricultural impacts on ground water quality through coordinated implementation of nutrient and irrigation water management. As part of the project, two paired-field monitoring networks (constructed to evaluate best management practices (BMPs) for nutrient and irrigation water management effects) are funded under Section 319 of the Clean Water Act.

PROJECT DESCRIPTION

Water Resource Type and Size

In the intensely irrigated areas overlying the Eastern Snake River Plain aquifer, shallow, unconfined ground water systems have developed primarily from irrigation water recharge. Domestic water is often supplied by the shallow systems. Within the project area, the general flow direction of the shallow ground water system is toward the north from the river; however, localized flow patterns due to irrigation practices and pumping effects are very common. This ground water system is very vulnerable to contamination because of the 1) proximity of the shallow system to ground surface, 2) intensive land use overlying the system, and 3) dominant recharge source (irrigation water) of the ground water.

Water Uses and Impairments

Some wells sampled for nitrate concentrations have exceeded state and federal standards for allowable levels. This occurrence of elevated nitrate concentrations in the ground water impairs the use of the shallow aquifer as a source of drinking water. Low-level pesticide concentrations in the ground water have been detected in domestic wells and are of concern in the project area. Both nitrate and potential pesticide concentrations threaten the present and future use of the aquifer system for domestic water use.

Pre-Project Water Quality

Ground water data collected and analyzed within the project area indicate the widespread occurrence of nitrate concentrations that exceed state and federal drinking water standards. In a study conducted from May through October 1991, 195 samples taken from 54 area wells were analyzed for nitrate. Average nitrate concentrations were around 6.5 milligrams per liter (mg/l), with a maximum of 28 mg/l. The federal Maximum Contaminant Level (MCL) for nitrate concentrations of 10 mg/l was exceeded in 16 % of the wells at least once during the sampling period. Five percent of the wells yielded samples that continuously exceeded the MCL during the sampling period.

Ninety-eight samples collected from the same 54 wells were analyzed for the presence of 107 pesticide compounds. Fourteen of the 54 wells yielded samples with at least one detectable pesticide present, but all concentrations measured were below the federal Safe Drinking Water MCL or Health Advisory for that compound. Even though the well water currently meets MCL standards, pesticide concentrations are still believed to be a future concern for the Eastern Snake River Plain Aquifer.

Current Water Quality Objectives

The overall USDA Demonstration Project objective is to decrease nitrate and pesticide concentrations through the adoption of BMPs on agricultural lands.

Specific project objectives for the USEPA 319 National Monitoring Program project are to:

- Evaluate the effects of irrigation water management on nitrate-nitrogen leaching to the ground water. A paired-field study, referred to as "M" (Figure 10), will allow a comparison of ground water quality conditions between regular irrigation scheduling and the use of a 12-hour sprinkler duration.
- Evaluate the effects of crop rotation on nitrate-nitrogen leaching to the ground water. A paired-field study, referred to as "F" (Figure 10), will allow a comparison of the amount of nitrogen leached to ground water as a result of growing beans after alfalfa, a practice that generates nitrogen, and the amount of nitrogen leached to ground water as a result of growing grain after alfalfa, a practice that utilizes excess nitrogen in the soil.

Source: James Osiensky (Personal communication), 1993.

Modifications Since Project Initiation

An original objective was to compare the effects of sprinkler versus gravity applied irrigation water on ground water nitrate-nitrogen concentrations, but was deleted because project personnel felt that this information was already available.

Project Time Frame

October 1991 to October 1997

Project Approval

1992

PROJECT AREA CHARACTERISTICS

Project Area

The USDA Demonstration Project encompasses over 1,946,000 acres. The ground water quality monitoring activities are limited to a 30,000-acre area of south Minidoka County. The 319 National Monitoring Program project consists of two sets of paired five-acre plots (a total of four five-acre plots) located in this 30,000-acre area (Fields "M" and "F," see Figure 10). The paired fields were located in the eastern and western portions of the area to illustrate BMP effects in differing soil textures. The "M" field soils are silty loams. The "F" field soils are fairly clean, fine to medium sands. Due to the differences in soils and the traditional irrigation methods employed on these fields (flood on "M" and furrow on "F"), the "M" field has a relatively lower spatial variability of existing water quality than the "F" field. The "F" field also shows greater influences of water and nutrient movement from adjacent fields.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The average annual rainfall is between 8 and 12 inches. Shallow and deep water aquifers are found within the project area. Because of the hydrogeologic regime of the project area, there is a wide range of depths to ground water. Soils in the demonstration area have been formed as a result of wind and water deposition. Strati-

fied loamy alluvial deposits and sandy wind deposits cover a permeable layer of basalt. These soils are predominantly level, moderately deep, and well drained.

Land Use

In the project area, over 99% of the land is irrigated. Of the irrigated cropland, at least 85% is in sprinkler irrigation and the remaining 15% is in furrow. A diversity of crops are grown in the area: beans, wheat, barley, potatoes, sugar beets, alfalfa, and commercial seed.

Pollutant Sources

Within the USDA project area, there are over 1,500 farms with an average size of 520 acres. Nutrient management on irrigated crops is intensive. Heavy nitrogen application and excessive irrigation are the primary causes of water quality problems in the shallow aquifer system. In addition, over 80 different agrochemicals have been used within the project area. Excessive irrigation may cause some leaching of these pesticides into ground water (Idaho Eastern Snake River Plain Water Quality Demonstration Project, 1991).

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

Presently, there is no plan to implement a separate information and education (I & E) campaign for the 319 National Monitoring Program project. I & E for the Snake River Section 319 National Monitoring Program project is included in the Demonstration Project I & E program.

Two Eastern Snake River Plain Demonstration Project brochures have been published. One brochure, targeting the local public, was designed to provide a general explanation of the project. The second explains results from the nitrate sampling of the project area.

Progress Toward Meeting Goals

The USDA Demonstration Project staff continue to provide the I&E program for this project. University articles are produced on the demonstration project, and project information is disseminated through university and producer conferences. Presentations on the project are also made to the public through local and regional outlets, such as the American Association of Retired Persons, Future Farmers of America, local and regional agricultural producers, local irrigation districts and canal companies, industry representatives, industry supply vendors, and primary and secondary education institutions. In addition, a public information workshop is held annually within the project area for project participants, cooperators, and interested individuals.

Cooperating farm operations implementing improved management practices for water quality are marked by project display boards to maximize exposure to the local population. These operations are also visited during the numerous project organized field trips.

Information has also been disseminated through local and regional television and radio programs and newspaper articles.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

The nonpoint source control strategy for the USDA Demonstration Project focuses on nitrogen, pesticide, and irrigation water management practices that will reduce the amount of nutrients and pesticides reaching surface water and leaching into the ground water. The following BMP strategies are being implemented:

- Fertilizer evaluations and recommendations based on soil tests, petiole analysis, crop growth stage, crop type, rotation, and water sampling are being adopted.
- Farmers have been asked to incorporate pesticide management strategies into their farming practices.
- An irrigation management program has been implemented for each participating farm in the Demonstration Project.

The nonpoint source control strategy for the 319 National Monitoring Program project is to reduce applied water in the "F" field, and the "M" paired field is being used to establish existing ground water baseline conditions under a "wheel line" sprinkler system. After baseline conditions have been established, the application rate of irrigation water to the "BMP" side of the paired field will be limited to approximately half that of the control side.

Baseline conditions under sprinkler-irrigated alfalfa production are being established on the "F" paired field. After baseline conditions have been established, the "BMP" side of the paired field will be planted in grain, while the "control" side of the field will be planted in beans.

Modifications Since Project Started

The design of the project has changed since its inception. Originally, the objective of the "M" paired field was to determine the effect of irrigation water management on nitrate-nitrogen leaching into the ground water. One side of the field was to have a sprinkler irrigation system, while the other side was to have furrow irrigation. However, cost share negotiations with the "M" field land owner for project participation lead to implementation of the same irrigation water supply system (sprinkler irrigation) in both the BMP test field and the control field.

Progress Toward Meeting Goals

Both fields that are part of the Eastern Snake River Plain National Monitoring Program project were converted to sprinkler from furrow and flood irrigation in 1993. Comparison demonstrations between sprinkler and gravity irrigation systems are not occurring because project personnel feel that this information is already available.

Nonpoint source control strategy and design problems in the paired-field water quality monitoring design are associated with coordination between project personnel and producers. Project staff have encountered difficulty interacting with producers during the growing season because of the heavy daily schedule of producers.

The type of crops produced and the production methods employed during baseline monitoring have been changed during the experimental design. The original objective of the "F" paired field was to compare water quality conditions under different cropping regimes (alfalfa vs. beans). However, scheduled crop rotations have been changed to meet commodity market demands on the "F" field. Due to the changes in experimental design, the duration of the monitoring project has been extended in order to re-establish baseline water quality data.

Additionally, adequate monitoring has been difficult to achieve. Monitoring information obtained on spatial soil variability has led to installation of additional infield instrumentation. The number and arrangement of the field instrumentation has complicated production field work as producers are forced to manipulate production equipment around monitoring instrumentation.

The dynamics of ground water quality monitoring of land use changes have presented significant challenges. As the monitoring project proceeds, new information is obtained, analyzed, and applied. The original monitoring design was based on the best available understanding of the local ground water system. Ground water quality information gained during baseline monitoring demonstrated a high degree of spatial variability in the paired fields. In order to address the spatial variability of the system and document ground water quality changes resulting from land use, the monitoring system has been expanded to provide a more intensive monitoring system based on a geostatistical evaluation of data obtained. Sampling and maintenance of this more intensive system has required more time and resources than originally planned.

WATER QUALITY MONITORING

Design

The 319 National Monitoring Program portion of the USDA Demonstration Project incorporates two paired-field networks consisting of a total of 24 constructed wells. Of the 12 wells on each paired field, 8 wells are centrally located "permanent" wells and 4 are peripheral "temporary" wells.

Modifications Since Project Started

The scope of work has been increased significantly since the project started in 1992. The changes were required to facilitate evaluation of the effects of spatial variability within the two paired fields. In addition to the original ground water sample collection scheme for the 12 wells in each field, soil water and additional ground water samples are being collected. Geostatistically-based soil water and ground water sampling programs have been initiated. Soil water samples, taken with suction lysimeters (soil water samplers), have been collected monthly during the growing season at both the "F" and "M" paired fields. Permanent, pressure-vacuum lysimeters (12 inch length) are installed to a depth of one meter below land surface at the "F" field. A seasonal (removed and replaced each growing season) sampling network that includes both vacuum lysimeters (24 inch length) and pressure-vacuum lysimeters (12 inch length) is installed in the "M" field. These lysimeters are installed at a depth of 0.5 meters below land surface. The soil water sampling program provides important information for the interpretation of spatial and temporal variability of the ground water samples collected from in-field monitoring wells.

Twenty-three lysimeters were installed in the "F" field during June, 1994. Six lysimeters were installed in the "M" field during July, 1994. The areal distribution of lysimeters installed in 1994 was based on grain size analyses of soil samples collected in the "F" and "M" fields.

Nitrate samples were collected from the lysimeters for the months of July, August, September, and October, 1994. Basic univariate statistics were computed and a preliminary geostatistical analysis was conducted. Based on these results, the following modifications to the sampling plan were implemented for the 1995 growing season:

- Reduce the length of the shortest lags

- Increase the overall number of short lags produced by the sampling configuration
- Include a greater number of the original soil sample locations as lysimeter installation locations

Total Kjeldahl nitrogen was detected in a few wells during the first three years of the project but did not appear to correlate with the nitrate concentrations measured. Nitrate was chosen as the primary constituent of interest as the indicator parameter for evaluation of BMP effectiveness.

Progress Toward Meeting Goals

Baseline data are still being collected.

Parameters Measured

Biological

None

Chemical and Other

Nitrate (NO_3)
pH
Temperature
Conductivity
Dissolved oxygen (DO)
Total dissolved solids (TDS)
Total Kjeldahl nitrogen (TKN) and Ammonium (NH^+_4)
Organic scans for pesticide

Covariates

Precipitation
Crop
Soil texture
Nutrient content of the irrigation water

Sampling Scheme

A number of covariate monitoring activities have been undertaken by some of the other agencies participating in the project. In addition, vadose zone suction lysimeters are being used to monitor NO_3 transport. Well monitoring consists of monthly grab samples. Chemical and other parameters are analyzed monthly, except for NH^+_4 and TKN, which are analyzed quarterly, and organics, which are analyzed semiannually.

Monitoring Scheme for the Eastern Snake River Plain Section 319 National Monitoring Program Project

Design	Site	Primary Parameters	Covariates	Frequency of WQ Sampling	Duration
Paired field	"M" field	NO_3 pH Temperature Conductivity DO TDS TKN NH^+_4 Pesticides	Precipitation Crop Soil texture Nutrient content of the irrigation water	Monthly for primary pollutants except Pesticides (sampled) semiannually) and Nitrogen (quarterly)	4 yrs pre-BMP 1 yr BMP 2 yrs post-BMP
Paired field	"F" field	NO_3 pH Temperature Conductivity DO TDS TKN NH^+_4 Pesticides	Precipitation Crop Soil texture Nutrient content of the irrigation water		4 yrs pre-BMP 1 yr BMP 2 yrs post-BMP

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

The Idaho Division of Environmental Quality is entering raw water quality data in the USEPA STORET system. Data are also entered into the USDA Water Quality Project's Central Data Base, and the Idaho Environmental Data Management System. Because this is a ground water project, the NonPoint Source Management System (NPSMS) software has limited utility.

This project is using geostatistical analysis to evaluate the influence of land use activities on ground water quality. Geostatistics is the branch of applied statistics that focuses on the characterization of spatial dependence of attributes that vary in value over space (or time) and the use of that dependence to predict values at unsampled locations. The usefulness of a geostatistical analysis is dependent upon the adequate characterization of the spatial dependence and of the parameter of interest in the given environment. The degree to which spatial dependence is characterized is a function of the configuration of the sampling locations. Thus, a geostatistic investigation centers around designing an areal distribution of sampling locations which ensures that spatial dependence of the parameter of interest can be recognized if it exists. Geostatistical factors, which must be considered in the design of a sampling plan, include the number of samples and the magnitude and density of separation distances provided by a given configuration.

NPSMS Data Summary

Not applicable.

Modifications Since Project Started

None.

Progress Toward Meeting Goals

Baseline data are still being collected.

TOTAL PROJECT BUDGET

Funds budgeted to the State for the Eastern Snake River Plain Section 319 National Monitoring Program project for the period of FY92–98 is approximately $500,000. This figure includes Section 319(h) funds utilized after the National Monitoring Program project monies were suspended, as well as funds provided by the Idaho Division of Environmental Quality and the Idaho Department of Agriculture for additional water quality monitoring.

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

None.

OTHER PERTINENT INFORMATION

The Eastern Snake River Plain Demonstration Project is led by the USDA Natural Resources Conservation Service (NRCS), the University of Idaho Cooperative Extension Service (CES), and the USDA Farm Service Agency (FSA). In addition to the three lead agencies, this project involves an extensive state and federal interagency cooperative effort. Numerous agencies, including the Idaho Division of Environmental Quality, the University of Idaho Water Resource Research Institute, the USDA Agricultural Research Service, the Idaho Department of Water Resources, the U.S. Geological Survey, and the Idaho Department of Agriculture, have taken on various project tasks.

The Idaho Department of Environmental Quality and the Idaho Water Resource Research Institute are responsible for the 319 National Monitoring Program portion of the project.

An institutional advantage of this project is that the NRCS and the CES are located in the same office.

Three local Soil and Water Conservation Districts, East Cassia, West Cassia, and Minidoka, as well as the Minidoka and Cassia County FSA, county committees, and the Cassia County Farm Bureau make up the USDA Demonstration Project Steering Committee.

A regional well monitoring network consisting of existing domestic sandpoint (driven) wells has also been established within the Demonstration Project Area. The regional network is intended to augment the paired-field data and provide a means to document the influence of the Demonstration Project on the quality of the area's shallow ground water system. This network consists of 25 wells which have been monitored for nitrogen-nitrate concentrations on a quarterly basis for an average of 12 sampling events.

During implementation of the regional domestic well water quality monitoring portion of the USDA project, agricultural chemicals and nitrate-nitrogen have been detected at levels of concern and measured in samples collected from domestic wells. The herbicide *Dacthal* has been detected at low levels in samples collected from one well during each sampling event. The same well yielded a single sample with 2,4-D measured at 195 ppb. Other wells have yielded samples containing nitrate-nitrogen as high as 30 mg/l. Concern generated by these data has led to site-specific ground water investigations by the Idaho Division of Environmental Quality and Idaho Department of Agriculture. The site-specific investigation demonstrated that the Dacthal contamination in the ground water originated on-site. The elevated nitrate-nitrogen levels measured in samples obtained from the site's monitoring network indicate that the nitrate-nitrogen concentration measured in the ground water decreases as ground water moves from the adjacent agricultural production fields toward the homestead.

The Mann-Kendall nonparametric statistical trend test was used to determine if a significant trend exists in the concentration of nitrate-nitrogen measured in the samples collected from these wells. Each data set was evaluated for the existence of outliers using a standard T-test. Data outliers were removed from data sets prior to subjecting the data to trend analysis. At the 90% confidence level, 9 (36%) of the wells show a statistically significant decreasing trend and 6 (24%) show a decreasing trend at the 95% confidence level. One well (4%) shows an increasing trend in nitrate-nitrogen concentrations measured in collected samples from the well at both the 90 and 95% confidence levels. The remaining wells do not show a statistically significant trend at the 90 or 95% confidence levels. In the future, when adequate data points are available, the Mann-Kendall statistical trend analysis will be used to analyze these data.

In addition, limited sampling and analyses of ground water drainage systems, irrigation return flows, and injection wells have identified nutrients and pesticides in certain surface water bodies within the project area. Nitrate-nitrogen concentrations in subsurface tile drain effluent as high as 8 mg/l have been measured. The herbicides MCPA and 2,4-D were detected in return flow irrigation water entering into an injection well. The 2,4-D was measured at levels greater than the allowable Safe Drinking Water MCL of 70 ppb.

PROJECT CONTACTS

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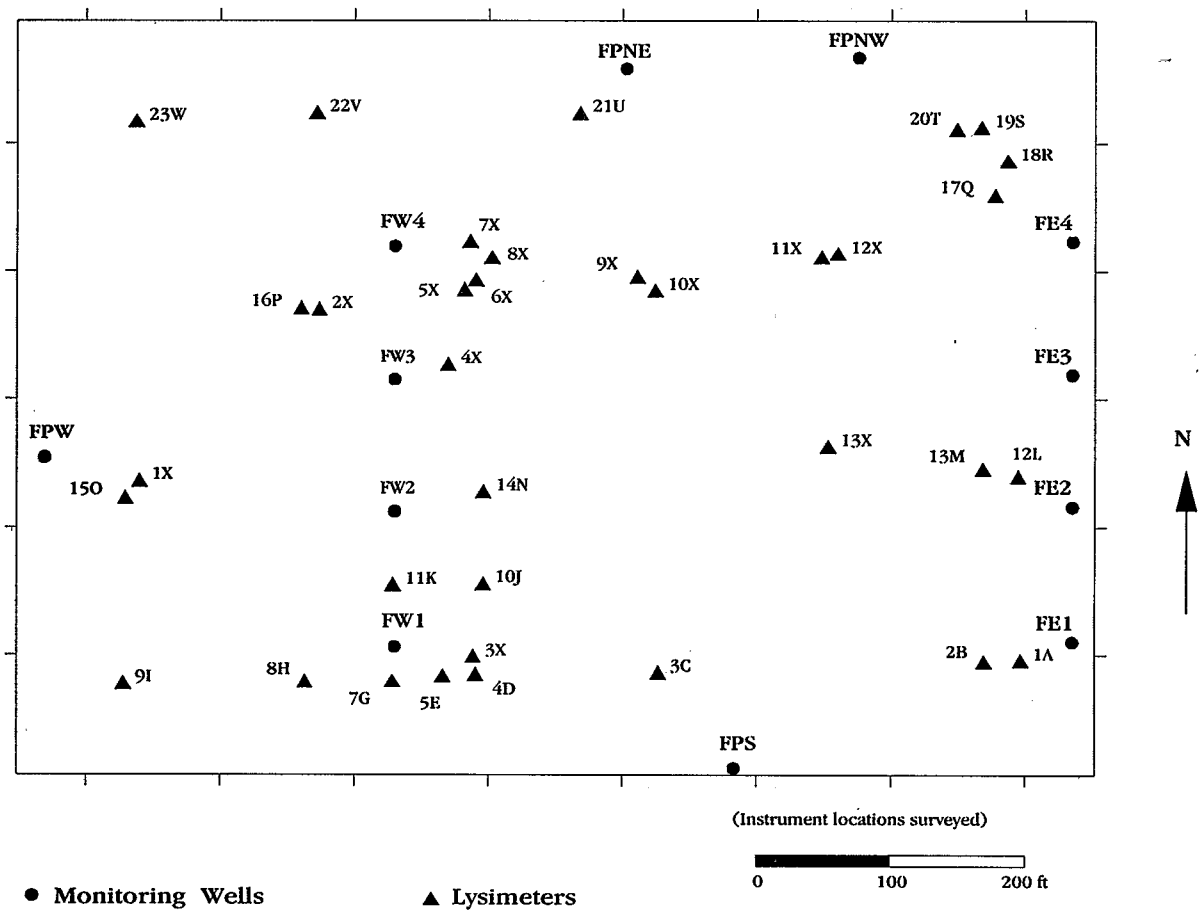
Snake River Plain
Water Quality Demonstration Project
Forgeon Test Field: Burley Idaho
Lysimeter and Monitoring Well Location Map

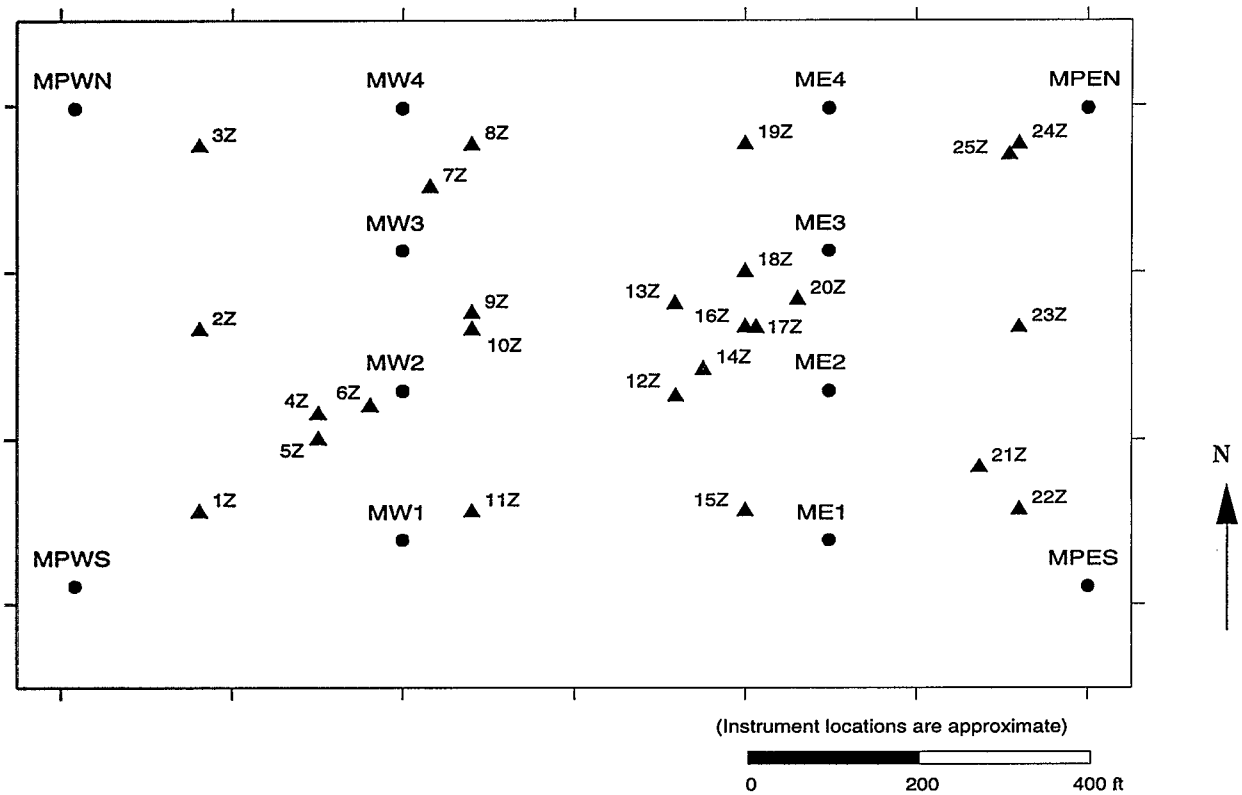


● **Monitoring Wells**
completed at a depth of 10 ft.
FE1, FE2, FE3, FE4,
FW1, FW2, FW3, FW4,
FPS, FPW, FPNE, FPNW

▲ **Lysimeters**
installed at a depth of 3 ft
1A to 23W
1X to 13X

Field Map 1.

Snake River Plain
Water Quality Demonstration Project
Moncur Test Field: Burley, Idaho
Lysimeter and Monitoring Well Location Map



● Monitoring Wells
completed at a depth of 10 ft.
MW1, MW2, MW3, MW4,
ME1, ME2, ME3, ME4,
MPES, MPEN, MPWS, MPWN

▲ Lysimeters
installed at a depth of 1.5 ft
1Z to 25Z

Field Map 2.

Illinois

Lake Pittsfield
Section 319
National Monitoring Program Project

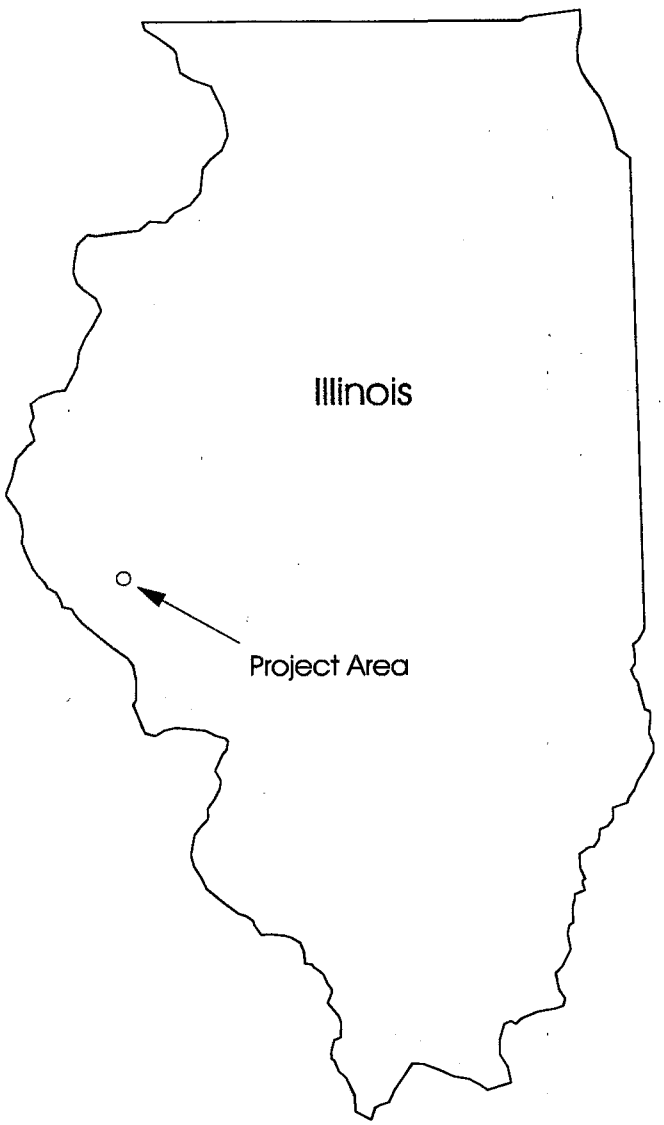


Figure 11: Lake Pittsfield (Illinois) Location

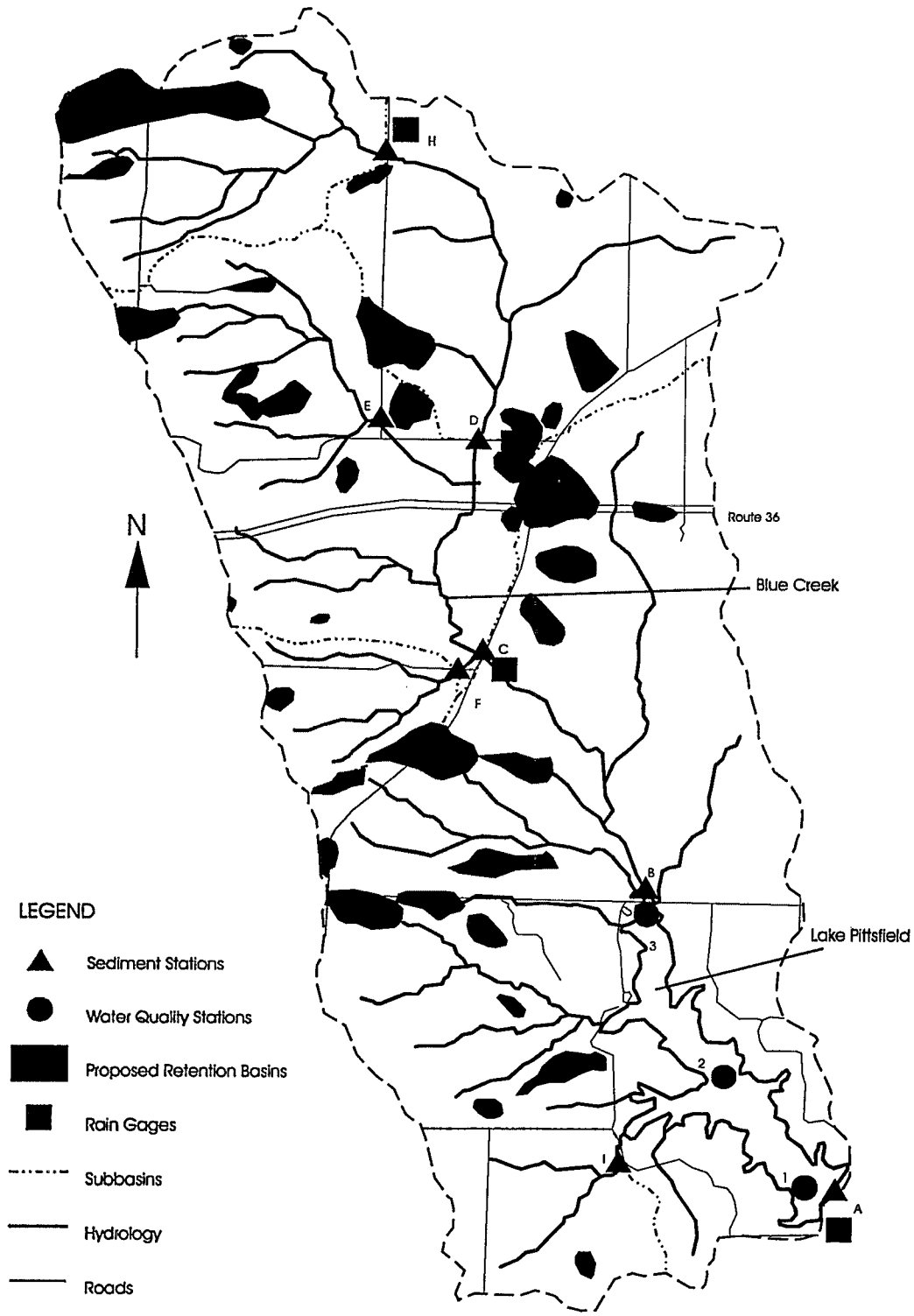


Figure 12: Water Quality Monitoring Stations for Blue Creek Watershed and Lake Pittsfield (Illinois)

PROJECT OVERVIEW

Lake Pittsfield was constructed in 1961 to serve as both a flood control structure and a public water supply for the city of Pittsfield, a western Illinois community of approximately 4,000 people. The 6,956.2-acre watershed (Blue Creek watershed) that drains into Lake Pittsfield is agricultural. Agricultural production consists primarily of row crops (corn and soybeans), and small livestock operations: hog production, generally on open lots, and some cattle on pasture.

Sedimentation is the major water quality problem in Lake Pittsfield. Sediment from farming operations, gullies, and shoreline erosion has decreased the surface area of Lake Pittsfield from 262 acres to 219.6 acres in the last 33 years. Other water quality problems are excessive nutrients and atrazine contamination. The lake is classified as hypereutrophic, a condition caused by excess nutrients.

The major land treatment strategy is to reduce sediment transport into Lake Pittsfield by constructing settling basins throughout the watershed, including a large basin at the upper end of Lake Pittsfield. Water Quality Incentive Project (WQIP) money, provided through the United States Department of Agriculture (USDA) Farm Service Agency (FSA), is being used to fund conservation tillage, integrated crop management, livestock exclusion, filter strips, and wildlife habitat management. An information and education program on the implementation of best management practices (BMPs) used to control sediment, fertilizer, and pesticides is being conducted by the Pike County Soil and Water Conservation District (SWCD).

The Illinois State Water Survey (ISWS) is conducting the Lake Pittsfield Section 319 National Monitoring Program project in order to evaluate the effectiveness of the settling basins. Water quality monitoring consists of storm event tributary sampling, lake water quality monitoring, and lake sedimentation rate monitoring.

Land-based data are being used by the ISWS to develop watershed maps of sediment sources and sediment yields using a geographic information system (GIS). The data for the different GIS layers consist of streams, land uses, soils, lake boundary, subwatersheds, topography, and roads.

PROJECT DESCRIPTION

Water Resource Type and Size

Lake Pittsfield is a 219.6-acre lake located near the city of Pittsfield in Pike County (western Illinois) (Figure 11).

Water Uses and Impairments

Lake Pittsfield serves as the primary drinking water source for the city of Pittsfield. Secondarily, the lake is used for recreational purposes (fishing and swimming). Decreased storage capacity in Lake Pittsfield, caused by excessive sedimentation, is the primary water quality impairment. Lake eutrophication and occasional concentrations of atrazine above the 3 ppb Maximum Contaminant Level (MCL) also impair lake uses.

Pre-Project Water Quality

Lake sedimentation studies have been conducted four times (1974, 1979, 1985, and 1992). Almost 15% of Lake Pittsfield's volume was lost in its first 13 years (see table below). An additional 10% of the lake's volume was lost in the next 18 years (1974 to 1992), suggesting that the rate of sedimentation has slowed. The majority of the lake volume that has been lost is at the Blue Creek inlet into the lake, which is in the northern portion of the lake.

Lake Pittsfield Sedimentation Studies

Year of Survey	Lake Age (Years)	Lake Volume		Sediment Volume		Original Volume Loss (%)
		ac-ft	MG	ac-ft	MG	
1961		3563	1161			
1974	13.5	3069	1000	494	161	13.9
1979	18.3	2865	933	697	227	19.6
1985	24.3	2760	899	803	262	22.5
1992	31.5	2679	873	884	288	24.8

Source: Illinois Environmental Protection Agency, 1993

Long-term water quality monitoring data demonstrate that the lake has been, and continues to be, hypereutrophic. In 1993, Lake Pittsfield's water quality was found to exceed the Illinois Pollution Control Board's general use water quality standards for total phosphorus (0.05 mg/l). Total phosphorus standards of 0.05 mg/l were exceeded in 70% of the samples taken. The 0.3 mg/l standard for inorganic nitrogen was exceeded in 60% of the water samples. Water quality samples collected in 1979 had similar concentrations in terms of phosphorus and nitrogen.

Current Water Quality Objectives

The objectives of the project are to

- reduce sediment loads into Lake Pittsfield and
- evaluate the effectiveness of sediment retention basins.

Modifications Since Project Initiated

None.

Project Time Frame

March 1, 1993 to September 30, 1995 (Watershed)
September 1, 1992 to 1994 (Monitoring Strategy)
Note: Money for monitoring is approved yearly. Contingent upon funding, monitoring is expected to be continued through 1999. This will allow monitoring for a period of four years past installation of sediment retention basins.

Project Approval

Initial water quality funding began in 1992 as a 319 Watershed Project. In 1994, the project was approved for the Section 319 National Monitoring Program.

PROJECT AREA CHARACTERISTICS

Project Area

The 7,000-acre Blue Creek watershed that drains into Lake Pittsfield is located in western Illinois (Figure 11). The terrain is rolling with many narrow forested draws in the lower portion of the watershed. The topography of the upper portion of the watershed is more gentle and the draws are generally grassed.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The area surrounding Lake Pittsfield receives approximately 39.5 inches of rainfall per year, most of which falls in the spring, summer, and early fall. Soils are primarily loess derived. Soils in the upper portion of the watershed developed under prairie vegetation, while those in the middle and lower portions of the watershed were developed under forest vegetation.

Land Use

Some sediment-reducing BMPs are currently being used by area farmers as a result of a program (Special Water Quality Project) that was started in 1979. Pike County SWCD personnel encouraged the use of terraces, no-till cultivation, contour plowing, and water control structures. Many terraces were constructed and most farmers

adopted contour plowing. However, greater adoption of no-till and other soil conserving BMPs is still needed.

Land Use	Acres	%
Agricultural	3350.5	48
Forest/Shrub	1505.1	21
Pasture/Rangeland	1374.9	20
Residential	132.4	2
Reservoir/Farm Ponds	258.7	4
Roads/Construction	137.1	2
Park	197.5	3
TOTAL	6956.2	100

Source: Illinois Environmental Protection Agency. 1993. Springfield, IL.

Pollutant Sources

Cropland, pasture, shoreline, and streambanks

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

Information and education is being conducted by a private organization (Farm Bureau) and the Pike County SWCD. Two public meetings have been held to inform producers about the project. Articles about the project have appeared in the local newspapers. Currently, farmers are being surveyed about their attitudes on water quality. This survey is being conducted by University of Illinois Extension personnel.

Progress Towards Meeting Goals

Information and education activities are ongoing.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

The nonpoint source control strategy is based on reducing sediment movement off-site and limiting the transport of sediment into the water resource, Lake Pittsfield.

Section 319(h) funds have been used to build 29 small (approximately two acres each) sediment retention basins. These basins are used to limit the transport of sediment into Lake Pittsfield. In addition, a larger basin, capable of trapping 90% of the sediment entering Lake Pittsfield at the upper end, is being constructed with 319(h) funds.

Funds from the Water Quality Incentive Program were used to encourage the adoption of BMPs that will reduce the movement off-site of sediment, fertilizer, and pesticides. These BMPs include conservation tillage, integrated crop management, livestock exclusion, filter strips, and wildlife habitat management.

In order to reduce shoreline erosion, shoreline stabilization BMPs will be implemented using Section 314 Clean Lakes Program funds. Old rip rap will be repaired, and new rip rap will be installed along the shoreline.

Modifications Since Project Started

The contract for building sediment basins was extended to August 20, 1996, due to design modification and the permit process for the large sediment basin.

Progress Towards Meeting Goals

A total of 29 sediment basins and the large riprap basin have been completed. It is estimated that these basins are reducing sediment delivery by 25-40%. The large sediment basin has also been completed. All WQIP projects have been implemented.

WATER QUALITY MONITORING

Design

- Storm sampling at four stations on the main channel into Lake Pittsfield (Blue Creek) and three stations at major tributaries to Blue Creek (Figure 12).
- Trend monitoring during baseflow of Blue Creek at one station.
- Trend monitoring at the three stations located in Lake Pittsfield.
- Lake sedimentation studies were conducted before and after dredging and will be conducted again.
- A shoreline severity survey is being conducted. The results of this survey allow shoreline to be evaluated for erosion.

Modifications Since Project Started

None.

Parameters Measured

Biological

None

Chemical and Other

Lake
Orthophosphate (OP)
Total phosphorus (TP)
Dissolved phosphorus (DP)
Total Kjeldahl nitrogen (TKN)
Nitrate + nitrite ($NO_3 + NO_2$)
Total suspended solids (TSS)
Volatile suspended solids (VSS)
pH
Total alkalinity
Phenolphthalein alkalinity
Specific conductivity
Water temperature
Air temperature
Dissolved oxygen (DO)
Atrazine

Storm Sampling (Stream)
Total suspended solids (TSS)

Single Station (Stream-Station C)
Total suspended solids (TSS)

Covariates

Rainfall

Sampling Scheme

Storm sampling is being conducted at four stations located on Blue Creek (stations B, C, D, and H — see Figure 12). These stations are equipped with ISCO automatic samplers and manual DH-59 depth-integrated samplers. A pressure transducer triggers sampling as the stream rises. The samplers measure stream height. In addition, the streams are checked manually with a gauge during flood events to determine the stage of the stream. During these flood events, the stream is rated to determine flow in cubic feet per second. Stream stage is then correlated with flow in order to construct a stream discharge curve. Water samples are analyzed to determine sediment loads.

Three stations located on tributaries of either Blue Creek or Lake Pittsfield (stations E, F, and I — see Figure 12) are also being monitored during storm events. Station I is equipped with an ISCO automatic sampler, while stations E and F are sampled manually. Base stream flow is sampled monthly on Blue Creek at Site C (see Figure 12).

Three lake sampling stations have been established in the most shallow portion of the lake, the middle of the lake, and the deepest part of the lake. Water quality grab samples are taken monthly from April through October.

In-situ observations are made for Secchi disk transparency and temperature and dissolved oxygen profiles at 2-foot intervals in Lake Pittsfield.

In addition, water chemistry samples are taken from the surface of all three lake stations, as well as the lowest depth at the deepest station, and analyzed for the chemical constituents listed above (see *Parameters Measured*).

Rain gauges have been placed near sampling sites C, D, and H (see Figure 12).

Monitoring Scheme for the Lake Pittsfield Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency	Duration
Storm sampling	Stations B, C, D, E, F, H, & I	TSS	Rainfall	During storms	2 yrs pre-BMP 1 yr BMP 3 yrs post-BMP
Single station	Station C	TSS	Rainfall	Monthly	2 yrs pre-BMP 1 yr BMP 3 yrs post-BMP
Single station	Lake stations 1, 2, & 3	Secchi disk transparency DO OP TP $NH_3 + NH^+_4$ Ammonia nitrogen TKN $NO_3 + NO_2$ TSS VSS pH Total alkalinity Phenolphthalein alkalinity Specific conductivity Water temperature Air temperature DO Atrazine	Rainfall	Monthly, April through October	2 yrs pre-BMP 1 yr BMP
Lake sedimentation study		Lake depth		Prior to dredging	
Shoreline erosion severity survey				Once	

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

The water quality monitoring data are entered into a database and then loaded into the USEPA (U.S. Environmental Protection Agency) water quality data base, STORET. Data are also stored and analyzed with the USEPA NonPoint Source Management System (NPSMS) software.

NPSMS Data Summary

Monitoring Station Parameters Report

PERIOD: Spring Season, 1995
STATION TYPE: Upstream Station **PRIMARY CODE:** Station C

CHEMICAL PARAMETERS

Parameter Name	Parm Type	Reporting Units	QUARTILEVALUES -75-	-50-	-25-
FLOW, STREAM, INSTANTANEOUS, CFS	S	cfs	6.3	3.6	2.8
INSTANTANEOUS YIELD	S	lbs/sec	0.025	0.005	0.002
PRECIPITATION, TOTAL	S	in/day	0.05	0.00	0.00
SEDIMENT, PARTICLE SIZE FRACT. < .0625 MM % dry wgt.	S	mg/L	60	27	14

STATION TYPE: Downstream Station **PRIMARY CODE:** Station B

Parameter Name	Parm Type	Reporting Units	QUARTILEVALUES -75-	-50-	-25-
FLOW, STREAM, INSTANTANEOUS, CFS	S	cfs	8.9	5.0	3.0
INSTANTANEOUS YIELD	S	lbs/sec	0.081	0.023	0.008
PRECIPITATION, TOTAL	S	in/day	0.08	0.00	0.00
SEDIMENT, PARTICLE SIZE FRACT. < .0625 MM % dry wgt.	S	mg/L	112	64	44

Modifications Since Project Started

Included nonpoint source national monitoring [tpypvp; for spring season at monitoring sites B and C, which includes 2 years of pre-BMP data, 1 year during BMP implementation, and 3 years of sampling after BMP implementation.

Progress Towards Meeting Goals

Data have been entered and analyzed.

TOTAL PROJECT BUDGET

The estimated budget for the Lake Pittsfield Section 319 National Monitoring Program project for the period of FY 92-99 is:

Project Element	Funding Source ($) Federal	State	Local	Sum
Proj Mgt	NA	NA	NA	NA
I&E	NA	NA	NA	NA
LT [319(h)]	689,000	459,333	NA	1,148,333
WQ Monit	455,000	NA	223,332	678,332
Cultural Practices (WQIP)	32,000	NA	NA	32,000
Dredge/Shoreline/ Aeration (314 Clean Lakes)	132,110	NA	132,110	264,220
TOTALS	1,308,110	459,333	355,442	2,122,885

Source: State of Illinois, 1993; State of Illinois, 1992; Gary Eicken (Personal Communication), 1995

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

In 1979, the Pike County SWCD began a Special Water Quality Project that encouraged the implementation of terraces, no-till cultivation, contour plowing, and water control structures. This project was instrumental, along with drier weather conditions, in reducing soil erosion from an average of 5.8 tons per acre to 3.3 tons per acre (a 45% decrease) from 1979 to 1994.

In the fall of 1997, funding will be available from the Illinois EPA and the Illinois Department of Agriculture for the construction of a series of low water crossing (loose stone weirs) located on Blue Creek. This construction will help reduce the increased amount of sedimentation monitored in the spring of 1996.

Section 314 funds have been used to install sediment-reducing shoreline BMPs and one destratifier (aerator) in Lake Pittsfield to increase oxygen concentrations throughout the lake, thereby increasing fish habitat. The lake will be dredged in late 1998 or early 1989 to reclaim the original capacity of the lake. The delay in the original proposal date is due to delays in the construction of the silt retention basin.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

Many organizations have combined resources and personnel in order to protect Lake Pittsfield from agricultural nonpoint source pollution. These organizations are listed below:

- USDA FSA
- City of Pittsfield
- Farm Bureau
- Illinois Environmental Protection Agency
- Illinois State Water Survey
- Landowners
- Pike County Soil and Water Conservation District

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Illinois

Waukegan River
Section 319
National Monitoring Program Project

Figure 13: Waukegan River (Illinois) Location

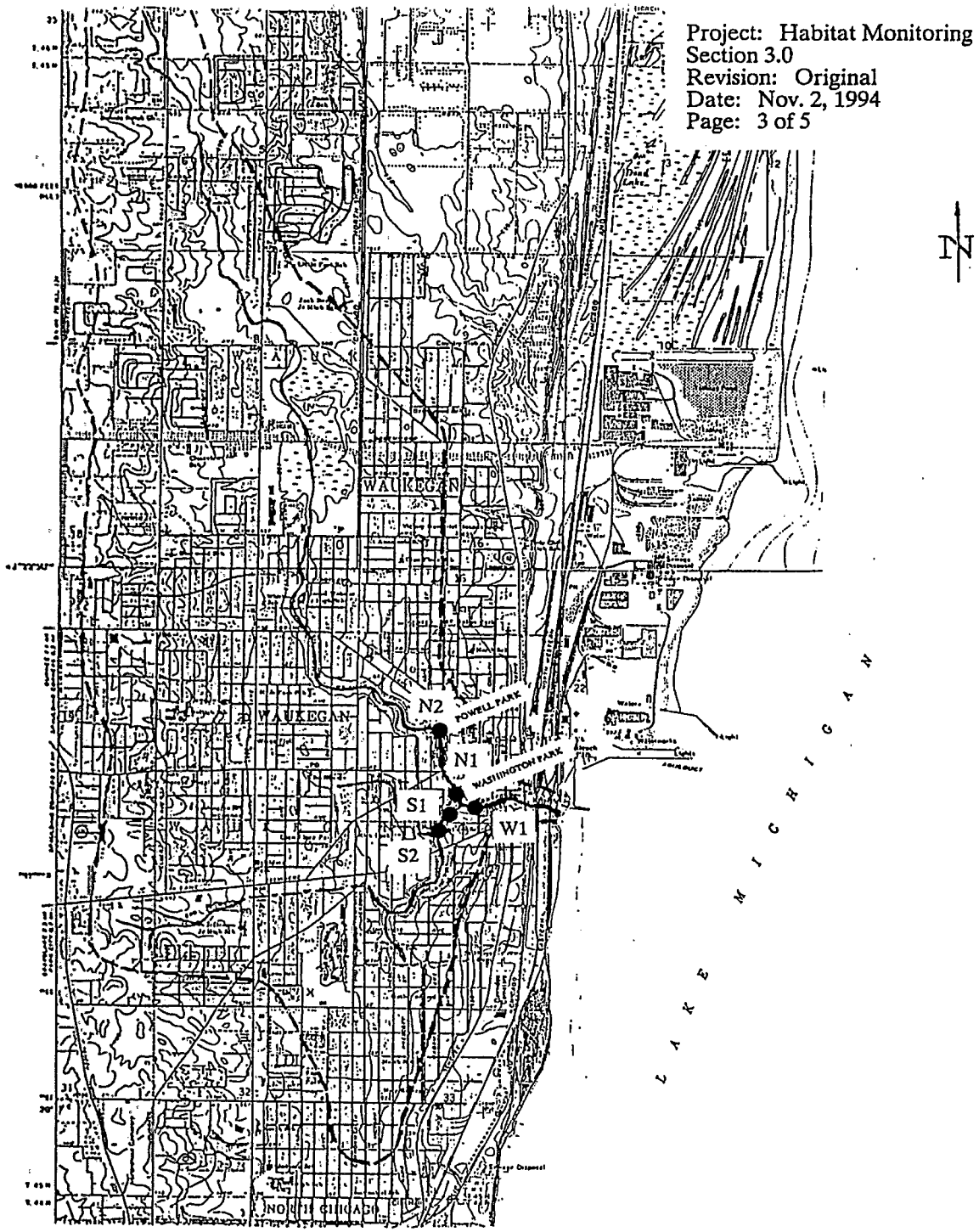

Figure 14: Water Quality Monitoring Stations for Waukegan River (Illinois)

PROJECT OVERVIEW

The project locations for the Waukegan River Section 319 National Monitoring Program project are located in Washington and Powell Parks in the City of Waukegan, Illinois. The Waukegan River, located about 35 miles north of Chicago, is 12.5 miles long. The watershed contains 7,640 acres, with major land uses consisting of residential (50%), agricultural (13%), commercial (8%), and industrial (3%). Washington Park represents the most urbanized reach of the river and is located about 1/2 mile upstream from the river mouth on Lake Michigan. Powell Park is located 1 mile from the river mouth and within a residential area. Most of the watershed was urbanized prior to any requirements for stormwater detention. Therefore, there is little control over stormwater quantity or quality, resulting in flashy runoff rates and heavy stormwater pollutant loads. Water quality concerns also include cross-connections between sanitary and storm sewers, potential sanitary sewer overflows during wet weather, severe streambank erosion, channel downcutting, and artificial lining.

Erosion control along eroding stream channels has been repaired with vegetative stabilization, structural stabilization, and habitat structures with vegetation. Lunkers, a-jacks, stone, dogwoods, willows, and grasses are being used to stabilize severe bank erosion. A series of pool-and-riffle complexes were recreated by the construction of low stone weirs from granite boulders in a channelized reach.

The Waukegan River Section 319 National Monitoring Program project is being used to demonstrate the effectiveness of stream restoration techniques implemented on the Waukegan River. The urban fisheries and stream habitat were surveyed before implementation of the stream restoration techniques. Stream fisheries and in-stream habitat are being surveyed to provide post-implementation data. The monitoring strategy includes macroinvertebrate sampling, physical habitat monitoring, and fisheries monitoring during the spring, summer, and fall cycles of the project period.

This project has demonstrated that biotechnical streambank stabilization techniques are more cost-effective than traditional armoring approaches in reducing erosion and also provide additional water quality and in-stream habitat benefits. It has been shown that rock riffles and pools add to the in-stream physical diversity which in turn leads to increased biodiversity. In addition to enhancing habitat, riffles and pools are effective in reducing erosion of the streambed, improving stream stability and increasing water aeration.

PROJECT DESCRIPTION

Water Resource Type and Size

The Waukegan River Section 319 National Monitoring Program project is located in the northeastern corner of Illinois (Figure 13). The length of the Waukegan River/Ravine main channel and tributaries, which drain predominantly urban areas in Waukegan, IL, is approximately 12.5 miles. Discharge of the Waukegan River is into Lake Michigan, just east of the downtown area and only 6,000 feet from the City's fresh water intake.

Water Uses and Impairments

As an urban stream, stormwater caused severe channel erosion. The primary pollutant of concern is sediment. Severe bank erosion, due to unstable stream channels and high velocity runoff, is increasing nonpoint source pollution loads into Lake Michigan, breaking smaller sewer lines that were buried in the stream and

endangering other sewer lines. In addition to the physical destruction, aquatic habitat has been impaired due to lack of water depth in pools, limited cobble substrates, and limited stream aeration.

Pre-Project Water Quality

Aquatic resources were limited by shallow pool depth and high summer water temperatures. Fine silts filled both pools and runs to the extent that little rock substrates were visible.

Current Water Quality Objectives

The purpose of the project is to restore the stream banks for the Waukegan River in Washington Park and Powell Park, which have become a source of urban nonpoint source pollution and a danger to the public. The detrimental effects of stormwater runoff will be reduced or mitigated.

Project Time Frame

1994 to 1999

Note: Money for monitoring is approved yearly. Contingent upon funding, monitoring is expected to be continued through 1999. This will allow for four years of post-BMP implementation.

Project Approval

The project was initially funded in 1994 as a 319 Watershed Project. Monitoring began in 1994 and was officially approved in 1996 as a Section 319 National Monitoring Program project.

PROJECT AREA CHARACTERISTICS

Project Area

The project streams are located within two city parks (Powell and Washington) of Waukegan, IL. The parks are located within an older, highly urbanized area of the city.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The Waukegan River falls from 730 msl to 580 msl, with the steepest lands located in Washington and Powell Parks.

Land Use

The 7,640 acre watershed of the Waukegan River is largely urbanized, with over 80% of the City of Waukegan lying within the watershed boundaries. There are over 60,000 people living in Waukegan. Because this is an older town, there are very few stormwater detention basins.

Pollutant Sources

High volume of runoff from impervious surfaces is degrading the urban streams within the Waukegan watershed. The steepest lands, and therefore the most eroded, are located in Washington and Powell Parks along the Lake Michigan bluffs.

INFORMATION, EDUCATION, AND PUBLICITY

One of the sites on the South Branch of the Waukegan River in Washington Park served as a training site for a streambank restoration class held during the *Second National Nonpoint Source Watershed Monitoring Workshop*. Senior personnel from the city's Public Works Department and the Waukegan District were taken through the restoration and stabilization process before and during construction. These individuals then helped with the next training during the *Second Workshop.*

An urban stream restoration manual and video of the biotechnical streambank restoration activities have been developed to highlight the biotechnical techniques that were used in the restoration.

A videotape production and color brochure were developed which describe the biotechnical stream stabilization techniques, the monitoring program, and the physical and biological enhancements achieved.

NONPOINT SOURCE CONTROL STRATEGIES

Description

Biotechnical bank restoration (a combined vegetative and structural approach) was selected to stabilize the streams. Erosion control along eroding stream channels will be repaired using bioengineering techniques: vegetative stabilization, structural stabilization, and habitat structures with vegetation.

Projects on the North Branch of the Waukegan River

Lunkers and a-jacks were installed in Powell Park. Lunkers with stone were installed in Washington Park. Willows, dogwood, grasses, and wetland plants were planted in the lower, middle, and upper zones of the stream banks where lunkers were installed. Two sampling stations, N1 and N2 (Figure 14), are utilized for background data collection, but are not part of the Section 319 National Monitoring Program project.

Projects on the South Branch of the Waukegan River

In 1994, lunkers, a-jacks, stone, dogwoods, willows, and grasses were used to stabilize a severe bank erosion site on the South Branch of the Waukegan River. Smaller bank erosion sites were stabilized with coir coconut fiber rolls, willows, and grasses. Because the original bank stabilization efforts did not significantly increase stream depth, in the winter of 1996, a series of six pool-and-riffle complexes were recreated by the construction of low stone weirs from granite boulders in this channelized reach.

WATER QUALITY MONITORING

Design

An upstream/downstream habitat monitoring design is being used to document water quality changes in the Waukegan River at the South Branch stations (S1 & S2 — Figure 14). With this design, urban water quality will affect both the control (S2) and the rehabilitated stations (S1) uniformly.

Biological parameters are measured during the spring, summer, and fall cycles of the project period. Flow is measured continuously.

Parameters Measured

Biological

Fish samples
Macroinvertebrates
Habitat

Chemical and Other

None

Covariates

Dissolved oxygen (DO)
Temperature
Flow

Sampling Scheme

This is an upstream/downstream water quality monitoring design.

The biological sampling since 1994 indicates that the number of fish species and abundance in the South Branch has more than doubled with the construction of lunkers and pool/riffle morphology. The Index of Biotic Integrity rose sharply from degraded to moderately degraded.

Monitoring Scheme for the Waukegan River 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Duration
Upstream/ Downstream	South Branch Stations S1 & S2	Fish samples Macroinvertebrates Habitat	DO Temperature Flow	Seasonal, 3x's/year	1 yr pre-BMP 1 yr BMP 4 yr post-BMP

Water Quality Data Management and Analysis

Water quality data are stored and maintained in the USEPA NonPoint Source Management System (NPSMS) databases.

TOTAL PROJECT BUDGET

The estimated budget for the Waukegan River Section 319 National Monitoring Program project for the life of the project is based on two years of funding, with four years completed (1992-1996):

Project Element	Funding Source ($)			
	Federal	State	Local	Sum
Proj Mgt	40,000	NA	NA	40,000
I&E	2,000	NA	NA	2,000
BT	2,000	NA	NA	2,000
WQ Monit	6,000	NA	NA	6,000
TOTALS	50,000	NA	NA	50,000

Source: Illinois Environmental Protection Agency (Personal Communication, 1997)

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

This project was originally funded with Section 319 funds. Local contractors are utilizing lunkers and a-jacks in constructing housing developments along stream sites.

OTHER PERTINENT INFORMATION

Participating agencies and organizations:

- Illinois Environmental Protection Agency
- Illinois Department of Natural Resources
- Illinois State Water Survey
- Private Contractor
- University of Illinois at Champaign—Urbana
- Waukegan Park District
- Waukegan Public Works Department

PROJECT CONTACTS

Administration / Water Quality Monitoring / River Restoration Treatment

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Iowa

Sny Magill Watershed
Section 319
National Monitoring Program Project

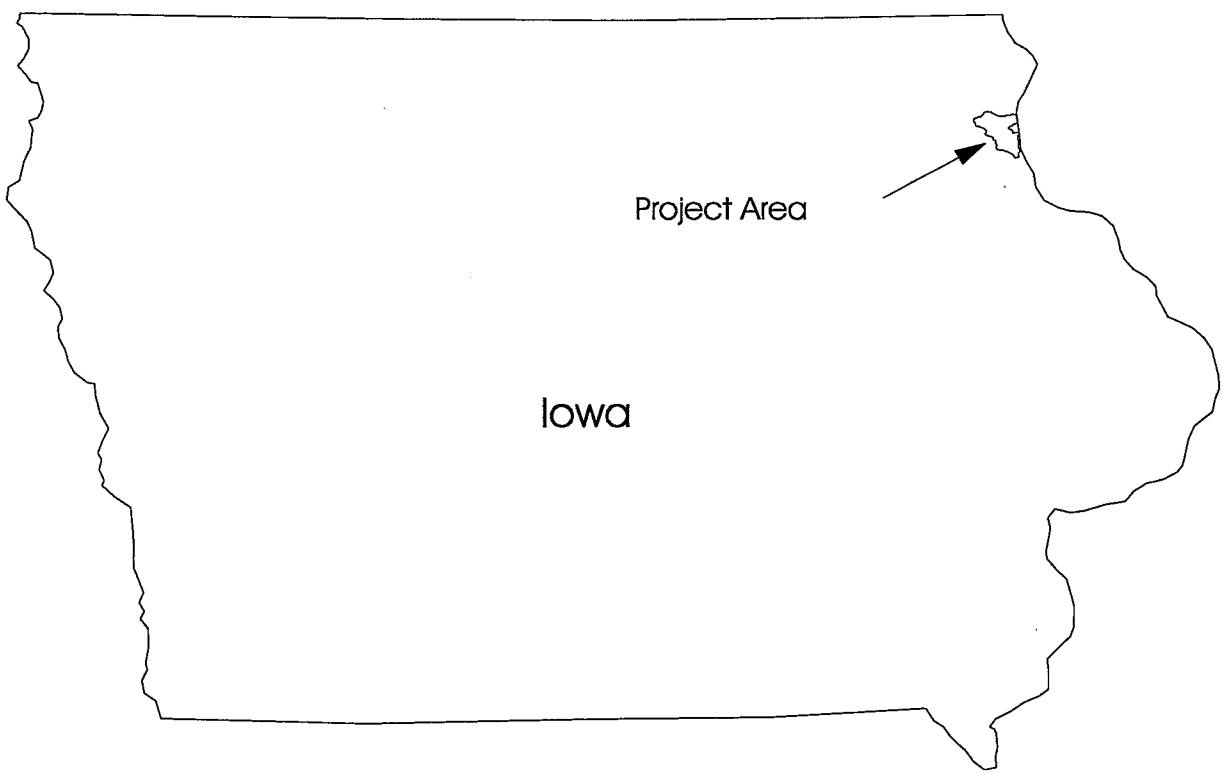

Figure 15: Sny Magill and Bloody Run (Iowa) Watershed Project Locations

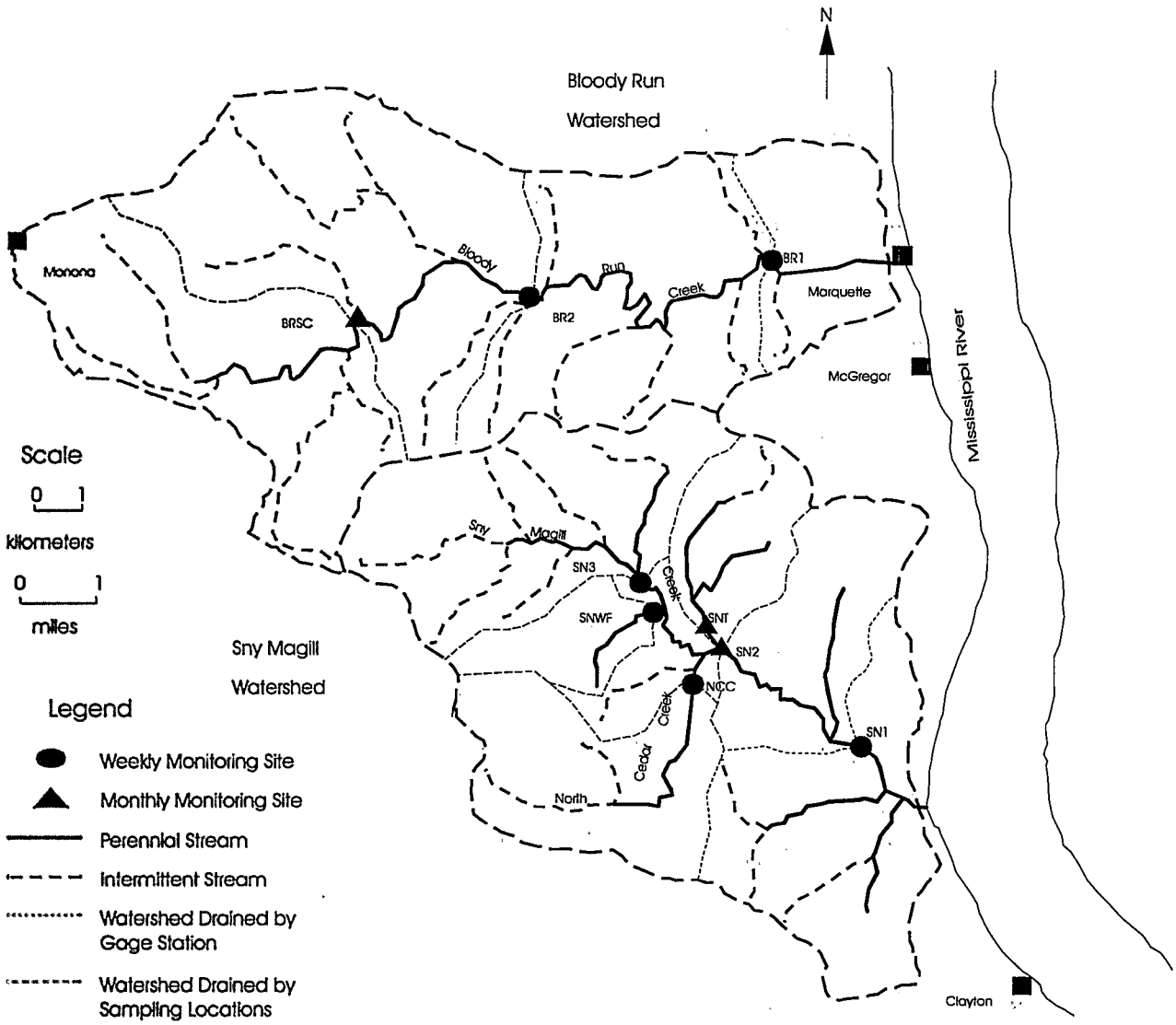

Figure 16: Water Quality Monitoring Stations for Sny Magill and Bloody Run (Iowa) Watersheds

PROJECT OVERVIEW

The Sny Magill Watershed Section 319 National Monitoring Program project is an interagency effort designed to monitor and assess improvements in water quality (reductions in sedimentation) resulting from the implementation of two U.S. Department of Agriculture (USDA) land treatment projects in the watershed: Sny Magill Hydrologic Unit Area (HUA) and the North Cedar Creek Water Quality Special Project (WQSP). The project areas include Sny Magill Creek and North Cedar Creek basins (henceforth referred to as the Sny Magill watershed) (Figure 16). Sny Magill and North Cedar creeks are Class "B" cold water streams located in northeastern Iowa (Figure 15). North Cedar Creek is a tributary of Sny Magill Creek. The creeks, managed for "put and take" trout fishing by the Iowa Department of Natural Resources (IDNR), are two of the more widely used recreational fishing streams in the state.

The entire Sny Magill watershed is agricultural, with no industrial or urban areas. There are no significant point sources of pollution in the watershed. Land use consists primarily of row crop, cover crop, pasture, and forest. There are about 95 producers in the watershed, with farms averaging 250 acres in size.

Water quality problems result primarily from agricultural nonpoint source pollution; sediment is the primary pollutant. Nutrients, pesticides, and animal waste are also of concern.

Two USDA land treatment projects implemented in the watershed support producers making voluntary changes in farm management practices that will result in improved water quality. The State of Iowa, through the Iowa Department of Agriculture and Land Stewardship (IDALS) and the IDNR, have agreed to work through the local Clayton County Soil and Water Conservation District (SWCD) to provide funds for the best management practice (BMP) implementation. Sediment control measures, water and sediment control basins, animal waste management systems, stream corridor management improvements, and bank stabilization demonstrations are being implemented to reduce agricultural nonpoint source pollution. A long-term goal of a 50% reduction in sediment delivery to Sny Magill Creek has been established.

A paired watershed approach is being used with the Bloody Run Creek watershed serving as the comparison watershed (Figure 16). Subbasins within the Sny Magill watershed are being compared using upstream/downstream stations.

Primary monitoring sites, equipped with U.S. Geological Survey (USGS) stream gauges to measure discharge and suspended sediment, have been established on both Sny Magill and Bloody Run creeks. The primary sites and several other sites on both creeks are being sampled for chemical and physical water quality parameters on a weekly to monthly basis. Annual habitat assessments are being conducted along stretches of both stream corridors. Biomonitoring of macroinvertebrates occurs on a bimonthly basis, and an annual fisheries survey is conducted.

PROJECT DESCRIPTION

Water Resource Type and Size

Sny Magill and North Cedar creeks are Class "B" cold water streams located in northeastern Iowa.

Water Uses and Impairments

Sny Magill and North Cedar creeks are managed for "put and take" trout fishing by the IDNR and are two of the more widely used streams for recreational fishing in Iowa. Sny Magill Creek ranks sixth in the state for angler usage.

The Sny Magill watershed drains an area of 35.6 square miles directly into the Upper Mississippi River Wildlife and Fish Refuge. The refuge consists of islands, backwaters, and wetlands of the Mississippi River. The creek also drains into part of Effigy Mounds National Monument. These backwaters are heavily used for fishing and also serve as an important nursery area for juvenile and young large-mouth bass.

The creeks are designated by the state as "high quality waters" to be protected against degradation of water quality. Only 17 streams in the state have received this special designation. The state's Nonpoint Source Assessment Report indicates that the present classifications of the creeks as protected for wildlife, fish, and semi-aquatic life and secondary aquatic usage are only partially supported. The report cites impairment of water quality primarily by nonpoint agricultural pollutants, particularly sediment, animal wastes, nutrients, and pesticides. There are no significant point sources of pollution within the Sny Magill watershed.

Sediment delivered to Sny Magill creek includes contributions from excessive sheet and rill erosion on approximately 4,700 acres of cropland and 1,600 acres of pasture and forest land in the watershed. Gully erosion problems have been identified at nearly 50 locations.

There are more than 13 locations where livestock facilities need improved runoff control and manure management systems to control solid and liquid animal wastes. Grazing management is needed to control sediment and animal waste runoff from over 750 acres of pasture and an additional 880 acres of grazed woodland.

Streambank erosion has contributed to significant sedimentation in the creeks. In order to mitigate animal waste and nutrient problems and improve bank stability in critical areas, improved stream corridor management designed to repair riparian vegetation and keep cattle out of the stream is necessary.

Pre-Project Water Quality

Water quality evaluations conducted by the University Hygienic Laboratory (UHL) in 1976 and 1978 during summer low-flow periods in Sny Magill and Bloody Run creeks showed elevated water temperatures and fecal coliform levels (from animal wastes) in Sny Magill Creek. Downstream declines in nutrients were related to algal growth and in-stream consumption. An inventory of macroinvertebrate communities was conducted in several reaches of the streams (Seigley et al., 1992).

Assessments in North Cedar Creek during the 1980s by IDNR and the USDA Natural Resources Conservation Service (NRCS) located areas where sediment covered the gravel and bedrock substrata of the streams, decreasing the depth of existing pools, increasing turbidity, and degrading aquatic habitat. Animal waste decomposition increases biochemical oxygen demand (BOD) in the streams to levels that are unsuitable for trout survival at times of high water temperature and low stream flows. The IDNR has identified these as the most important factors contributing to the failure of brook trout to establish a viable population (Seigley et al., 1992).

Several reports summarize pre-project water quality studies conducted in the two watersheds (i.e., water quality, including available data from STORET – Seigley and Hallberg, 1994; habitat assessment – Wilton, 1994; benthic biomonitoring – Schueller et al., 1994, and Birmingham and Kennedy, 1994; fish assessment – Wunder and Stahl, 1994; and Hallberg and others, 1994) provide perspectives on water quality monitoring in northeast Iowa.

Current Water Quality Objectives

Project objectives include the following:

- To quantitatively document the significance of water quality improvements resulting from the implementation of the Sny Magill HUA Project and North Cedar Creek WQSP;
- To develop the protocols and procedures for a collaborative interagency program to fulfill the U.S. Environmental Protection Agency (USEPA) standards for Nonpoint Source Monitoring and Reporting Requirements for Watershed Implementation Projects;
- To refine monitoring protocols to define water quality impacts and the effectiveness of particular management practices;
- To develop Iowa's capacity for utilization of rapid habitat and biologic monitoring;
- To use water quality and habitat monitoring data interactively with implementation programs to aid targeting of BMPs, and for public education to expand awareness of the need for nonpoint source pollution prevention by farmers; and
- To provide Iowa and the USEPA with needed documentation for measures of success of nonpoint source control implementation (Seigley et al., 1992).

Specific quantitative water quality goals need to be developed that are directly related to the water quality impairment and the primary pollutants being addressed by the land treatment implemented through the USDA projects.

Modifications Since Project Initiation

None.

Project Time Frame

1991 to 2001 (if funding allows)

Project Approval

1992

PROJECT AREA CHARACTERISTICS

Project Area

The watershed drains an area of 22,780 acres directly into the Upper Mississippi River Wildlife and Fish Refuge and part of Effigy Mounds National Monument.

Relevant Hydrologic, Geologic, and Meteorologic Factors

Average yearly rainfall in the area is 30.6 inches.

The watershed is characterized by narrow, gently sloping uplands that break into steep slopes with abundant rock outcrops. Up to 550 feet of relief occurs across the watershed. The landscape is mantled with approximately 10-20 feet of loess, overlying thin remnants of glacial till on upland interfluves, which in turn overlie Paleozoic-age bedrock formations. The bedrock over much of the area is Ordovician Galena Group rocks, which compose the Galena aquifer, an important source of ground water and also drinking water in the area. Some sinkholes and small springs have developed in the Ordovician-age limestone and dolomite.

The creeks are marked by high proportions (70-80% or more of annual flow) of ground water base flow, which provides the cold water characteristics of the creeks. Hence, ground water quality is also important in the overall water resource management considerations for area streams.

The stream bottom of Sny Magill and its tributaries is primarily rock and gravel with frequent riffle areas. Along the lower reach of the creek where the gradient is less steep, the stream bottom is generally silty. The upstream areas have been degraded by sediment deposition.

Land Use

The entire watershed is agricultural, with no industrial or urban areas. There are no significant point sources in the watershed. Sixty-five percent of the cropland is corn, with the rest primarily in oats and alfalfa in rotation with corn. There are about 95 producers in the watershed, with farm sizes averaging 250 acres.

Land use is variable on the alluvial plain of Sny Magill Creek, ranging from row cropped areas, to pasture and forest, to areas with an improved riparian right-of-way where the IDNR owns and manages the land in the immediate stream corridor. The IDNR owns approximately 1,800 acres of stream corridor along approximately eight miles of the length of Sny Magill and North Cedar creeks. Some of the land within the corridor is used for pasture and cropping through management contracts with the IDNR.

Row crop acreage planted to corn has increased substantially over the past 20 years. Land use changes in the watershed have paralleled the changes elsewhere in Clayton County, with increases in row crop acreage and fertilizer and chemical use, and attendant increases in erosion, runoff, and nutrient concentrations. U.S. Forest Service data show a 4% decline in woodland between 1974 and 1982. Much of this conversion to more erosive row crop acreage occurred without adequate installation of soil conservation practices.

Land Use	Sny Magill		Bloody Run	
	Acres	%	Acres	%
Rowcrop	5,842	25.9	9,344	38.6
Cover crop, pasture	5,400	23.9	6,909	28.5
Forest, forested pasture	11,034	48.9	7,171	29.6
Farmstead	263	1.2	415	1.7
Other	28	0.1	376	1.6
TOTALS	22,567	100	24,215	100

Source: Bettis et al., 1994

Pollutant Sources

Sediment — cropland erosion, streambank erosion, gully erosion, animal grazing
Nutrients — animal waste from livestock facilities (cattle), pasture, and grazed woodland; commercial fertilizers; crop rotations
Pesticides — cropland, brush cleaning

Modifications Since Project Started

Federal funding from the Agricultural Conservation Program to encourage BMP implementation was lost in 1993; however, applications for alternative funding sources were filed in 1994. Funding for sediment reducing practices, such as terraces, was secured through the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, for Fiscal Years 1995-1997. An application for funding was filed through the USEPA Section 319(h) Program for animal manure structures, Integrated Crop Management (ICM), and streambank stabilization practices. The USEPA Section 319(h) funding became available in 1995.

INFORMATION, EDUCATION, AND PUBLICITY

The focus of information and education efforts in the watershed are

- Demonstration and education efforts in improved alfalfa hay management (to reduce runoff potential on hayland and increase profitability and acreage of hay production);
- Improved crop rotation management and manure management (to reduce fertilizer and chemical use);
- Implementation of the Farmstead Assessment System [NRCS, Iowa State University Extension (ISUE)];
- Woodland management programs (to enhance pollution-prevention efforts on marginal cropland, steep slopes, riparian corridors, and buffer areas in sinkhole basins);
- Expansion of interest in the environmental and economic benefits of ICM, BMPs, and sinkhole and wellhead protection; and
- Implementation of an educational program to bring information and results of the Sny Magill HUA project to the widest possible audience in the watershed and adjacent areas of the state.

Information is also disseminated through newsletters, field days, special meetings, press/media releases, surveys of watershed project participants, and summaries of the project are available on the Internet (http://www.igsb.uiowa.edu/htmls/inforsh/sny.html).

Additional resources for technical assistance and educational programs are provided in the area through the Northeast Iowa Demonstration Project, directed by ISUE, and the Big Spring Basin Demonstration Project, directed by IDNR.

Progress Towards Meeting Goals

- Various management plots, including manure, nitrogen, tillage, and weed, have been maintained for demonstration and educational purposes in the watershed area.
- Numerous field days were held at plot sites designed to be toured on a self-guided basis.
- Over the past few years, the land treatment projects in Sny Magill have experienced changes in funding sources and the practices that can be cost shared. An information packet was developed and distributed to landowners. These packets included information on soil conservation practices, nutrient and pest management programs, wellhead assessment surveys, post-CRP land use options, available cost share programs, and a list of project personnel to contact for additional information. Packets were hand-delivered and a free water test was offered.
- The media outreach program has included preparation of demonstration plot brochures, press releases, booklets for the "self-guided" tours of the watershed, and articles for local newspapers. *Water Watch*, a bimonthly newsletter published by Extension Service, is disseminated to over 1,750 subscribers. Article topics have included upcoming project activities, ongoing demonstrations and other conclusions or trends that develop from these efforts, update on water quality monitoring of Sny Magill Creek, field visits by local high school classes, and post-CRP land use options.
- Tours of the Sny Magill watershed and presentations on the Sny Magill HUA have included information on the water quality monitoring, tillage and manure structures, ICM, manure management, and nutrient and pest management.

- Three new sites were added to the series of streambank stabilization installations along Sny Magill Creek, including a warm season grass demonstration and a handicap-accessible streambank stabilization demonstration. Information provided by the Sny Magill project, through the use of videos, workshops, and design reports, has been used to install soil bioengineering practices in four different locations across Iowa.
- The Nutrient and Pest Management Incentive Education Program has enrolled eight cooperators with over 2,000 acres total. This program promotes nutrient and pest management through participant education and implementation, rather than relying on the private sector for crop management services.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

The Sny Magill HUA project contains 10,468 acres of Highly Erodible Land (HEL); conservation plans have been developed for all of these acres. Of these conservation plans, 7,303 acres, or 70%, are written to the Tolerable, or T, level. Conservation plans have been fully implemented on 4,174 acres, or 40% of the HEL acres in the project area. There are 98 landowners in the Sny Magill HUA, of which 81% have chosen to participate in the HUA project.

The Section 319 National Monitoring Program project is intimately connected to two ongoing land treatment projects in the watershed: the Sny Magill HUA project and the North Cedar Creek Agricultural Conservation Program – WQSP. The HUA Project was a five-year project begun in 1991 and covering 19,560 acres (86%) of the Sny Magill watershed. The HUA Project will continue through FY99, pending annual reviews. Best management practice implementation will end July 1, 1998, but other project activities will continue through FY99. The remainder of the watershed is included in the WQSP, which began in 1988 and was completed in 1994. The purpose of these projects has been to provide technical and cost sharing assistance and educational programs to assist farmers in the watershed in implementing voluntary changes in farm management practices that will result in improved water quality in Sny Magill Creek.

No special critical areas have been defined for the HUA Project. Highly erodible land has been defined and an attempt is being made to treat all farms, prioritizing fields within each farm to be treated first. Structural practices, such as terracing and a few animal waste systems, are being implemented, as well as a variety of management practices such as crop residue management and contour stripcropping. Extension staff are assisting farmers with farmstead assessment and with ICM, in the hope of reducing fertilizer and pesticide inputs by at least 25% while maintaining production levels.

The WQSP has been completed. Practices implemented were primarily structural (terraces). No ICM or other information and education programs were implemented. Farmer participation was 80-85%.

The long-term sediment delivery reduction goal for Sny Magill Creek is 50%. Fertilizer and pesticide inputs are expected to be reduced by more than 25%.

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Through FY96, the following nonpoint source pollution controls have been completed in North Cedar Creek and Sny Magill Creek watersheds:

- 325,045 feet of terraces
- 92 grade stabilization structures
- 54 water and sediment control basins
- 2 agricultural waste structures
- The more effective use of nitrogen, phosphorus, and pesticides on 5,330 acres in the Sny Magill watershed

Four streambank stabilization demonstrations have been implemented using soil bioengineering technology and warm season grass species.

The Nutrient and Pest Management Incentive Education Program has enrolled eight cooperators with over 2,000 acres. This program, developed in the fall of 1994, promotes nutrient and pest management through participant education and implementation, rather than relying on the private sector for crop management services.

Based on USLE estimates, sediment delivery has been reduced by 35%.

WATER QUALITY MONITORING

Design

The Sny Magill watershed is amenable to documentation of water quality responses to land treatment. The cold water stream has a high ground water baseflow which provides year-round discharge, minimizing potential missing data problems. These conditions also make possible analysis of both runoff and ground water contributions to the water quality conditions. Because of the intimate linkage of ground and surface water in the region, the watershed has a very responsive hydrologic system and should be relatively sensitive to the changes induced through the land treatment implementation programs.

A paired watershed study compares Sny Magill watershed to the (control) Bloody Run Creek watershed (adjacent to the north and draining 24,064 acres). Watershed size, ground water hydrogeology, and surface hydrology are similar; both watersheds receive baseflow from the Ordovician Galena aquifer. The watersheds share surface and ground water divides and their proximity to one another minimizes rainfall variation. However, the large size of the two watersheds creates significant challenges in conducting a true paired watershed study. Land treatment and land use changes were to a minimum in the Bloody Run Creek watershed throughout the project period and for the first two years of water quality monitoring in the Sny Magill watershed.

Within the Sny Magill watershed, subbasins are compared using upstream/downstream stations.

Modifications Since Project Started

None.

Parameters Measured

Biological

Fecal coliform (FC)
Habitat assessment
Fisheries survey
Benthic macroinvertebrates

Chemical and Other

Suspended sediment (SS)
Nitrogen (N)-series (NO_3+NO_2-N, NH_4-N, Organic-N)
Anions
Total phosphorus (TP)
Biological oxygen demand (BOD)
Immunoassay for triazine herbicides
Water temperature
Conductivity
Dissolved oxygen (DO)
Turbidity

Covariates

Stream discharge
Precipitation

Sampling Scheme

Primary monitoring sites (SN1, BR1) (Figure 16) are established on both Sny Magill and Bloody Run creeks. The sites are equipped with USGS stream gauges to provide continuous stage measurements and daily discharge measurements. Suspended sediment samples are collected daily by local observers and weekly by water quality monitoring personnel when a significant rainfall event occurs.

Monthly measurements of stream discharge are made at seven supplemental sites (NCC, SN2, SNT, SNWF, SN3, BRSC, and BR2) (Figure 16).

Baseline data were collected during the summer of 1991. A report documenting these data was published (Seigley and Hallberg, 1994). The monitoring program, as described below, began in October of 1991.

Weekly grab sampling is conducted at the primary surface water sites (SN1, BR1) for fecal coliform bacteria, N-series (NO_3 +NO_2-N, NH_4-N, Organic-N), anions, TP, BOD, and immunoassay for triazine herbicides.

Four secondary sites are monitored weekly (three on Sny Magill: SN3, SNWF, and NCC; and one on Bloody Run: BR2).* Grab sampling is conducted for fecal coliform, partial N-series (NO_3 + NO_2-N, NH_4-N), and anions.

Weekly sampling is conducted by the U.S. National Park Service (weeks 1 and 3) and IDNR-GSB (weeks 2,4, and 5).

Three additional sites are monitored on a monthly basis (two on Sny Magill: SN2, SNT; and one on Bloody Run: BRSC).* These are grab sampled for FC, partial N-series, and anions.

* Note: Originally, site BRSC was monitored weekly and site BR2 was monitored monthly. However, after one water-year of sampling, the invertebrate biomonitoring group requested (in March of 1992) that the sites be switched. Thus, since October 1, 1992, BRSC is monitored monthly and BR2 is monitored weekly.

Temperature, conductivity, DO, and turbidity are measured at all sites when sampling occurs.

An annual habitat assessment is conducted along stretches of stream corridor, biomonitoring of macroinvertebrates occurs on a bimonthly basis, and an annual fisheries survey is conducted.

Monitoring Scheme for the Sny Magill and Bloody Run Watershed Section 319 National Monitoring Program Project

Design	Sites	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired watershed with upstream/ downstream stations (for each creek)	Sny Magill[T] and Bloody Run[C]	Habitat assessment Fishery survey Benthic macro-invertebrates SS Nitrogen series Anions TP* BOD* Triazine herbicides* Water temperature Conductivity DO Turbidity FC	Stream discharge (daily at sites SN1 & BR1; monthly at sites NCC, SN2, SNT, SNWF, SN3, BRSC, BR2) Stage (continuous at SN1, BR1) Precipitation	Weekly (for SN1, BR1, SN3, SNWF, NCC, BR2) Monthly (for SN2, SNT, BRSC)	Habitat and fisheries data collected annually. Macroinvertebrate data collected every two months.	1 yr pre-BMP 6 yrs BMP 2 yrs post-BMP

[T]Treatment watershed
[C]Control watershed
* These parameters are only sampled at sites SN1 and BR1

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

Data Management

Data management and reporting is handled by the IDNR – GSB and follows the Nonpoint Source Monitoring and Reporting Requirements for Watershed Implementation Grants.

USEPA Nonpoint Source Management System (NPSMS) software is used to track and report data to USEPA using four information "files": the Waterbody System File, the Nonpoint Source Management File, the Monitoring Plan File, and the Annual Report File.

All water quality data are entered in STORET. Biological monitoring data are entered into BIOS. All U.S. Geological Survey (USGS) data are entered in WATSTORE, the USGS national database.

Data transfer processes are already established between USGS, UHL, and IDNR-GSB. Coordination is also established with NRCS and ISUE for reporting on implementation progress.

Data Analysis

For annual reports, data are evaluated and summarized on a water-year basis; monthly and seasonal summaries are presented, as well.

Statistical analysis and comparisons are performed as warranted using recommended SAS packages and other methods for statistical significance and time-series analysis.

Water years 1995 and 1996 represent the fourth and fifth years of water quality monitoring. At this time, results from the monitoring are mixed. Improvements in benthic macroinvertebrates and pesticide detections have been measured, while fish, habitat, and nitrate and sediment loads are unchanged.

To date, the frequency of pesticide detections in Sny Magill Creek has declined from 60% to 33% while remaining relatively unchanged in Bloody Run Creek (90-100%).

The benthic macroinvertebrate metrics that may indicate some discernible trends are the EPT Index and the percent dominant taxa. Both suggest trends of improving water quality in Sny Magill Creek. The Bloody Run sampling sites have shown slight decreases in EPT Index values each year, suggesting steady to worsening water quality, while the Sny Magill Creek sites have shown consistent increases in EPT values since 1992. The percent dominant taxon metric has declined for Sny Magill Creek during the monitoring period; values for Bloody Run Creek have fluctuated but shown no substantial improvements.

For both streams, the majority of a year's sediment load is delivered during two periods: a spring snowmelt period and a summer storm period. Although BMPs have effectively reduced the sediment delivered from the uplands to Sny Magill Creek by an estimated 35%, these reductions have yet to be reflected in the sediment loads discharged by Sny Magill Creek. In spite of the close proximity of the watersheds, some intense rainstorms have had a greater impact on Sny Magill Creek than Bloody Run Creek. For Water Year 1995, a total of 4,775 tons of sediment was discharged from Sny Magill Creek while 3,117 tons were discharged from Bloody Run Creek. For Water Year 1996, 3,342 tons were discharged from Sny Magill Creek and 662 tons from Bloody Run Creek. Data from 1996 illustrate the significance of these rainstorms. In 1996, 14 days accounted for 90% of the year's total sediment load for Sny Magill while 204 days accounted for 90% of Bloody Run's annual total. Also, there is the concern over the large volume of historical sediment in the drainage network. Though implementation of BMPs in the uplands has reduced sediment delivery to Sny Magill Creek, the impact the large quantity of sediment historically stored in the drainage network may have on the sediment loads discharged from Sny Magill Creek is poorly understood.

Results from the habitat assessment suggest a strong relation between the drainage area size and position of each monitoring site in the landscape to the habitat variables. Monitoring sites with similar drainage size showed greater habitat similarity to each other than to other sites. The apparent interrelatedness of habitat, drainage area size, and channel slope suggests that physiography and stream morphological processes such as channel erosion and sediment deposition are important determinants of monitoring site habitat character.

Results of the fish survey from all years show that the streams' forage fish populations are typical of Iowa cold water streams. With the exception of 1995 and 1996, year-to-year fluctuations in fish populations appear to be a normal response to variations in precipitation, runoff, water clarity, and water stage. Extremely low

numbers were reported for the Sny Magill sites during 1995 and 1996. Fish numbers from Bloody Run Creek for those two years were comparable to previous years. The cause of the low numbers is not known. Other water-quality data showed no negative response or decline during this period. Future surveys will indicate if this trend continues.

NPSMS Data Summary

Monitoring Station Parameters Report (WY95)

STATION TYPE: Control Station

CHEMICAL PARAMETERS

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
FECAL COLIFORM, MEMBR FILTER, M-FC BROTH, 44.5 C	S		218	65	10
FLOW, STREAM, MEAN DAILY, CFS	S	CFS	26	23	19
NITROGEN, AMMONIA, TOTAL (MG/L AS N)	S		<0.1	<0.1	<0.1
NITROGEN, ORGANIC, TOTAL (MG/L AS N)	S		0.3	0.2	<0.1
PHOSPHORUS, TOTAL (MG/L AS P)	S		<0.1	<0.1	<0.1
PRECIPITATION, TOTAL (INCHES PER DAY)	S		0	0	0
TEMPERATURE, WATER (DEGREES CENTIGRADE)	S		15	11	4

STATION TYPE: Study Station

CHEMICAL PARAMETERS

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
FECAL COLIFORM, MEMBR FILTER, M-FC BROTH, 44.5 C	S		180	70	30
FLOW, STREAM, MEAN DAILY, CFS	S	CFS	17	16	14
NITROGEN, AMMONIA, TOTAL (MG/L AS N)	S		<0.1	<0.1	<0.1
NITROGEN, ORGANIC, TOTAL (MG/L AS N)	S		0.2	0.2	0.1
PHOSPHORUS, TOTAL (MG/L AS P)	S		<0.1	<0.1	<0.1
PRECIPITATION, TOTAL (INCHES PER DAY)	S		0	0	0
TEMPERATURE, WATER (DEGREES CENTIGRADE)	S		10	5	3

Monitoring Station Parameters Report (WY96)

STATION TYPE: Control Station

CHEMICAL PARAMETERS

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
FECAL COLIFORM, MEMBR FILTER, M-FC BROTH, 44.5 C	S		70	25	<10
FLOW, STREAM, MEAN DAILY, CFS	S	CFS	22	18	16
NITROGEN, AMMONIA, TOTAL (MG/L AS N)	S		<0.1	<0.1	<0.1
NITROGEN, ORGANIC, TOTAL (MG/L AS N)	S		0.3	0.2	<0.1
PHOSPHORUS, TOTAL (MG/L AS P)	S		<0.1	<0.1	<0.1
PRECIPITATION, TOTAL (INCHES PER DAY)	S		0	0	0
TEMPERATURE, WATER (DEGREES CENTIGRADE)	S		14	10	5

STATION TYPE: Study Station

CHEMICAL PARAMETERS

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
FECAL COLIFORM, MEMBR FILTER, M-FC BROTH, 44.5 C	S		158	48	10
FLOW, STREAM, MEAN DAILY, CFS	S	CFS	19	15	11
NITROGEN, AMMONIA, TOTAL (MG/L AS N)	S		<0.1	<0.1	<0.1
NITROGEN, ORGANIC, TOTAL (MG/L AS N)	S		0.3	0.2	0.1
PHOSPHORUS, TOTAL (MG/L AS P)	S		<0.1	<0.1	<0.1
PRECIPITATION, TOTAL (INCHES PER DAY)	S		0	0	0
TEMPERATURE, WATER (DEGREES CENTIGRADE)	S		15	9	3

Modifications Since Project Started

None.

Progress Towards Meeting Goals

The USEPA nonpoint source monitoring and reporting requirements for watershed implementation grants have been completed for the data from Water Years 1992, 1993, and 1994. Technical reports on data from water years 1992 and 1993 (Seigley et al., 1994), and water year 1994 (Seigley et al., 1996) have been completed.

TOTAL PROJECT BUDGET

Estimated budget for the Sny Magill Watershed Section 319 National Monitoring Program project for the period FY91-96:

Project Element	Funding Source ($)			
	Federal	State	Local	Sum
I&E	310,000	155,000	NA	465,000
LT (cost share)	374,000	186,000	NA	560,000
LT (technical assist.)	610,000	NA	NA	610,000
WQ Monit	*504,738	NA	NA	504,738
TOTALS	1,798,738	341,000	NA	2,139,738

* from Section 319 National Monitoring Program funds
Source: Lynette Seigley (personal communication, 1996)

Modifications Since Project Started

Funding restrictions in the Sny Magill HUA for FY94 affected cost-share funding to assist cooperating producers in installing BMPs. The HUA was able to operate in FY94 on limited funding that remained from previous years. The project applied for alternate funding to meet the unmet needs of producers to install BMPs. Funding for BMP implementation for 1995 and 1996 was provided by the Iowa Department of Agriculture and Land Stewardship – Division of Soil Conservation and the Iowa Department of Natural Resources.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

Please refer to the section entitled Nonpoint Source Control Strategy.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

Agencies participating in the Sny Magill Section 319 National Monitoring Program project are listed below:

- Clayton County USDA Farm Service Agency Committee
- Iowa State University Extension
- Iowa Department of Agriculture and Land Stewardship
- Iowa Department of Natural Resources

- University of Iowa Preventive Medicine
- Natural Resources Conservation Service
- University Hygienic Laboratory
- U.S. Forest Service
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. National Park Service
- U.S. Environmental Protection Agency

PROJECT CONTACTS

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Iowa

Walnut Creek
Section 319
National Monitoring Program Project

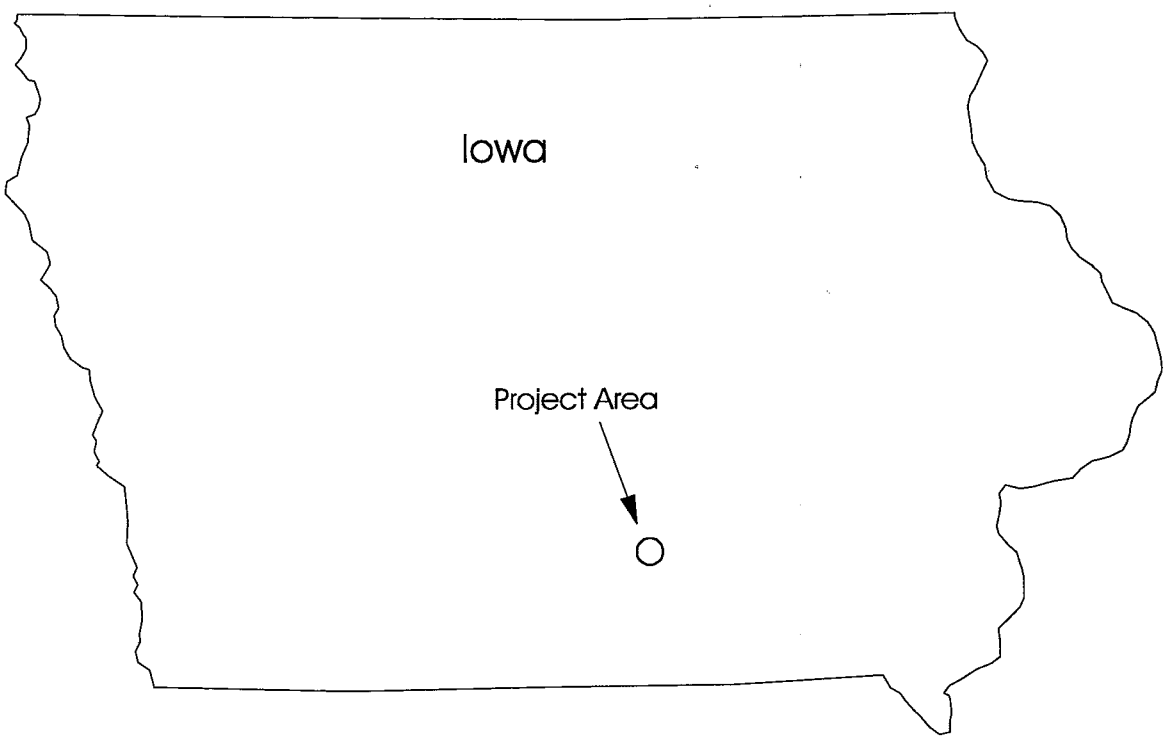
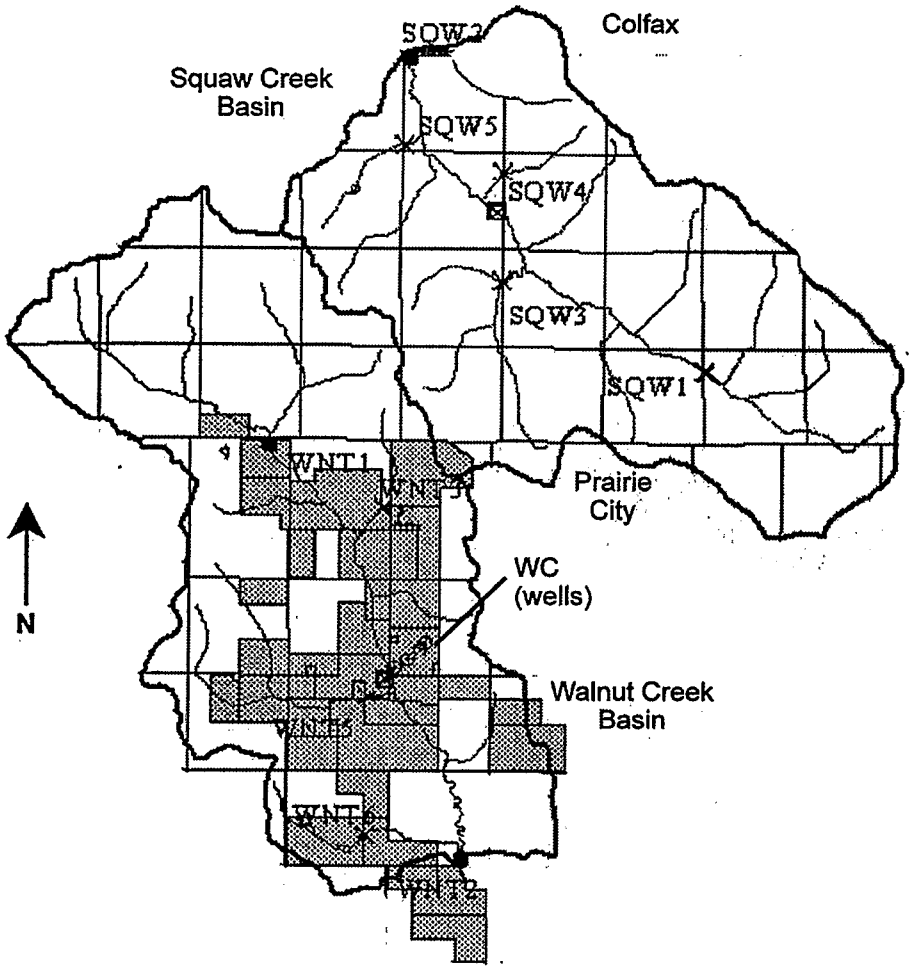


Figure 17: Walnut Creek (Section 319) Project Location



Legend

- Gaging stations and surface water sampling points
- Surface water sampling points
- Wells
- Biomonitoring stations

Figure 18: Water Quality Monitoring Stations for Walnut Creek (Iowa)

PROJECT OVERVIEW

The Walnut Creek Watershed Restoration and Water Quality Monitoring Project began in April, 1995, and is designed as a nonpoint source monitoring program in relation to the watershed habitat restoration and agricultural management changes implemented by the U.S. Fish and Wildlife Service (USFWS) at Walnut Creek National Wildlife Refuge and Prairie Learning Center (WNT) in central Iowa. The watershed is being restored from row crop to native prairie.

There are two components to the land use changes being implemented by USFWS: ecosystem resources restoration to prairie/savanna and mandatory (contractual) use of improved agricultural management practices on farmlands prior to conversion. The majority of the Refuge area will be seeded to tall-grass prairie with savanna components where applicable. In the riparian areas, 100 foot-wide vegetative filter strips will be seeded along all of the streams in the Refuge that are not allowed to revert to wetlands. Riparian and upland wetlands will also be restored or allowed to revert to wetlands by the elimination of tile lines.

Cropland management within the WNT Refuge is also controlled by the USFWS management team. Farming is done on a contractual, cash-rent basis, with various management measures specified; some are flexible, some more prescriptive. The measures include soil conservation practices; nutrient management through soil testing, yield goals, and nutrient credit records; and integrated pest management. Crop scouting for pest management is mandatory for all farms on Refuge lands, as are no-till production methods. Insecticide use is highly restricted and herbicide use is also controlled in order to minimize adverse impacts on non-target plants and animals.

The project will use a paired watershed approach as well as an upstream/downstream assessment. The treatment watershed is Walnut Creek, the paired site is Squaw Creek. Both watersheds are primarily agricultural dominated by row crop, mainly corn and soybeans. Although no specific water quality objectives have been set for this project, the intent of the USFWS is to restore the area to pre-settlement conditions. In general, the decrease in active row crop agriculture should lead to reductions in nutrients and pesticides in Walnut Creek.

Three gaging stations for flow and sediment have been established, two on Walnut Creek and one on Squaw Creek. Both creeks will be monitored for biological and chemical parameters. Both the main creek and tributaries are included in the sampling scheme.

PROJECT DESCRIPTION

Water Resource Type and Size

Walnut Creek and Squaw Creek are warmwater streams located in central Iowa.

Water Uses and Impairments

Walnut Creek and Squaw Creek are designated under the general use category. No designated use classification has been assigned to Walnut Creek.

Walnut Creek drains into a segment of the Des Moines River that is classified as *Not Supporting* its designated uses in the Iowa Department of Natural Resources' (IDNR) water quality assessments; Squaw Creek and the Skunk River are classified as *Partially Supporting*. Assessments in this area cite agricultural nonpoint source as the principal concern.

Walnut and Squaw creeks are affected by many agricultural nonpoint source water pollutants, including sediment, nutrients, pesticides, and animal waste. Water quality in these streams is typical for many of Iowa's small warmwater streams: water quality varies significantly with changes in discharge and runoff. Streambank erosion has contributed to significant sedimentation in the creeks.

Pre-Project Water Quality

Three pre-project water quality studies were completed. Data were collected during the pre-implementation period by the US Fish and Wildlife Service in 1991. The Tri-State Monitoring Project collected data in the Walnut Creek basin from 1992 to 1994. Two sets of storm event samples were collected in 1995.

In 1991, nitrate-nitrogen concentrations ranged from 14 to 19 mg/l with a mean of 16. Atrazine concentrations were from 0.24 to 1.2 ug/l. The Tri-State data were similar, with nitrogen from 5 to 44 mg/l, averaging 14.5 mg/l and atrazine from 0.1 to 2.7 ug/l. The event sampling in 1994 had fewer samples, but nitrogen ranged from 2.1 to 11.0 mg/l (avg. 6.1) in Walnut Creek and from 0.1 to 20 (avg. 10.0) in the tributaries. Atrazine in the main stem of Walnut Creek ranged from <0.1 to 0.3 ug/l and was higher in the tributaries (up to 3.1 ug/l).

Primary biological productivity is low and the condition of the fish community is poor.

Current Water Quality Objectives

Maintain or exceed water quality criteria for general use waters. The long-term goal of the US Fish and Wildlife Service is to restore this area to pre-settlement conditions.

Modifications Since Project Initiation

None.

Project Time Frame

April, 1995 to September, 1998

Project Approval

April, 1996

PROJECT AREA CHARACTERISTICS

Project Area

The project area, located in central Iowa (Figure 17), consists of a total of 24,570 acres. The Walnut Creek Basin is the treatment watershed (12,860 acres) and the Squaw Creek Basin (11,710) is the control watershed (Figure 18). Both creeks have been channelized in part. Both are characterized by silty bottoms and high, often vertical, banks. Deposition of up to 4 feet of post-settlement alluvium is not uncommon.

Relevant Hydrologic, Geologic, and Meteorological Factors

The total project area is located in the Southern Iowa Drift Plain, an area characterized by steeply rolling hills and well-developed drainage. Dominant soils are silty clay loams, silt loams, or clay loams formed in loess and till. Average annual rainfall for the project area is approximately 32 inches. Both creeks have been extensively channelized and are incised into their valleys. Two to six feet of post-settlement alluvium is present in both valleys. Stream gradients in the main stem vary from 0.01 to 0.002. An analysis of sediment delivery and extensive characterization of beds and banks began in the summery of 1997. Discharge is similar in both streams, although Walnut Creek experiences slightly lower flows. Both streams display rapid responses to precipitation. Baseflow percentages for WY96 are Walnut Creek (upstream) — 41%, Walnut Creek (downstream) — 29%, and Squaw Creek (downstream) — 37%.

An analysis of slopes within the basin showed that both watersheds are very similar:

Slope Class	Walnut Creek (%)	Squaw Creek (%)
A (0-2%)	19.9	19.7
B (2-5%)	26.2	26.7
C (5-9%)	24.4	25.0
D (9-14%)	24.5	22.2
E (>14%)	5.0	6.5

Land Use

1996 land use data:

	Walnut Creek %	Squaw Creek %
Corn	37.3	42.3
Beans	28.4	32.0
Other harvested crops	4.3	11.3
Grass	21.1	7.4
Forest	2.4	2.3
Other	6.5	4.7

Pollutant Sources

Sediment — streambank erosion, cropland erosion, gully erosion, animal grazing
Nutrients — crop fertilizers, manure
Pesticides — cropland

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

The WNT's educational commitment and resources will allow for educational and demonstration activities far beyond the scope of those that could typically be accomplished by 319 projects. Of particular note, the linkages between land use changes and water quality improvements will be an integral part of these educational efforts. In addition, existing curriculum creates opportunities for interested visitors to acquire, enter, and interpret hydrologic and water quality data from the watershed. Both streamside and visitor center-based activities and educational stations are planned. Information presentations could readily be tailored to school, environmental, or agricultural interest groups. It is anticipated that visitors to the WNT will number in the tens of thousands annually, offering a uniquely wide exposure of residents to the land use changes and monitoring activities in the watershed.

USFWS will utilize the WNT as a demonstration area for landscape restoration projects. Information will be disseminated to visitors and invited groups, the public (through published reports), and the news media. Of broader interest, the project is also serving as a demonstration site for riparian restoration and small wetland restoration. Having a linked water quality evaluation program makes these demonstrations more effective for general use and translation to a broader audience.

Progress Towards Meeting Goals

Several tours were provided in 1996 to teacher groups, natural history organizations, and surrounding landowners. The visitor center opened in the spring of 1997.

Tours have been done for a variety of different groups, including students from grade school through college; scientists from several institutions, including Iowa

and several other states and counties; Iowa and U.S. legislators; and members of the farming community and general public.

Formal oral and/or poster presentations have been given at several meetings around the Midwest both to scientific groups and to the general public.

Information on the project is contained on the IDNR-GSB web page as well as a web page maintained by the USFWS. Several contacts have been made via this avenue.

The visitor center was opened in April 1997. From May 5 to July 10, 1997, there have been 12,100 visitors. Improvement in water quality is part of one of the displays at the center.

NONPOINT SOURCE CONTROL STRATEGY

Description

The best management practices (BMPs) for row crop production include specific erosion control measures along with nutrient and pesticide management. The primary land treatment activity, however, is to remove 5,000 acres of cropland from production by converting it to native tall grass prairie. Wetlands and riparian zones will also be restored. Limited nutrient and pesticide management is expected for the remainder of the Walnut Creek watershed.

Modifications Since Project Started

None.

WATER QUALITY MONITORING

Design

A paired monitoring design will be used (Figure 18). For the paired watershed design, the outlets of Walnut Creek (treatment) and Squaw Creek (control) watersheds will be monitored. Each watershed also has stations upstream and downstream in order to differentiate natural processes from land use changes. Water quality will be compared before and after treatment to evaluate land treatment effectiveness.

Modifications Since Project Started

None.

Parameters Measured

Biological

Fecal coliform (FC)
Macroinvertebrates
Fisheries

Chemical and Other

Alkalinity
Ammonia (NH_3)
Bentazon
Biochemical oxygen demand (BOD)
Bromide (Br)
Calcium (Ca)
Chloride (Cl)

Common herbicides
Dicamba
Dissolved oxygen (DO)
Fluoride (Fl)
Magnesium (Mg)
Nitrate (NO_3)
Orthophosphate (OP)
pH
Phosphate (PO_4^{3-})
Potassium (K)
Sodium (Na)
Specific conductivity
Sulfate (SO_4^{-})
Suspended solids (SS)
Turbidity

Covariates

Precipitation
Water Discharge

Sampling Scheme

The outlets at Walnut and Squaw Creeks are gaged, as is an upstream station on the main stem of Walnut Creek. At these three stations, water discharge and SS will be monitored daily, and data compiled for storm event statistical evaluation.

Ten stations are monitoring biweekly to monthly in March through July and September. Four stations are sampled once in August, October, December, and February. Additional event sampling is done throughout the year.

Monitoring Scheme for the Walnut Creek Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired	Watershed	NO_3 OP Turbidity SS	Precipitation Water Discharge	Monthly Storm events	Annual	Unknown
Upstream/ Downstream	Tributary to Des Moines River	NO_3 OP Turbidity SS	Precipitation Water Discharge	Monthly Storm events	Annual	Unknown

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

All United States Geological Survey (USGS) data will be reported in WATSTORE, the USGS national database. The project will use ARCINFO for land use changes. Statistical analyses on water quality data for trend detection will be completed as deemed necessary. Water quality parameters and land use activities will be tracked using the NonPoint Source Management System (NPSMS) software.

Data management and reporting is handled by the Iowa Department of Natural Resources Geological Survey Bureau (IDNR-GSB) and follows the Nonpoint

Source Monitoring and Reporting Requirements for Watershed Implementation Grants. All water quality data are entered into STORET.

Pesticides. There were detections of six difference compounds during 1995 and 1996 in Walnut and Squaw Creek surface waters. Atrazine was by far the most frequently detected compound, as is true across Iowa, with frequency of detections from 71% to 88% in the main stems. Atrazine concentrations were higher in 1996 than 1995 in both Squaw and Walnut creeks. Five pesticides were detected in rain samples. Atrazine was the most frequently detected compound with concentrations ranging from 0.11 to 0.36 Ug/l. No significant differences are seen between 1995 and 1996 data.

Nitrate. Nitrate concentrations were high, but typical for streams in Iowa. Ranges and averages for the four main stem sampling sites were:

Site	Range NO_3-N (mg/l)	Avg. NO_3-N (mg/l)
Walnut (upstream)	4.1 - 15.8	10.5
Walnut (downstream)	2.1 - 13.0	8.1
Squaw (upstream)	6.8 - 15.5	12.8
Squaw (downstream)	3.9 - 12.3	8.6

In addition, both creeks show downstream declines in nitrate concentrations. This can be attributable to instream reductions caused by either denitrification or dilution from larger flow volumes. A comparison of data from the two years shows that the slope has decreased, indicating perhaps a slight decline in nitrate in the Walnut Creek basin; however, this is not statistically significant.

NPSMS Data Summary

Not available.

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Walnut Creek is characterized by a macroinvertebrate community that was dominated by relatively few taxa, with occasional new taxa appearing at low frequencies and abundances. The macroinvertebrate trends that occurred in both Squaw and Walnut Creek watersheds (based on 1995 and 1996 data) were similar and continued to respond in equivalent ways seasonally, approximating each other in community structure and population. The HBI values continue to show good water quality, but other metrics (percent dominant taxon, EPT index, and total taxa) indicate unbalanced communities. Additionally, from an ecoregion perspective, both creeks rate in the lower quartile with respect to two metric indicators (EPT taxa, total number of taxa) of macroinvertebrate community health.

The fish communities retained the same dominant species as 1995; however, the less frequent species were variable. The 1996 field season, as in the previous season, showed that aquatic macrophyte populations are not present at the biomonitoring sites and, based on field observations, were not likely present anywhere in the stream reaches located within the refuge.

TOTAL PROJECT BUDGET

The estimated budget for the Walnut Creek Section 319 National Monitoring Program project for the life of the project is:

Project Element	Funding Source ($)			
	Federal*	USFWS	State	Sum
Proj Mgt	102,029	NA	113,196	215,225
I & E	3,000	NA	1,000	4,000
L T	NA	500,000	NA	500,000
WQ Monit	330,300	NA	NA	330,300
TOTALS	435,329	500,000	114,196	1,049,525

*from Section 319 NMP funds
Source: Carol Thompson, 1996 (personal communication)

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

None.

OTHER PERTINENT INFORMATION

Participating Agencies and Organizations:

- Iowa Department of Natural Resources
- U.S. Fish and Wildlife Service
- U.S. Geological Survey — Water Resources Division
- University of Iowa Hygienic Laboratory
- Farm Service Agency
- Iowa Department of Natural Resources — Environmental Protection Division
- U.S. Environmental Protection Agency

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Maryland

Warner Creek Watershed
Section 319
National Monitoring Program Project

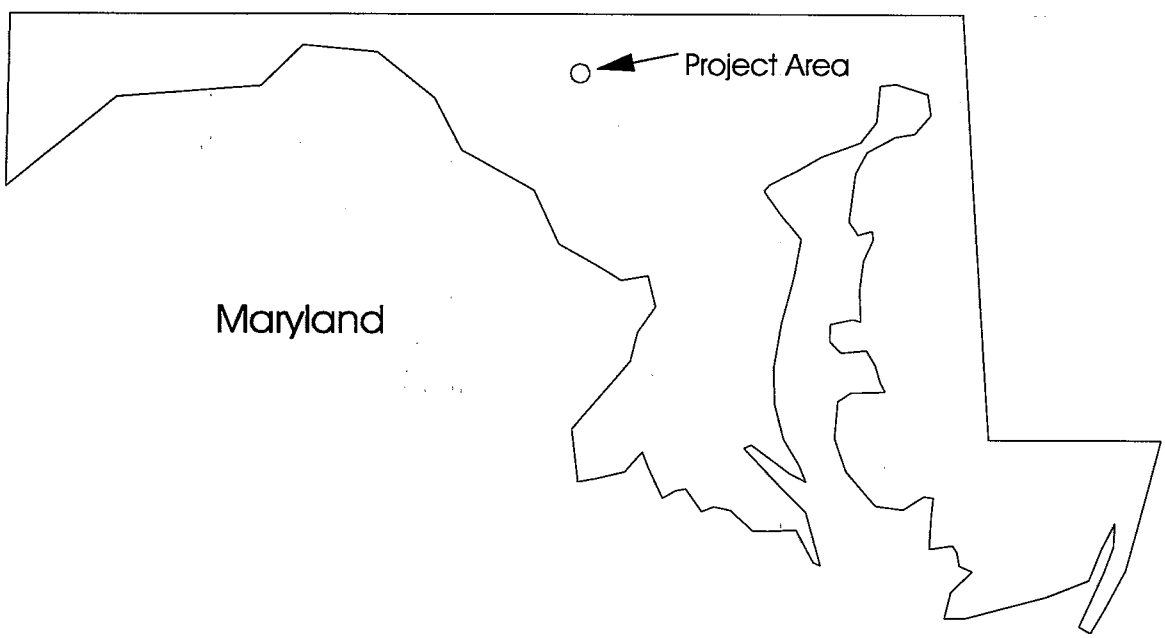

Figure 19: Warner Creek (Maryland) Watershed Project Location

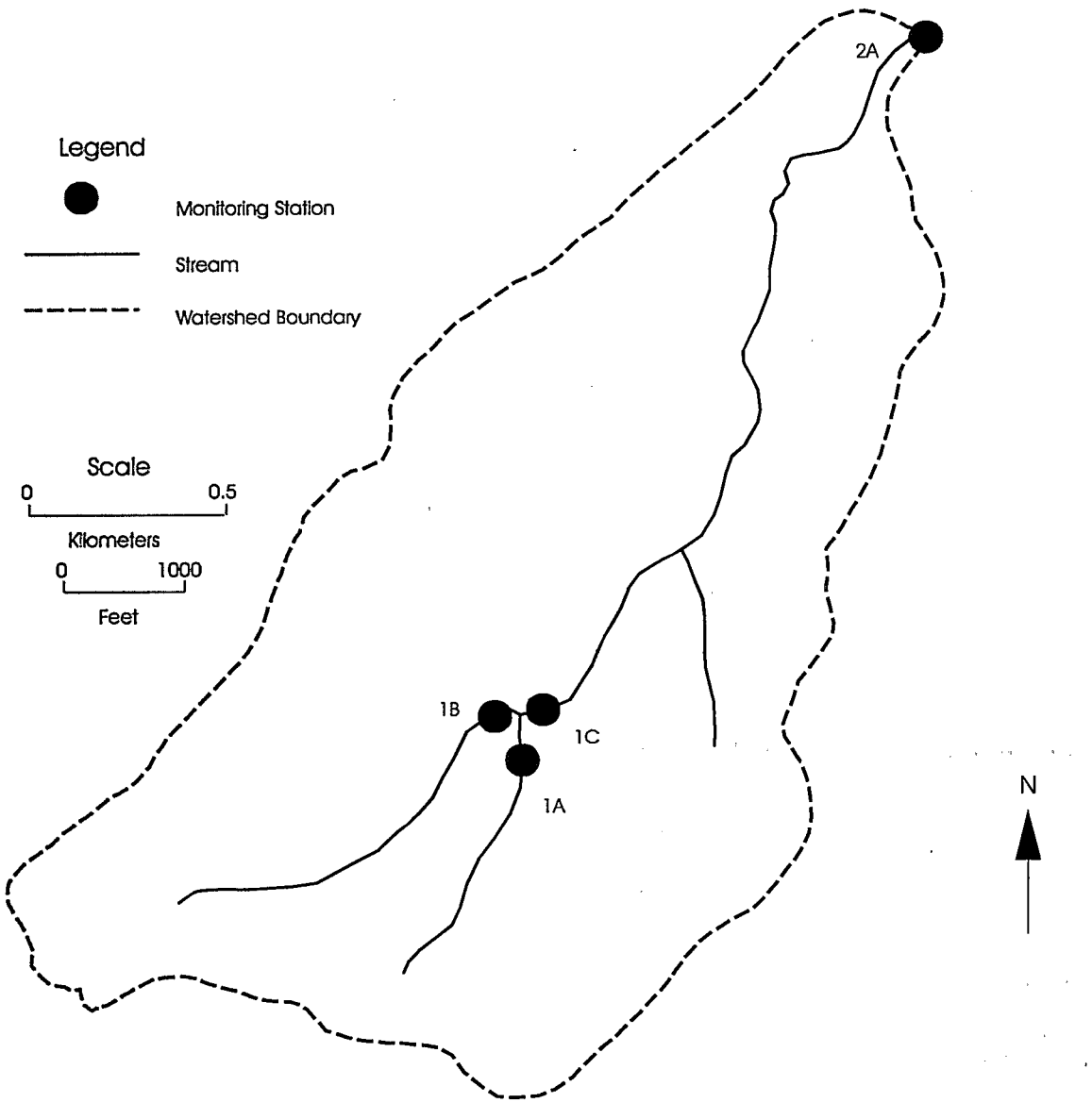

Figure 20: Water Quality Monitoring Stations for Warner Creek (Maryland) Watershed

PROJECT OVERVIEW

The Warner Creek watershed is located in the Piedmont physiographic region of northcentral Maryland (Figure 19). Land use in the 830-acre watershed is almost exclusively agricultural, primarily beef and dairy production and associated activities.

Agricultural activities related to dairy production are believed to be the major nonpoint source of pollutants to the small stream draining the watershed. A headwater subwatershed, in which the primary agricultural activity is dairy farming (treatment), will be compared to another subwatershed, in which the primary agricultural activity is beef production (control).

Proposed land treatment for the treatment watershed includes conversion of cropland to pasture, installation of watering systems, fencing to exclude livestock from tributary streams, and the proper use of newly constructed manure slurry storage tanks.

Water quality monitoring involves both paired watershed and upstream/downstream experimental designs. Sampling will occur at the outlets of the paired watersheds (stations 1A and 1B) and at the upstream/downstream stations (1C and 2A) on a biweekly basis (Figure 20). Storm-event sampling by an automatic sampler will occur at station 2A. Water samples will be analyzed for sediment, nitrogen, and phosphorus.

Warner Creek is a subtributary of the Monocacy River basin. Monitoring data will be used to evaluate the suitability of a modified version of the CREAMS and/or ANSWERS model for its use in the larger Monocacy River basin.

PROJECT DESCRIPTION

Water Resource Type and Size

Warner Creek is a small stream with a drainage area of about 830 acres, all of which are included in the study area. Its average discharge is 30 gallons per minute. Warner Creek drains into a tributary that drains into the Monocacy River basin.

Water Uses and Impairments

The water resource has no significant use, except for biological habitat.

Pre-Project Water Quality

Seven weeks of pre-project water quality monitoring at four stations yielded the following data:

Nitrate (mg/l)	Nitrite (mg/l)	Ammonia (mg/l)	TKN (mg/l)	TKP (mg/l)	Orthophosphorus (mg/l)
3.3-6.7	.01-.05	0-23.0	0-73.0	0-6.7	0-3.6

Source: Shirmohammadi and Magette, 1993

Current Water Quality Objectives

The objectives of the project are to

- develop and validate a hydrologic and water quality model capable of predicting the effects of agricultural best management practices (BMPs) on water quality, both at the field and basin scale;

- collect water quality data for use in the validation of the basin-scale hydrologic and water quality model; and
- apply the validated model to illustrate relationships between agricultural BMPs and watershed water quality in support of the USDA Monocacy River Demonstration Project.

Modifications Since Project Initiation

None.

Project Time Frame

May, 1993 to March, 2001

Project Approval

June, 1995

PROJECT AREA CHARACTERISTICS

Project Area

Approximately 830 acres.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The watershed is in the Piedmont physiographic province. Geologically, bedrock in this area has been metamorphosed. Upland soils in the watershed belong to the Penn silt loam series with an average slope of three to eight percent. Average annual rainfall near the watershed is 44-46 inches.

Land Use

Land use in the upper part (upstream of 1C) of the watershed is mostly pasture and cropland, with a few beef and dairy operators. The subwatershed upstream of station 1B contains a dairy operation, and a recent survey indicated that about sixty-five percent of the land was used for corn silage production. Downstream of station 1C, land use is also mostly pasture and cropland, which is used to support dairy and beef production.

Pollutant Sources

The major sources of pollutants are thought to be the dairy operations and the associated cropland. Pastures in which cows have unlimited access to the tributary streams also contribute significant amounts of pollutants.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

The project will draw support from University of Maryland Cooperative Extension Service (CES) agents, the Natural Resources Conservation Service (NRCS) and Frederick Soil Conservation District offices in Frederick, Maryland, and project specialists located in the Monocacy River Water Quality Demonstration offices, several of whom have already established lines of communication between watershed farmers and the local personnel of the relevant USDA agencies. Education and public awareness will be accomplished through the CES in the form of tours, press releases, scientific articles, and oral presentations.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

Upstream/Downstream Study Area (1C and 2A):
Best management practices planned for this area include construction of watering systems for animals, fencing animals from streams, and the proper use of newly constructed manure slurry storage tanks. Conversion of cropland to pasture is also anticipated in this area.

Paired Watershed (1A and 1B):
The implementation of BMPs in the treatment (1B) watershed has been uncertain; however, due to a concerted effort, an animal waste storage system was installed in 1996. Cropland conservation practices and a reception pit are also planned and will be installed when funding is approved.

Modifications Since Project Started

None.

WATER QUALITY MONITORING

Design

The water quality monitoring component incorporates the following two designs:

- Upstream/downstream on Warner Creek
- Paired watersheds in the uppermost areas of the watershed

Modifications Since Project Started

None.

Parameters Measured

Chemical and Other

Ammonia (NH_3)
Total Kjeldahl nitrogen (TKN)
Nitrate + nitrite (NO_3+NO_2)
Nitrite (NO_2)
Orthophosphate (OP)
Total Kjeldahl phosphorus (TKP)
Sediment

Covariates

Rainfall
Discharge: instantaneous (1A, 1B and 1C) continuous (2A)

Sampling Scheme

Upstream/Downstream Study Area (1C and 2A) (Figure 20):
Type: grab (1C and 2A); automated storm event (2A)
Frequency and season: weekly from February to June and biweekly for the remainder of the year (1993 through 1995) and biweekly since 1996.

Paired Watershed (1A and 1B) (Figure 20):
Type: grab (1A and 1B)
Frequency and season: weekly from February to June and biweekly for the remainder of the year

Monitoring Scheme for the Warner Creek Watershed Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired		NH_3 TKN	Rainfall discharge	Weekly Feb. to June and bi-weekly the remainder of the year (1993-1995) biweekly since 1996		3 yrs. pre-BMP 1 yrs. BMP 1 yrs. post-BMP
Upstream/ Downstream	Warner Creek	NO_3+NO_2 NO_2 OP TKP Sediment				

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

Monitoring data are stored and analyzed at the University of Maryland. In addition, data will be reported using the Nonpoint Source Management System (NPSMS) software.

NPSMS Data Summary

Not available.

Data currently available: Average annual concentrations (mg/L) and associated standard deviations (mg/L) and coefficient of variations (%) for nitrogen and phosphorus constituents measured from grab samples at different stations (1A, 1B, 1C, and 2A) in the Warner watershed.

	1993				1994				1995			
	1A	1B	1C	2A	1A	1B	1C	2A	1A	1B	1C	2A
NO_3-N	4.07	3.22	3.58	4.17	3.24	3.02	3.06	2.98	3.23	3.97	3.69	3.76
	1.23	1.54	1.31	1.75	0.90	1.55	1.00	1.63	1.01	2.02	1.33	1.58
	30	48	37	42	28	51	33	55	31	0.51	36	42
TKN	0.81	11.70	6.57	1.69	1.90	11.20	6.44	3.66	0.114	7.77	5.78	1.72
	2.26	15.9	9.11	2.72	6.94	12.94	5.96	4.38	0.25	5.70	5.17	2.11
	278	136	139	161	366	116	93	120	181	73	89	123
NH_4-N	0.04	5.75	3.33	0.35	0.05	7.22	3.67	1.16	0.02	5.42	2.88	0.83
	0.10	6.10	3.89	0.65	0.11	8.99	4.56	2.00	0.03	5.75	3.05	1.37
	259	106	117	187	204	124	124	172	156	106	106	166
PO_4-P	0.04	0.96	0.55	0.23	0.10	1.60	0.89	0.49	0.02	1.70	0.88	0.43
	0.12	1.06	0.60	0.15	0.40	2.06	1.32	0.72	0.02	2.01	1.01	0.48
	353	111	109	66	404	129	149	147	118	119	115	111
TKP	0.09	2.46	1.39	0.70	0.10	2.40	1.61	0.90	0.04	1.96	0.94	8.45
	1.00	0.82	0.99	1.69	0.27	2.88	2.11	1.42	0.07	2.62	1.20	0.60
	1111	35	71	241	260	120	130	159	156	134	128	134
			n = 31				n = 31				n = 13	

Modifications Since Project Started

None.

TOTAL PROJECT BUDGET

Project Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Monitoring						
Personnel	$41,600	$32,500	$45,000	$49,000	$51,500	$54,500
Equipment	10,000	3,000	NA	NA	NA	NA
Other	26,733	35,938	37,140	34,190	35,215	36,445
TOTALS	78,333	71,438	82,140	83,190	86,715	90,945

Source: FFY94 Work Plan (6/23/94).

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The USDA Monocacy River Demonstration Watershed Project will facilitate the dissemination of information gained from the project and help provide cost-share funds for implementing BMPs.

OTHER PERTINENT INFORMATION

None.

PROJECT CONTACTS

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Michigan

Sycamore Creek Watershed
Section 319
National Monitoring Program Project

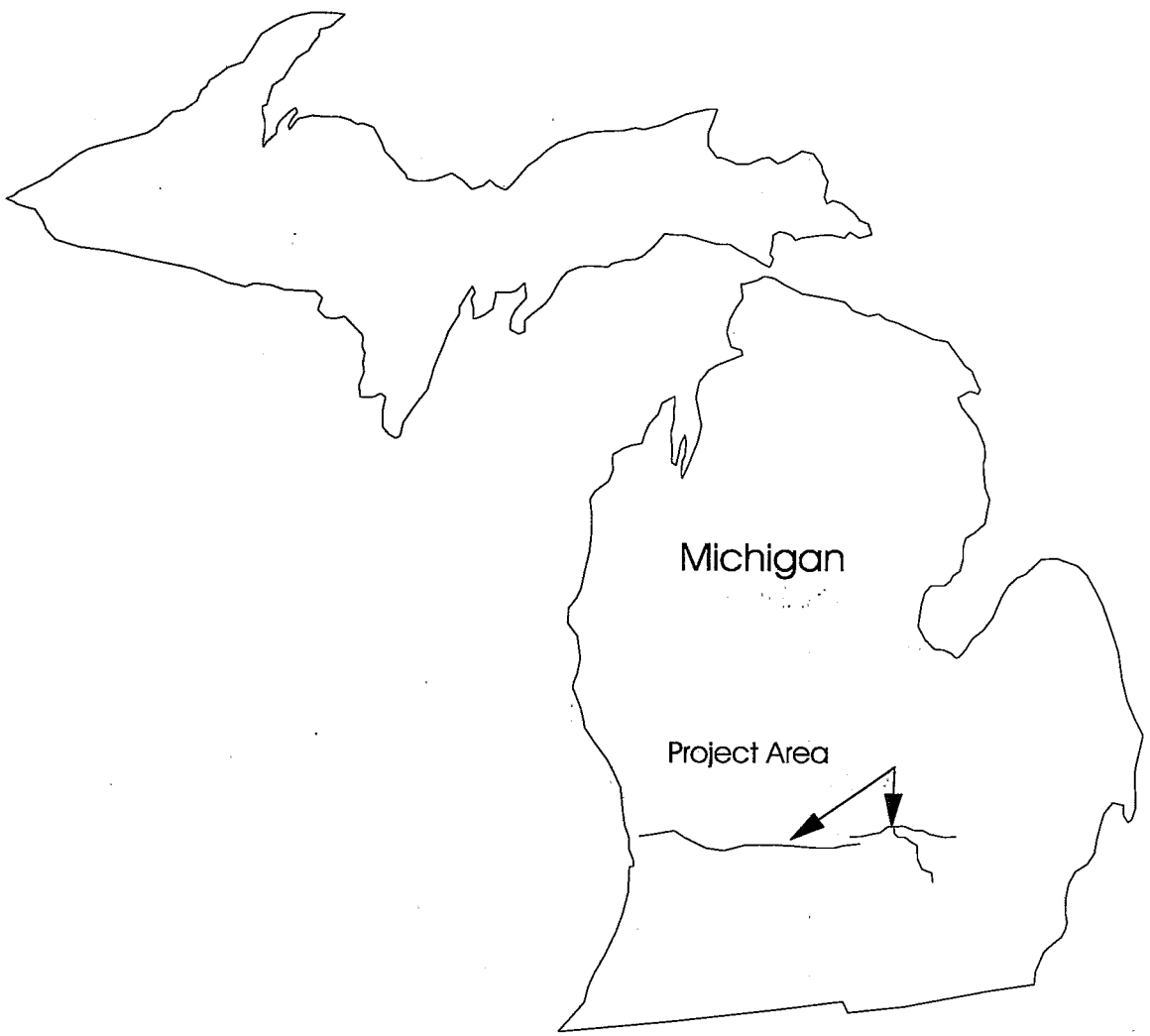

Figure 21: Sycamore Creek (Michigan) Project Location

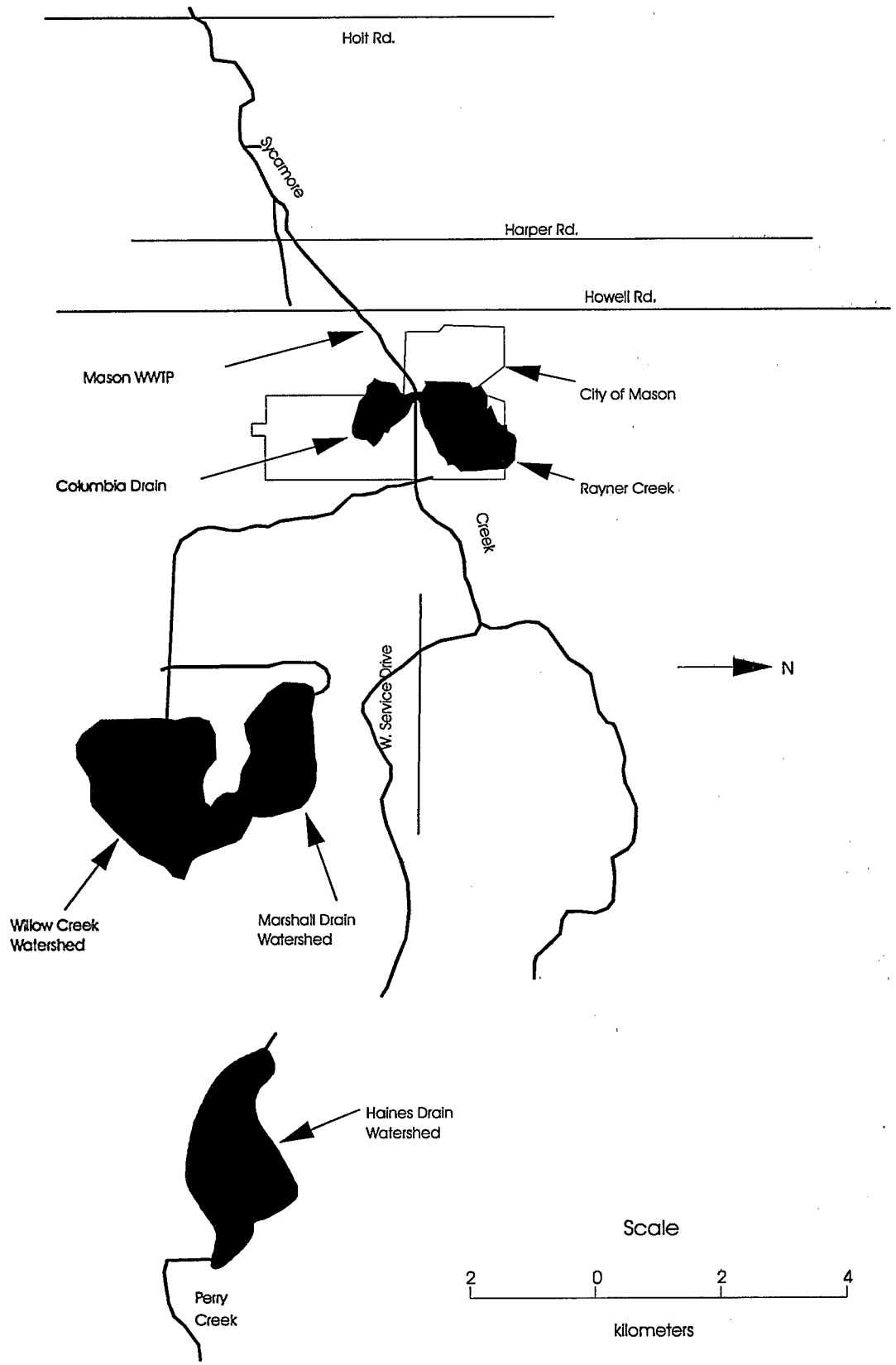

Figure 22: Paired Water Quality Monitoring Stations for the Sycamore Creek (Michigan) Watershed

PROJECT OVERVIEW

Sycamore Creek is located in southcentral Michigan (Ingham County) (Figure 21). 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.

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

Water quality monitoring occurs in three subwatersheds: Haines Drain, Willow Creek, and Marshall Drain (Figure 22). The Haines subwatershed, where best management practices (BMPs) have been installed, serves as the control and is outside the Sycamore Creek watershed. Stormflow and baseflow water quality samples from each watershed are from March through July of each project year. Water is sampled for turbidity, total suspended solids, chemical oxygen demand (COD), nitrogen (N), and phosphorus (P).

Land treatment consists primarily of sediment and nutrient-reducing BMPs on cropland, pastureland, and hayland. Implementation BMPs is funded as part of the U.S. Department of Agriculture (USDA) Sycamore Creek Hydrologic Unit Area (HUA) project.

PROJECT DESCRIPTION

Water Resource Type and Size

Sycamore Creek is a tributary of the Red Cedar River. The Red Cedar River flows into the Grand River, which flows into Lake Michigan.

Water Uses and Impairments

Sycamore Creek is designated through Michigan State Water Quality Standards for warmwater fish, body contact recreation, and navigation. Currently the pollutant levels in the creek are greater than prescribed standards. In particular, dissolved oxygen levels (the minimum standard level is 5 milligram per liter) are below the minimum standard, primarily because of sediment but also, in some cases, nutrients (Suppnick, 1992).

Pre-Project Water Quality

The primary pollutant is sediment. Widespread aquatic habitat destruction from sedimentation has been documented. Nutrients (nitrogen and phosphorus) are secondary pollutants. Pesticides may be polluting ground water; however, evidence of contamination by pesticides is currently lacking. Low levels of dissolved oxygen in the creek are a result of excess plant growth and organic matter associated with the sediment.

Sediment and Phosphorus Content of Sycamore Creek Under Routine (dry) and Storm (wet) Flow Conditions

Dry P mg/l	Wet P mg/l	Dry Sediment mg/l	Wet Sediment mg/l
0.01-0.09	0.04-0.71	4-28	6-348

Source: NRCS/CES/FSA, 1990

A biological investigation of Sycamore Creek, conducted in 1989, revealed an impaired fish and macroinvertebrate community. Fish and macroinvertebrate numbers were low, suggesting lack of available habitat.

Channelization of Sycamore Creek is causing unstable flow discharge, significant bank-slumping, and erosion at sites that have been dredged.

Current Water Quality Objectives

The water quality objective is to reduce the impact of agricultural nonpoint source pollutants on surface and ground water of Sycamore Creek.

The goal of the project is to reduce sediment delivery into Sycamore Creek by 52%.

Modifications Since Project Initiation

None.

Project Time Frame

Monitoring will be conducted for a minimum of six years, contingent upon federal funding.

Project Approval

1993

PROJECT AREA CHARACTERISTICS

Project Area

The project, located in southcentral Michigan, encompasses 67,740 acres.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The geology of the watershed consists of till plains, moraines, and eskers (glacially deposited gravel and sand that form ridges 30 to 40 feet in height). The Mason Esker and associated loamy sand and sandy loam soil areas are the major ground water recharge areas in Ingham County. Eskers are the predominant geologic feature near the stream. These grade into moraines that are approximately one-half to one mile in width. The moraines have sandy loam textures with slopes of 6 -18%. The moraines grade into till plains. Interspersed within the area, in depressional areas and drainageways, are organic soils.

Land Use

Approximately 50% of the land in this primarily agricultural watershed is used for crops, forage, and livestock.

Critical areas for targeting BMPs are agricultural fields (cropland, hayland, or pasture) within one-half mile of a stream.

Major BMPs already implemented in the project area are pasture and hayland planting, pasture and hayland management, diversions, cover and green manure crops, critical area plantings, conservation tillage, grade stabilization structures, grassed waterways, and integrated crop management.

Crop and residue cover are recorded on a 10-acre cell basis in each of the three monitored subwatersheds.

Land Use	Acres	(%)
Agricultural	35,453	52
Forest	8,017	12
Residential	9,336	14
Business/Industrial	2,562	4
Idle	6,381	10
Wetlands	2,324	3
Transportation	1,349	2
Open land	826	1
Gravel pits and wells	806	1
Water	359	0.5
Other	325	0.5
Total	67,738	100

Source: NRCS/CES/FSA, 1990

Pollutant Sources

Streambanks, urban areas, agricultural fields

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

The Ingham County Cooperative Extension Service (CES) is responsible for all information and education (I&E) activities within the watershed. These I&E activities have been developed and are being implemented as part of the Sycamore Creek HUA project. Activities include public awareness campaigns, conservation tours, media events such as news releases and radio shows, display setups, workshops, short courses, farmer-targeted newsletters, homeowner-targeted newsletters, on-farm demonstrations, meetings, and presentations. Ingham County CES assists producers with nutrient management plans and integrated pest management.

Progress Towards Meeting Goals

1994 activities include:

- Ten on-farm demonstrations
- One watershed tour
- One watershed winter meeting
- Monthly newsletters for area farmers
- One homeowners' newsletter
- Twenty-five farm plans for nutrient and pesticide management

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

The Sycamore Creek U.S. Environmental Protection Agency (USEPA) Section 319 National Monitoring Program project is nested within the Sycamore Creek HUA project. The nonpoint source control strategy includes: 1) identification and prioritization of significant nonpoint sources of water quality contamination in the watershed and 2) promotion of the adoption of BMPs that significantly reduce the affects of agriculture on surface water and ground water quality.

Selection of the BMPs depends on land use: cropland, hayland, pasture land, or urban land. Cropland BMPs include conservation tillage, conservation cropping sequence, crop residue use, pest management, nutrient management, waste utilization, critical area planting, and erosion control structures. Hayland- area BMPs consist of conservation cropping sequence, conservation tillage, pest management, nutrient management, pasture/hayland management, and pasture/hayland planting. BMPs to be utilized on pastureland are conservation cropping sequence, conservation tillage, pasture/hayland management, pasture/hayland planting, fencing, waste utilization, filter strips, and critical area planting. The following practices are eligible for ACP funding:

- No till
- Permanent vegetative cover establishment
- Diversions
- Cropland protective cover
- Permanent vegetative cover on critical areas
- Sediment retention erosion or water control structure
- Sod waterways
- Integrated crop management
- Critical area planting
- Pest management
- Nutrient management

Practice installation and the effect on water quality is tracked using the database ADSWQ (Automatic Data System for Water Quality). The EPIC model (Erosion Productivity Index Calculator) is being used to estimate changes in edge-of-field delivery of sediment, nutrients, and bottom of root zone delivery of nutrients resulting from BMP implementation.

Modifications Since Project Started

None.

Progress Toward Meeting Goals

The Ingham County Drain Commission (ICDC) has received an implementation grant under Section 319 of the Clean Water Act for the installation of streambank stabilization in Willow Creek (Figure 22). Innovative and environmentally sensitive techniques for streambank stabilization were selected to minimize the sediment load in Willow Creek. Measures were selected based on their effectiveness in reducing ground water seepage and slope instability. The techniques chosen for implementation on Willow Creek included brush mattresses, live fascines, fiber rolls, biolunkers, riprap, underdrain, slope reduction, vegetative plantings, tree/branch revetments, current deflectors, and rock cascades.

Priority areas for streambank stabilization were defined as those locations where bank undercutting, coupled with bare channel banks and ground water seepage, were visibly contributing to the sediment load. Priority areas were chosen by the ICDC and consultants based on observations during several field visits. The streambank stabilization measures have been installed and are growing well.

WATER QUALITY MONITORING

Design

A paired watershed design is being used to document water quality changes in Sycamore Creek. Two subwatersheds within the project, Willow Creek and Marshall Drain, have been compared to a control subwatershed, Haines Drain, that lies outside the boundaries of the project (Figure 22). BMPs were installed in the Haines Drain prior to the commencement of water quality monitoring in 1990.

Modifications Since Project Started

The Willow Creek and Marshall Drain subwatersheds were selected among all subwatersheds in the Sycamore Creek watershed because they contained the highest sediment loads and the largest percentage of erodible land within one-quarter mile of a channel.

An additional station was added in 1995 at the United States Geological Survey (USGS) gauging station at Holt Road. Sampling is conducted year round using a flow stratified strategy. The monitoring data from this station will be used to determine the annual load of pollutants near the mouth of the stream and to compare these loads with various models for estimating pollutant loads in the watershed. Automatic sampling equipment is used to collect samples and the USGS flow data are used to determine loads. The parameters tested for are the same as the other three stations.

Parameters Measured

Biological

None

Chemical and Other

Total suspended solids (TSS)
Turbidity
Total phosphorus (TP)
Total Kjeldahl nitrogen (TKN)
Nitrate + nitrite ($NO_3 + NO_2$)
Chemical oxygen demand (COD)
Orthophosphate (OP)
Ammonia (NH_3)

Covariates

Rainfall
Flow
Erosion-intensity index

Sampling Scheme

Sampling during storm events is conducted from after snow melt (ground thaw) through the appearance of a crop canopy (sometime in July). Samples are collected every one to two hours during storms. For each location and storm, six to twelve samples are selected for analysis. Automatic stormwater samplers equipped with liquid level actuators are used.

Twenty evenly spaced weekly grab samples are also taken for trend determination. Sampling begins in March when the ground thaws and continues for the next 20 weeks.

A continuous record of river stage is being obtained with Isco model 2870 flow meters. The river stage converts to a continuous flow record using a stage discharge

relationship which is periodically updated by field staff of the Land and Water Management Division of the Michigan Department of Environmental Quality.

One recording rain gauge is installed in each agricultural subwatershed (Figure 22).

Monitoring Scheme for the Sycamore Creek Section 319 National Monitoring Program Project

Design	Sites*	Primary Parameters**	Covariates***	Frequency of WQ Sampling	Duration
Three-way paired	Willow Creek[I]	TSS Turbidity	Rainfall flow Erosion-intensity	Weekly for 20 samples starting	6 yrs pre-BMP 1 yr BMP
	Haines Drain[C]	TP TKN	index	after snow melt	1 yr post-BMP
	Marshall Drain[T]	$NO_3 + NO_2$ COD OP NH_3		Storm sampling (from after snow melt until canopy closure)	3 yrs pre-BMP 3 yrs BMP 1 yr post-BMP

[T] Treatment watersheds
[C] Control watershed

Modifications Since Project Started

Prior to 1993, weekly grab samples were not collected, but occasional grab samples during base flow were collected.

Water Quality Data Management and Analysis

Preliminary exploratory analysis includes a linear regression of control values versus target values for storm loads, storm event mean concentrations, storm rainfall amounts, storm runoff volume, and storm runoff coefficients. Storm loads were also compared to the AGNPS model for the first two years of data. Land use and cover data are recorded each year on a 10 acre grid scale.

NPSMS Data Summary

Summaries of quartile data from 1990 through 1993 are presented in the table below. These summaries include all data including storm event data for 1990-1993, base flow grab samples for 1990-1992, and weekly sampling in 1993. Differences can be seen among the watersheds, for example, stable flow and NO_2+NO_3 levels in Willow Creek compared to the other stations and the higher flows in Haines Drain compared to the other stations.

Monitoring Station Parameters Report

CHEMICAL PARAMETERS

STATION NAME: Haines Drain (Control; 848 acres) **YEAR:** 1990

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	85	8	6	2
SUSPENDED SOLIDS	mg/l	84	38	15	7
TOTAL PHOSPHORUS	mg/l	84	0.196	0.107	0.048
$NO_3 + NO_2$	mg/l	84	3.8	3.5	2.9
COD	mg/l	84	35.5	29	22

STATION NAME: Haines Drain (Control; 848 acres) **YEAR:** 1991

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	44	8	5	4
SUSPENDED SOLIDS	mg/l	43	147	46	20
TOTAL PHOSPHORUS	mg/l	45	0.64	0.34	0.178
$NO_3 + NO_2$	mg/l	45	36.	3. 3	3
COD	mg/l	15	55	36	29

STATION NAME: Haines Drain (Control; 848 acres) **YEAR:** 1992

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	31	14	6	0.9
SUSPENDED SOLIDS	mg/l	31	270	95	24
TOTAL PHOSPHORUS	mg/l	31	0.8	0.47	0.126
$NO_3 + NO_2$	mg/l	31	4.2	3.4	2.9
COD	mg/l	31	59	37	20

STATION NAME: Haines Drain (Control; 848 acres) **YEAR:** 1993

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	67	8.3	2	1
SUSPENDED SOLIDS	mg/l	66	91	45	15
TOTAL PHOSPHORUS	mg/l	67	0.48	0.24	0.105
$NO_3 + NO_2$	mg/l	66	7.4	2.9	1.82
COD	mg/l	66	45	31	23

STATION NAME: Marshall Drain (Target; 422 acres) **YEAR:** 1990

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	44	0.5	0.4	0.2
SUSPENDED SOLIDS	mg/l	44	98.5	29	16.5
TOTAL PHOSPHORUS	mg/l	44	0.059	0.04	0.029
$NO_3 + NO_2$	mg/l	36	5.8	2.55	1.9
COD	mg/l	44	19	16	14

STATION NAME: Marshall Drain (Target; 422 acres) **YEAR:** 1991

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	40	2	1	0.8
SUSPENDED SOLIDS	mg/l	39	115	29	17
TOTAL PHOSPHORUS	mg/l	41	0.35	0.118	0.062
$NO_3 + NO_2$	mg/l	41	7.5	6.4	5
COD	mg/l	23	40	31	17

STATION NAME: Marshall Drain (Target; 422 acres) **YEAR:** 1992

Parameter Name	Reporting Units	N	QUARTILEVALUES -75-	-50-	-25-
FLOW,CFS	cfs	23	5	0.9	0.3
SUSPENDED SOLIDS	mg/l	23	100	30	7
TOTAL PHOSPHORUS	mg/l	23	0.4	0.152	0.046
$NO_3 + NO_2$	mg/l	23	6.2	4.8	2.4
COD	mg/l	23	49	26	16

STATION NAME: Marshall Drain (Target; 422 acres) **YEAR:** 1993

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	52	4.87	0.57	0.32
SUSPENDED SOLIDS	mg/l	52	60	26	7
TOTAL PHOSPHORUS	mg/l	52	0.27	0.177	0.06
$NO_3 + NO_2$	mg/l	51	12	3.9	3
COD	mg/l	52	32	22	12

STATION NAME: Willow Creek (Target; 1087 acres) **YEAR:** 1990

Parameter Name	Reporting Units	N	QUARTILE VALUES -75-	-50-	-25-
FLOW,CFS	cfs	83	5	4	3
SUSPENDED SOLIDS	mg/l	82	44	32	18
TOTAL PHOSPHORUS	mg/l	83	0.075	0.055	0.036
$NO_3 + NO_2$	mg/l	83	2.7	2.4	2.1
COD	mg/l	83	31	24	18

STATION NAME: Willow Creek (Target; 1087 acres)	YEAR: 1991				
	Reporting		QUARTILE VALUES		
Parameter Name	Units	N	-75-	-50-	-25-
FLOW,CFS	cfs	47	4	4	3
SUSPENDED SOLIDS	mg/l	47	197	80	44
TOTAL PHOSPHORUS	mg/l	50	0.36	0.137	0.066
$NO_3 + NO_2$	mg/l	50	3	2.3	2.3
COD	mg/l	21	67	51	32

STATION NAME: Willow Creek (Target; 1087 acres)	YEAR: 1992				
	Reporting		QUARTILE VALUES		
Parameter Name	Units	N	-75-	-50-	-25-
FLOW,CFS	cfs	37	6	4	3
SUSPENDED SOLIDS	mg/l	37	150	70	28
TOTAL PHOSPHORUS	mg/l	37	0.26	0.135	0.052
$NO_3 + NO_2$	mg/l	37	3.5	1.94	1.75
COD	mg/l	37	82	45	27

STATION NAME: Willow Creek (Target, 1087 acres)	YEAR: 1993				
	Reporting		QUARTILE VALUES		
Parameter Name	Units	N	-75-	-50-	-25-
FLOW,CFS	cfs	74	7.36	4.98	4.14
SUSPENDED SOLIDS	mg/l	74	130	80	40
TOTAL PHOSPHORUS	mg/l	73	0.21	0.128	0.069
$NO_3 + NO_2$	mg/l	72	2.5	2.2	1.9
COD	mg/l	74	76	49	33

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Eight years of sampling have been completed in the paired watersheds. Three years of sampling at the single downstream station will be complete in October 1997.

TOTAL PROJECT BUDGET

The estimated budget for the Sycamore Creek Watershed Section 319 National Monitoring Program project for the life of the project is:

Project Element	Funding Source: ($)			
	Federal	State	Local	Sum
Project Mgt	129,370	122,000	3,130	254,500
I & E	159,900	NA	9,935	169,835
LT	1,078,300	NA	500,751	1,579,051
WQ Monit	285,000	222,000	NA	507,000
TOTALS	1,652,570	344,000	513,816	2,510,386

Source: John Suppnick (Personal Communication), 1993

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The funds for the 319 National Monitoring Program project provide for the water quality monitoring in the HUA project area. The county Farm Service Agency Committee has agreed to use Agricultural Conservation Program (ACP) funds for land treatment (erosion control, water quality improvement, and agricultural waste management).

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

Agencies involved in this project are as follows:

- USDA – Natural Resources Conservation Service (NRCS)
- Farm Service Agency (FSA)
- Michigan State University Extension – Ingham County
- Ingham County Health Department (Environmental Division)
- Ingham Conservation District
- Landowners within the Sycamore Creek watershed
- Michigan Department of Environmental Quality

PROJECT CONTACTS

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Nebraska

Elm Creek Watershed
Section 319
National Monitoring Program Project

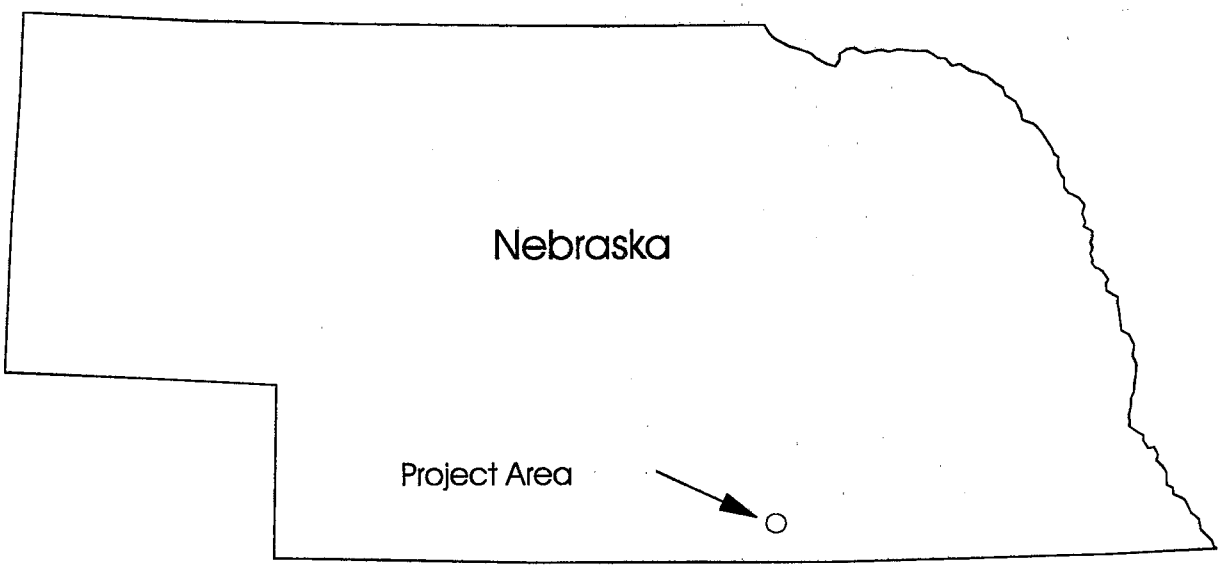

Figure 23: Elm Creek (Nebraska) Watershed Project Location

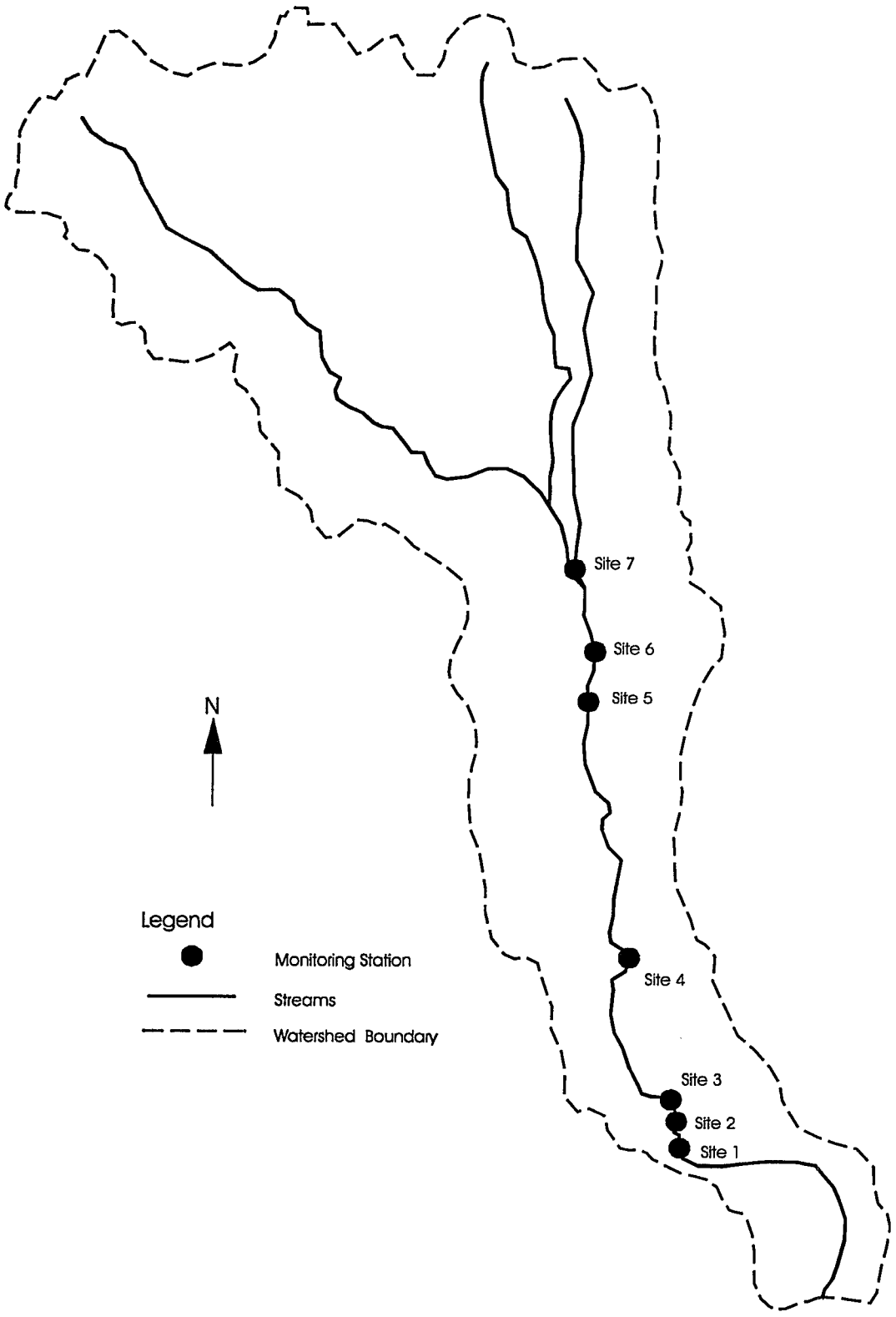

Figure 24: Water Quality Monitoring Stations for Elm Creek (Nebraska) Watershed

PROJECT OVERVIEW

Elm Creek is located in southcentral Nebraska, near the Kansas border (Figure 23). The creek flows in a southerly direction through agricultural lands of rolling hills and gently sloping uplands. The creek has a drainage area of 35,800 acres, consisting mainly of dryland crops of wheat and sorghum and pasture/rangelands with some areas of irrigated corn production.

A primary water use of Elm Creek is recreation, particularly as a coldwater trout stream. Sedimentation increases water temperatures and high peak flows, thus impairing aquatic life by destroying habitat, which reduces the creek's recreational use due to lowered trout productivity.

Land treatment for creek remediation includes non-conventional best management practices (BMPs), water quality and runoff control structures, water quality land treatment, and conventional water quality management practices (see section on Nonpoint Source Control Strategy). Many of these BMPs are being funded as part of a U.S. Department of Agriculture (USDA) Hydrologic Unit Area (HUA) project. Land use is being inventoried. Cropland and BMP implementation are being tracked. Additionally, land treatment monitoring will include tracking land use changes based on the 40-acre grid system of the Agricultural Nonpoint Source (AGNPS) model at the end of the project.

Water quality monitoring includes an upstream/downstream design as well as a single station downstream design for trend detection. Grab samples are collected weekly from March through September to provide water quality data. Additional biological and habitat data are being collected on a seasonal basis.

PROJECT DESCRIPTION

Water Resource Type and Size

Elm Creek flows through cropland and pasture/range into the Republican River. Flow in the creek is dominated by inflow springs. The average discharge of Elm Creek is 21.4 cubic feet per second and the drainage area is 56 square miles.

Water Uses and Impairments

Elm Creek is valued as a coldwater aquatic life stream, as an agricultural water supply source, and for its aesthetic appeal. It is one of only two coldwater habitat streams in southcentral Nebraska. Sedimentation, increased water temperatures, and peak flows are impairing aquatic life by destroying stream habitat of the macroinvertebrates and trout. These negative impacts on the stream result from farming practices that cause excessive erosion and overland water flow.

Pre-Project Water Quality

A thorough water quality analysis of Elm Creek conducted in the early 1980s indicated that the water quality of Elm Creek was very good. There was, however, short-term degradation of water quality following storm events. The coldwater habitat use assignment of Elm Creek appeared to be attainable if it was not impaired by nonpoint source (NPS) pollution, particularly sedimentation and scouring of vegetation during storm events.

Current Water Quality Objectives

The NPS management objective in the Elm Creek watershed is to implement appropriate and feasible NPS pollution control measures for the protection and enhancement of water quality in Elm Creek. Project goals are to:

- Reduce maximum summer water temperature
- Reduce in-stream sedimentation
- Reduce peak flows
- Improve in-stream aquatic habitat

Modifications Since Project Initiation

None.

Project Time Frame

Monitoring activities began in April, 1992, and were scheduled to end in 1996. Funds have been secured to continue post-BMP implementation monitoring until 1999.

Project Approval

1992

PROJECT AREA CHARACTERISTICS

Project Area

The project area, in southcentral Nebraska, consists of 35,800 acres of rolling hills, gently sloping uplands, and moderately steep slopes.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The Elm Creek watershed, which receives 26.5 inches of rainfall per year, lies in a sub-humid ecological region. Seventy-five percent of this rainfall occurs between April and September. The average temperature is 52 degrees Fahrenheit with averages of 25 degrees in January and 79 degrees in July. The soils are derived from loess and the predominant soil types are highly erosive.

Land Use

Wheat and sorghum are the primary dryland crops produced. Corn is the primary irrigated crop. Range and pasture dominate the more steeply sloping lands.

Land Use	Acres	%
Agricultural		
Dryland	14,630	42
Irrigated	2,680	7
Pasture/Range	16,170	44
Forest	650	2
Other	1,670	5
Total	35,800	100

Source: Elm Creek Project, 1992

Pollutant Sources

Streambank erosion, irrigation return flows, cattle access, cropland runoff

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

Information and education (I&E) activities have been developed and are being implemented as part of the Elm Creek HUA Project. The University of Nebraska and Cooperative Extension in Webster County are in charge of I&E activities. I&E activities include newsletters, an NPS video, slide shows, programs, questionnaires, fact sheets, demonstration sites, field days, and meetings.

Progress Toward Meeting Goals

The process of addressing nonpoint source issues in the Elm Creek watershed through information and education activities has been coordinated by the University of Nebraska Cooperative Extension as part of the USDA HUA effort. In addition to those activities listed below, a newsletter promoting implementation of NPS pollution prevention practices continues to be developed and delivered to owners/operators in the watershed.

I&E activities implemented in the Elm Creek watershed include the following:

- Seven producers have agreed to host field days and BMP demonstration plots.
- To encourage no-till practices, a no-till drill is available for rent at $8.00 per acre.
- A videotape on no-till crop planting practices has been completed and a videotape on rotational grazing is currently being produced.
- Two newsletters are currently being produced for the project. One newsletter is sent to all landowners and operators in the project area and includes articles on BMPs, cost share funds available, and updates on project progress and upcoming events. In addition, a quarterly project newsletter detailing relevant project activities (i.e., budget, progress, etc.) is mailed to all cooperators.
- A series of educational programs have been held to provide producers with background information to encourage the adoption of BMPs. Other program topics included new tools for pasture production, rotational grazing tour, and a prescribed burn workshop.
- An eco-farming clinic was held where no-till drills were demonstrated. Topics of discussion for the program included winter wheat production and weed control, diseases, cultivar selection, insect control, and soil fertility.
- Eight demonstration plots exhibiting various BMPs are currently being used as an educational tool. Practices being demonstrated include: nitrogen management, integrated crop management - irrigated, integrated crop management - dryland, no-till milo production, no-till wheat production, conservation tillage wheat production, cedar revetments for streambank protection, and sediment retention basin restoration.
- Numerous news stories, articles, meeting announcements and updates have been published in local newspapers.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

BMPs, both structural and non-structural, continue to be implemented throughout the Elm Creek watershed. These BMPs have been divided into four BMP types.

Non-conventional

Vegetative Filter Strips
Permanent Vegetative Cover on
Critical Areas
Streambank Stabilization
Livestock Access & Exclusion
Ground Water Recharge
Abandoned Well Plugging
Trickle Flow Outlets
Sediment Barriers
Grade Stabilization

Water Quality & Runoff Control Structures

Water Quality Land Treatment

Tree Planting
Permanent Vegetative Cover
Terraces
Stripcropping

Conventional Water Quality Management Programs

Irrigation Management
Conservation Tillage
Range Management
Integrated Pest Management

Non-conventional BMPs are being funded under the Section 319 National Monitoring Program. Other BMPs will be funded with 75% cost share funds from the HUA project. Finally, selected BMPs will be cost shared at 100% [75% from the Section 319 National Monitoring Program and 25% from Lower Republican Natural Resource District (LRNRD)]. The number and types of BMPs implemented will depend on voluntary farmer participation.

Land use will be inventoried. Cropland and BMP implementation will be tracked over the life of the project. Tracking will be based on the 40-acre grid system used for AGNPS modeling.

Modifications Since Project Started

As originally proposed, land use and BMP implementation were to be tracked based on a 40-acre grid system of the Agricultural Nonpoint Source (AGNPS) model. This scheme was to be used since a pre-project inventory of current land uses had been completed by the Natural Resource Conservation Service (NRCS) to run the AGNPS model. The goal was to then rerun the model with updated land use and BMP implementation data. However, once the Section 319 and HUA projects were initiated, staff quickly realized that annual tracking of land use changes and BMP implementation on a 40-acre basis in such a large watershed could not be accomplished with the resources available. The NRCS plans to rerun AGNPS with the updated information once the projects have been completed.

Progress Toward Meeting Goals

Currently, 56 applications have been processed for USEPA Section 319 funds. Since 1990, when the HUA project was initiated, 178 cooperators have requested technical funds for BMP cost-share. From 1991 through 1995, the practices and activities outlined in the following table have been implemented primarily for erosion control in the Elm Creek watershed.

Significant strides have also been made in implementing NPS control measures throughout the watershed (see following table).

Application of Practices/Activities for Erosion Control in the Elm Creek Watershed (7-31-96).

NRCS PRACTICE/ACTIVITY AND I.D. #	UNITS	NUMBER INSTALLED
Conservation Cropping Sequence (328)	acres	5,550
Conservation Tillage (329)	acres	3,795
Contour Farming (330)	acres	2,661
Critical Area Planting (342)	acres	40
Crop Residue Use (344)	acres	3,389
Deferred Grazing (352)	acres	163
Diversion (362)	feet	4,236
Pond (378)	number	17
Fencing (382)	feet	45,028
Field Border (386)	feet	31,777
Filter Strip (393)	acres	5
Grade Stabilization Structure (410)	number	5
Grassed Waterway (412)	acres	8.3
Irrigation Water Management (449)	acres	2,262
Livestock Exclusion (472)	acres	212
Pasture and Hayland Management (510)	acres	313
Pasture and Hayland Planting (512)	acres	105
Pipeline (516)	feet	2,732
Proper Grazing Use (528)	acres	4,345
Range Seeding (550)	acres	93
Planned Grazing System (556)	acres	2,117
Streambank Protection/Habitat Restoration	feet	280
Terrace (600)	feet	126,029
Tree Planting (612)	acres	4
Trough or Tank (614)	number	12
Underground Outlet (620)	feet	2,892
Well (642)	number	6
Wildlife Upland Habitat Management (645)	acres	156

Source: Scott Montgomery (personal communication, 1996)

Although significant progress has been made, a few problems have also been encountered with monitoring efforts. Preliminary evaluation of the project monitoring design (upstream-downstream and single downstream) and water quality data suggests that the large size of the watershed above the upstream monitoring station (approximately 31,142 acres) inhibits documentation of water quality improvements due to land treatment implementation. More specifically, this problem can be attributed to the variability associated with regional and watershed conditions. The majority of non-structural BMPs recommended by the NRCS implemented in the Elm Creek watershed are designed only to control runoff from one-in-ten year storm events. When such storm events occur in the watershed, water quality (including in-stream habitat) remains good. However, with such a large watershed area above the perennial stream reach (which starts within a mile above the upstream monitoring station), even slightly larger storm events generally contribute to high flows, which degrade water and habitat quality, making it difficult to detect improvements.

WATER QUALITY MONITORING

Design

Upstream/downstream: The two sampling sites (sites 2 & 5) are located two miles apart (Figure 24)
Single downstream for trend detection (site 5) (Figure 24)

Parameters Measured

Biological

Qualitative and quantitative macroinvertebrate sampling
Fish collections
Creel survey

Chemical and Other

Water temperature
Dissolved oxygen (DO)
Substrate samples (% Gravel, % Fines)
Total suspended solids (TSS)
Atrazine/Alachlor
Stream morphological characteristics (width, depth, velocity) and habitat
Water temperature (June – September)

Covariates

Stream discharge (United States Geological Survey gauging station)

Modifications Since Project Started

Artificial salmonid redds were initially used to monitor trout reproduction. However, the redds have been discontinued because initial monitoring results indicate substrates are not suitable for salmonid spawning.

Sampling Scheme

(See Figure 24 for sampling site locations.)

Qualitative and quantitative macroinvertebrate sampling spring, summer, fall, and winter (sites 2 and 5).

Fish collections spring and fall (sites 1, 2, 3, 4, 5, 6).

Creel survey (passive).

DO (sites 2, 5): Weekly grab samples from April through September. Monthly samples from October through March.

Substrate samples spring and fall at sites 2, 4, 5.

TSS (sites 2,5): Weekly grab samples from April through September and monthly samples, October through March. Selected runoff samples are collected April through September.

Stream morphological characteristics (width, depth, velocity) and habitat: spring/summer (sites 2, 5).

Continuous recording thermograph (hourly water temperatures for at least 60% of the period June through September and at least 80% of the period July through August) (sites 2, 5).

Monitoring Scheme for the Elm Creek Section 319 National Monitoring Program Project

Design	Sites	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Upstream/ downstream	2, 5	Macroinvertebrate survey	Stream discharge		4 times/yr spring & fall passive	0 yrs pre-BMP 5 yrs BMP 3 yrs post-BMP
	1, 2, 3, 4, 5, 6	Fish survey				
Single downstream		Creel survey				
	2, 5	Water temperature				
	2, 4, 5	Substrate samples		Spring & fall		
	2, 5	DO		Weekly (April-Sept.) & monthly (Oct.-March)		
	2, 5	TSS				
	2, 5	Stream morphological characteristics		Spring		
	2, 5			Spring/summer		
	2, 5	Water temperature				

Modifications Since Project Started

Plans to place a recording rain gauge in the Elm Creek watershed have been cancelled because of the variability associated with its large size. For the same reason, the volunteer network for recording rainfall amounts has also been discontinued.

Water Quality Data Management and Analysis

Ambient water quality data are entered into USEPA STORET. Biological data are stored in USEPA BIOS. Other data will be stored and analyzed using Microsoft Excel 5.0 spreadsheet program and USEPA NonPoint Source Management System (NPSMS). Water quality data are being analyzed using SAS statistical software. These data are being managed by the Nebraska Department of Environmental Quality (NDEQ).

Data assessment and reporting consists of quarterly activity reports, yearly interim reports focusing on BMP implementation, and a final report that will assess and link water quality and land treatment results.

NPSMS Data Summary

ANNUAL REPORT WQ PARAMETER FREQUENCIES

YEAR: 1995
STATION TYPE: Upstream Station

CHEMICAL PARAMETERS

Parameter Name	QUARTILE VALUES -75-	-50-	-25-	Counts/Season:	1	2	3	4
FLOW, STREAM, INSTANTANEOUS, CFS	13.3	12.0	10.7	Highest	6	5	0	0
				High	1	0	0	0
				Low	1	0	0	0
				Lowest	7	1	0	0
OXYGEN, DISSOLVED (METER)	8.7	7.75	6.9	Highest	6	5	0	0
				High	10	1	0	0
				Low	8	0	0	0
				Lowest	1	0	0	0
SUSPENDED SOLIDS, TOTAL	51.0	16.5	2.0	Highest	3	1	0	0
				High	2	0	0	0
				Low	20	5	0	0
				Lowest	0	0	0	0
TEMPERATURE, WATER (DEGREE CENTIGRADE)	15.7	14.3	11.5	Highest	4	0	0	0
				High	6	0	0	0
				Low	9	0	0	0
				Lowest	6	5	0	0

BIOLOGICAL PARAMETERS (Non-Chemical)

Parameter Name	Fully	INDICES Threatened	Partially	Scores/Values	1	2	3	4
INDEX OF BIOLOGICAL INTEGRITY	30	--	22		29	--	29	--
INVERTEBRATE COMMUNITY INDEX	31	--	17		18	30	--	32
TROUT HABITAT QUALITY INDEX	--	--	--		--	--	4.1	--

STATION TYPE: Downstream Station

CHEMICAL PARAMETERS

Parameter Name	QUARTILE VALUES -75-	-50-	-25-	Counts/Season:	1	2	3	4
FLOW, STREAM, INSTANTANEOUS, CFS	13.3	12.0	10.7	Highest	6	5	0	0
				High	1	0	0	0
				Low	1	0	0	0
				Lowest	7	1	0	0
OXYGEN, DISSOLVED (METER)	9.9	8.85	8.5	Highest	6	5	0	0
				High	9	1	0	0
				Low	6	0	0	0
				Lowest	4	0	0	0
SUSPENDED SOLIDS, TOTAL	65.3	20.75	6.0	Highest	4	0	0	0
				High	10	2	0	0
				Low	10	3	0	0
				Lowest	1	1	0	0
TEMPERATURE, WATER (DEGREE CENTIGRADE)	16.6	14.8	11.2	Highest	8	0	0	0
				High	3	0	0	0
				Low	8	0	0	0
				Lowest	6	6	0	0

BIOLOGICAL PARAMETERS (Non-Chemical)

Parameter Name	Fully	INDICES Threatened	Partially	Scores/Values	1	2	3	4
INDEX OF BIOLOGICAL INTEGRITY	30	--	22		35	--	31	--
INVERTEBRATE COMMUNITY INDEX	31	--	17		28	26	32	32
TROUT HABITAT QUALITY INDEX	--	--	--		--	--	2.2	--

Modifications Since Project Started

Quartile data for all chemical and physicochemical parameters indicate water quality conditions are relatively good. The values presented are accurate for water quality under baseflow conditions, but not necessarily reflective of impacts caused by runoff events. After heavy rainfall events, the stream is often subject to high flows and the associated NPS pollutants seemingly have only a short-term degrading impact on the in-stream chemical and physiochemical water quality. However, long-lasting impacts not reflected in the data are the scouring and sedimentation resulting from these events which impair designated aquatic life uses.

Metrics comprising the biological indices used to assess aquatic communities are currently being refined for the State of Nebraska. Once this process is complete, more definitive conclusions can be drawn from the data collected in Elm Creek.

Progress Towards Meeting Goals

The following water quality monitoring goals have been met:

- Ambient water quality data are currently being entered and stored in USEPA STORET.
- Biological data are currently being entered and stored in USEPA BIOS.
- Quarterly and yearly interim reports have been developed as planned.

TOTAL PROJECT BUDGET

The estimated budget for the Elm Creek Watershed Section 319 National Monitoring Program project for the life of the project is:

Project Element	Funding Source ($)				
	Federal		State	Local	Sum
	HUA/WQIP	319			
Proj Mgt	0	11,200	0	0	11,200
I&E	0	0	0	3,400	3,400
Reports	0	6,300	0	0	6,300
LT	260,000	115,000	0	101,600	476,600
WQ Initiative Program (WQIP)	30,000	0	0	0	30,000
WQ Monit	0	100,000	0	15,000	115,000
Post-Project Monit	0	30,000	0	0	30,000
TOTALS	290,000	262,500	0	120,000	672,500

Source: Elm Creek Project, 1991

Time frame for funding sources:

- Section 319(h) funds in the amount of $30,000 have been secured to continue post-BMP implementation monitoring activities for an additional three years (1999)
- Local/Section 319 — April, 1992 to October, 1996
- HUA — May, 1990 to October, 1997 (The HUA project was scheduled to end in September, 1995, but has received a three year extension)
- WQIP — Contracts were written for cropping years 1992, 1993, and 1994. All funds were allocated in 1992

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The Elm Creek Watershed Section 319 National Monitoring Program project provides the water quality monitoring for the area HUA project. Agricultural Conservation Program (a USDA program) funding will be used for approved, conventional BMPs.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

The HUA activities are jointly administered by the University of Nebraska Cooperative Extension and the USDA NRCS. Employees of these two agencies will work with local landowners, Farm Service Agency (FSA) personnel, personnel of the NDEQ, and personnel of the LRNRD. Section 319 National Monitoring Program project activities are administered by the NDEQ.

Agencies or groups involved in the project are listed below.

- USDA FSA
- Landowners
- Lower Republican Natural Resources District: Monitoring
- Little Blue Natural Resources District
- Nebraska Game and Parks Commission
- USDA NRCS
- Nebraska Department of Environmental Quality
- Nebraska Natural Resources Commission
- U.S. Geological Survey
- University of Nebraska Cooperative Extension
- U.S. Environmental Protection Agency
- Webster County Conservation Foundation (WCCF)
- Future Farmers of America Chapters and 4-H Clubs
- Center for Semi-Arid Agroforestry and Nebraska Forest Service
- Webster County Board of Commissioners

PROJECT CONTACTS

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North Carolina

Long Creek Watershed
Section 319
National Monitoring Program Project

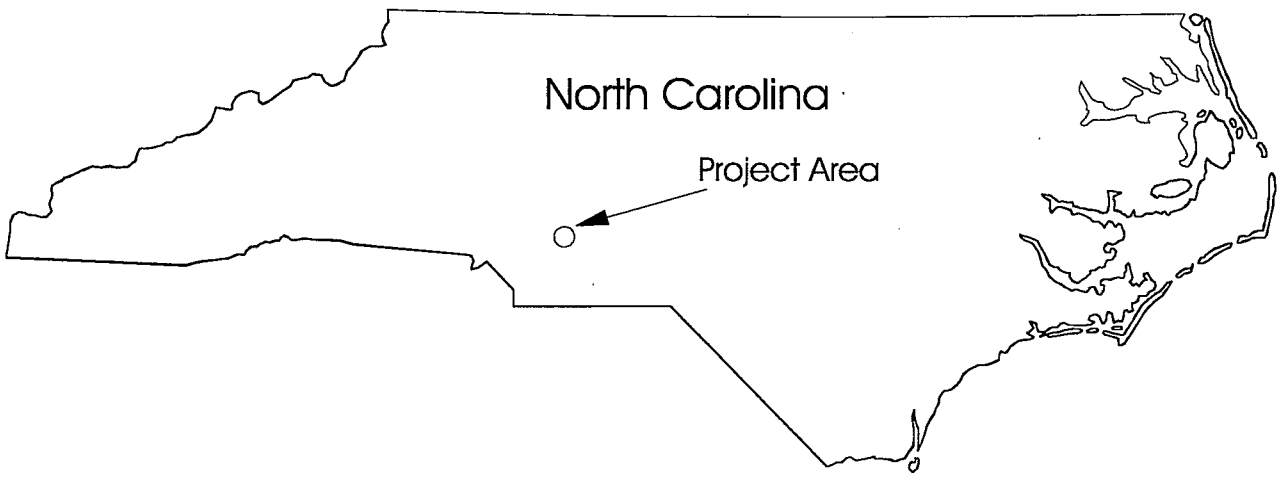

Figure 25: Long Creek (North Carolina) Watershed Project Location

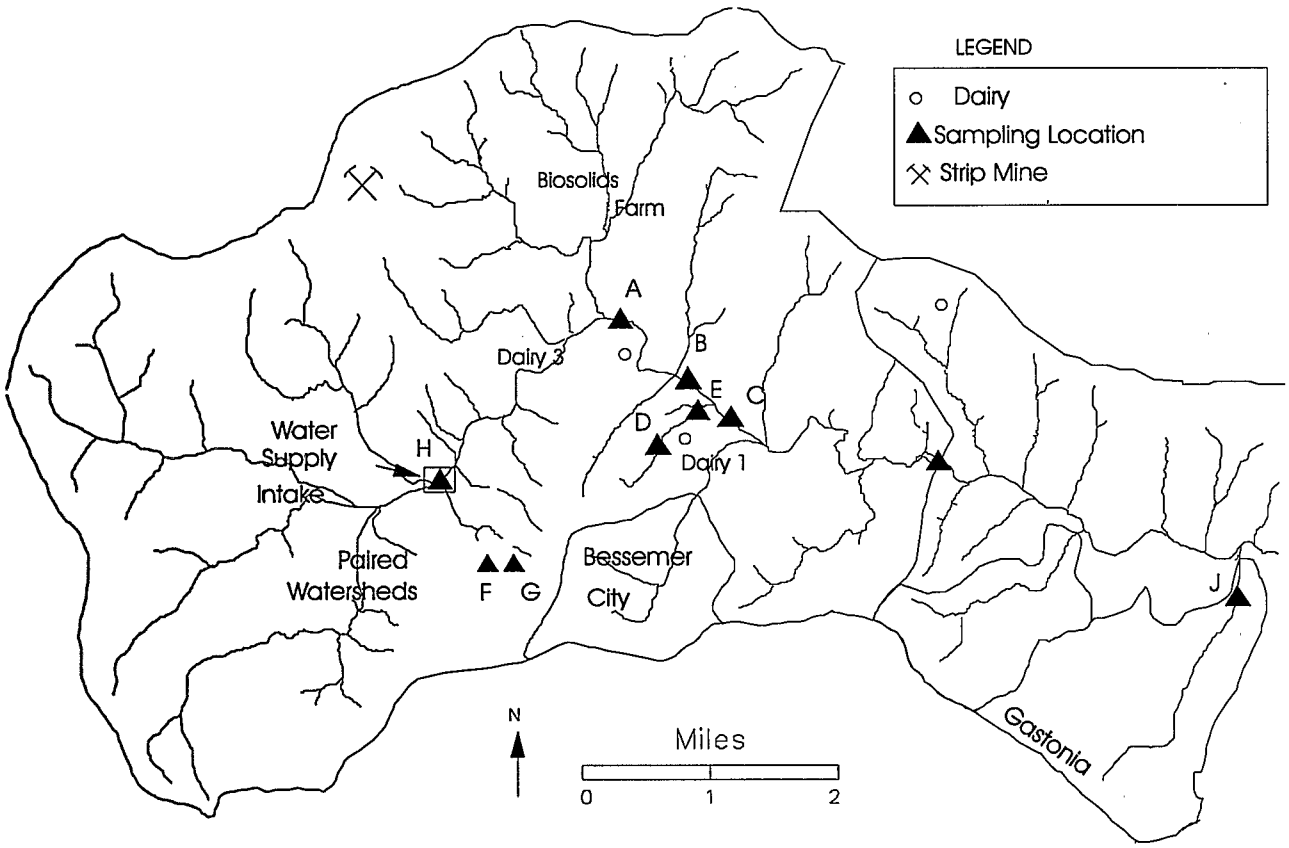

Figure 26: Water Quality Monitoring Stations for Long Creek (North Carolina) Watershed

PROJECT OVERVIEW

The Long Creek Watershed Section 319 National Monitoring Program project (28,480 acres), located in the southwestern Piedmont of North Carolina, consists of an area of mixed agricultural and urban/industrial land use (Figure 25). Long Creek is a perennial stream that serves as the primary water supply for Bessemer City, a municipality with a population of about 4,888 people (1994 estimate).

Agricultural activities related to crop and dairy production are believed to be the major nonpoint sources of pollutants to Long Creek. Sediment from eroding cropland is the major problem in the upper third of the watershed. Currently, the water supply intake pool must be dredged annually to maintain adequate storage volume, and quarterly prior to the project and land acquisition. Below the intake, Long Creek is impaired primarily by bacteria and nutrients from urban areas and animal-holding facilities.

Proposed land treatment upstream of the water supply intake includes implementing the land use restrictions of the state water supply watershed protection law and the soil conservation provisions of the Food Security Act.

Below the intake, land treatment will involve implementing a comprehensive nutrient management plan on a large dairy farm and installing fence for livestock exclusion from a tributary to Long Creek. Land treatment and land use tracking will be based on a combination of voluntary farmer record-keeping and frequent farm visits by extension personnel. Data will be stored and managed in a geographic information system (GIS).

Water quality monitoring includes a single-station, before-and-after-land treatment design near the Bessemer City water intake (Figure 26), upstream and downstream stations above and below an unnamed tributary on Long Creek (B and C), stations upstream and downstream of a dairy farmstead on an unnamed tributary to Long Creek (D and E), and monitoring stations on paired watersheds at a cropland runoff site (F and G). Storm-event and weekly grab samples are being collected at various sites to provide the chemical and hydrologic data needed to assess the effectiveness of the land treatment program.

PROJECT DESCRIPTION

Water Resource Type and Size

The study area encompasses approximately seven miles of Long Creek (North Carolina stream classification index # 11-129-16). Annual mean discharges at the outlet of the study area (I) range between 17 and 59 cubic feet per second over a 40 year period of record.

Water Uses and Impairments

Long Creek is the primary water supply for Bessemer City. Water quality impairments include high sediment, bacteria, and nutrient levels. The stream channel near the water supply intake in the headwaters area requires frequent dredging due to sediment deposition. The section of Long Creek from the Bessemer City water supply intake to near the watershed outlet sampling station (Figure 26) is listed as support-threatened by the North Carolina Nonpoint Source Management Program. Biological (macroinvertebrate) habitat is degraded in this section due to the presence of fecal coliform, excessive sediment, and nutrient loading from agricultural and urban nonpoint sources.

Pre-Project Water Quality

Water quality parameters change with time and location along Long Creek, but generally are close to the following averages:

Fecal Coliform #/100ml	BOD (mg/l)	TSS (mg/l)	TKN (mg/l)	NO_3-N (mg/l)	TP (mg/l)
2100	2	14	0.35	0.41	<0.17

Note: These average values were computed from the analyses of twelve monthly grab samples taken from three locations along Long Creek.

Current Water Quality Objectives

The objectives of the project are to quantify the effects of nonpoint source pollution controls on:

- Bacteria, sediment, and nutrient loadings to a stream from a working dairy farm;
- Sediment and nutrient loss from a field with a long history of manure application; and
- Sediment loads from the water supply watershed (goal is to reduce sediment yield by 60 percent).

In addition, biological monitoring of streams will attempt to show improvements in biological habitat associated with the implementation of nonpoint source pollution controls.

Modifications Since Project Initiation

None.

Project Time Frame

January, 1993 to September, 2001

Project Approval

1992

PROJECT AREA CHARACTERISTICS

Project Area

About 44.5 square miles or 28,480 acres

Relevant Hydrologic, Geologic, and Meteorologic Factors

The average annual rainfall is about 43 inches. The watershed geology is typical of the western Piedmont, with a saprolite layer of varying thickness overlaying fractured igneous and metamorphic rock. Soils in the study area are well drained and have a loamy surface layer underlain by a clay subsoil.

Land Use

Land Use	Acres	%
Agricultural	6,975	24
Forest	15,289	54
Residential	3,985	14
Business/Industrial	1,842	6
Mining	516	2
Total	28,607	100

Source: Jennings et al., 1992

Pollutant Sources

The monitored area contains the following dairy farms:

Dairy Name	Cows (#)	Feedlot Drainage
Dairy 4	125	Open lot into holding pond
Dairy 3	85	Open lot across pasture
Dairy 1	400	Under roof and open lot across grass buffer

Source: Jennings et al., 1992

Modifications Since Project Started

Dairy 2 went out of business and was purchased by the city of Gastonia for conversion to a biosolids application area.

INFORMATION, EDUCATION, AND PUBLICITY

Cooperative Extension Service (CES) personnel conducts public meetings and media campaigns to inform the general public, elected officials, community leaders, and school children about the project and water quality in general. In addition, project personnel make many one-to-one visits to cooperating and non-cooperating farmers in the watershed to inform them of project activities and address any questions or concerns they may have.

Progress Towards Meeting Goals

An education plan developed for Gaston County includes activities in the Long Creek watershed. Also, a Stream Watch group has been formed to 1) educate other watershed residents and 2) conduct quality monitoring by volunteers. Project overviews continue to be presented at state, local, and regional water-related conferences.

The Gaston County Conservation District is continuing an extensive natural resources education outreach program to local schools. Eighty-five percent of schools (100% of elementary and junior high schools) located in the Long Creek watershed participate in District programs.

Modifications Since Project Started

The information and education effort was expanded to an urban watershed that is drained by Kaglor Branch. Streambank stabilization practices and a stormwater wetland were installed in an urban park near the outlet of the Kaglor watershed. A boardwalk and educational displays are being planned to facilitate viewing of various features of the watershed.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

Water Supply Watershed (site H):
Bessemer City purchased 13 acres of cropland immediately upstream of the intake with the intention of implementing runoff and erosion controls. Also, to comply with the North Carolina Water Supply Watershed Protection Act, land use requirements are implemented on land within one-half mile of and draining to the intake. Less strict requirements such as the conservation provisions of the Food Security Act are implemented in the remainder of the watershed.

Up/downstream of Dairy 1 Tributary on Long Creek (sites B and C):
In addition to the best management practices (BMPs) planned for the Dairy 1 farmstead, the control strategy is to design and implement a comprehensive nutrient management plan on the land between the sampling stations.

Dairy 1 Farmstead (sites D and E):
A larger waste storage structure has been constructed. Improved pasture management, livestock exclusion from the unnamed tributary, and stream bank stabilization between sites D and E have been implemented. A fenceline feeding system that channels runoff to a waste holding pond is also being planned.

Paired Cropland Watersheds (sites F and G):
The control strategy on the paired watersheds involves implementing improved nutrient management on the treatment watershed while continuing current nutrient management and cropping practices on the control watershed. The number and types of BMPs implemented depends on voluntary farmer participation.

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Farm plans for more than 20 farms within the watershed have been developed. Twenty-five Water Quality Incentive Project (WQIP) applications have been submitted by landowners in the Long Creek watershed. Eight plans have been prepared representing more than $50,000 of BMP installations to control nonpoint source pollution on these sites.

Water Supply Watershed (site H):
A land use survey of the agricultural portion of the water supply watershed has been completed. These data were then used by the North Carolina Division of Soil and Water Conservation (DSWC) to develop a Watershed Management Plan. Along with developing the plan, DSWC staff used data from 1984 and 1994 to estimate erosion and sediment delivery rates in the watershed. The comparison indicated a 52% reduction in estimated annual erosion and a 51% reduction in sediment delivery to stream channels. However, visual inspection of the watershed tributaries indicates that considerable work remains in controlling stream channel erosion.

A watering system and a stream crossing are installed at a beef farm and fencing is being planned on a dairy farm to exclude cows from tributary streams.

Dairy 1 Farmstead (sites D and E):
The Conservation District and the landowner completed the installation of a Waste Holding Pond in September, 1993. North Carolina Agriculture Cost Share Funds were utilized for this project. In addition, an underground main and hydrant with a stationary gun for applying waste effluent on the pasture/hayland areas was installed in July, 1994.

A solid waste storage structure was completed in July, 1993. A watering system has been installed in the pastures of the watershed. Fencing for cattle exclusion between monitoring sites D and E was completed and the streamside buffers have been planted in pine and hardwood trees. Grass has been planted on severely eroding streambanks.

WATER QUALITY MONITORING

Design

The water quality monitoring effort incorporates the following four designs:

- Single downstream station at water supply intake and watershed outlet
- Upstream/downstream design on Long Creek and unnamed tributary
- Paired watersheds on Dairy 1 cropland
- Urban stream storm sampling done on a tributary to Long Creek (Kaglor Branch)

Modifications Since Project Started

A watershed screening study for pathogens began in April, 1996. Samples from three current sites, as well as additional sites, were collected and analyzed for indicator organisms such as E. coli, clostridium perfringens, and coliphages and the pathogens giardia and cryptosporidium.

Parameters Measured

Biological

Percent canopy and aufwuchs (organisms growing on aquatic plants)

Invertebrate taxa richness: ephemeroptera, plecoptera, trichoptera, coleoptera, odonata, megaloptera, diptera, oligochaeta, crustacea, mollusca, and other taxa

Bacteria: Fecal coliform (FC) and fecal streptococci (FS)

Chemical and Other

Total suspended solids (TSS)
Total solids (TS)
Dissolved oxygen (DO)
Biochemical oxygen demand (BOD) (1991-92)
pH
Conductivity
Nitrate + nitrite ($NO_3 + NO_2$)
Total Kjeldahl nitrogen (TKN)
Total phosphorus (TP)

Physical stream indicators: width, depth and bank erosion

Covariates

Rainfall, humidity, solar radiation, air temperature, and wind speed
Discharge rate of Long Creek and a tributary
Rainfall at paired watersheds and Dairy 1 farmstead

Sampling Scheme

Water Supply Watershed (Figure 26):
Type: grab (site H)
Frequency and season: weekly from December through May and monthly for the remainder of the year for TS, TSS, FC, FS, temperature, conductivity, DO, pathogens, pH, and turbidity

Upstream/downstream of Dairy 1 Tributary on Long Creek (Figure 26):
Type: grab (sites B and C)
Frequency and season: weekly from December through May and monthly for the remainder of the year for FC and FS, temperature, pH, conductivity, turbidity, DO, TSS, TP, TKN, and NO_2+NO_3

Annual biological survey for sensitive species at station C only

Dairy 1 Farmstead Storm Event:
Type: grab (sites D and E)
Frequency and season: weekly all year for FC and FS, temperature, pH, conductivity, DO, TSS, TS, TKN, NO_2+NO_3, and TP; storm events for TSS, TS, TKN, NO_2+NO_3, and TP

Paired Cropland Watersheds (Figure 26):
Type: storm event (sites F and G)
Frequency and season: stage-activated storm event for runoff, TS, TKN, NO_2+NO_3, TP, and pathogens

Single Downstream Station at Watershed Outlet (Figure 26):
Type: grab (site I)
Frequency and season: weekly from December through May and monthly for the rest of the year for temperature, pH, conductivity, turbidity, DO, TSS, TP, TS, TKN, NO_2+NO_3, and FC and FS; annual biological for sensitive species

Monitoring Scheme for the Long Creek Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Single downstream	Water supply watershed	TS TSS FC FS Pathogens	Discharge (weekly)	Weekly (Dec.-May) Monthly	Annually	2 yrs pre-BMP 6 yrs BMP
Upstream/ downstream	Long Creek	TP NO_3 + NO_2 TKN TSS FC FS	Discharge (weekly)	Weekly (Dec. - May) Monthly (June-Nov.)	Annually (downstream)	2 yrs pre-BMP 4 yrs BMP 2 yrs post-BMP
Upstream/ downstream	Dairy 1 Farmstead	TP NO_3 + NO_2 TS TSS FC FS Pathogens	Discharge (continuous) Rainfall Water table	Weekly and storm event		2 yrs pre-BMP 2 yrs post-BMP
Paired	Paired cropland watersheds	TP NO_3 + NO_2 TS TKN Pathogens	Discharge (continuous) Rainfall Water table	Storm event		2 yrs pre-BMP 6 yrs post-BMP
Single downstream	Watershed outlet	TP NO_3 + NO_2 TKN TSS FC FS	Discharge (continuous)	Weekly (Dec.-May) Monthly (June-Nov.)	Annually	2 yrs pre-BMP 6 yrs BMP

Modifications Since Project Started

In May – June, 1994, four monitoring wells were installed at the paired watersheds to gain a better understanding of ground water movement. Ten wells were installed between Sites D and E in July, 1996, and have been sampled monthly for nutrients, bacteria, and metals. Approximately 16 wells above Site B are also being installed on a Biosolids Application site.

Also, storm-event sampling (Site J) on a small stream draining an urban watershed has been added. Assessment monitoring for the pathogens cryptosporidium and giardia has been initiated at several locations in the watershed. The monitoring includes collecting grab samples at 12 locations within the watershed and analyzing the samples for indicator organisms as well as the pathogens themselves.

Progress Towards Meeting Goals

The water quality monitoring stations have been established and several years of data have been collected. Also, climatic and flow measurements are being made at several points in the watershed.

Water Quality Data Management and Analysis

Data are stored locally at the county Extension Service office. The data are also stored and analyzed at North Carolina State University using the U.S. Environmental Protection Agency's (USEPA) NonPoint Source Management System software. The North Carolina Division of Water Quality will also store the water quality data in the USEPA STORET system. Data will be shared among all participating agencies for use in their data bases. Data analysis will involve performing statistical tests for detection of long term-trends in water quality.

NPSMS Data Summary

STATION TYPE: Upstream Station **PRIMARY CODE:** Site B **YEAR:** 1994

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	3600	1700	810
Fecal Streptoccoci 9230C	U	CFU/100ML	3700	1400	270
Nitrate + Nitrite (353.1 EPA, 1983)	U	MG/L	.53	.49	.45
Nitrogen, Kjeldahl, Total (MG/L as N)	S		.3	.22	.15
Phosphorus, Total (MG/L as P)	S		.3	.18	.1
Total Suspended Solids (2540c 17th SMEWWW)	U	MG/L	8	5.0	4.0

STATION TYPE: Downstream Station **PRIMARY CODE:** Site C

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	3400	1350	940
Fecal Streptoccoci 9230C	U	CFU/100ML	4150	1650	495
Nitrate + Nitrite (353.1 EPA, 1983)	U	MG/L	.56	.51	.46
Nitrogen, Kjeldahl, Total (MG/L as N)	S		.35	.22	1.7
Phosphorus, Total (MG/L as P)	S		.29	.2	.13
Total Suspended Solids (2540C 17th SMEWWW)	U	MG/L	11	7	3

STATION TYPE: Upstream Station **PRIMARY CODE:** Site D

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	81000	31000	7700
Fecal Streptoccoci 9230C	U	CFU/100ML	28000	10000	2600
Flow, Stream, Instantaneous, CFS	S	CFS	.169	.04	.018
Nitrate + Nitrite (353.1 EPA, 1983)	U	MG/L	2.7	2.085	1.405
Nitrogen, Kjeldahl, Total (MG/L as N)	S		3.2	1.3	.615
Phosphorus, Total (MG/L as P)	S		.745	.45	.285
Total Solids (Residue) 2540B (17th SMEWWW)	U	MG/L	145	102	90
Total Suspended Solids (2540C 17th SMEWWW)	U	MG/L	44.5	12.5	2

NPSMS Data Summary (Continued)

STATION TYPE: Downstream Station **PRIMARY CODE:** Site E

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	485000	60000	21000
Fecal Streptoccoci 9230C	U	CFU/100ML	215000	42500	8150
Flow, Stream, Instantaneous (CFS)	S	CFS	.171	.075	.042
Nitrate + Nitrite (353.1 EPA, 1983)	U	MG/L	3.275	1.925	1.28
Nitrogen, Kjeldahl, Total (MG/L as N)	S		12.00	2.80	1.65
Phosphorus, Total (MG/L as P)	S		2.865	.815	.59
Total Solids (Residue) 2540B (17th SMEWWW)	U	MG/L	309	139	114
Total Suspended Solids	U	MG/L	71.5	13	3

STATION TYPE: Upstream Station **PRIMARY CODE:** Site H

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE COUNTS -75-	-50-	-25-
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	910	630	270
Fecal Streptoccoci 9230C	U	CFU/100ML	1300	360	100
Total Solids (Residue) 2540B (17th SMEWWW)	U	MG/L	75	68	61
Total Suspended Solids (2540C 17th SMEWWW)	U	MG/L	8	5	3

STATION TYPE: Upstream Station **PRIMARY CODE:** Site B **YEAR:** 1995

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE COUNTS 1	2	3	4
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	9	9	9	6
Nitrogen, Kjeldahl, Total (MG/L as N)	S		3	8	6	16
Phosphorus, Total (MG/L as P)	S		22	6	4	1
Total Suspended Solids (2540c 17th SMEWWW)	U	MG/L	8	3	14	8

STATION TYPE: Downstream Station **PRIMARY CODE:** Site C

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE COUNTS 1	2	3	4
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	7	5	13	8
Nitrogen, Kjeldahl, Total (MG/L as N)	S		3	6	16	8
Phosphorus, Total (MG/L as P)	S		24	5	3	1
Total Suspended Solids (2540C 17th SMEWWW)	U	MG/L	4	15	6	8

STATION TYPE: Upstream Station **PRIMARY CODE:** Site D

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE COUNTS 1	2	3	4
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	7	3	13	8
Fecal Streptoccoci 9230C	U	CFU/100ML	11	20	24	5
Flow, Stream, Instantaneous, CFS	S	CFS	1	8	39	3
Nitrogen, Kjeldahl, Total (MG/L as N)	S		19	23	9	1
Phosphorus, Total (MG/L as P)	S		29	16	5	2
Total Solids (Residue) 2540B (17th SMEWWW)	U	MG/L	21	14	11	6
Total Suspended Solids (2540C 17th SMEWWW)	U	MG/L	9	33	7	3

NPSMS Data Summary (Continued)

STATION TYPE: Downstream Station **PRIMARY CODE:** Site E

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE COUNTS 1	2	3	4
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	19	10	8	15
Fecal Streptoccoci 9230C	U	CFU/100ML	11	17	17	7
Flow, Stream, Instantaneous (CFS)	S	CFS	0	10	32	9
Nitrogen, Kjeldahl, Total (MG/L as N)	S		31	6	14	1
Phosphorus, Total (MG/L as P)	S		29	8	13	2
Total Solids (Residue) 2540B (17th SMEWWW)	U	MG/L	25	12	10	5
Total Suspended Solids	U	MG/L	13	21	12	6

STATION TYPE: Upstream Station **PRIMARY CODE:** Site H

Chemical Parameters

Parameter Name	Parm Type	Reporting Units	QUARTILE COUNTS 1	2	3	4
Fecal Coliform, Membr Filter, M-FC Broth, 44.5 C	S	CFU/100ML	3	12	8	5
Fecal Streptoccoci 9230C	U	CFU/100ML	7	7	9	5
Total Solids (Residue) 2540B (17th SMEWWW)	U	MG/L	16	6	3	7
Total Suspended Solids (2540C 17th SMEWWW)	U	MG/L	8	8	11	5

TOTAL PROJECT BUDGET

The estimated budget for the Long Creek Watershed National Monitoring Program project for the life of the project is:

Project Element	Funding Source ($) Federal	State	Local	Sum
Proj Mgt	340,300	147,360	98,240	585,900
I & E	0	20,000	80,000	100,000
L T	0	370,000	80,000	450,000
WQ Monit	561,186	0	12,000	573,186
TOTALS	901,486	537,360	270,240	1,709,086

Source: Jennings et al., 1992

Modifications Since Project Started

A 319(h) grant has been awarded to provide cost share for BMP implementation.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

State and probably federal United States Department of Agriculture (USDA) - Agricultural Conservation Program cost share programs will be essential for the implementation of BMPs. The provisions of the North Carolina Water Supply Watershed Protection Act (see section below) and the threat of additional regulation will motivate dairy farmers to implement animal waste management and erosion control BMPs.

OTHER PERTINENT INFORMATION

The North Carolina Water Supply Watershed Protection Act, as applied to this class of watershed, requires that 1) agricultural activities within one-half mile of and draining to a water intake maintain at least a 10-foot vegetated buffer or equivalent control and 2) animal operations of more than 100 animal units use BMPs as determined by the North Carolina Soil and Water Conservation Commission. Other regulations in the Act apply to activities such as forestry, transportation, residential development, and sludge application.

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Oklahoma

Peacheater Creek
Section 319
National Monitoring Program Project

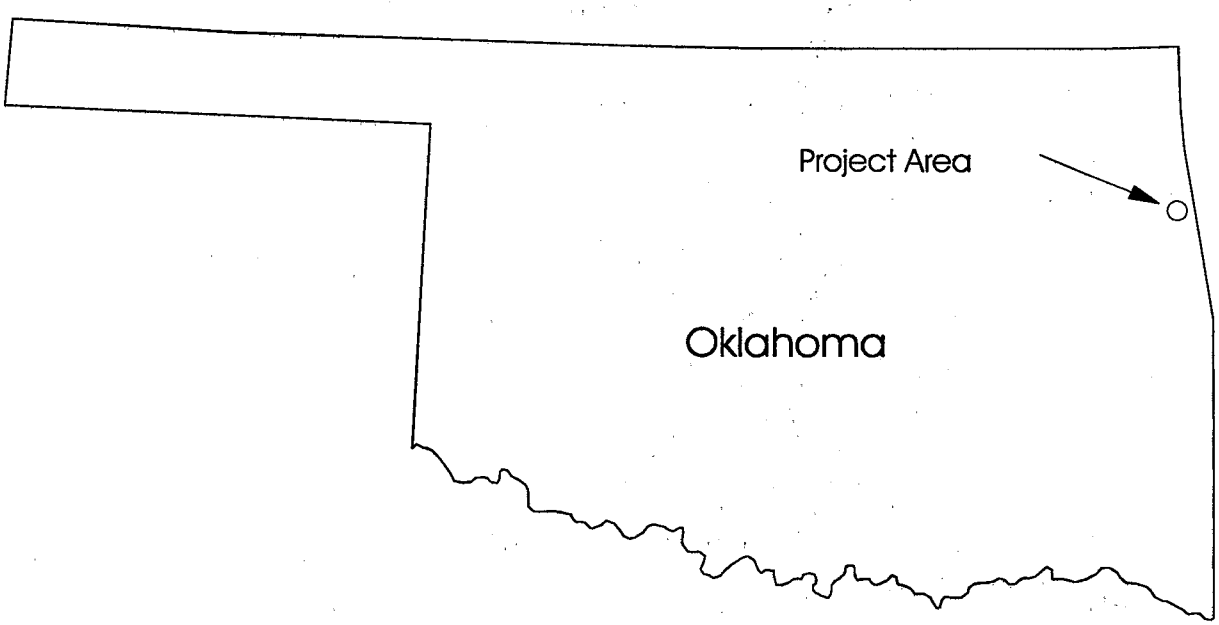

Figure 27: Peacheater Creek (Oklahoma) Project Location

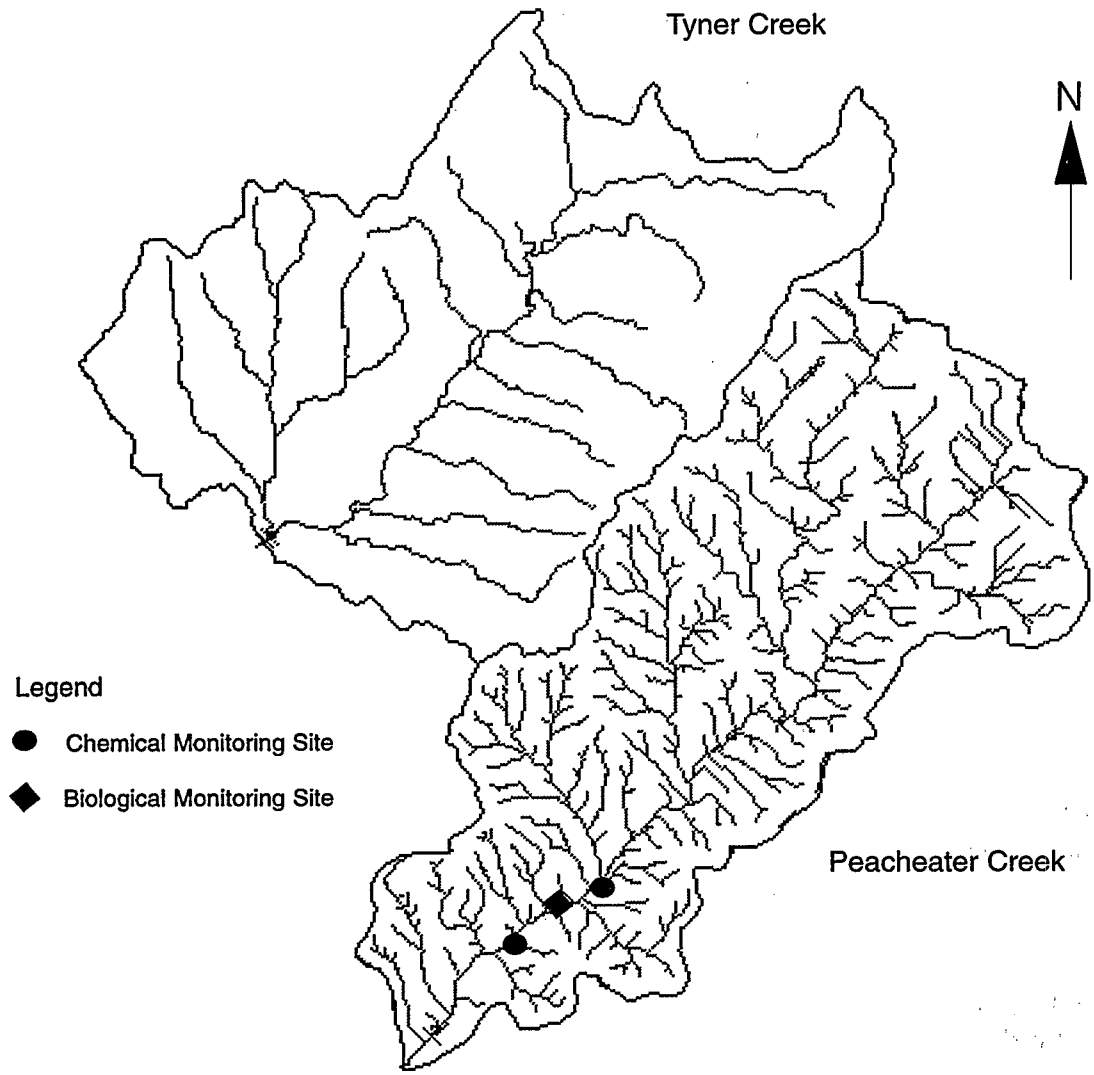

Figure 28: Water Quality Monitoring Stations for Peacheater Creek (Oklahoma) Watershed

PROJECT OVERVIEW

Peacheater Creek is located in eastern Oklahoma (Figure 27). The watershed is primarily pastureland and forestland with little cropland and rangeland. There are 51 poultry houses, 9 dairies, and 1200 beef cattle in the watershed. Large gravel bars generated from streambank erosion impair fish and macroinvertebrate habitat quality. Cattle traffic and forestry activities are known to be major contributors to streambank erosion. Streambank erosion is being quantified to estimate loads of gravel, sand, silt, clay, total nitrogen, and total phosphorus contributed to each stream. This process is nearing completion as samples have been collected, erosion rates have been calculated, and lab results are pending. Baseflow monitoring shows intermittent nutrient levels contribute to creek eutrophication. Impacts downstream of Peacheater Creek include streambank erosion, habitat degradation, and nuisance periphyton growth in Baron Fork and the Illinois River and phytoplankton blooms and summer hypolimnetic anoxia in Lake Tenkiller.

The project team has completed an extensive natural resource and stream corridor inventory. Data from the inventory have been digitized and mapped in a geographic information system. A distributed parameter watershed model has been used for determining critical areas for treatment. Critical areas are pasturelands, riparian areas, and dairies. Nutrient management planning is underway to improve poultry and dairy waste utilization on cropland and pastureland. A paired watershed study is ongoing using chemical variables. Sufficient data have been collected to develop statistically significant relationships between the two watersheds using water quality parameters. Thus, the project is nearing completion of the calibration phase and initiation of the implementation or treatment phase. Biological and habitat monitoring is ongoing for tributaries and the main stem stream.

PROJECT DESCRIPTION

Water Resource Type and Size

Water resources of concern are the Illinois River and Lake Tenkiller, a downstream impoundment of the river. The project water resource is Peacheater Creek, a fourth order stream, with baseflow ranging from 5 to 10 cubic feet per second. Peacheater Creek flows into Baron Fork, a tributary of the Illinois River upstream of Lake Tenkiller.

Water Uses and Impairments

Peacheater Creek is used for recreation and aquatic life support. Such use of Peacheater Creek is impaired by nutrient enrichment and loss of in-stream habitat. The Illinois River has been degraded by stream bank erosion, loss of habitat, reduced water clarity, and nuisance periphyton growth. Lake Tenkiller experiences phytoplankton blooms and summer hypolimnetic anoxia which threatens the fishery and recreational resource.

Pre-Project Water Quality

Baseflow monitoring for both Peacheater Creek (treatment watershed) and Tyner Creek (control watershed) for 1990-1992 indicated high dissolved oxygen levels (generally well above 6 mg/l), suggesting little concern about oxygen demanding pollutants. Turbidity was very low, with all samples collected less than 8 NTU. Specific conductivities ranged from 120 to 183mS/cm. Nitrate-nitrogen concentrations for Peacheater Creek ranged from 0.82 mg/l to 3.4 mg/l. Nitrate-nitrogen levels near 3 mg/l may be considered elevated if significantly above background for the area. Total Kjeldahl nitrogen (TKN) levels ranged from the detection limit of 0.2 mg/l to 1.5 mg/l. Eleven of the thirty TKN observations were equal to or greater than 0.3 mg/l, which is sufficient organic nitrogen to promote eutrophication. Generally, TKN concentrations for Tyner Creek were lower than Peacheater Creek.

Three of the thirty baseflow samples showed total phosphorus (TP) levels above 0.05 mg/l, which may be considered a minimum level for eutrophication. Storm sample TP concentrations are elevated. Storm sample TN concentrations are similar to baseflow concentrations.

Both Peacheater and Tyner Creeks have poor in-stream habitat. Large chert gravel bars cover expansive portions of the streambed in Peacheater Creek. These gravel bars continue to grow and shift following major runoff events. The gravel covers natural geologic and vegetative substrates reducing habitat quality for macroinvertebrates and fish. Peacheater Creek has extensive streambank erosion due to forestry activities and cattle traffic. The streambank erosion is believed to be further accelerated by the destabilization of the stream channel by the growing bed load.

Current Water Quality Objectives

Restore recreational and aquatic life beneficial uses in Peacheater Creek and minimize eutrophication impacts on the Illinois River and Lake Tenkiller.

Modifications Since Project Initiation

None.

Project Time Frame

1995 to 2000

Project Approval

Approved October, 1995

PROJECT AREA CHARACTERISTICS

Project Area

The Peacheater Creek watershed area is 16,209 acres. The creek is a tributary of Baron Fork, a tributary of the Illinois River which is impounded to form Lake Tenkiller.

Relevant Hydrologic, Geologic, and Meteorological Factors

Average baseflow for Upper Tyner and Peacheater Creeks is 2-13 cubic feet per second. Rocks in the project area are chert rubble. Surface rocks are from the Boone Formation, the Osage Series, and of the Mississippian Age. Geology in the basin in karstic.

Project area soils are generally gravelly silt loams with high infiltration rates. Typical slopes in the floodplains range from 2-5%. A large portion of the watershed is steeply sloped land (15-40% slopes).

Land Use

Land Use	%
Forest land	36
Grassed pastureland	14
Brushy pastureland	40
Cropland	3
Rangeland	7
TOTAL	100

Pollutant Sources

Primary sources of pollution include poultry houses and dairies in the treatment and control watersheds. Other sources of nutrients could include septic systems of private residents. Peacheater Creek has 51 poultry houses, 9 dairies, and 176 private residences. Upper Tyner Creek has 65 poultry houses, 7 dairies, and 150 private residences. The gravel which degrades in-stream habitat is also a pollutant. Its primary source is believed to be streambank erosion. Forestry activities on steep slopes are an important secondary source of gravel.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

Several methods are being used to educate the general public and agricultural community about pollution control and water quality management. A primary concern in the watershed is animal waste and nutrient management. Producer meetings are used to provide updates on regulations for concentrated animal feeding operations, which include egg laying poultry operations and various types of poultry for flesh production. Records on waste clean-out operations and litter applications are recommended. Cooperative Extension Service and the US Department of Agriculture Natural Resources Conservation Service are working together to promote the proper use of waste holding ponds for dairies in the watershed. Soil nutrient sampling is provided free-of-charge to identify fields with excessive phosphorus levels. Litter testing is also available for broiler and laying operations. Litter application demonstrations are used to illustrate nutrient management principles on bermuda grass and fescue.

Progress Towards Meeting Goals

Rainfall simulator studies and demonstrations have been held to show effects of animal waste best management practices (BMPs) on water quality. The effect of nutrient application rate and filter strips was demonstrated during a summer field day. Future rainfall simulator study demonstrations are planned.

A three-day summer youth camp is planned annually to provide water quality education. An inner tubing excursion was used to show the extent and effect of stream bank erosion on stream habitat quality. Youth camp participants also tested the chemical quality of Peacheater Creek using portable kits.

NONPOINT SOURCE CONTROL STRATEGY

Description

Land treatment implemented through the project will be designed to 1) reduce nutrient loading to the Illinois River system and Tenkiller Lake and 2) restore streambanks with the objective of improving pool depth and reducing gravel loading in the system. Implementation of land treatment is on hold until the calibration phase has been finalized.

The eight dairies in the Peacheater Creek watershed have a total of approximately 800 cows. Seven of the eight dairies have animal waste management plans. A total of seven waste management systems, including waste storage strictures, are recommended and three have been installed to date. Eight planned grazing systems have been recommended and one planned grazing and one cell grazing system have been adopted under an earlier program. All implementation activities are on hold until the calibration phase of the project has been finalized.

There are 59 poultry houses in the watershed with a total capacity of approximately 1,300,000 birds. Five broods a year are produced for a total annual population of approximately 6.5×10^6 birds. Types of poultry grown in the watershed include broilers, layers, pullets, and breeder hens. Seventy-five percent of the producers have current Conservation Plans of Operation. Fifteen mortality composters have been recommended and five have been installed. Buffer zones along streams have been recommended to reduce nutrient runoff from land applied manure. The current extent of buffers in the watershed has been evaluated and will soon be reported. A

waste holding pond has been recommended but has not yet been constructed for the sole layer operation. Short-term storage for litter is recommended when poultry house cleaning occurs during wet weather or outside the crop growth season.

Approximately 1,200 beef cattle graze in the watershed. Recommended BMPs include planned grazing systems, cell grazing systems, buffer zones adjacent to streams, watering facilities, critical area vegetation, and soil testing to support nutrient management planning in pastures receiving land applied litter.

Twelve critical riparian areas have been identified. Activities in riparian areas such as forestry practices, cattle traffic, and cattle grazing have caused stream bank erosion. Best management practices recommended include fencing, no land application of litter in riparian areas, off-site watering systems, and vegetative establishment.

Modifications Since Project Started

The implementation program for Peacheater Creek watershed is deferred until the calibration phase of the project is finalized. A final implementation plan will be drafted based upon water quality, biological and habitat assessment results, as well as nutrient reductions for the Illinois River and Lake Tenkiller.

WATER QUALITY MONITORING

Design

The water quality design for the Peacheater Creek 319 National Monitoring Program project is a paired design. Peacheater Creek watershed treatment is paired with Tyner Creek watershed (control) (Figure 28). Water quality monitoring occurs at each watershed outlet. Habitat and biological monitoring occurs in both streams at appropriate locations.

Modifications Since Project Started

None.

Parameters Measured

Biological

Periphyton productivity
Fisheries survey
Macroinvertebrate survey
Intensive and extensive habitat assessment
Bank erosion and bank soil sampling

Chemical

Dissolved oxygen (DO)
Specific conductance (SC)
pH
Alkalinity
Turbidity
Total Kjeldahl nitrogen (TKN)
Nitrate + nitrite nitrogen (NO2 and N03)
Total phosphorus (TP) and ortho-phosphorus (oP)
Total suspended solids (TSS)
Sulfate
Chloride
Hardness

Covariates

Stream discharge
Precipitation

Sampling Scheme

Chemical variables are monitored monthly from July through January, weekly during February through June, and during storm events for a duration of 20 weeks. Storm event monitoring is stage-activated and samples are taken continuously over the hydrograph. Concentration samples are flow-weighted composites.

Biological monitoring varies considerably with assemblage being sampled. Periphyton productivity is measured in the summer and the winter. Macroinvertebrates are monitored twice per year: once in the summer and once in the winter. Fish are intensively monitored every other year. Pool dwelling fish are inventoried quarterly. Intensive habitat was monitored intensively the first year. Future frequency will be determined by variance of parameters. Extensive habitat will be monitored on alternate years. Bank erosion and bank soil sampling are monitored on alternate years.

Monitoring Scheme for the Peacheater Creek Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired	Tyner Creek[C] Peacheater Creek[T]	Periphyton productivity Fisheries survey Macroinvertebrate survey Stream habitat quality Bank erosion	Stream discharge Precipitation		Summer / winter Alternate years Summer / winter As needed Alternate years	2 yrs. pre-BMP 1 yr. BMP 1 yr. post-BMP
		Turbidity DO TKN $NO_3 + NO_2$ TP and OP TSS		Monthly (July-Jan.) Weekly (Feb.-June) Storm event		

[C]Control watershed
[T]Treatment watershed

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

Chemical parameters will be entered into the U.S. Environmental Protection Agency (USEPA) STORET system, the Oklahoma Conservation Commission (OCC) Water Quality Data Base and OCC office library. Biological variables will be entered into the OCC Water Quality Data Base, the collections stored at the OCC, and archived in the BIOS data base.

NPSMS Data Summary

The OCC will prepare data and summary statistics for entry into the USEPA Nonpoint Management System Software (NPSMS).

Modifications Since Project Started

None.

Progress Towards Meeting Goals

The sampling program was initiated in December 1995. An extensive habitat assessment, based on transects every 100 meters over the stream length, has been completed for both streams. Permanent transects have been established to monitor channel morphology and streambank erosion. Intensive habitat assessments, consisting of transects every 20 meters at biological sites, have been completed and replicated for quality assurance. A fishery survey of both streams has been completed, involving one intensive survey and four catch and release surveys of large pools requiring sampling by electroshocking. Measurements of high flow events continue to be conducted on both Peacheater and Tyner Creeks in order to update the discharge curve. A depth/discharge curve for programming the auto-sampler in both Peacheater and Tyner Creeks has been completed and the samplers are fully operational. The winter sets of periphytometer samples have been collected, processed, and are awaiting data analysis. Water quality parameters were compared between the treatment and control watersheds and calibration requirements were met under variable flow regimes. A statistically significant relationship has been defined between water quality analysis for Tyner and Peacheater Creeks. This relationship is based on USEPA requirements for paired watershed studies and signifies completion of the calibration phase of the project. The first set of bank erosion samples has been collected. Bank loss has been calculated, samples sieved for particle size analysis, and analyzed for nutrients. Results of nutrient analysis are pending.

TOTAL PROJECT BUDGET

The estimated budget for the Peacheater Creek National Monitoring Program project for the life of the project is:

Project Element	Funding Source ($)			
	Federal	State	Local	Sum
WQ Monitoring	250,000	166,667	NA	416,667
Flow Monitoring	100,000	66,670	NA	166,670
Implementation	108,000	72,000	NA	180,000
TOTALS	458,000	305,337	NA	763,337

Source: Phillip Moershel (Personal Communication), 1996

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

This project compliments a larger program to improve the water quality of the Illinois River and Lake Tenkiller. An effort to establish a Total Maximum Daily Load (TMDL) for the system has been initiated, which may build upon the results in Peacheater Creek.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

None.

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Oregon

Upper Grande Ronde Basin
Section 319
National Monitoring Program Project

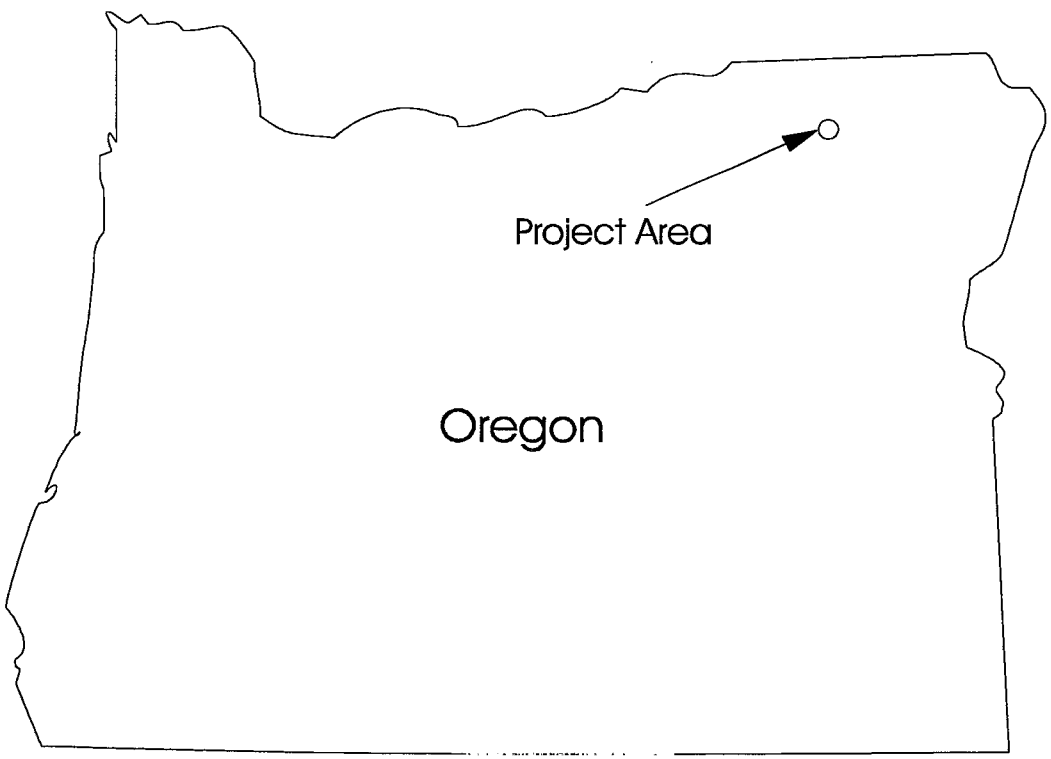

Figure 29: Upper Grande Ronde Basin (Oregon) Project Location

Legend of Monitoring Sites

2 — Meadow Creek – Starkey
3 — Dark Canyon Creek – Upper Reach
4 — McCoy Creek – Middle Reach
5 — Dark Canyon Creek – Lower Reach
6 — McCoy Creek – Lower Reach #1
7 — McCoy Creek – Lower Reach #2
8 — Meadow Creek – Lower Reach
9 — Lookout Creek
10 — Limber Jim Creek – Upper Reach
11 — Limber Jim Creek – Lower Reach

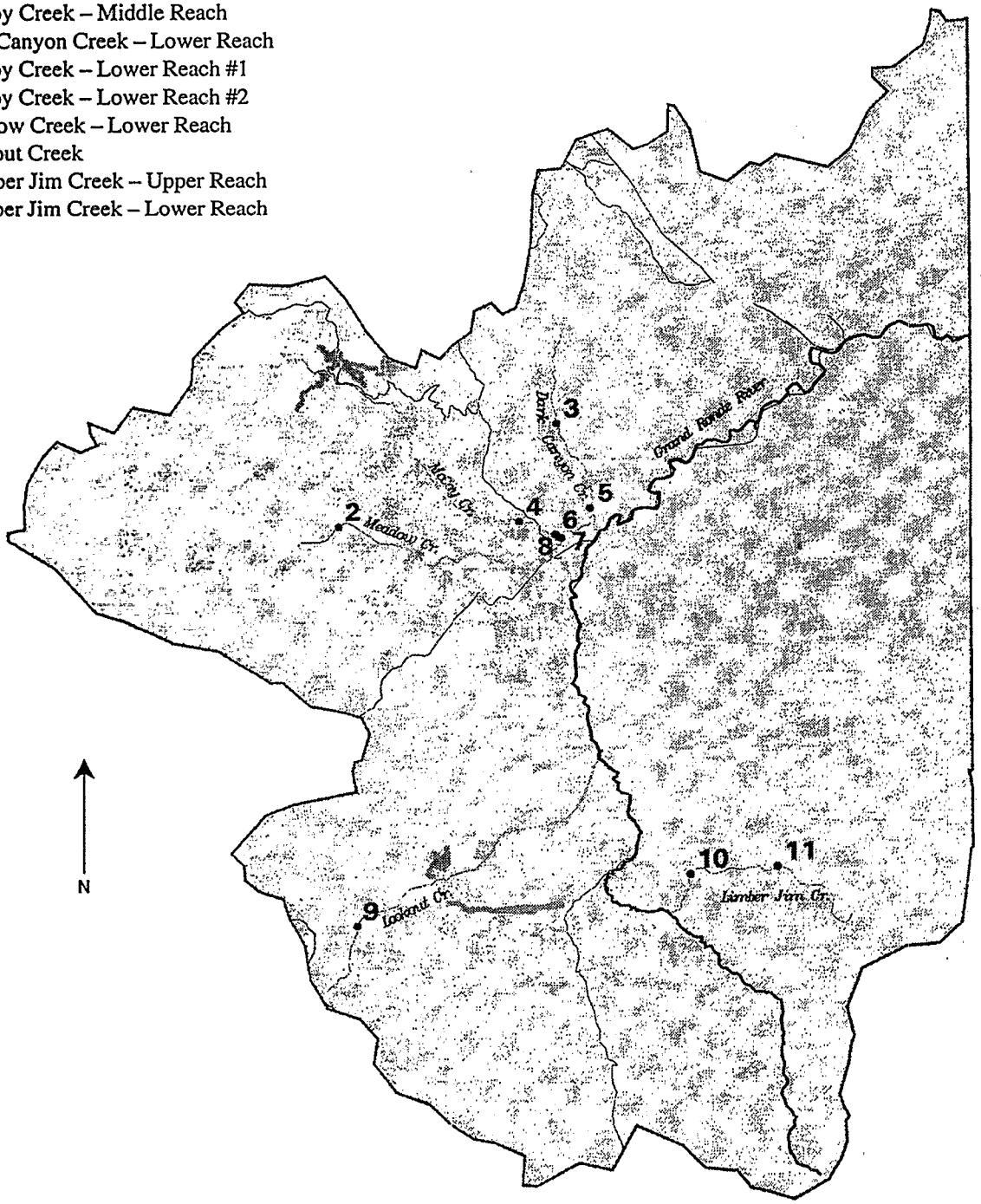

Figure 30: Water Quality Monitoring Stations for Upper Grande Ronde Basin (Oregon) Watershed

PROJECT OVERVIEW

The Upper Grande Ronde Basin (695 square miles) is located in the Columbia Intermontane Central Mountains of northeast Oregon (Figure 29). The Grande Ronde River traverses primarily forest and grazing lands draining into the Snake River, a major tributary of the Columbia River. The study area is included in the ceded lands of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and is a culturally significant area.

The watershed has historically been important for anadromous fish production, but from about 1970 to the present fish numbers have been declining. Land use activities, such as grazing, timber harvest, road construction, and livestock production, have been cited as contributing to fish and other aquatic species' habitat degradation.

Water temperature and loss of physical habitat have been identified by the US Forest Service (USFS) as the most important factors affecting spring Chinook salmon and steelhead populations (Hafele, 1996). An important cause of increased stream temperature is the loss of riparian vegetation. It has been estimated that land use activities have reduced stream shading from a potential of 80% to a total of 28% (Hafele, 1996). As a result of these and other water quality violations (primarily pH), the Grande Ronde has been listed by the Oregon Department of Environmental Quality (ODEQ) as water quality limited.

Since 1993, a water quality monitoring program has been conducted by ODEQ to evaluate the basin's biological communities and the physical and chemical factors that affect them. This monitoring project is part of the US Environmental Protection Agency (USEPA) Section 319 National Monitoring Program. The monitoring effort targets five subbasins within the Upper Grande Ronde Basin. Water quality monitoring is based on a paired watershed design for two highly impacted basins, while other basins represent a range of less impacted control sites. Additionally, an upstream/downstream approach is used to evaluate changing land use along individual streams. The major monitoring components include habitat, macroinvertebrates, fish and water quality. A significant measure of success will be a reduction in maximum summer temperatures, improved habitat for aquatic life, and increased biotic index scores for fish and macroinvertebrates.

The Upper Grande Ronde Basin 319 National Monitoring Program project has evolved from local, state, and tribal cooperation. In 1995, a watershed assessment was completed by ODEQ under the Oregon Watershed Health Program (Bach, 1995). ODEQ is currently carrying out a Total Maximum Daily Load (TMDL) study and developing waste load allocations for the basin. The USFS has developed a restoration plan for anadromous fish in the Upper Grande Ronde Basin and identified desired future conditions (Hafele, 1996). Stream habitat restoration activities aimed at improving habitat conditions will be implemented on McCoy Creek in cooperation with the landowner and CTUIR.

PROJECT DESCRIPTION

Water Resource Type and Size

The total drainage area of the Upper Grande Ronde Basin is approximately 695 square miles with a stream density of 1.44 (miles/square miles). Ten sites from five subbasins located in the upper southwest portion of the watershed have been selected for this monitoring project. They are as follows:

McCoy Creek	55.3 sq. mi.	paired basin (3 sites)
Dark Canyon Creek	18.8 sq. mi.	paired basin (2 sites)
Meadow Creek	56.2 sq. mi.	paired basin (2 sites)
Lookout Creek	15 sq. mi.	single site (1 site)
Limber Jim Creek	18.8 sq. mi.	paired basin (2 sites)

Water Uses and Impairments

The designated beneficial uses of concern in the basin include anadromous populations of spring/summer Chinook salmon, summer steelhead, and resident populations of bull trout.

Important beneficial uses of the streams that drain the watershed include cold water fish migration, spawning, and rearing; domestic and agricultural water supply; primary and secondary contact recreation; and wildlife habitat.

Pre-Project Water Quality

Most water chemistry violations (mostly pH) in the Grande Ronde Basin have been shown to occur in the main stem of the Grande Ronde. Water chemistry results for 1993-95 indicate that no significant water chemistry problems were observed for the ten study sites based on sixteen separate parameters.

Monitoring of habitat conditions indicates that Lookout Creek has the most stable and highest quality habitat with Dark Canyon Creek the lowest. Habitat conditions in McCoy Creek show impaired conditions at the two lower sites and moderately impaired at the upper site. Lower McCoy Creek is characterized by channelized banks, little riparian vegetation, and shallow pools and riffles, and is the target of the stream restoration efforts. Habitat conditions are summarized in Figure 30.

Water temperature has been identified as a significant factor affecting both water quality and biological communities in the Grande Ronde. Temperature in the basin has been characterized by placing continuous recording thermographs at the top and bottom of each stream reach selected for bioassessment. For the Grande Ronde Basin, the water temperature standard is based on the 7-day maximum mean and should not exceed 17.8°C for cold water species when salmonids are not spawning; water temperature should not exceed 12.8°C during salmonid spawning and incubation. The 17.8°C temperature maximum applies to the study sites during July, August and September. This maximum temperature was exceeded at all sites except Limber Jim Creek in 1993 and Upper Limber Jim and Lookout Creeks in 1994. The sites on McCoy Creek, Dark Canyon Creek and Meadow Creek generally exceeded the standard throughout the sampling period.

Current Water Quality Objectives

Project objectives include the following:

- To improve salmonid and aquatic macroinvertebrate communities in McCoy Creek by restoring habitat quality and lowering stream temperatures.
- To quantitatively document a cause-and-effect relationship between improved habitat, lower water temperatures and improved salmonid and macroinvertebrate communities.

Differences in fish and macroinvertebrate communities and pre-project water quality results suggest that the above objectives can be achieved. The results of snorkel surveys for fish completed during the summers of 1994 and 1995 show two interesting factors:

- Rainbow trout were present in all streams, including Meadow and McCoy Creeks, where summer temperatures exceed 25°C, well above the acceptable range for trout. Temperature measurements indicate a 5°C gradient was present in pools as shallow as 18 inches. These areas of temperature refugia may be

critical for fish survival under the temperature conditions of streams like Meadow and McCoy Creeks.

- Fish communities at Meadow and McCoy creeks were dominated by warm water red-sided shiner and dace. These species were scarce or completely absent at the other study sites, presumably because of cooler water temperatures. It is expected that fish communities will shift from one dominated by red-sided shiner and dace to one dominated by trout in the McCoy reaches if water temperatures can be lowered by restoration work.

Macroinvertebrate results from 1993 show a similar pattern to the fish surveys and temperature results. It is expected then that if temperatures in McCoy Creek can be improved through habitat restoration, the macroinvertebrate and fish communities will respond favorably and that these responses can be measured.

Modifications Since Project Initiation

None.

Project Time Frame

1993 to 2003 (if funding permits)

Project Approval

1997

PROJECT AREA CHARACTERISTICS

Project Area

The Upper Grande Ronde Basin Monitoring Project consists of ten study sites in five subbasins located within the Blue Mountain ecoregion (Omernick, 1987). The total area of the Upper Basin is approximately 695 square miles, with 1,000 miles of stream (Bach, 1995).

Relevant Hydrologic, Geologic, and Meteorological Factors

The study region is characterized by a semi-arid climate and rugged mountains in the headwater areas. Temperature and precipitation vary with elevation, which ranges from approximately 2,300 feet to 7,800 feet. The climate is characterized by warm, dry summers and cold, moist winters. At elevations above 5,000 feet, average annual precipitation is greater than 50 inches, and usually occurs as snow (Bach, 1995).

Land Use

Slopes vary throughout the basin, with relatively gentle slopes in the valley and steeper slopes (as high as 90% in some areas) in the upper parts of the watershed (Bach, 1995). The combination of slope, rainfall, and snowpack can lead to large runoff events in the mid and upper elevations.

Approximately 60% of the land in the Grande Ronde Basin is devoted to forestry, while approximately 36% is agricultural. Land use activities such as grazing, timber harvesting, road construction, and livestock practices have been cited as causes for beneficial use impairment. Land ownership in the Upper Basin is approximately 53% private and 47% federal. The only two land use/cover types present in the study subbasins are range and evergreen forest.

Pollutant Sources

The major sources of nonpoint source temperature pollution are loss of riparian habitat through historic grazing practices and channel modifications.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

There has been little quantitative documentation of the effects of habitat restoration on stream temperatures and aquatic communities. The Upper Grande Ronde Basin Monitoring project will provide useful information on the effects of riparian restoration on fish and macroinvertebrate habitat improvement for areas elsewhere in the basin. This project will also enhance interagency coordination among other agencies and watershed councils which have expressed interest in restoration work. Interagency cooperation is reflected by the involvement in this project of Oregon Department of Fish and Wildlife (ODF&W), NRCS, local Soil and Water Conservation Districts (SWCD), USFS, USEPA, and the CTUIR.

NONPOINT SOURCE CONTROL STRATEGIES

Description

The nonpoint source treatment to be implemented in the study area will consist of stream channel and riparian restoration activities on the lower reach of McCoy Creek. Lower McCoy Creek is characterized by channelized banks, little riparian vegetation, and shallow pools and riffles. Restoration will include diverting flow back into remnants of the old stream channel to redevelop meanders, better pool quality, and more habitat complexity. Further improvements, especially in stream temperatures, will be attempted by increasing riparian vegetation and restoring wet meadow conditions in the flood plain. The Confederated Tribes of the Umatilla Indian Reservation will be coordinating the restoration work in cooperation with ODEQ (CTUIR, 1997).

Modifications Since Project Started

None.

WATER QUALITY MONITORING

Design

A paired watershed approach is being used for the McCoy Creek (treatment) / Dark Canyon (control) subbasins to document change in stream temperatures and aquatic communities as a result of best management practice (BMP) implementation. Dark Canyon is the control subbasin, while McCoy Creek is the treatment basin. Upstream / downstream monitoring sites of these subbasins will be implemented in both. Three additional subbasins will be used as background subbasins representing a range of water quality and habitat conditions.

Modifications Since Project Started

None.

Parameters Measured

Biological

Habitat
Macroinvertebrates
Fish

Chemical and Other

Continuous water temperature
Specific conductivity
Alkalinity
Dissolved oxygen (DO)

pH
Ammonia (NH_3)
Biochemical oxygen demand (BOD)
Total organic carbon (TOC)
Turbidity

Covariates

Continuous air temperature
Discharge
Precipitation (from nearby climate station)
Shading and solar input
Time of travel
Slope or gradient
Width/depth measurements.

Sampling Scheme

Water quality monitoring is conducted from early April through early October. Air and water temperature is measured continuously at each site throughout the monitoring season. Water quality, habitat, and macroinvertebrate surveys are conducted three times and fish snorkel surveys are done once during each monitoring season. The methods used for identifying sites are based on a modified Hankin and Reeves procedure (Hafele, 1996). The habitat and macroinvertebrate assessment procedures follow Oregon's biomonitoring protocols.

Time of travel data, to be used in temperature modeling, have been collected during the 1996 monitoring season and will be collected again after restoration work is completed. Pool volumes and detailed temperature refugia measurements are being collected during the 1996 monitoring season. Photo and video documentation taken at all study sites during summer low flows will provide before and after documentation of habitat conditions.

Monitoring Scheme for the Upper Grande Ronde Basin Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired Upstream/ downstream	McCoy Creek Dark Canyon Creek	Habitat Macroinvertebrate Fish Water temperature	Air temperature Discharge Precipitation	3 times yearly	3 times yearly	2 years pre-BMP 5 years BMP 5 years post-BMP

Modifications Since Project Started

None.

Water Quality Data Management and Analysis

Water quality data are stored and maintained locally by ODEQ in spreadsheet form and later will be transferred to USEPA's STORET and NonPoint Source Management System (NPSMS) databases. Other reporting formats involve spreadsheet tabulations and graphic presentation. Data will be shared among participating agencies. Data analysis will involve performing statistical tests for detecting trends in water and habitat quality and aquatic communities.

NPSMS Data Summary

Currently unavailable.

Modifications Since Project Started

None.

TOTAL PROJECT BUDGET

The estimated budget for the Upper Grande Ronde National Monitoring Project for the life of the project is based on 10 years of funding, with four years completed (1993–1996):

Project Element	Funding Source ($)				
	Federal	State	Local	Tribal	Total
Proj Mgt	230,000	92,000	NA	NA	322,000
I&E	NA	NA	NA	NA	NA
LT	185,000	NA	NA	70,000	255,000
WQ Monit	470,000	188,000	NA	NA	658,000
TOTALS	885,000	280,000	NA	70,000	1,235,000

Source: Rick Hafele, personal communication (1996).

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The Upper Grande Ronde Basin Monitoring Project is a major component of the Grande Ronde Watershed Enhancement Project, a cooperative effort between ODEQ, EPA, NRCS and Union County SWCD.

The National Marine Fisheries Service (NMFS) listed the Snake River spring/ summer Chinook salmon as an endangered species under the Endangered Species Act (ESA) in August 1994. The US Fish and Wildlife Service determined the Bull trout to be warranted for ESA listing in February 1995. Bull trout are also on the Oregon sensitive species list. Snake River summer steelhead are currently classified as a stock of concern by the Oregon Department of Fish and Wildlife, sensitive by the USFS, and part of a region-wide review for potential listing under the ESA (Bach 1995).

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

None.

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Pennsylvania

Pequea and Mill Creek Watershed
Section 319
National Monitoring Program Project

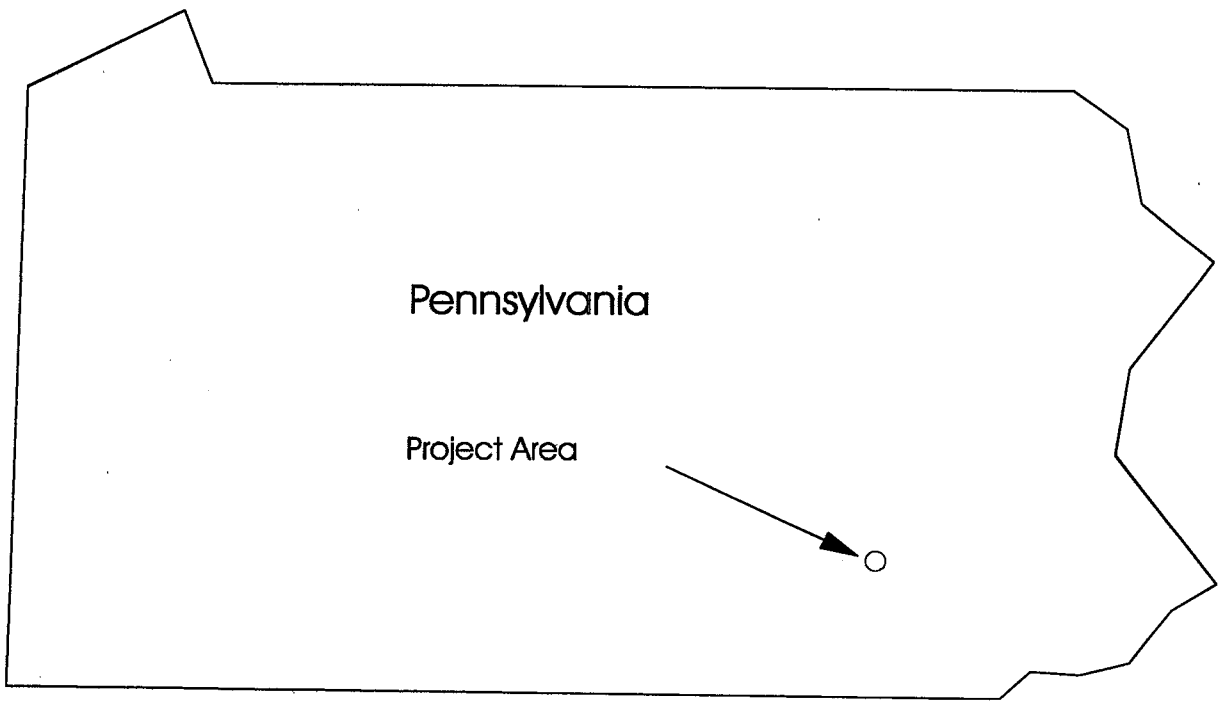

Figure 31: Pequea and Mill Creek (Pennsylvania) Watershed Project Location

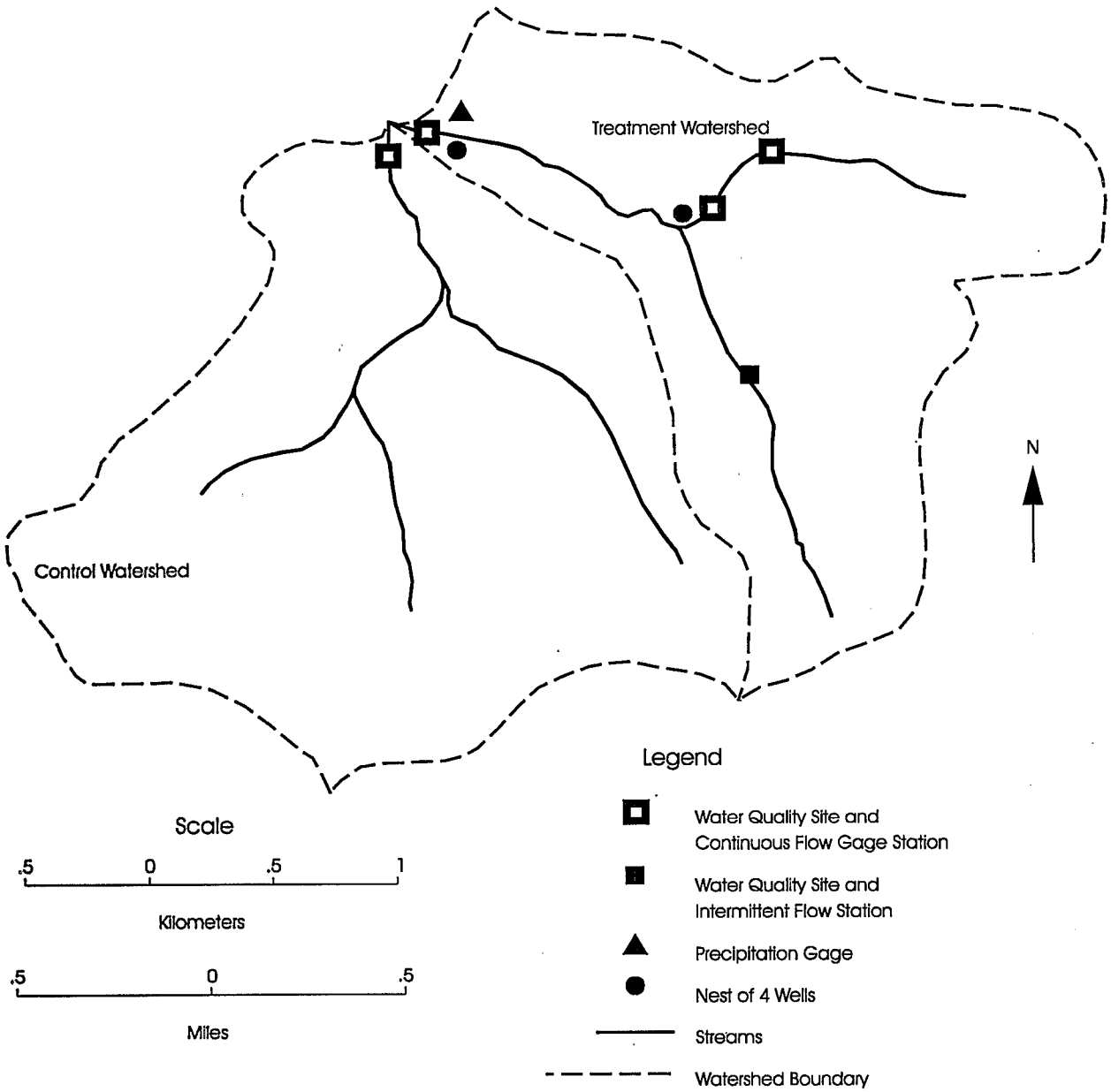

Figure 32: Water Quality Monitoring Stations for Pequea and Mill Creek (Pennsylvania) Watershed

PROJECT OVERVIEW

The Big Spring Run is a spring-fed stream located in the Mill Creek Watershed of southcentral Pennsylvania (Figure 31). Its primary uses are livestock watering, aquatic life support, and fish and wildlife support. In addition, receiving streams are used for recreation and public drinking water supply. Stream uses such as recreation and drinking water supply are impaired by elevated bacteria and nutrient concentrations.

Uncontrolled access of about 200 dairy cows and heifers to each of the two watershed streams is considered to be a major source of pollutants. Pastures adjacent to streams also are thought to contribute significant amounts of nonpoint source pollutants. Therefore, proposed land treatment will focus on streambank fencing to exclude livestock from streams, except for cattle crossings, which will also be used for drinking water access for the cattle. This will allow a natural riparian buffer to become established, which will stabilize streambanks and potentially filter pollutants from pasture runoff.

Water quality monitoring is based on a paired watershed design in which the proposed nonpoint source control is to implement livestock exclusion fencing on nearly 100 percent of the stream miles in the treatment subwatershed (Figure 32). Grab samples are collected every 10 days at the outlet of each paired subwatershed from April through November. Storm event, ground water, biological, and other monitoring is planned to help document the effectiveness of fencing in the treatment subwatershed.

PROJECT DESCRIPTION

Water Resource Type and Size

The study area encompasses about 2.8 and 2.7 miles of tributary streams in the treatment and control subwatersheds, respectively. Annual mean discharges for 1994–1996 water years were 2.06 and 3.52 cfs at the outlets of the treatment and control subwatersheds, respectively.

Water Uses and Impairments

The subwatershed streams have relatively high nutrient and fecal coliform concentrations that contribute to use impairments of receiving waters.

Pre-Project Water Quality

Onetime baseflow grab sampling at four and seven locations in the control and treatment subwatershed are presented in tabular form:

	Fecal coliform	TP (mg/l)	OP (mg/l)	TKN (mg/l)	NO_3+NO_2 (mg/l)
Treatment	1,100-38,000	.06-.25	.03-.15	.3-1.6	10-18
Control	10,000	.02-.04	.01-.03	.1-.3	4-12

Current Water Quality Objectives

The overall objective is to document the effectiveness of livestock exclusion fencing at reducing nonpoint source pollutants in a stream. Another objective is to reduce annual total ammonia plus organic nitrogen and total phosphorus loads from the project watershed by 40 percent.

Modifications Since Project Initiated

None.

Project Time Frame October, 1993 to September, 1998-2003

Project Approval July, 1993

PROJECT AREA CHARACTERISTICS

Project Area Total area is 3.2 square miles (mi^2); Control = 1.8 mi^2; Treatment = 1.4 mi^2

Relevant Hydrologic, Geologic, and Meteorologic Factors The average annual precipitation is 43 inches. The watershed geology consists of deep well-drained silt-loam soils underlain by carbonate rock. About five percent of each subwatershed is underlain by noncarbonate rock.

Land Use

Type	Control Watershed		Treatment Watershed	
	Acres	%	Acres	%
Agricultural	922	80	762	85
Urban	150	13	116	13
Commercial	80	7	18	2
Total	1152	100	896	100

Source: *Pequea and Mill Creek Watersheds Project Proposal*, 1993.

Pollutant Sources The primary source of pollutants is believed to be pastured dairy cows and heifers with uncontrolled access to stream and streambanks. About 200 animals are pastured in the treatment and control watersheds. It is estimated that grazing animals deposit an average of 40 pounds of nitrogen and 8 pounds of phosphorus annually per animal.

Other (commercial and urban) sources of pollutants are considered insignificant.

Modifications Since Project Started A new residential community is being developed in the treatment subwatershed.

INFORMATION, EDUCATION, AND PUBLICITY

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) has had an important role in the information and education (I&E) programs in the Pequea and Mill Creek watershed. NRCS provides an employee to gather nutrient management data in the watershed. The Lancaster Conservation District and the Pennsylvania State University Cooperative Extension Service maintain active I&E programs in the area. Also, as part of the USDA-funded Pequea-Mill Creeks Hydrologic Unit Area (HUA), the landowners in the watersheds will be targeted for additional educational programs.

Progress Towards Meeting Goals The Pennsylvania State University Cooperative Extension Service has produced an educational video which includes information about the project and participating farmers.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

The control strategy involves installing streambank fencing on nearly 100 percent of the pasture land adjacent to the stream draining the treatment subwatershed. All of the farmers in this watershed have agreed to install fencing. A stabilizing vegetative buffer is expected to develop naturally soon after the fencing is installed.

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Streambank fencing in pastured areas of the treatment basin will be completed by the end of June, 1997.

WATER QUALITY MONITORING

Design

The water quality monitoring effort is based on a paired watershed experimental design (Figure 32).

Modifications Since Project Started

A new biological site, water quality site, and continuous monitoring station were added.

Parameters Measured

Biological

Habitat survey
Benthic invertebrate monitoring
Algal mass
Fecal streptococcus (FS) (only during base flow)

Chemical and Other

Suspended solids (SS)
Total and dissolved ammonia (NH_3) plus organic nitrogen
Dissolved ammonia (NH_3)
Dissolved nitrate + nitrite ($NO_3 + NO_2$)
Dissolved nitrite (NO_2)
Total and dissolved phosphorus (TP and DP)
Dissolved orthophosphate (OP)

Covariates

Continuous streamflow
Continuous precipitation
Ground water level

Sampling Scheme

Continuous Streamflow Sites (4):
Type: grab and storm event composite
Frequency and season: grab every 10 days from April through November. Monthly grab December through March. Fifteen to 20 composite storm flow samples per year are collected.

Partial Streamflow Site (1):
Type: grab
Frequency and season: every 10 days from April through November. Monthly grab December through March.

Ground Water:
Type: grab
Frequency and season: monthly and analyzed for nitrate. On a quarterly basis, analysis includes dissolved NO_2, $NO_3 + NO_2$, NH_3, and phosphorus.

Habitat, benthic invertebrate, and algal mass surveys are conducted twice per year, preferably during May and September, at the outlet of each subwatershed, at two points upstream in the treatment subwatershed, and at one point upstream in the control subwatershed.

Continuous streamflow at watershed outlets and two tributary sites and partial streamflow at one upstream site.
Continuous precipitation amount is recorded at one site.
Additionally, ground water level is continuously monitored in eight wells.

Monitoring Scheme for the Pequea and Mill Creek Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired watershed	Treatment watershed Control watershed	Habitat survey Benthic invertebrate survey Algal mass SS Total organic nitrogen NH_3 $NO_3 + NO_2$ NO_2 TP DP OP FS	Discharge Precipitation Ground water level	Sampling every 10 days (Apr.-Nov.) Monthly sampling from Dec. to March Storm event samples (15-20)	Twice per year (May & September)	3 yrs pre-BMP 5 yrs post-BMP

Modifications Since Project Started

A new biological site was added upstream in the control subwatershed. A new continuous monitoring station and water quality site was added to the treatment subwatershed to document effects of a new residential development upstream of pasture land.

Water Quality Data Management and Analysis

Data are stored and maintained locally by U.S. Geological Survey (USGS) and entered into the USGS WATSTORE database and STORET. Data will also be entered into the U.S. Environmental Protection Agency's (USEPA) NonPoint Source Management System (NPSMS) software and submitted to USEPA Region III.

NPSMS Data Summary

STATION TYPE: CONTROL **STUDY TYPE:** Paired **YEAR:** 1996

CHEMICAL PARAMETERS

Parameter Name	QUARTILE VALUES -75-	-50-	-25-		Counts/Season:
TEMPERATURE, WATER (DEGREE CENTIGRADE)	15.9	15.2	12.5	Highest	5
				High	20
				Low	10
				Lowest	6
PRECIPITATION, TOTAL (INCHES PER DAY)	0.64	.31	.11	Highest	21
				High	15
				Low	15
				Lowest	35
FLOW, STREAM, INSTANTANEOUS, CFS	2.2	1.8	1.4	Highest	18
				High	4
				Low	1
				Lowest	0
TURBIDITY, HACH TURBIDIMETER	9	6.1	3.5	Highest	6
				High	3
				Low	5
				Lowest	9
SPECIFIC CONDUCTANCE	700	691	682.5	Highest	5
				High	5
				Low	5
				Lowest	8
OXYGEN, DISSOLVED	10.8	10.1	9.4	Highest	7
				High	4
				Low	8
				Lowest	4
PH (STANDARD UNITS)	7.86	7.75	7.5	Highest	3
				High	3
				Low	12
				Lowest	5
NITROGEN, AMMONIA, DISSOLVED	0.05	0.04	0.02	Highest	4
				High	4
				Low	14
				Lowest	1
NITROGEN, NITRITE, DISSOLVED	0.04	0.03	0.02	Highest	8
				High	4
				Low	9
				Lowest	2
NITROGEN, AMMONIA+ORGANIC, DISSOLVED	0.30	<0.20	<0.20	Highest	4
				High	6
				Low	13
				Lowest	0
NITROGEN, KJELDAHL, TOTAL	0.40	0.30	<0.20	Highest	5
				High	1
				Low	7
				Lowest	10
NITROGEN, NITRITE+NITRATE, DISSOLVED	10	10	9.7	Highest	15
				High	3
				Low	2
				Lowest	3
PHOSPHORUS, TOTAL (MG/L)	0.08	0.04	0.03	Highest	4
				High	6
				Low	5
				Lowest	8
PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE	0.04	0.03	0.02	Highest	3
				High	5
				Low	6
				Lowest	9
PHOSPHORUS, DISSOLVED	0.03	0.03	0.02	Highest	6
				High	7
				Low	7
				Lowest	3
STREPTOCOCCI, FECAL, KF AGAR	5720	3580	2190	Highest	4
				High	0
				Low	3
				Lowest	1
SUSPENDED SEDIMENT	107	84	20	Highest	2
				High	0
				Low	8
				Lowest	11
PASTURE STREAM MILES FENCED	0	0	0	Highest	0
				High	0
				Low	0
				Lowest	0

NPSMS Data Summary (Continued)

STATION TYPE: STUDY

CHEMICAL PARAMETERS

Parameter Name	QUARTILE VALUES -75-	-50-	-25-		Counts/Season:
TEMPERATURE, WATER (DEGREE CENTIGRADE)	20.5	18.7	13	Highest	0
				High	4
				Low	12
				Lowest	7
PRECIPITATION, TOTAL (INCHES PER DAY)	0.64	.31	.11	Highest	21
				High	15
				Low	15
				Lowest	35
FLOW, STREAM, INSTANTANEOUS, CFS	1.5	.9	.6	Highest	18
				High	5
				Low	0
				Lowest	0
TURBIDITY, HACH TURBIDIMETER	7	4	3	Highest	8
				High	5
				Low	5
				Lowest	5
SPECIFIC CONDUCTANCE	680	640	609	Highest	3
				High	10
				Low	5
				Lowest	5
OXYGEN, DISSOLVED	12.4	11.4	9.8	Highest	3
				High	4
				Low	4
				Lowest	12
PH (STANDARD UNITS)	8	7.84	7.67	Highest	0
				High	3
				Low	4
				Lowest	16
NITROGEN, AMMONIA, DISSOLVED	0.06	0035	0.03	Highest	7
				High	9
				Low	1
				Lowest	6
NITROGEN, NITRITE, DISSOLVED	0.07	0.06	0.05	Highest	11
				High	3
				Low	3
				Lowest	6
NITROGEN, AMMONIA+ORGANIC, DISSOLVED	0.42	0.3	0.2	Highest	4
				High	7
				Low	8
				Lowest	4
NITROGEN, KJELDAHL, TOTAL	0.7	0.55	0.38	Highest	3
				High	1
				Low	7
				Lowest	12
NITROGEN, NITRITE+NITRATE, DISSOLVED	12.2	11	9.4	Highest	3
				High	12
				Low	4
				Lowest	4
PHOSPHORUS, TOTAL (MG/L)	0.1	0.06	0.04	Highest	3
				High	1
				Low	3
				Lowest	16
PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE	0.06	0.025	0.02	Highest	3
				High	4
				Low	6
				Lowest	10
PHOSPHORUS, DISSOLVED	0.05	0.025	0.02	Highest	3
				High	4
				Low	7
				Lowest	9
STREPTOCOCCI, FECAL, KF AGAR	98320	10880	1710	Highest	0
				High	1
				Low	6
				Lowest	1
SUSPENDED SEDIMENT	54	26	6	Highest	2
				High	4
				Low	13
				Lowest	2
PASTURE STREAM MILES FENCED	0	0	0	Highest	0
				High	0
				Low	0
				Lowest	0

NPSMS Data Summary (Continued)

DATA TYPE: Bio/Habitat **STUDY TYPE:** Paired

STATION TYPE: CONTROL
BIOLOGICAL PARAMETERS (Non-Chemical)

Parameter Name	INDICES Fully	Threatened	Partially	Scores/Values PASTURED
HILSENHOFF BIOTIC INDEX	0-6.5	6.51-8.5	8.51-10	5.62
TAXA RICHNESS	20	11	10	21
EPT INDEX	6	4	1	2
PERCENT DOMINANT TAXA	20	35	50	25.9
SCRAPERS/FILTER COLLECT	.8	.4	.2	.081

STATION TYPE: STUDY
BIOLOGICAL PARAMETERS (Non-Chemical)

Parameter Name	INDICES Fully	Threatened	Partially	Scores/Values PASTURED
HILSENHOFF BIOTIC INDEX	0-6.5	6.51-8.5	8.51-10	5.92
TAXA RICHNESS	20	11	10	26
EPT INDEX	6	4	1	3
PERCENT DOMINANT TAXA	20	35	50	25.2
SCRAPERS/FILTER COLLECT	.8	.4	.2	.072

Modifications Since Project Started

None.

Progress Toward Meeting Goals

1994 through 1996 water quality data have been entered into WATSTORE and into NPSMS software.

TOTAL PROJECT BUDGET

Project Element	Funding Required 1993	1994	1995	1996	1997
Personnel	$ 57,508	$ 91,970	$ 67,656	$ 90,097	$ 94,207
Equipment and Supplies	20,300	5,600	5,020	4,000	4,000
Contracted Services	16,200	14,200	6,200	7,380	6,181
USGS (lab and gauging)	25,100	38,800	40,770	30,500	31,057
USGS Overhead	115,192	139,834	109,214	121,393	119,614
Other	2,000	2,000	3,000	4,000	10,241
TOTAL*	$236,300	292,404	231,860	257,370	265,300

*50% of total funds are USGS matching funds
Source: *Pequea and Mill Creek Watersheds Project Proposal*, 1993.

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The Chesapeake Bay Program, which has set a goal of a 40% reduction in annual loads of total ammonia plus organic nitrogen and total phosphorus to the Bay, should have a significant impact on the project. The Bay Program is expected to provide up to 100% cost-share money to help landowners install streambank fencing.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

None.

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South Dakota

Bad River
Section 319
National Monitoring Program Project

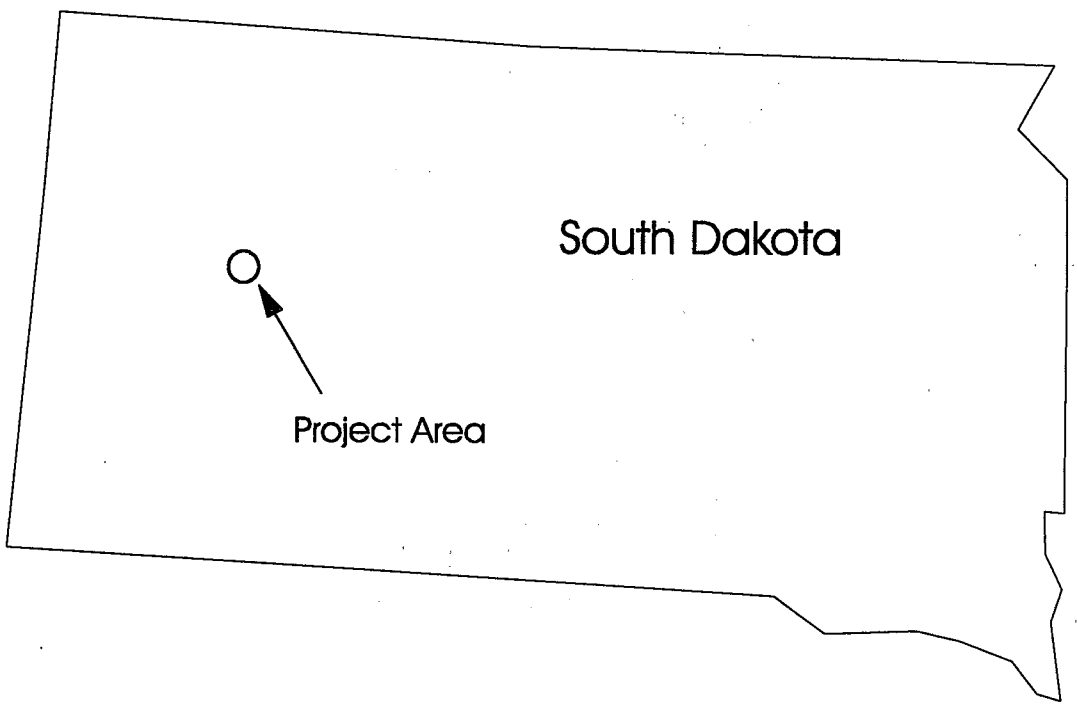
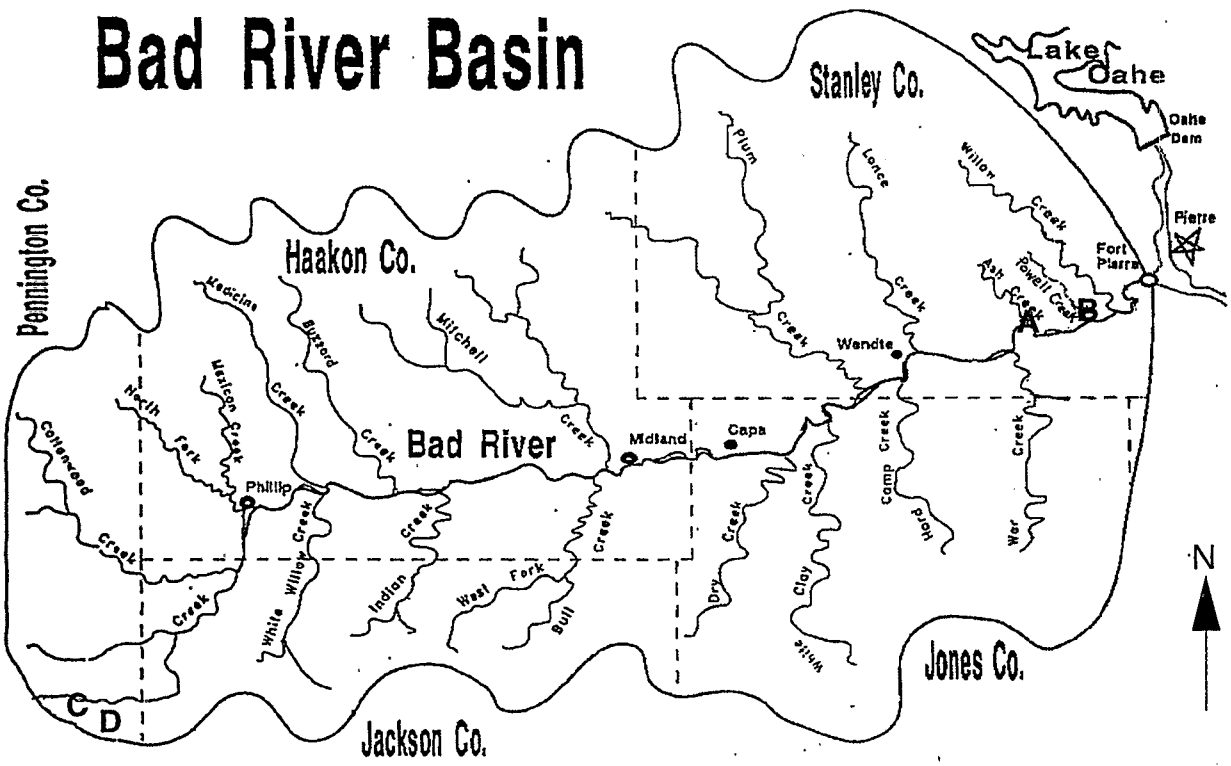


Figure 33: Bad River (South Dakota) Project Location



Legend

- Watershed Boundary
- County Boundary
- Cities and Towns
- **A** Ash Creek Monitoring Site (Control)
- **B** Powell Creek Monitoring Site (Treatment)
- **C** Whitewater North Monitoring Site (Treatment)
- **D** Whitewater South Monitoring Site (Control)

Figure 34: Water Quality Monitoring Stations for Bad River (South Dakota)

PROJECT OVERVIEW

The Bad River watershed, located in westcentral South Dakota (Figure 33), consists entirely of rolling prairie rangeland. Livestock grazing and dryland wheat farming are the main land uses of the watershed. The Bad River joins with the Missouri River at its mouth, near Ft. Pierre, South Dakota. Soil erosion, primarily from poor grazing management and poorly maintained riparian areas, is causing excessive sedimentation to the main channel of the Missouri River. This has impaired recreation due to loss of depth in the Missouri Channel. Loss of channel depth for the Oahe Reservoir on the Missouri River, located 10 miles upstream from the mouth of the Bad River, has impaired the hydropower generation of Oahe Dam during winter months. This, in turn, causes flooding in the cities of Pierre and Ft. Pierre.

The Bad River Section 319 National Monitoring Program project, by using a two-paired watershed design, will determine the effectiveness of best management practices (BMPs). The rangeland, cropland and riparian areas in the treatment watersheds (Powell Creek in the eastern part of the Bad River watershed and Whitewater North Creek in the western part of the watershed) will be treated with appropriate BMPs, such as fencing, rotational grazing, alternative feeding and watering stations, and vegetation plantings. All land uses will be monitored regularly and the information will be tracked by the use of a Geographic Information System (GIS) database.

Because the streams in this region are ephemeral, only storm-event samples will be collected, along with spring snowmelt samples. On average, four storms per season produce enough runoff for the streams to flow. Twenty-four hour integrated samples will be collected, usually for two to three days per storm event. During the spring snowmelt period, two 24-hour composite samples will be collected during the first week of runoff, with one 24-hour composite sample collected per week until runoff ceases. Samples are to be analyzed for total suspended sediment. Rainfall and stream discharge are being measured as covariates.

PROJECT DESCRIPTION

Water Resource Type and Size

The Bad River watershed encompasses 3,209 square miles of western rangeland. The small streams that feed the main channel are ephemeral as are the upper reaches of the Bad River itself. The Bad River enters the Missouri in the town of Ft. Pierre in Stanley County, South Dakota.

Water Uses and Impairments

The official beneficial uses of the Bad River include the following:

- Warmwater marginal fish life propagation waters
- Limited contact recreation waters
- Wildlife propagation and stock watering waters
- Irrigation waters

The main impairment to the Bad River is excess sediment from eroded soils in poorly managed rangeland and riparian areas. The load of sediment from the Bad River creates a problem in the Missouri near the mouth of the Bad River. Loss of channel capacity and water clarity impacts on sport fishing are problems on the Missouri in the Pierre area due to the Bad River sediment.

Pre-Project Water Quality

There is no existing water quality data from the paired watersheds of the Bad River National Monitoring Project.

Current Water Quality Objectives

The main objective of the project is to document water quality improvements in the treatment subwatersheds through the implementation of BMPs.

Project Time Frame

1996-2006

Project Approval

1996

PROJECT AREA CHARACTERISTICS

Project Area

The drainage area of the Bad River is located in westcentral South Dakota (Figure 33) and covers 3,209 square miles of mostly rangeland. The rolling topography of fine textured, deep, shale-derived soils allows for significant soil erosion when rangeland and cropland is not properly managed. The project area supports an abundance of wildlife including mule deer, pronghorn antelope, porcupines, bobcats, prairie grouse, and numerous other species.

Relevant Hydrologic, Geologic, and Meteorologic Factors

This area of South Dakota receives, on average, 15-16 inches of rainfall per year. Most of the precipitation is derived from thunderstorm events during the spring and summer, although snowmelt produces significant runoff. On average there are four storms in the year that produce enough rainfall that runoff occurs in the tributaries. Runoff usually lasts for four to five days per storm event.

Land Use

The land use in the watershed is primarily agricultural and consists of 75% rangeland and 25% dryland wheat farming. A large portion of the upper end of the Bad River watershed is owned by the U.S. Forest Service. Rotational grazing practices have been implemented on the federal rangeland and also on many private ranches.

Pollutant Sources

Soil erosion, primarily from rangeland and riparian areas, is the primary source of the stream sediment.

INFORMATION, EDUCATION AND PUBLICITY

Meetings are currently being held with the ranch communities to explain the project. The Upper Bad River Task Force, a group comprised of ranchers and agency personnel that are committed to improving water quality in the Bad River watershed, is currently meeting to discuss nonpoint source pollution control strategies. As the project progresses, it is anticipated that newspaper articles and radio spots will be used to highlight project activities.

NONPOINT SOURCE CONTROL STRATEGIES

Description

A two-paired watershed design was implemented for this project, with one pair located in the eastern part of the Bad River watershed (A and B — Figure 34), and the other pair in the western part (C and D — Figure 34), at a higher elevation than the east. The nonpoint source pollution control strategies vary for the different subwatershed that are being treated.

Powell Creek, located in the eastern part of the watershed and comprised of 11,221 acres, will serve as the lower treatment subwatershed, while Ash Creek, with 13,702 acres, will be the lower control. Best management practices expected for the Powell Creek subwatershed include riparian management (cross-fencing, willow plantings, and alternative feed and watering sites) and rangeland management (rotational grazing).

In the western part of the watershed, Whitewater North Creek (6,780 acres) will serve as the higher treatment subwatershed while Whitewater South Creek (6,605 acres) will be the higher control. The BMPs to be implemented at Whitewater North Creek include riparian management, small dam structures, and water spreaders.

Riparian habitat will be monitored during the project. Five riparian reaches will be selected for each subwatershed. A stream channel cross section and stream classification (Rosgen method) will be obtained for each reach and during the duration of the project, cross sections will be completed annually. Photographs will be utilized to show changes during the project and riparian information will be entered into the GIS.

Rangeland will be monitored by measuring range condition and vegetative cover during the project period. Range condition will be determined at the start of the project, five years into the project and at the end of the project. Natural Resources Conservation Service (NRCS) personnel will rate the range condition using the *NRCS South Dakota Technical Guide* range site descriptions. The Robel Pole method will be used to determine vegetative cover at permanent transects located within each subwatershed (Ash Creek — 21 transects, Powell Creek — 13 transects, Whitewater North — 10 transects, and Whitewater South — 9 transects). The Robel Pole measurements will be taken 3 times per transect per year. This information will be entered into the GIS.

WATER QUALITY MONITORING

Design

The Bad River Section 319 National Monitoring Project uses a paired watershed monitoring design, with two pairs as part of the protocol. Two subwatersheds have been identified in the eastern part of the watershed (Ash and Powell Creeks) and two in the western portion (Whitewater North and Whitewater South) (Figure 34).

Parameters Measured

Biological

N/A

Chemical and Other

Total suspended sediment

Explanatory Variables

Stream discharge
Rainfall: amount, duration, intensity
Riparian condition

Sampling Scheme

Because the streams in this area are ephemeral, monitoring is storm-event driven. Storm event occurrence, rainfall amounts, and rainfall intensity are compared with the hydrologic discharge and sediment loads. Complete hydrologic and sediment loads will be calculated on each storm event. Storm samples will be flow integrated.

Twenty-four-hour composite samples are collected and analyzed for the duration of flow of each storm event.

In the spring during snowmelt, two 24-hour composite samples are collected during the first week of snowmelt with one sample collected per week thereafter until runoff ceases

Monitoring Scheme for the Bad River Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Duration
Paired Watershed	Whitewater North Creek[T] Whitewater South Creek[C] Powell Creek[T] Ash Creek[C]	TSS	Stream discharge Rainfall	During spring snowmelt Storm event	? yr pre-BMP ? yr BMP ? yr post-BMP

[T]Treatment
[C]Control

Water Quality Data Management and Analysis

All data collected during the Bad River 319 National Monitoring program will be entered into a relational database, Microsoft FoxPro. Files will be backed up daily and the water quality data will also be stored in the U.S. Environmental Protection Agency's STORET database. The U.S. Environmental Protection Agency (EPA) NonPoint Source Management System (NPSMS) software will be used to track and report data to EPA.

A GIS map will be constructed for the Bad River watershed. The GIS will allow cropland and rangeland BMP tracking throughout the life of the project. Other information, such as rangeland and riparian conditions will be entered into the system.

Statistical comparisons of sediment load to rainfall intensity will be determined by regression analysis at all four subwatersheds. The effectiveness of implementing watershed BMPs will be tested through regression and/or correlation analyses.

TOTAL PROJECT BUDGET

Project Element	Funding Source ($)			
	Federal	State	Local	Sum
LT	154,428	2,000	NA	156,428
WQ Monit	148,978	18,300	NA	167,278
TOTALS	303,406	20,300	NA	323,706

Source: *Bad River National Monitoring Project Workplan, 1996*

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

Currently Section 319 watershed funds are being used in the Bad River watershed to implement BMPs. This watershed has been given priority status for funding under the U.S. Department of Agriculture EQUIP (Environmental Quality Incentive Program). Matching funds are provided by the State of South Dakota and participating private ranchers.

OTHER PERTINENT INFORMATION

Project contributors are listed below:

- Private Landowners
- Natural Resources Conservation Service
- South Dakota Department of Environment and Natural Resources
- Upper Bad River Task Force
- Stanley County Conservation District
- East Pennington Conservation District

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Vermont

Lake Champlain Basin Watersheds
Section 319
National Monitoring Program Project

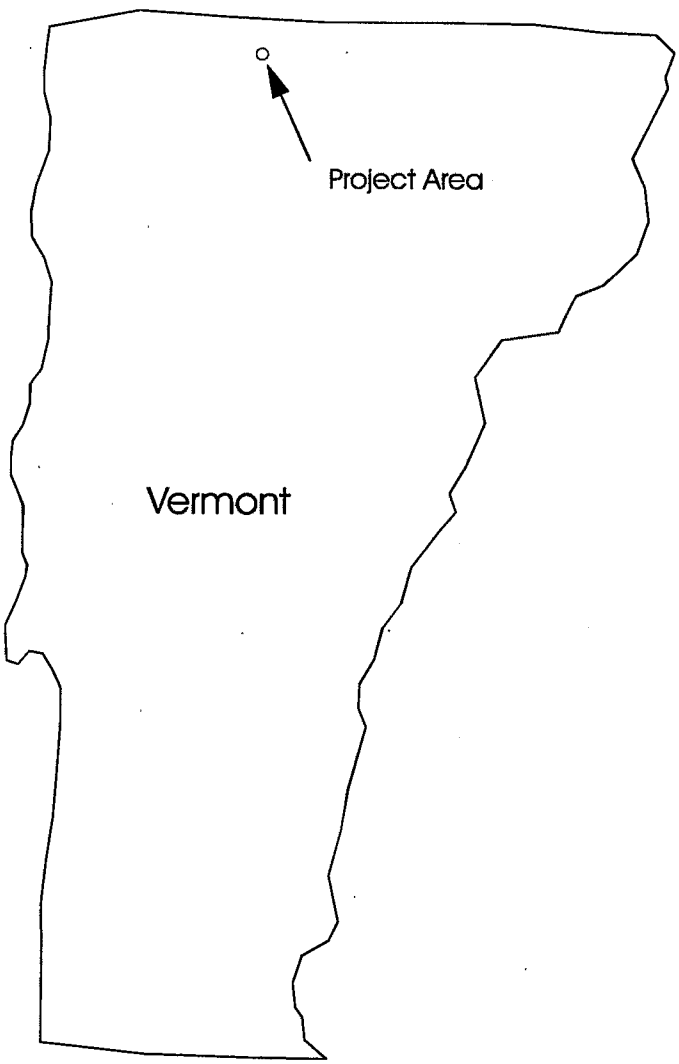

Figure 35: Lake Champlain Basin (Vermont) Watersheds Project Location

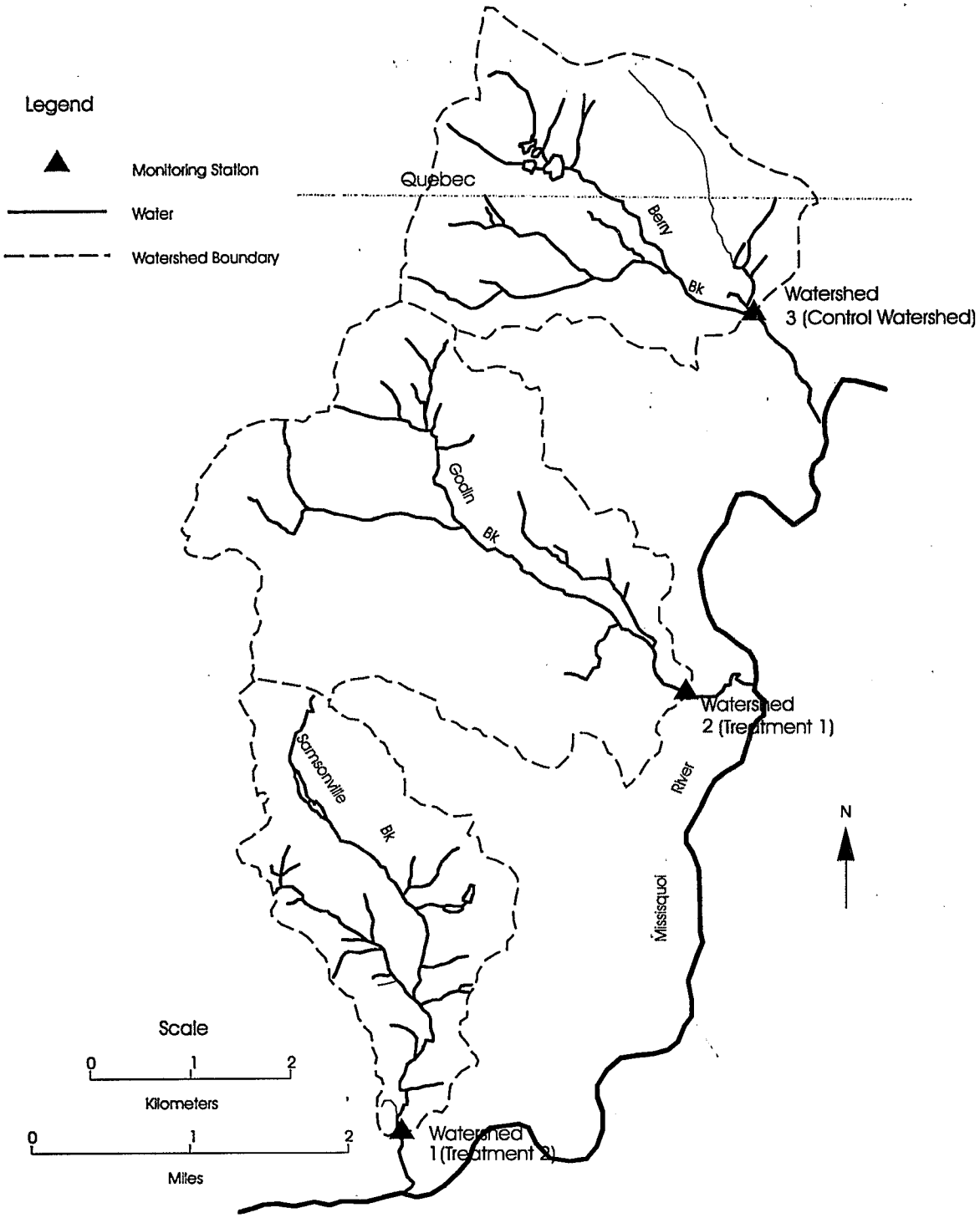

Figure 36: Water Quality Monitoring Stations for Lake Champlain Basin (Vermont) Watersheds

PROJECT OVERVIEW

The Lake Champlain Basin Watersheds Section 319 National Monitoring Program project (also known as the Lake Champlain Agricultural Watersheds Best Management Practice Implementation and Effectiveness Monitoring Project) is located in northcentral Vermont in an area of transition between the lowlands of the Champlain Valley and the foothills of the Green Mountains (Figure 35). Agricultural activity, primarily dairy farming, is the major land use in this area of Vermont.

The streams in these project watersheds drain into the Missisquoi River, a major tributary of Lake Champlain. The designated uses of many of the streams in this region are impaired by agricultural nonpoint source pollution. The pollutants responsible for the water quality impairment are nutrients, particularly phosphorus, E. coli, fecal streptococcus, fecal coliform bacteria, and organic matter. The source of most of the agricultural nonpoint source pollution is the manure generated from area dairy farms, livestock activity within streams and riparian areas, and crop production. The Missisquoi River has the second largest discharge of water and contributes the greatest nonpoint source load of phosphorus to Lake Champlain.

The Lake Champlain Basin Watersheds 319 National Monitoring Program project is designed to evaluate a set of treatments to control the pollutants generated by agricultural activities, focusing on grazing management. A system of best management practices (BMPs) has been implemented to exclude livestock from selected critical areas of streams and to protect stream crossings and streambanks. Individual BMPs include fencing, minimization of livestock crossing areas in streams, strengthening of necessary crossings, watering systems, and streambank stabilization through bioengineering techniques.

The water quality monitoring program is based on a three-way paired design: one control watershed and two treatment watersheds receiving similar BMP systems at different intensities (Figure 36). The watersheds are being monitored during a three-year calibration period prior to BMP implementation. Implementation monitoring will occur for one year and post-treatment monitoring will extend for at least two years.

Biological, chemical, and covariates will be monitored during all three monitoring phases. Fish, macroinvertebrates, fecal streptococcus, fecal coliform, and E. coli bacteria are the monitored biological parameters. The chemical parameters monitored are total phosphorus, total Kjeldahl nitrogen, total suspended solids, dissolved oxygen, conductivity, and temperature. Two covariates, precipitation and continuous discharge, are also being monitored.

Nutrients and suspended sediment are monitored weekly in a flow-proportional composite sample. Bacteria grab samples are collected twice weekly, with concurrent in-situ measurements of temperature, dissolved oxygen, and conductivity. Macroinvertebrate communities are being sampled annually and fish are evaluated twice each year. Invertebrate and fish monitoring are also being conducted at an unimpaired reference site.

PROJECT DESCRIPTION

Water Resource Type and Size

The study streams are small second- or third-order permanent streams that drain to the Missisquoi River, a major tributary of Lake Champlain. The streams are generally 10-15 feet wide at the monitoring stations. Historical stream flow data do not exist for these streams; discharge has ranged from 0.1–300 cubic feet per second (cfs) since May, 1993.

Water Uses and Impairments

Because of their size, the study streams themselves are subject to very limited use for agricultural purposes (livestock watering) and recreation (swimming and fishing). No historical data exist to document support or nonsupport of these or other uses. Initial project data indicate that Vermont water quality (bacteriological) criteria for body contact recreation are consistently violated in these streams.

Early biological data for fish and macroinvertebrates indicate moderate to severe impact by nutrients and organic matter. These particular small watersheds were selected to represent agricultural watersheds in the Lake Champlain Basin, where streams often violate state water quality criteria (Clausen and Meals, 1989; Meals, 1990; Vermont RCWP Coordinating Committee, 1991) and contribute nutrient concentrations and areal loads that generally exceed average values reported from across the United States (Omernik, 1977) and in the Great Lakes Region (PLUARG, 1978).

The receiving waters for these streams — the Missisquoi River and Lake Champlain — have very high recreational use that is being impaired by agricultural runoff (Vermont Agency of Natural Resources, 1994). The Missisquoi River is the second largest tributary to Lake Champlain in terms of discharge (mean flow =1450 cfs) and contributes the highest annual nonpoint source phosphorus load to Lake Champlain among the major tributary watersheds (75.1 mt/yr) (VT and NY Departments of Environmental Conservation, 1994). Lake Champlain currently fails to meet state water quality standards for phosphorus, primarily due to excessive nonpoint source loads (Vermont Agency of Natural Resources, 1994). About 66% of the nonpoint source phosphorus load to Lake Champlain is attributed to agricultural land (Budd and Meals, 1994).

Pre-Project Water Quality

No historical physical/chemical data exist for the study streams. Early pretreatment monitoring data show the following ranges:

E. Coli (#/100 ml)	Fecal Coliform (#/100 ml)	Fecal Strep.
4 – 200,000	1 – 200,000	9 – 200,000

TP (mg/l)	TKN (mg/l)	TSS (mg/l)
0.03 – 1.33	0.20 – 0.25	2 – 250

(Note: these values represent the range observed in May, 1994 - June, 1996.)

Current Water Quality Objectives

The overall goal of the project is a quantitative assessment of the effectiveness of livestock/grazing management practices focused on the riparian zone in reducing concentrations and loads of nutrients, bacteria, and sediment from small agricultural watersheds. Major water quality objectives are to 1) document changes in sediment, nutrient, and bacteria concentrations and loads due to treatment at the watershed outlets and 2) evaluate response of stream biota to treatment.

Modifications Since Project Initiation

Delay in implementation resulting in extension of pre-treatment monitoring and reduction of planned post-treatment monitoring.

Project Time Frame

September 1993 to September, 1999 (Approximate)

Project Approval

September 1993

PROJECT AREA CHARACTERISTICS

Project Area

1705 ac (WS 1) + 3513 ac (WS 2) + 2358 ac (WS 3) = 7576 ac

Relevant Hydrologic, Geologic, and Meteorologic Factors

The project area is in northcentral Vermont (Franklin County) in an area of transition between the lowlands of the Champlain Valley and the foothills of the Green Mountains. Average annual precipitation is about 41 inches; average annual temperature is about 42°F. Frost-free growing season averages 118 days.

Most of the watershed soils are till soils, loamy soils of widely variable drainage characteristics. There are significant areas of somewhat poorly drained silt/clay soils in the lower portions of the watersheds.

Land Use

The three watersheds are generally similar in land use:

	WS1		WS2		WS3	
Land Use	Acres	%	Acres	%	Acres	%
Corn/hay	369	22%	860	25%	569	24%
Pasture/ hay-pasture	60	4%	426	12%	167	7%
Forest	1135	67%	2118	60%	1408	60%
Other	141	8%	110	3%	213	9%

Source: 1993 CFSA aerial photography, unverified

Pollutant Sources

Nonpoint sources of pollutants are streambanks, degraded riparian zones, and dairy-related agricultural activities, such as field-spread and pasture-deposited manure and livestock access. Some agricultural point sources such as milkhouse waste or corn silage leachate are thought to exist.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

Pre-project activity included letters to all watershed agricultural landowners followed by small "kitchen table" meetings with farmers in each watershed. The purpose of these meetings was to assess landowner interest and acceptance of the project.

Two articles concerning the project have been published in the weekly county newspaper. A semiannual project newsletter was initiated in the summer of 1995.

In July, 1994, a monitoring station "open-house" was held to present the project, monitoring hardware, and some early monitoring results.

The first annual winter lunch meeting was held in February, 1995, where watershed farmers discussed the project and heard a talk by a local farmer engaged in rotational grazing. A second such meeting was held in April, 1996.

A semi-annual project newsletter is distributed to watershed farmers and other interested parties. In addition, a feature story on the project has been published in the monthly magazine of a regional environmental advocacy group.

The project includes a Project Advisory Committee with representatives from United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS), Extension, Vermont Dept. of Agriculture, Vermont Dept. of Environmental Conservation, Vermont Natural Resources Conservation Council, U.S. Fish and Wildlife Service, the Vermont Pasturelands Outreach Program, and a watershed dairy farmer. The committee meets quarterly to review progress and assist in program direction.

Progress Towards Meeting Goals

Information and education efforts during the pretreatment calibration phase focus on laying the groundwork for treatment by presenting demonstrations and information concerning rotational grazing and livestock access control. Additional contact with farmers will occur through routine collection of agricultural management data.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Design

The project is designed to test a suite of practices that treat and protect the stream and riparian zone. In both treatment watersheds, work will focus on selective exclusion of livestock from the streams, creation of a protected riparian zone, improvement or elimination of heavily used livestock stream crossings, and revegetation of degraded streambanks. The treatment requires fencing, watering systems, reducing the number of livestock crossing areas, bridging or strengthening necessary crossing areas, and streambank erosion control through willow planting and other bioengineering techniques.

During the pretreatment monitoring period, treatment needs are being assessed, specific plans and specifications are being developed, and agreements with landowners are being pursued. It is anticipated that the project will provide 100% cost support for cooperating landowners. Agricultural management activity — both routine and treatment implementation — is monitored by farmer record-keeping and annual interviews.

It is also anticipated that some work will be done as necessary on agricultural point sources if and when such pollutant sources are identified.

Modifications Since Project Started

Problems with funding and personnel shifts delayed the start of treatment implementation by approximately one year. In 1996, the project timetable was revised to reflect a three-year calibration period (1994–1996), one year of implementation (1997), and two years of post-treatment monitoring (1998–1999).

The nonpoint source control strategy and design have been changed due to changes in agricultural operations in WS1. The original project design called for the implementation of intensive grazing management in WS1 as a means to minimize the

time spent by livestock in or near the streamcourse without resorting to complete exclusion. However, since the beginning of the project, one farmer in WS1 ceased operations, one changed his management to complete confinement, and another was determined to have no riparian pasture. Moreover, the owner of the large dairy operation immediately above the monitoring station has implemented full rotational grazing on his own. Thus, opportunities for implementing the planned treatment were essentially eliminated. After additional field surveys and discussions with the Project Advisory Committee, the Principal Investigator requested approval from EPA Region I for a change in treatment design. Approval was granted in June, 1997.

Under the modified strategy, WS1 will receive the same set of treatments as WS2, i.e. livestock exclusion, crossing protection, and streambank stabilization. Thus, WS1 can now be viewed as a replicate of WS2 with respect to treatment. Because of the lower intensity of grazing resulting from the changes in agriculture in the watershed, the level of treatment will be lower in WS1 compared to WS2, offering the opportunity to evaluate thresholds and degrees of water quality response to varying levels of treatment.

Progress Towards Meeting Goals

The water quality monitoring component of the project is fully operational and is currently meeting project goals. A severe drought and elevated temperatures during June and July, 1995, have interfered slightly with chemical and physical monitoring, and may have some lasting influence on biological communities in the monitored streams.

Following a baseline inventory and new aerial videography in 1995, land use/agricultural activity has been conducted through farmer recordkeeping, annual interviews, and windshield surveys.

The process of identifying specific treatment needs and designs and negotiating agreements with landowners began in the fall of 1995. However, project difficulties and changes noted earlier delayed this process significantly. Under renewed initiatives, agreements were signed with eight watershed landowners in the spring of 1997 and implementation is underway. As of midsummer, 1997, installed practices included more than 7,000 feet of riparian fence, elimination of three livestock crossings, a culvert livestock crossing, three armored livestock crossings, and a bridge. In addition, several thousand feet of streambank have been protected with brushrolls and tree revetments and willow plants. Significant assistance has been given by the Vermont Youth Conservation Corps, the Missisquoi River Basin Association, and local volunteers.

The principal impediment to project progress is funding, both mechanism and quantity. While in principle, Section 319 National Monitoring Program funding is intended to be set up for the entire project period, this has not been the case in this project. The requirement to renew funding each year causes significant problems, including accounting confusion over fiscal vs. project vs. monitoring "years," inefficient expenditure of staff time, and, most importantly, difficulty in accounting for and documenting required match. This is a particular problem in the implementation budget, since actual implementation (and associated match) will not take place until project year 3, while funds have been allocated in project year 1 and 2 budgets. Budgeting over the entire project lifetime would substantially alleviate these problems.

The other financial impediment to the project involves significant increases in charges for sample analysis by the state Department of Environmental Conservation (DEC) laboratory. These costs have increased dramatically (on the order of $11,000–$16,500 per year) since the first funding year and, with no corresponding

increase in overall funding, other budget categories have had to be cut. In the current FY96 budget, this has required elimination of all nonsignificant principal investigator support, limiting available time commitment to the project. The increase in analytical costs also reduces the previous match contributions from DEC. Annual funding from U.S. Environmental Protection Agency (USEPA), however, has been essentially level and nonnegotiable for the last two years. Some flexibility in funding, such as increasing USEPA funding to cover such cost increases, would be helpful. The project was significantly under-funded in FY 1997, resulting in a five-month suspension of project activities beyond continuation of basic water quality monitoring. This problem has been corrected.

WATER QUALITY MONITORING

Design

The study is based on a paired-watershed design, with a control watershed and two treatment watersheds (Figure 36). The design calls for three years of calibration monitoring, one year of implementation monitoring, and two years of post-treatment monitoring.

Modifications Since Project Started

None.

Parameters Measured

Biological

E. coli bacteria
Fecal coliform (FC)
Fecal streptococcus (FS)
Macroinvertebrates
Fish

Chemical and Other

Total phosphorus (TP)
Total Kjeldahl nitrogen (TKN)
Total suspended solids (TSS)
Dissolved oxygen (DO)
Conductivity
Temperature

Covariates

Precipitation
Discharge (continuous)

Sampling Scheme

Automated sampling stations are located at three watershed outlets for continuous recording of streamflow, automatic flow-proportional sampling, and weekly composite samples for sediment and nutrients. Twice-weekly grab samples for bacteria are collected. Concurrent in-stream measurement of temperature, dissolved oxygen, and conductivity also occur at the same time that the grab samples are collected. Three precipitation gauges have been installed. All monitoring systems operate year-round.

The macroinvertebrate community at each site and a fourth "background reference" site are sampled annually using a kick net/timed effort technique. Methods and analysis follow USEPA's Rapid Bioassessment Protocols (Protocol III). Fish are

sampled twice a year by electroshocking and evaluated according to Rapid Bioassessment Protocols Protocol V.

Physical habitat assessments are performed during each sampling run.

Monitoring Scheme for the Lake Champlain Basin Watersheds Section 319 National Monitoring Program Project

Design	Site or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Biological Assessment	Duration
Three-way paired watershed	Samsonville Brook[T] Godin Brook[T] Berry Brook[C]	E. coli FC FS Macroinvertebrates Fish survey TP TKN TSS DO Conductivity Temperature	Precipitation Discharge (continuous)	Weekly except bacteria temperature, dissolved oxygen, and conductivity which will be twice weekly	Fish sampled twice per year Macroinvertebrates sampled once per year	2 yrs pre-BMP 1 yr BMP 3 yrs post-BMP

[T]Treatment watershed
[C]Control watershed

Modifications Since Project Started

While no changes to the monitoring program have occurred, changes in the TKN analysis within the Vermont Department of Environmental Conservation laboratory have threatened the utility of that parameter in evaluating treatment response. Continuation of the TKN analysis is currently under review.

Primary data management is done using an in-house spreadsheet system. The USEPA Nonpoint Source Management System (NPSMS) software will be used to track and report data to USEPA when it is upgraded to handle three watersheds and a version provided that runs on the available PC. Requisite data entry into STORET and BIOS has been completed through file transfer. Biological data are being formatted for transfer to BIOS.

Water Quality Data Management and Analysis

Water quality data are being compiled and reported for quarterly project advisory committee meetings, including basic plots and univariate statistics. For annual reports, data are analyzed on a water-year basis.

Data analysis is being performed using both parametric and nonparametric statistical procedures in standard statistical software.

NPSMS Data Summary

Monitoring Station Parameters Report

DATE: 08/04/95 PERIOD: 5/94 – 6/95

STATION TYPE: Treatment Watershed #1 (Samsonville Brook)

CHEMICAL PARAMETERS

Parameter Name	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
CONDUCTANCE	uS/CM	120	95	80
E. COLI	CFU/100ML	200	120	24
FECAL COLIFORM	CFU/100ML	180	82	26
FECAL STREPTOCOCCUS	CFU/100ML	1040	300	60
FLOW, STREAM, WEEKLY MEAN	CFS	3.7	2.3	1.4
OXYGEN, DISSOLVED	MG/L	13.0	11.8	9.9
PRECIPITATION, TOTAL	IN/WEEK	0.58	0.29	0.07
NITROGEN, TOTAL KJELDAHL	MG/L	1.24	1.00	0.69
PHOSPHORUS, TOTAL	MG/L	0.160	0.076	0.052
TEMPERATURE, WATER	oC	0.8	9.1	17.1
TOTAL SUSPENDED SOLIDS	MG/L	59.6	26.8	13.8

STATION TYPE: Treatment Watershed #2 (Godin Brook)

CHEMICAL PARAMETERS

Parameter Name	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
CONDUCTANCE	uS/CM	139	117	90
E. COLI	CFU/100ML	4500	610	39
FECAL COLIFORM	CFU/100ML	4450	600	41
FECAL STREPTOCOCCUS	CFU/100ML	1200	520	50
FLOW, STREAM, WEEKLY MEAN	CFS	7.7	4.8	3.1
OXYGEN, DISSOLVED	MG/L	13.1	11.5	9.7
PRECIPITATION, TOTAL	IN/WEEK	0.76	0.40	0.09
NITROGEN, TOTAL KJELDAHL	MG/L	1.15	0.89	0.66
PHOSPHORUS, TOTAL	MG/L	0.185	0.088	0.037
TEMPERATURE, WATER	oC	18.0	10.4	2.3
TOTAL SUSPENDED SOLIDS	MG/L	36.0	14.4	5.2

STATION TYPE: Control Watershed (Berry Brook)

CHEMICAL PARAMETERS

Parameter Name	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
CONDUCTANCE	uS/CM	130	111	94
E. COLI	CFU/100ML	3850	490	33
FECAL COLIFORM	CFU/100ML	2800	630	31
FECAL STREPTOCOCCUS	CFU/100ML	1900	405	60
FLOW, STREAM, WEEKLY MEAN	CFS	9.2	5.9	3.7
OXYGEN, DISSOLVED	MG/L	12.6	10.6	9.2
PRECIPITATION, TOTAL	IN/WEEK	0.75	0.48	0.12
NITROGEN, TOTAL KJELDAHL	MG/L	1.06	0.77	0.68
PHOSPHORUS, TOTAL	MG/L	0.179	0.058	0.040
TEMPERATURE, WATER	oC	17.4	10.6	2.7
TOTAL SUSPENDED SOLIDS	MG/L	31.0	8.6	5.0

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Analysis of physical and chemical monitoring data collected through 1996 indicates that conditions for acceptable calibration have been met. Significant regression relationships exist between watershed pairs for all parameters of interest. For most parameters, the calibration period has been adequate to detect changes following treatment. Residual errors around the regressions are small enough to allow determination for changes of 23% or smaller in response to treatment. Calibration regressions are acceptable for all combinations of treatment/control watersheds examined. Therefore, while some problems remain to be worked out with respect to TKN, data collected during the calibration phase appear to be adequate for the project to proceed into the treatment period.

PROJECT BUDGET

The estimated budget for the Lake Champlain Basin Watersheds National Monitoring Program project for years 1–4 is:

Project Element	Funding Source ($)				
	Federal	State	University	Other	Total
LT	121,093	3,388	21,918	54,981	201,380
WQ Monit	443,354	134,229	106,601	NA	684,184
TOTALS	564,447	137,617	128,519	54,981	885,564

Source: Don Meals (Personal Communication), 1997. Federal includes funds from 319 and 104b3; Other represents potential labor/materials from landowners/ volunteers. (Dollar figures are rounded.)

Modifications Since Project Started

Project budget continues to be renewed yearly.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The project area is within the area of the Lake Champlain Basin Program (a program modeled after the Chesapeake Bay Program), directed toward the management of Lake Champlain and its watershed. Considerable effort on agricultural nonpoint source control is associated with this program, including funding for pollution control/prevention demonstration projects.

Additionally, the state of Vermont's phosphorus management strategy calls for targeted reductions of phosphorus loads from selected subbasins of Lake Champlain.

Because this 319 National Monitoring Program project contributes to two ongoing projects (the Lake Champlain Basin Program and the phosphorus reduction program), it is anticipated that some support — technical assistance, funding, or other — will be actively sought from these programs.

Modifications Since Project Started

The U.S. Fish and Wildlife Service (USF&WS) is an active participant in the project. Two watershed landowners have signed agreements with the USF&WS *Partners for Wildlife* riparian zone restoration program. NRCS has rendered valuable assistance in engineering design and streambank restoration. The onset of the new USDA EQUIP program, however, severely curtailed the availability of staff time to assist in the project. The Vermont Youth Conservation Corps Franklin

County crew donated three days of labor in streambank stabilization. The Missisquoi River Basin Association, a citizens group, organized several days of volunteer labor, and employees of Ben & Jerry's Homemade donated substantial field work.

OTHER PERTINENT INFORMATION

None.

PROJECT CONTACTS

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Washington

Totten and Eld Inlet
Section 319
National Monitoring Program Project

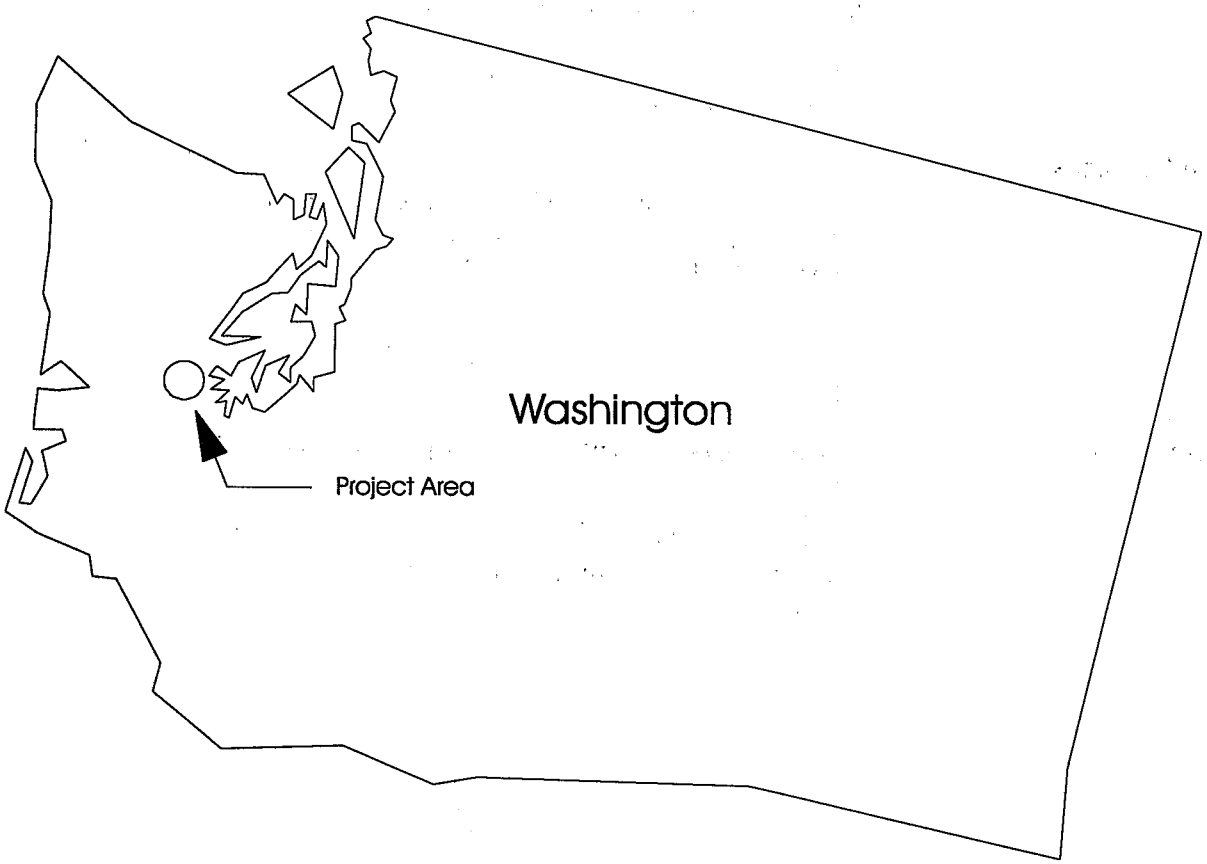

Figure 37: Totten and Eld Inlet (Washington) Project Location

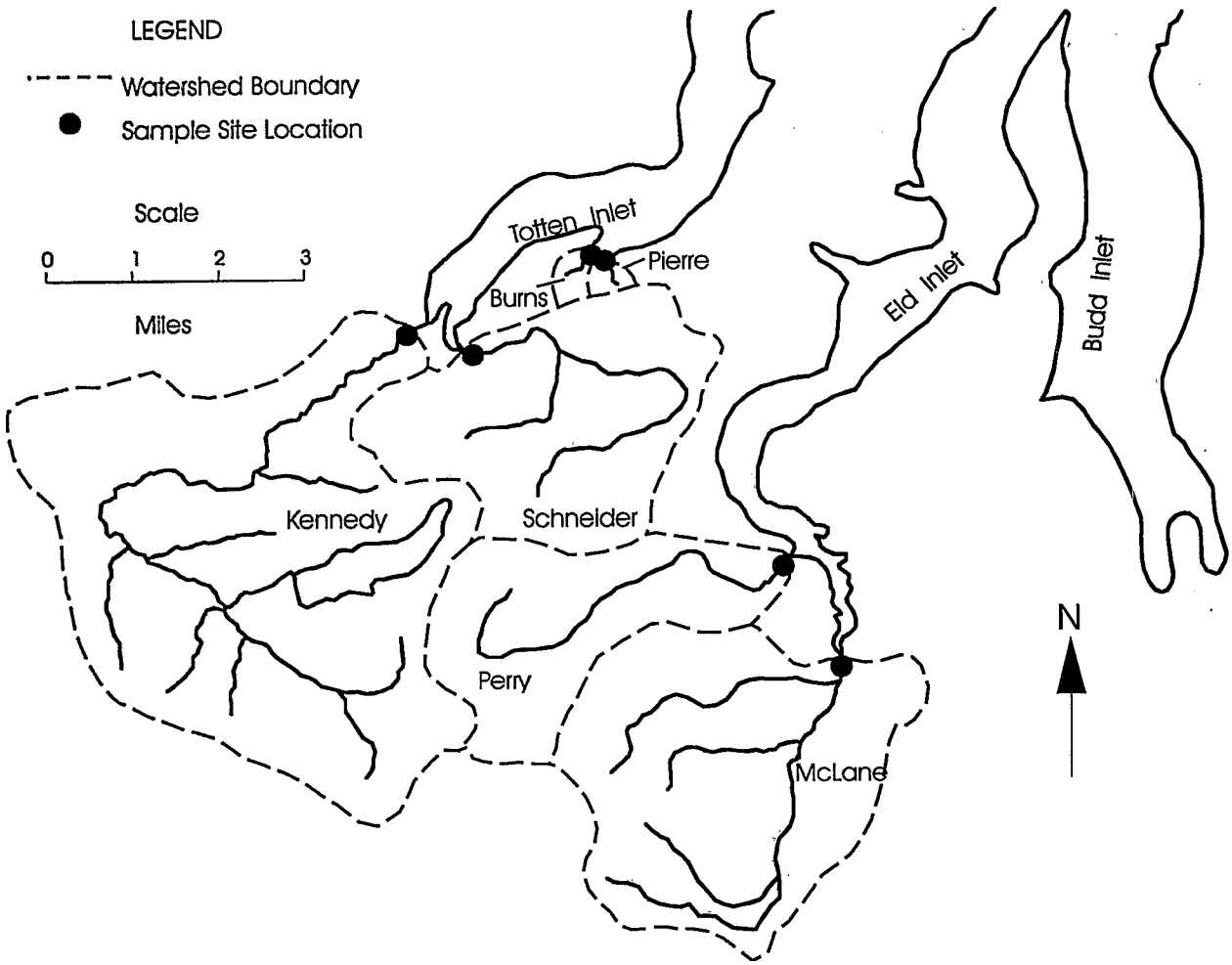

Figure 38: Water Quality Monitoring Stations for Totten and Eld Inlet (Washington)

PROJECT OVERVIEW

Totten and Eld Inlets are located in southern Puget Sound (Figure 37). These adjacent inlets are exceptional shellfish production areas. The rural nature of the area makes it an attractive place in which to live. Consequently, stream corridors and shoreline areas have experienced considerable urban, suburban, and rural growth in the past decade. Located in the area are many recreational, noncommercial farms that keep various livestock. Upland and lowland areas are highly productive forest lands.

The most significant nonpoint source pollution problem in these inlets is bacterial contamination of shellfish production. Totten Inlet is currently classified as an approved shellfish harvest area but is considered threatened due to bacterial nonpoint source pollution. The southern portion of Eld Inlet is currently classified as conditional for shellfish harvest. This conditional classification means shellfish may not be harvested for 3 days following rain events that are greater than 1.25 inches in 24 hours. The major sources of fecal coliform (FC) bacteria are failing on-site wastewater treatment systems and livestock-keeping practices along stream corridors and marine shorelines.

The Totten and Eld Inlet Clean Water Projects have evolved from the combined efforts and resources of local and state government. Watershed action plans were completed in 1989 for both Totten and Eld Inlet. While a significant level of public involvement and planning has occurred, material resources for implementing on-the-ground best management practices (BMPs) have been scarce. In 1993, revenue from property assessments and grants provided funds for local government to implement remedial actions in targeted areas within these watersheds. The goal of the remedial efforts is to minimize the impacts of nonpoint source pollution by implementing farm plans on priority farm sites and identifying and repairing failing on-site wastewater treatment systems. These focused efforts are expected to last into 1999.

In 1993, a water quality monitoring program was initiated to evaluate the effectiveness of remedial land treatment practices on water quality. This monitoring effort was formalized in 1995 into a U.S. Environmental Protection Agency (USEPA) Section 319 National Monitoring Program project. The monitoring effort targets six subbasins within the larger Totten and Eld Inlet watersheds. The goals of water quality monitoring are to detect, over time 1) trends in water quality and implementation of land treatment practices and 2) associated changes in water quality to changes in land treatment practices. A paired watershed design is being used for two basins while a single site approach will be used for four basins. Water quality monitoring is conducted from November to April on a weekly basis for at least 20 consecutive weeks each year. Fecal coliform bacteria, suspended solids, turbidity, flow, and precipitation are the main parameters of interest. Best management practices are also being tracked.

PROJECT DESCRIPTION

Water Resource Type and Size

Totten and Eld Inlets are estuaries separated by peninsulas in southern Puget Sound. The total drainage basin for the two inlets is approximately 67,200 acres. Six subbasins have been selected for this monitoring project. They are as follows:

Burns	82-acre single site
Kennedy	13,046-acre paired site
Pierre	65-acre single site
Schneider	4,588-acre paired site
McLane	7,425-acre single site
Perry	3,857-acre single site

Water Uses and Impairments

Important beneficial uses of the Totten and Eld Inlet marine waters include shellfish culturing, finfish migration and rearing, wildlife habitat, and primary and secondary contact recreation.

Important beneficial uses of the freshwater streams that drain into the Totten and Eld Inlets include finfish migration, spawning, and rearing; domestic and agricultural water supply; primary and secondary contact recreation; and wildlife habitat.

Pre-Project Water Quality

Three of the six project streams (Burns, Pierre, and Schneider) failed to meet water quality standards for fecal coliform bacteria for the 1992-93 and 1993-94 monitoring seasons. The water quality standard for fecal coliform (FC) bacteria for these streams requires that the geometric mean value not exceed 50 cfu/100 ml and that not more than 10% of samples exceed 100 cfu/100 ml.

Site	Class	GMV		Part 1 meet standard?		% samples greater than Part 2 of standard		Part 2 meet standard?	
		92-93	93-94	92-93	93-94	92-93	93-94	92-93	93-94
Burns	AA	94	206	No	No	35	74	No	No
Kennedy	AA	5	6	Yes	Yes	0	0	Yes	Yes
Pierre	AA	52	55	No	No	22	42	No	No
Schneider	AA	24	17	Yes	Yes	17	11	No	No
McLane	A	37	27	Yes	Yes	4	4	Yes	Yes
Perry	A	14	10	Yes	Yes	0	0	Yes	Yes

Class AA Standard: Part 1—geometric mean value (GMV) shall not exceed 50 colonies/100ml. Part 2—not more than 10% of the samples used for calculating the GMV shall exceed 100 colonies/100ml.

Class A Standard: Part 1—geometric mean value shall not exceed 100 colonies/100ml. Part 2—not more than 10% of the samples used for calculating the GMV shall exceed 200 colonies/100ml.

Current Water Quality Objectives

Pierre Creek

- reduce median FC concentration by 69% (reduce to 10 cfu/100ml)

Burns Creek

- reduce median FC concentration by 63% (reduce to 20 cfu/100 ml)

Schneider Creek

- reduce median FC concentration by 50% (reduce to 10 cfu/100 ml)

McLane Creek

- reduce median FC concentration by 44% (reduce to 22 cfu/100 ml)

Modifications Since Project Initiation

None.

Project Time Frame

1993 to 2002

Project Approval

1995

PROJECT AREA CHARACTERISTICS

Project Area

The Totten and Eld Inlets Section 319 National Monitoring Program project area consists of six subbasins within the Totten and Eld Inlets. The Totten watershed is approximately 44,300 acres and the Eld Inlet watershed is approximately 22,900 acres.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The topography of the project area includes the rugged Black Hills area southwest of the city of Olympia, upland prairies, fresh and estuarine wetlands, high and low gradient stream reaches, and rolling hills. Pleistocene glacial activity was the most recent major land-forming process.

The predominant till formations generally consist of compact silts and clays.

Wet, mild winters and warm, dry summers are characteristic of the Puget Sound region. The climate and precipitation of the project area are similar. Rainfall ranges from about 50 to 60 inches per year, depending on elevation and longitude. The precipitation received in the areas mostly occurs between October and April.

Land Use

Land Use	Totten/Little Skookum Inlet	Eld Inlet
Forest	82.0%	63.0%
Residential	4.3%	6.3%
Agriculture	5.0%	5.1%
Public Use	0.3%	5.1%
Undeveloped	7.5%	19.8%
Other	0.9%	0.7%

Pollutant Sources

Sources of fecal coliform bacteria are failing on-site wastewater treatment systems and livestock-keeping practices along stream corridors and marine shorelines. Wet season (October-April) soil saturation hampers the ability of many on-site systems to operate correctly. Saturated soils and stormwater runoff also contribute to water quality problems associated with overgrazed pastures, manure-contaminated runoff, and livestock access to streams. The major source of pollution in the monitoring subbasins is considered to be animal-keeping practices. Livestock common to these farms include horses, beef cattle, llamas, donkeys, goats, sheep, and chickens. Animal types and numbers from inventories were converted to animal units (1 AU = 1,000 lbs animal weight) in order to estimate the wet season animal population for each basin. These estimates are: Kennedy – 1.0 AU, Schneider – 93.0 AU, Burns – 7.7 AU, Pierre – 5.0 AU, McLane – 142 AU, and Perry – 44.3 AU.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

There are a variety of educational and informational activities within the project counties (Thurston and Mason counties) that address land and water stewardship. Local and state initiatives over the past six years have resulted in stewardship activities that cover the spectrum of personal commitment activities, including awareness, learning, experience, and personal action programs. Many educators involved with these activities share ideas, resources, and programs through a stewardship-focused Regional Education Team.

A Section 319 Clean Water Act grant funded a watershed resident survey in August, 1994. The survey explored public awareness and opinions regarding water quality and environmental issues. The survey targeted the Totten and Eld Inlet watersheds in southern Puget Sound, as well as northern Puget Sound watersheds in Whatcom, Skagit, and Snohomish counties. Approximately 1300 residents responded to the mail survey. The survey was designed to help state and local governments evaluate levels of public awareness and effectiveness of current educational programs, and determine where educational efforts, and efforts to involve the public, should be directed (Elway Research, 1994).

The objective of the project's public involvement and education component is to participate in and lend support to established public information and education activities addressing environmental stewardship in the project areas and in the larger South Puget Sound area.

Progress Towards Meeting Goals

Educational and informational activities are continuing.

NONPOINT SOURCE CONTROL STRATEGY

Description

The nonpoint source treatment in the project area is designed to minimize the impacts of nonpoint source pollution by repairing failing on-site wastewater treatment systems and implementing farm plans on priority farm sites. Priority farm sites are those farms that potentially threaten the quality of a receiving water due to a variety of physical and managerial properties such as closeness to stream, numbers of animals, and lack of pollution prevention practices. The nonpoint source control strategy involves surveying all potential pollution sources in critical areas, estimating the water quality impact, and, finally, planning and implementing corrective actions.

Resource management plans (farm plans) are developed cooperatively by the landowner and local conservation districts. The farm planning process identifies potential water quality impacts and recommends BMPs to mitigate those impacts. Conservation district staff and the landowner discuss implementation costs and schedules of BMPs and cost-share opportunities. The landowner then chooses what he or she is willing to implement and agrees to implement the plan as funding allows. Specific BMPs most likely to be employed for nonpoint source control in project watersheds include pasture and grazing management, stream fencing, stream buffer zones, rainwater and runoff management, livestock density reduction, and animal waste management. Monies from the Farm Service Agency, State Revolving Fund, U.S. Fish and Wildlife Service, and other sources may be available for cost-share or low interest loan contracts.

Voluntary participation (due to education/outreach activities and local ordinances) is anticipated to be the major mechanism for implementation of farm plans. Farm

owners whose operations have impacts on water quality and who do not comply with local ordinances become involved in a formal compliance procedure, which is outlined by a memorandum of agreement between the Ecology Water Quality Program and each conservation district. Legal recourse is seldom needed.

Modifications Since Project Started

Changes in Thurston County's Sanitary Code 1996 disallowed the use of administrative search warrants for the inspection of on-site wastewater systems. This followed a Washington State Supreme Court ruling that administrative search warrants could not be used for such inspection programs. Consequently, voluntary participation in the 1996-97 survey in Schneider basin was low, with only 36% of homeowners allowing their on-site wastewater systems to be inspected (Hofstad et al., 1996). Voluntary participation in the farm plan development has also been less than expected. Ten of 22 priority farms in the Schneider, Burns, and Pierre basins developed farm plans. Five of these farm plans resulted from some level of pressure by the local health department. It is uncertain if farm planning for the remaining 12 priority farms in Schneider basin will occur. Farm planning and implementation in McLane and Perry basins is scheduled to continue into 1999.

Progress Towards Meeting Goals

Three on-site wastewater treatment systems were inspected in Burns and Pierre basins in 1994. In Schneider basin, 12 of a targeted 33 On-site Sewage Systems (OSSS) were surveyed in 1997; 21 of the 33 homeowners chose not to participate in the survey. No on-site wastewater treatment system surveys were scheduled for the McLane or Perry basins during this project. About 120 OSSS in the Summit Lake drainage area, in the Kennedy basin, were also inspected and remedial actions are underway. However, it is unlikely that remedial actions will affect bacteria levels at the Kennedy Creek monitoring site, because in-lake bacterial levels have historically been at or below detection limits.

About 180 of 234 planned agricultural BMPs were implemented on 30 sites in Schneider, McLane, Perry, Burns, and Pierre basins since 1986. These pollution controls were installed on noncommercial farms that keep various types of livestock. About 61% of these controls were installed from 1993 and 1997, while about 39% were installed from 1986 to 1992. Most farm planning and BMP installation activities in the Totten basins will end in 1997, while Eld basin activities will continue into 1998.

Within each basin, the average number of BMPs planned per farm ranged from 7.8 to 10.5 while the average number of BMPs implemented per farm ranged from 5.0 to 8.7. The number of individual practices installed per farm ranged from 1 to 14. The most frequently applied BMPs include fencing, prescribed grazing, filter strips, livestock exclusion, nutrient management, and watering troughs. Other commonly employed practices include roof runoff management and fish stream improvement.

Over half of farm operators signed their farm plans symbolizing some level of commitment to implementing the farm plan. For all basins, 53% of farms implemented all of their planned BMPs, while 30% of farms had implementation rates of less than 60%. For the remaining farms, the completeness of farm plan implementation was better than 70%. The completeness or rate of implementation of a farm plan is defined as the percentage of planned BMPs actually implemented.

For Burns and Pierre basins, all priority farms entered the farm planning process. In Schneider basin, 24% of the priority farms entered the farm planning process. Several prioritizations were done in the McLane and Perry basins, and 33% to 52% of priority farms entered the farm planning process depending on which prioritization scheme is considered.

TYPE AND NUMBER OF BMPS IMPLEMENTED IN STUDY BASINS

BMP#	BMP Description	Units	Kennedy	Schneider	McLane	Perry	Burns	Pierre	Total
322	Channel Vegetation	acres	0	0	1	0	0	0	1
342	Critical Area Planting	acres	0	1	0	0	0	0	1
352	Deferred Grazing	acres	0	0	2	0	3	1	6
382	Fencing	feet	0	6	12	6	3	1	28
393	Filter Strip	acres	0	4	9	2	1	2	18
395	Fish Stream Improvement	feet	0	4	5	1	0	0	10
654	Forest Harvest Trails	acres	0	1	0	0	0	0	1
490	Forest Site Preparation	acres	0	1	0	0	0	0	1
666	Forest Stand Improvement	acres	0	1	0	0	0	0	1
412	Grassed Waterway	acres	0	0	1	0	0	1	2
561	Heavy Use Area Protection	acres	0	0	2	0	0	0	2
430	Irrigation Pipeline	feet	0	0	1	0	0	0	1
575	Livestock Crossing	each	0	0	1	0	0	0	1
472	Livestock Exclusion	acres	0	4	8	2	1	2	17
590	Nutrient Mgmt	acres	0	2	2	0	3	1	8
510	Pasture & Hayland Mgmt	acres	0	2	7	0	0	0	9
512	Pasture & Hayland Planting	acres	0	1	0	1	2	1	5
516	Pipeline	feet	0	0	1	1	1	0	3
556	Planned Grazing System	acres	0	0	1	0	1	0	2
528	Prescribed Grazing	acres	0	2	3	0	3	2	10
530	Proper Woodland Grazing	acres	0	0	0	0	0	0	0
558	Roof Runoff Mgmt	system	0	1	4	2	2	1	10
570	Runoff Mgmt System	system	0	0	0	0	0	0	0
575	Stock Trails and Walkways	feet	0	1	0	0	0	0	1
580	Streambank Protection	feet	0	1	1	1	0	0	3
612	Tree/Shrub Establishment	acres	0	0	0	0	1	0	1
660	Tree/Shrub Pruning	acres	0	1	0	0	0	0	1
614	Trough	each	0	0	8	6	1	0	15
620	Underground Outlet	feet	0	0	0	0	0	0	0
312	Waste Mgmt System	system	0	0	0	0	0	0	0
313	Waste Storage Structure	structure	0	1	3	0	1	1	6
633	Waste Utilization	acres	0	3	4	0	0	0	7
645	Wildlife Upland Habitat	acres	0	2	3	0	2	0	7
644	Wildlife Wetland Habitat	acres	0	0	1	0	0	0	1
	Total BMPs installed		0	39	80	22	26	13	180
	Percent of planned BMPs installed		–	87%	77%	52%	100%	76%	–
	Total number of farms with farm plans		0	5	18	4	3	2	30
	Percent of priority farms with farm plans		–	24%	52%	43%	100%	100%	–
	Percent of animal units under farm plan		–	27%	71%	83%	100%	100%	–

WATER QUALITY MONITORING

Design

A paired watershed approach is being used for the Kennedy/Schneider subbasins to document the change in water quality as a result of BMP implementation. Kennedy is a background (control) subbasin, while Schneider is the treatment basin (Figure 38). A single site approach will be used for Burns, Pierre, Perry and McLane subbasins (Figure 38).

Modifications Since Project Started

None.

Parameters Measured

Chemical and Other

Biological

Fecal coliform (FC)

Covariates

Conductivity
Daily precipitation
Flow
Temperature
Total suspended solids (TSS)
Turbidity

Sampling Scheme

Water quality monitoring is conducted from early November through mid-April. Grab samples are collected on a weekly schedule (Tuesdays) for at least 20 consecutive weeks each year of the project. Up to six additional samples are collected each season during runoff events at each site. The rain-event sampling is based on the criterion of previous 24-hour precipitation amounting to greater than 0.2 inches. The sample sites are located at the mouth of each stream. Historically, sampling has occurred at this location.

The Puget Sound Protocols for freshwater and general quality assurance/quality control (Tetra Tech, 1986) will be followed for water sample collection, identification, preservation, storage, and transport. Replicate samples (two samples taken from the same location at nearly the same time) for at least 10% of the total number of laboratory samples will be taken and analyzed each week. All sample sites are represented every sampling season.

Monitoring Scheme for the Totten and Eld Inlet Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of Primary Parameter Sampling	Duration
Single downstream	Burns Pierre Perry McLane	FC	Conductivity Daily precipitation Flow Temperature TSS Turbidity	Weekly (Nov. to mid-April) during storms	Schneider Burns Pierre: 1 yr. pre-BMP 3 yrs BMP 2 yrs post-BMP Perry: 3 yrs pre-BMP 3 yrs BMP 1 yr post-BMP McLane: 1 yr pre-BMP 5 yrs BMP 1 yr post-BMP
Paired watershed	Kennedy/ Schneider	FC			

Modifications Since Project Started

Rain event sampling beyond the regularly scheduled weekly sampling has been discontinued. Changes have occurred in the definition of pre- and post-BMP sampling periods for each basin as real versus projected BMP implementation data becomes available.

Water Quality Data Management and Analysis

Water quality data will be stored and managed in spreadsheet formats and later transferred to USEPA's STORET and NonPoint Source Management System (NPSMS) databases. Other reporting formats for the Ecology Water Quality Program and local use may involve spreadsheet tabulation and graphic presentations. Data evaluation and analysis strategies include the following:

- Determining statistically significant temporal trends in water quality by comparison of 95% Confidence Interval about seasonal medians using notched boxplots (single site approach); linear regression of monthly or seasonal medians over time, and the significance of slope tested to indicate a decreasing trend of FC concentrations over time (single site approach); change in linear relationship of FC concentrations between paired basins (paired watershed approach); comparison of frequencies of water quality standards violations between years; and comparison of the 95% Confidence Interval about the median of pre- and post-BMP data sets. This approach may use historical data from 1986–1993 (n=4 per season); these data were collected by the Thurston County Environmental Health Division.
- Determining temporal trends in BMP implementation by bar graph of BMPs (individual or grouped) implemented over time and plot of cumulative histogram of BMPs implemented over time (individual measures or groups of measures).
- Evaluating combined water quality and BMP trends by linear regression of FC as a function of BMPs (individually or grouped) such as livestock management, acres treated, farm plans implemented, and streambank protected; and graphical expression of water quality and BMP information plotted over the same time scale (e.g. seasonal median FC values with cumulative histogram of fully implemented farm plans).

NPSMS Data Summary

Currently unavailable.

Modifications Since Project Started

None.

Progress Towards Meeting Goals

Pre- and post-BMP periods were defined by examining available farm and BMP implementation data (see the following table). Pre- and post-BMP periods for McLane and Perry basins will be defined when BMP implementation concludes in 1999. For the paired-watershed analysis, Kennedy data were paired according to pre- and post-BMP period data for Schneider. Two approaches were used to evaluate water quality: comparison of pre- and post-BMP median FC concentrations using notched boxplots, and comparison of pre- and post-BMP paired-basin FC relationships using linear regression. These analyses suggest that FC concentrations decreased 31% in Schneider Creek, did not change in Burns Creek, and increased 600% in Pierre Creek.

Pre- and Post-BMP Periods in Study Basins

Basin	Pre-BMP period	Post-BMP period
Kennedy	none	none
Schneider	1988-1993, 5 seasons	1995-1997, 2 seasons
Burns	1989-1993, 4 seasons	1995-1997, 2 seasons
Pierre	1986-1989, 3 seasons	1993-1997, 4 seasons

The next table summaries the results of the pre- and post-BMP comparison of the median FC concentration. Notched boxplots suggest that pre- and post-BMP median FC concentrations did not change in Schneider or Burns and increased in Pierre.

For the paired-watershed analysis with Kennedy and Schneider, pre- and post-BMP period regression outputs were examined after Zar (1984) and EPA (1993). The slopes of these regressions were not different while the y-intercepts were different ($P<0.001$). The difference in intercepts, rather than slopes, indicates a parallel shift in the regression equation. This shift in the regression represents a 31% decrease from the pre-BMP period (mean log FC=1.43) to the post-BMP period (mean log FC=0.99).

Median FC Concentrations from Pre- and Post-BMP Periods

Basin	Pre-BMP median FC and (n)	Post-BMP median FC and (n)	Significant difference
Kennedy	5 (39)	5 (45)	no
Schneider	25 (39)	12 (45)	no*
Burns	84 (35)	56 (45)	no
Pierre	25 (11)	150 (89)	yes

*see discussion of paired-watershed results above where a difference in the mean log FC concentration was detected.

The results of linear regression analyses show that flow and Antecedent Precipitation Index (API) correlate poorly with FC. API slope, TSS, and turbidity correlate more strongly with FC but were generally inconsistent among the stations or between years. Results suggest that the hydrologic characteristics in the study basins will make poor covariates of FC data for use in trends analyses or pre-and post-BMP comparisons. API slope, TSS, and turbidity will be more closely examined over the coming years for their possible use as covariates.

TOTAL PROJECT BUDGET

The estimated budget for the Totten and Eld Inlet National Monitoring Program project for the period of FY 1993 - 1999 (six years):

Project Element	Funding Source ($)			
	Federal	State	Local	Total
Proj Mgt	NA	NA	NA	NA
I&E	NA	NA	NA	NA
LT	NA	300,000	100,000	400,000
WQ Monit	250,000	50,000	NA	300,000
TOTALS	250,000	350,000	100,000	700,000

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

In response to increased and persistent closures of shellfish harvest areas and threats to close additional areas, state and local groups developed the Shellfish Protection Initiative (SPI). This program provides $3 million from State Referendum 39 funds for implementing BMPs in targeted watersheds. The Totten Basin, a targeted watershed, will receive $1.3 million in grant funds as part of the SPI. Eld Inlet, although not selected as an SPI project, will receive $260,000 from the SPI program to augment ongoing nonpoint source control efforts in specific areas. In addition, $331,000 will be targeted for farm planning and implementation activities in the Eld watershed from 1996 to 1999.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

None.

PROJECT CONTACTS

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Wisconsin

Otter Creek
Section 319
National Monitoring Program Project

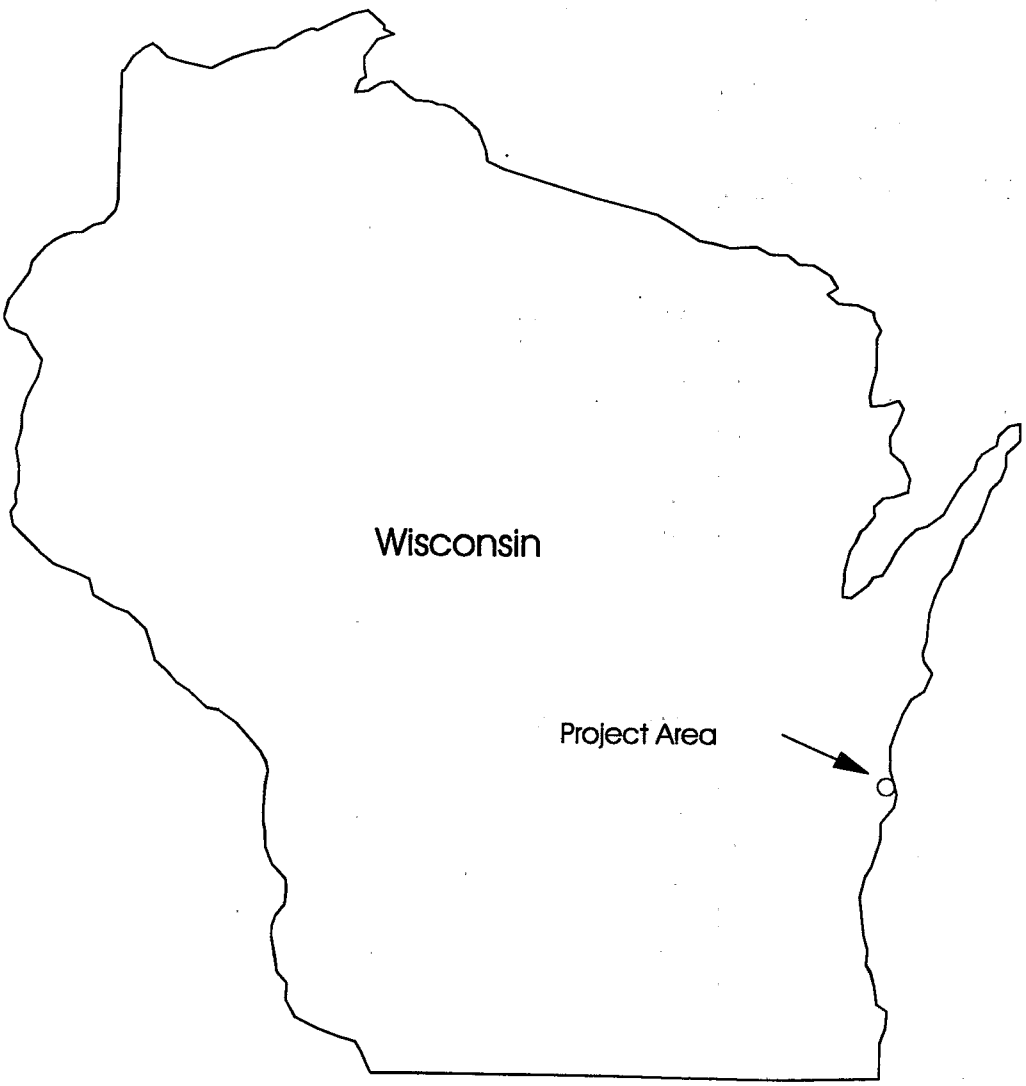

Figure 39: Otter Creek (Wisconsin) Project Location

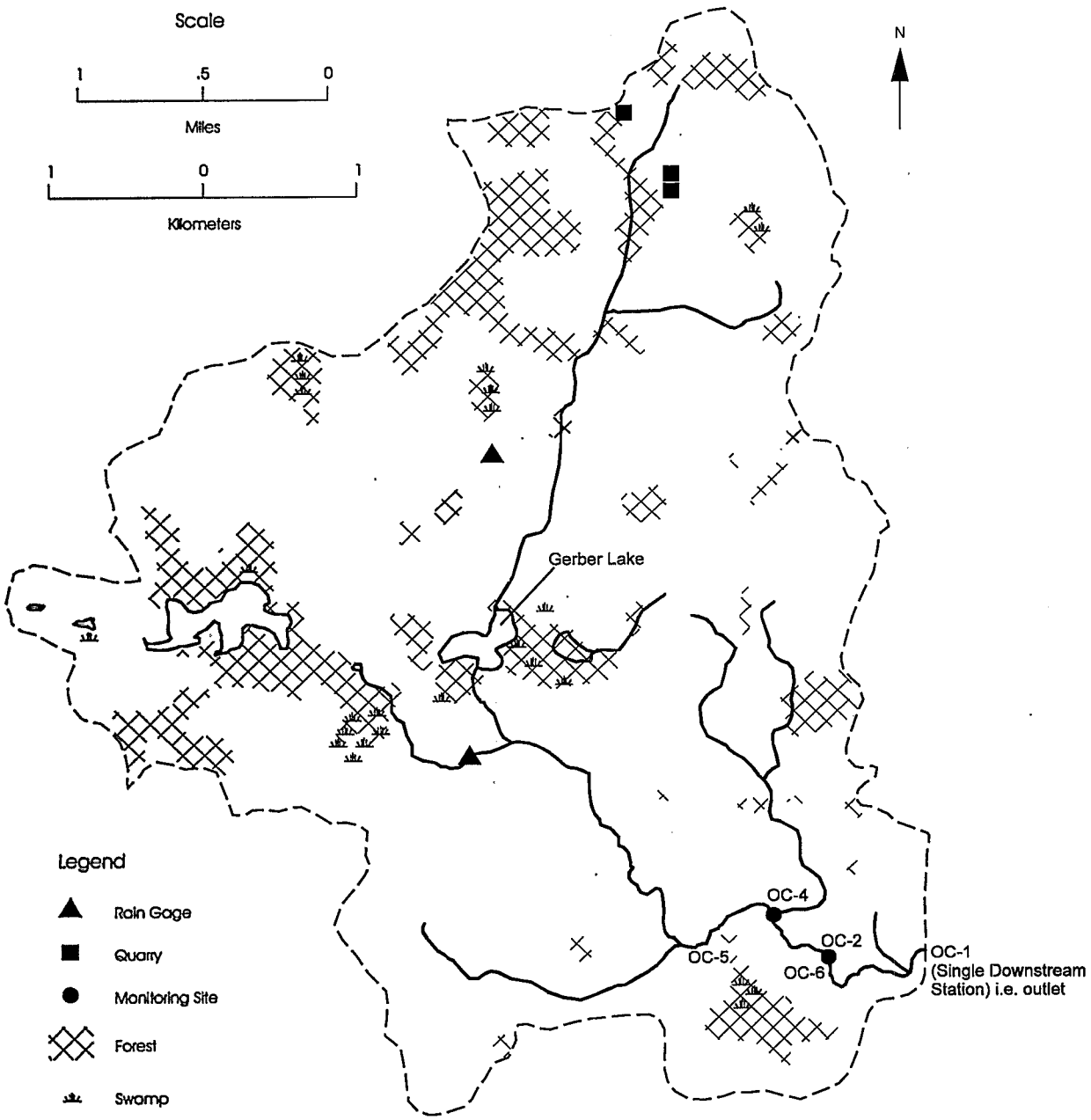

Figure 40: Water Quality Monitoring Stations for Otter Creek (Wisconsin)

PROJECT OVERVIEW

The Otter Creek Section 319 National Monitoring Program project is in east central Wisconsin (Figure 39), with a project area of 11 square miles. Otter Creek drains into the Sheboygan River, which then drains into Lake Michigan. Land use mainly consists of dairies and croplands.

Otter Creek has a warmwater forage fishery. The fish community is degraded by lack of cover, disturbed streambanks, and siltation. Fecal coliform levels frequently exceed the state standard of 400 counts per 100 ml, and dissolved oxygen often drops below 2 mg/l during runoff events. Fifteen percent of all water oxygen concentration samples fall below the state standard of 5 mg/L. Otter Creek delivers high concentrations of phosphorus and fecal coliform to the Sheboygan River. These pollutants then travel to the near shore waters of Lake Michigan, which serves as a water supply for municipal use and also supports recreational fisheries.

Streambed sediments originating from cropland erosion, eroding streambanks, and overgrazed dairy pastures are reducing the reproductive potential for a high quality fishery with abundant forage fish. Otter Creek is further degraded by total phosphorus and fecal coliform export from dairy barnyards, pastures, cropland, and alfalfa fields. The mean concentration of 22 runoff events is 104 mg/l for suspended solids and 0.39 mg/l for total phosphorus.

Critical area criteria are being used to reduce phosphorus and sediment loading to project area streams. Eight of the nine dairy operations in the project area were classified as critical; two of the eight critical dairy operations spread enough manure that their cropland was classified as critical. Streambank critical areas are the 6,200 feet of streambank trampled by cattle.

Land treatment design is based on the pollutant type and the source of the pollutant. Upland fields will be treated with cropland erosion control practices to reduce sediment loss. Streambanks are being fenced to limit cattle access, and barnyard structural practices are being installed to reduce nutrient runoff into Otter Creek.

PROJECT DESCRIPTION

Water Resource Type and Size

Otter Creek is 4.2 miles long with an average gradient of .0023 ft/ft or 12.4 ft/mile (Figure 40). The creek flows into and out of a small spring-fed lake called Gerber Lake.

Water Uses and Impairments

Otter Creek is used for fishing and for secondary body contact recreation. The fishery is impaired by degraded habitat, while contact recreation is impaired by high fecal coliform counts. Both uses are also impaired by eutrophic conditions.

Pre-Project Water Quality

The Otter Creek project area is part of the larger Sheboygan River watershed, identified as a Priority Watershed in 1985. The watershed is characterized by streambank degradation due to cattle traffic. Excessive phosphorus, fecal coliform, and sediment runoff originate from manure spreading and cropland. Fisheries are impaired because of degraded aquatic habitat that limits reproduction. Recreation is limited by degraded fisheries and highly eutrophic and organically enriched stream waters.

Current Water Quality Objectives

The Otter Creek project water quality objectives are as follows:

- Increase the numbers of intolerant fish species by improving the fish habitat and water quality.
- Improve the recreational uses by reducing the bacteria levels.
- Reduce the loading of pollutants to the Sheboygan River and Lake Michigan by installation of best management practices (BMPs) in the Otter Creek watershed.
- Improve the wildlife habitat by restoring riparian vegetation.

Modifications Since Project Initiation

None.

Project Time Frame

Spring, 1994 through Spring, 2001

Project Approval

July, 1993

PROJECT AREA CHARACTERISTICS

Project Area

The Otter Creek watershed area is about 11 square miles. The Meeme River watershed is the control watershed, with an area of about 16 square miles.

Relevant Hydrologic, Geologic, and Meteorological Factors

Average annual precipitation is 29 inches. Fifteen inches of rain falls during the growing season between May and September. About 42 inches of snow (five inches of equivalent rain) falls during a typical winter.

The topography of the watershed ranges from rolling hills to nearly level. The soils are clay loams or silty clay loams that have poor infiltration and poor percolation but high fertility. Soils are glacial drift underlain by Niagara dolomite.

Land Use

Land Use	%
Agricultural	72
Forest	13
Suburban	11
Wetland	3
Water	1
Total	100

Best management practices are being installed on critical dairies. Livestock exclusion practices are also being installed.

Source: Wisconsin Department of Natural Resources, 1993a

Pollutant Sources

There are eight critical dairy operations that serve as important pollutant sources. Trampled streambanks and cropland and pastureland receiving dairy manure are also critical sources. Some critical area cropland is in need of erosion control practice installation.

Modifications Since Project Started

None.

INFORMATION, EDUCATION, AND PUBLICITY

The Sheboygan County Land Conservation Department has developed and implemented an effective educational program to reach project dairymen. Project personnel have achieved a high level of participation through education, technical assistance, effective communication, and cost-share assistance.

Progress Towards Meeting Goals

- Watershed tours are held for landowners.
- Watershed newsletters are sent biannually to landowners.
- Annual watershed advisory committee meetings are held.
- Small group tours of BMP installation sites are given for landowners considering installing BMPs.

NONPOINT SOURCE CONTROL STRATEGY AND DESIGN

Description

Streambank erosion and cattle exclusion practices include shoreline and streambank fencing and stabilization; barnyard management includes barnyard runoff management and manure storage facilities; and cropland practices include grassed waterways, reduced tillage, and nutrient and pesticide management.

Modifications Since Project Started

The Sheboygan County Land Conservation Department has obtained funds through a private organization, "Pheasants Forever," to plant and maintain vegetative buffers on 18 acres of riparian land for 10 years.

Progress Towards Meeting Goals

Eight thousand, one hundred feet of streambank fencing has been installed, as well as a significant change in cropping practices to reduce upland soil erosion.

WATER QUALITY MONITORING

Design

Two monitoring studies are being conducted in the Otter Creek National Monitoring Program project. They include a paired watershed study and an above and below study (Figure 40).

There are six sampling sites on Otter Creek, and one site each at the outlet of the Meeme and Pigeon River watershed. One of the sampling sites on Otter Creek is also an outlet station that serves as the site for the single station before and after monitoring site. There are two mainstem sites above and below a critical area dairy.

The above and below watershed study is being conducted using stations OC2 and OC4. Station OC2 is below the dairy where BMPs are being installed. Station OC4 (Figure 40) is above this dairy. Station OC5 is a background station, and station OC6 is below a dairy where BMPs are being installed.

The paired watershed study is being conducted using stations OC1 and MR1, the outlet for the Meeme River watershed. Station OC1 is the outlet of the Otter Creek Watershed where animal waste management and nutrient management BMPs are being installed. It also serves as the monitoring site for a single downstream station study. MR1 is being used as the control site for the paired watershed study.

The paired watershed study is used to assess the overall impact of best management practices on water quality. The treatment watershed is 11 square miles and is being monitored at station OC1. The control watershed area is 16 square miles of the Meeme River watershed being monitored at station MR1. Biological, bacterial, and chemical parameters are being monitored; precipitation and water discharge are covariates for the paired watershed study.

The following table provides details on the sampling design for the paired study, the upstream/downstream, and the single downstream station. The monitoring sites are listed for reference. The primary covariates are very similar for each study except for methods used for macroinvertebrates. The frequency of sampling, the covariates, and the duration of each study are also listed.

Modifications Since Project Started

The above and below watershed study of a single dairy that implemented barnyard runoff control structures has been completed. Data on the pollutant loads from the barnyard prior to BMPs are reported in USGS Fact Sheet FS-221-95. Findings on this before and after – above and below study will be presented at the 1997 National 319 Conference. Study findings will be reported in a USGS Fact Sheet scheduled to be completed in the fall of 1997.

Parameters Measured

Biological

Fisheries survey
Macroinvertebrate survey
Habitat assessment
Fecal coliform (FC)

Chemical

Total phosphorus (TP)
Dissolved phosphorus (DP)
Total Kjeldahl nitrogen (TKN)
Ammonia (NH_3)
Nitrogen series ($N0_2$-N and $N0_3$-N)
Turbidity
Total suspended solids (TSS)
Dissolved oxygen (DO)
pH

Covariates

Stream discharge
Precipitation

Sampling Scheme

Automatic, continuous water chemistry sampling occurs on an event basis. The schedule for chemical grab sampling and biological and habitat monitoring varies by station and by year. Chemical grab sampling occurred at a time characterized as midsummer-fall for 1990 and 1994 and during spring-midsummer in 1991. Future plans are for spring-midsummer monitoring in 1995 and 1999 and midsummer-fall monitoring for 1998. Fisheries, macroinvertebrate, and habitat monitoring has been scheduled for midsummer in 1990, 1994, and 1998, and for the spring of 1991, 1995, and 1999.

Fisheries monitoring includes sampling fish species, frequencies, and biomass. Fisheries data are summarized and interpreted based on the Index of Biotic Integrity (Lyons, 1992). Macroinvertebrate monitoring criteria includes macroinvertebrate species or genera and numbers. Macroinvertebrate data are

summarized and interpreted using the Hilsenhoff Biotic Index (Hilsenhoff , 1987). Habitat parameters include riparian buffer width, bank erosion, pool area, stream width to depth ratio, riffle-to-riffle or bend-to-bend rating, percent fine sediments, and cover for fish. Habitat information is rated using the fish habitat rating system established for Wisconsin streams by Simonson et al. (1994).

Grab and event-flow samples are being used for water chemistry monitoring. Parameters sampled include TP, FC, DO, and TSS.

Monitoring Scheme for the Otter Creek Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of Primary Parameter Sampling	Duration
		Biological			
Paired watershed design	Otter Creek[T] OC1 Meeme River[C] MR1	Fisheries index Macroinvertebrates[H] Habitat FC	Precipitation Discharge	Annually Annually Annually	1990-1999
		Bacterial & Chemical			
		TP DP TKN NH_3 NO_3 NO_2 Turbidity TSS DO		30 samples per monitoring season; weekly April-Oct.	
Upstream/ downstream	Above Dairy[C] OC4 Below Dairy[T] OC2	Fisheries index Macroinvertebrates[F] Habitat Same bacterial & chemical parameters as paired watershed study	Precipitation Discharge	Annually Annually Annually 30 samples per monitoring season; weekly April-Oct.	1990-1999
Single downstream	Otter Creek OC1	Fisheries index Macroinvertebrates[F] Habitat Same bacterial & chemical parameters as paired watershed study	Precipitation Discharge	Annually Annually 30 samples per monitoring season; weekly April-Oct.	1990-1999

[T] Treatment Area
[C] Control Area
[H] Hilsenhoff Biotic Index level; kick samples
[F] Family level; kick samples

Modifications Since Project Started

The before and after – above and below component of the project has been completed.

Water Quality Data Management and Analysis

All water chemistry data are being entered into the Wisconsin Department of Natural Resources (DNR) data management system, WATSTORE (the U.S. Geological Survey national database), U.S. Environmental Protection Agency's Nonpoint Source Management System software (NPSMS), and STORET.

NPSMS Data Summary

Monitoring Station Parameters Report (FY95)

CHEMICAL PARAMETERS

Parameter Name	Parm Type	Reporting Units	QUARTILE VALUES -75-	-50-	-25-
FLOW, STREAM, INSTANTANEOUS, CFS	S	CFS			
PRECIPITATION, TOTAL (INCHES PER DAY)	S				
BOD, 5 DAY	S	MG/L	5.3	1.7	1.3
FECAL COLIFORM, MF, M-FC, 0.7 UM	S		370	175	30
NITROGEN, AMMONIA, TOTAL (MG/L AS N)	S		.056	.037	.02
PHOSPHORUS, TOTAL (MG/L AS P)	S		.21	.158	.08
FLOW, STREAM, INSTANTANEOUS, CFS	S	CFS			
PRECIPITATION, TOTAL (INCHES PER DAY)	S				
BOD, 5 DAY, 20 DEG C	S	MG/L	8.2	4.0	2.4
FECAL COLIFORM, MF, M-FC, 0.7 UM	S		5000	1200	490
NITROGEN, AMMONIA, TOTAL (MG/L AS N)	S		.39	.147	.073
PHOSPHORUS, TOTAL (MG/L AS P)	S		.53	.25	.13
PH, LAB, STANDARD UNITS	S		8.3	8.2	7.9
PH, LAB, STANDARD UNITS	S		8.2	8.1	7.9
FLOW, STREAM, INSTANTANEOUS, CFS	S	CFS			
PRECIPITATION, TOTAL (INCHES PER DAY)	S				
BOD, 5 DAY, 20 DEG C	S	MG/L	6.4	3.4	2.2
FECAL COLIFORM, MF, M-FC, 0.7 UM	S		15000	2600	1000
NITROGEN, AMMONIA, DISSOLVED (MG/L AS N)	S	MG/L N	.104	.059	.032
PH, LAB, STANDARD UNITS	S		8.3	8.2	8.1
PHOSPHORUS, TOTAL (MG/L AS P)	S		.286	.17	.07
FLOW, STREAM, INSTANTANEOUS, CFS	S	CFS			
PRECIPITATION, TOTAL (INCHES PER DAY)	S				
BOD, 5 DAY	S	MG/L	7.3	3.3	2.2
FECAL COLIFORM, MF, M-FC, 0.7 UM	S		69000	14000	3300
NITROGEN, AMMONIA, DISSOLVED (MG/L AS N)	S	MG/L N	.257	.11	.042
PH, LAB, STANDARD UNITS	S		8.4	8.2	8.1
PHOSPHORUS, TOTAL (MG/L AS P)	S		.89	.34	.11
FISH HABITAT CONDITION INDEX	B	SCORE	80	50	40
INDEX OF BIOLOGICAL INTEGRITY	B	SCORE	70	50	40
FISH HABITAT CONDITION INDEX	B	SCORE	70	50	40
INDEX OF BIOLOGICAL INTEGRITY	B	SCORE	70	50	40
SUSPENDED SEDIMENT TOTAL RESIDUE AT 105C	U	MG/L	9	7	5
SUSPENDED SEDIMENT TOTAL RESIDUE AT 105C	U	MG/L	172	41	12
SUSPENDED SEDIMENT TOTAL RESIDUE AT 105C	U	MG/L	324	60	16
SUSPENDED SEDIMENT TOTAL RESIDUE AT 105C	U	MG/L	112	45	20
FISH HABITAT CONDITION INDEX	B	SCORE	80	40	25
INDEX OF BIOLOGICAL INTEGRITY	B	SCORE	80	40	25

Modifications Since Project Started

None.

Progress Toward Meeting Goals

The water quality data are being collected and will be added to STORET.

TOTAL PROJECT BUDGET

The total estimated cost of needed land treatment practices is $221,000. Funds through the state of Wisconsin Nonpoint Source Program will be used to fund cost-share practices. The estimated budget for the Otter Creek National Monitoring Program project for the period FY94-FY95 (2 years) is:

Project Element	Funding Source($)			
	Federal	State	Local	Total
Proj Mgt	NA	30,000	NA	30,000
LT	NA	221,000	NA	221,000
I&E	NA	2,000	NA	2,000
WQ Monit	120,000	NA	NA	120,000
TOTALS	120,000	253,000	NA	373,000

(Wisconsin DNR will spend approximately $60,000 on monitoring in 1997.) Source: Wisconsin Department of Natural Resources, 1993a (M. Miller, Personal Communication, 1994)

Modifications Since Project Started

None.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

State grants are being provided to cover the cost of land treatment technical assistance and information and educational support.

Modifications Since Project Started

None.

OTHER PERTINENT INFORMATION

Cooperating agencies include the Wisconsin Department of Natural Resources, Department of Agriculture, Trade, and Consumer Protection, Sheboygan County Land Conservation Department, and the U.S. Geological Survey.

PROJECT CONTACTS

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Appendices

Appendix I

Minimum Reporting Requirements For Section 319 National Monitoring Program Projects

The United States Environmental Protection Agency (USEPA) has developed the NonPoint Source Management System (NPSMS) software to support the required annual reporting of water quality and implementation data for Section 319 National Monitoring Program projects (USEPA, 1991). The software tracks nonpoint source control measure implementation with respect to the pollutants causing the water quality problem.

Currently, NPSMS can accept and track the following information (USEPA, 1991):

Management Area Description:

- State, USEPA Region, and lead agency.
- Watershed management area description (management area name, management area identification, participating agencies, area description narrative).
- 305(b) waterbody name and identification.
- Designated use support for the waterbody.
- Major pollutants causing water quality problems in waterbody and relative source contributions from point, nonpoint, and background sources.

Best Management Practices (BMPs) and Nonpoint Source Pollution Control Measures:

- Best management practices (BMP name, reporting units, indication whether the life of the practice is annual or multi-year).
- Land treatment implementation goals for management area.
- Pollutant sources causing impaired uses that are controlled by each BMP. Each control practice must be linked directly to the control of one or more sources of pollutants causing impaired uses.

Funding Information:

- Annual contributions from each funding source and use of funding for each management area.

Water Quality Monitoring Plan:

- Choice of monitoring approach (chemical/physical or biological/habitat).
- Monitoring design and monitoring station identification (paired watersheds, upstream-downstream, reference site for biological/habitat monitoring, single downstream station). The paired watershed approach is recommended; the single downstream station is discouraged.
- Drainage area and land use for each water quality monitoring station.
- Delineation of monitoring year, seasons, and monitoring program duration.
- Parameters measured (parameter name; indication if the parameter is a covariate; STORET, BIOSTORET, or 305(b) Waterbody System code; reporting units).
- Quartile values for chemical/physical parameters. Quartile values are established cutoffs based on historical or first-year data for each season and monitoring station.
- Maximum potential and reasonable attainment scores for biological monitoring parameters. Indices scores that correspond to full, threatened, and partial use supports are required.
- Monitoring frequency. Chemical/physical monitoring, with associated covariates, must be performed with at least 20 evenly-spaced grab samples in each season. Fishery surveys must be performed at least one to three times per year. Benthic macroinvertebrates must be performed at least once per season, with at least one to three replicates or composites per sample. Habitat monitoring and bioassays must be performed at least once per season.

Annual Reporting:

- The NPSMS software is used to report annual summary information. The raw chemical/physical and biological/habitat data are required to be entered into STORET and BIOSTORET, respectively.
- Annual chemical/physical and covariates. The frequency count for each quartile is reported for each monitoring station, season, and parameter.
- Annual biological/habitat and covariates. The scores for each monitoring station and season are reported.
- Implementation tracking in the watershed and/or subwatersheds that constitute the drainage areas for each monitoring station. Implementation reported corresponds to active practices in the reporting year and includes practices with a one-year life span and practices previously installed and still being maintained.

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Appendix II

Abbreviations

ACP	Agricultural Conservation Program
ADSWQ	Automatic Data System for Water Quality
Ag	Silver
AGNPS	Agricultural Nonpoint Source Pollution Model
Al	Aluminum
ANSWERS	Areal Nonpoint Source Watershed Environment Response Simulation
API	Antecedent Precipitation Index
As	Arsenic
ASCS	Agricultural Stabilization and Conservation Service, USDA
B	Boron
Ba	Barium
Be	Beryllium
BMPs	Best Management Practices
BIBI	Biological Index of Biotic Integrity
BIOS	USEPA Natural Biological Data Management System
BOD	Biochemical Oxygen Demand
Ca	Calcium
Cal Poly	California Polytechnic State University
Cd	Cadmium
CES	Cooperative Extension Service, USDA
cfs	Cubic Feet per Second
cfu	Colony Forming Units
Cl	Chloride
COD	Chemical Oxygen Demand
Cr	Chromium
CREAMS	Chemicals, Runoff, and Erosion from Agricultural Management Systems Model

CTUIR	Confederated Tribes of the Umatilla Indian Reservation
Cu	Copper
DEC	Department of Environmental Conservation
DO	Dissolved Oxygen
DP	Dissolved Phosphorus
DNR	Department of Natural Resources
DSWC	Division of Soil and Water Conservation
DWQ	Division of Water Quality
EPIC	Erosion Productivity Index Calculator
FC	Fecal Coliform
Fe	Iron
FS	Fecal Streptococcus
FSA	Farm Service Agency (USDA)
GIS	Geographic Information System
GMV	Geometric Mean Value
GRASS	Geographic Resources Analysis Support System
HBI	Hilsenhoff Biotic Index
HEL	Highly Erodible Land
HUA	Hydrologic Unit Area
I&E	Information and Education Programs
IBI	Index of Biotic Integrity
ICM	Integrated Crop Management
IDNR	Iowa Department of Natural Resources
IDNR-GSB	Iowa Department of Natural Resources Geological Survey Bureau
ISU-CES	Iowa State University Cooperative Extension Service
ISUE	Iowa State University Extension
K	Potassium
LRNRD	Lower Republican Natural Resource District
LT	Land Treatment
Ma	Manganese
MCL	Maximum Contaminant Level
Mg	Magnesium
Mg/l	Milligrams Per Liter
N	Nitrogen
Na	Sodium
NA	Information Not Available

NCSU	North Carolina State University
NDEQ	Nebraska Department of Environmental Quality
NEP	National Estuary Program
NH_3	Ammonia-Nitrogen
NH^+_4	Ammonium-Nitrogen
Ni	Nickel
NMP	National Monitoring Program
NO_2	Nitrite-Nitrogen
NO_3	Nitrate-Nitrogen
NPS	Nonpoint Source
NPSMS	NonPoint Source Management System
NRCS	Natural Resources Conservation Service (USDA)
NTU	Nephelometric Turbidity Units
OCC	Oklahoma Conservation Commission
OP	Orthophosphate
OSSS	On-site Sewage System
P	Phosphorus
Pb	Lead
Proj Mgt	Project Management
QA/QC	Quality Assurance/Quality Control
RCWP	Rural Clean Water Program
Se	Selenium
Section 319	Section 319 of the Water Quality Act of 1987
Si	Silica
Sn	Tin
SO_4^-	Sulfate
SPI	Shellfish Protection Initiative
SS	Suspended Solids
STORET	USEPA STOrage and RETrieval Data Base for Water Quality
TDP	Total Dissolved Phosphorus
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TP	Total Phosphorus
TS	Total Solids
TSS	Total Suspended Solids

Ug/l	Micrograms Per Liter
UHL	University Hygienic Laboratory (Iowa)
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey (U.S. Department of the Interior)
VSS	Volatile Suspended Solids
WATSTORE	USGS Water Data Storage System
WCCF	Webster County Conservation Foundation
WQ	Water Quality
WQIP	Water Quality Incentive Project
WQ Monit	Water Quality Monitoring
WQSP	Water Quality Special Project
Zn	Zinc

Appendix III

Glossary of Terms

AGNPS *(Agricultural Nonpoint Source Pollution Model)* — an event-based, watershed-scale model developed to simulate runoff, sediment, chemical oxygen demand, and nutrient transport in surface runoff from ungauged agricultural watersheds.

Animal unit *(AU)* — One mature cow weighing 454 kg or the equivalent. For instance, a dairy cow is 1.4 AU because it weighs almost 1.5 times a mature beef cow. The animal units of smaller animals than beef cows is less than one: pigs = 0.4 AU and chickens = 0.033 AU.

Anadromous — Fish that return to their natal fresh water streams to spawn. Once hatched, these fish swim to the ocean and remain in salt water until sexual maturity.

Artificial redds — An artificial egg basket fabricated of extruded PVC netting and placed in a constructed egg pocket. Artificial redds are used to measure the development of fertilized fish eggs to the alevin stage (newly hatched fish).

Alachlor — Herbicide (trade name Lasso) that is used to control most annual grasses and certain broadleaf weeds and yellow nutsedge in corn, soybeans, peanuts, cotton, woody fruits, and certain ornamentals.

Atrazine — Herbicide (trade name Atrex, Gesa prim, or Primatol) that is widely used for control of broadleaf and grassy weeds in corn, sorghum, sugar cane, macadamia orchards, pineapple, and turf grass sod.

Autocorrelation — The correlation between adjacent observations in time or space.

Bedload — Sediment or other material that slides, rolls, or bounces along a stream or channel bed of flowing water.

Before-after design — A term referring to monitoring designs that require collection of data before and after BMP implementation.

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

Best management practices (BMPs) — Management or structural practices designed to reduce the quantities of pollutants — such as sediment, nitrogen, phosphorus, bacteria, and pesticides — that are washed by rain and snow melt from farms into nearby surface waters, such as lakes, creeks, streams, rivers, and estuaries. Agricultural BMPs can include fairly simple changes in practices such as fencing cows out of streams (to keep animal waste out of streams), planting grass in gullies where water flows off a planted field (to reduce the amount of sediment that runoff water picks up as it flows to rivers and lakes), and reducing the amount of plowing in fields where row crops are planted (in order to reduce soil erosion and loss of nitrogen and phosphorus from fertilizers applied to the crop land). BMPs can also involve building structures, such as large animal waste storage tanks that allow farmers to choose when to spread manure on their fields as opposed to having to spread it based on the volume of manure accumulated.

BMP system — A combination of individual BMPs into a "system" that functions to reduce the same pollutant.

Biochemical oxygen demand (BOD) — Quantitative measure of the strength of contamination by organic carbon materials.

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

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

County ASC Committee — County Agricultural Stabilization and Conservation Committee: a county-level committee, consisting of three elected members of the farming community in a particular county, responsible for prioritizing and approving practices to be cost shared and for overseeing dissemination of cost-share funds by the local USDA-Agricultural Stabilization and Conservation Service office.

Covariance — A measure of the relationship between two variables whose values are observed at the same time.

Covariate — The parameter which is related to another parameter.

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.

Demonstration project — A project designed to install or implement pollution control practices primarily for educational or promotional purposes. These projects often involve no (or very limited) evaluations of the effectiveness of the control practices.

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

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

Ecoregion — A physical region that is defined by its ecology, which includes meteorological factors, elevation, plant and animal speciation, landscape position, and soils.

EPIC *(Erosion Productivity Index Calculator)* — A mechanistic computer model that calculates erosion from field-size watersheds.

Erosion — Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical or chemical forces.

Eskers — Glacially deposited gravel and sand that form ridges 30 to 40 feet in height.

Explanatory variables — Explanatory variables, such as climatic, hydrological, land use, or additional water quality variables, that change over time and could affect the water quality variables related to the primary pollutant(s) of concern or the use impairment being measured. Specific examples of explanatory variables are season, precipitation, streamflow, ground water table depth, salinity, pH, animal units, cropping patterns, and impervious land surface.

Fecal coliform *(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 within 48 hours at 35 degrees Celsius.

Fertilizer management — A BMP designed to minimize the contamination of surface and ground water by limiting 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, and timing.

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.

Goal — A narrowly focused measurable or quantitative milestone used to assess progress toward attainment of an objective.

Interfluve — A flat area between streams.

Land treatment — The whole range of BMPs implemented to control or reduce NPS pollution.

Loading — The influx of pollutants to a selected water body.

Macroinvertebrate — Any non-vertebrate organism that is large enough to be seen without the aid of a microscope.

Mechanistic — Step-by-step path from cause to effect with ability to make linkages at each step.

Moraine — Glacial till (materials deposited directly by ice) which is generally irregularly deposited.

Nitrogen — An element occurring in manure and chemical fertilizer that is essential to the growth and development of plants, but which, in excess, can cause water to become polluted and threaten aquatic animals.

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.

Objective — A focus and overall framework or purpose for a project or other endeavor, which may be further defined by one or more goals.

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 treatment while the other (control) watershed does not. Monitoring of both watersheds continues for one to three years. This experimental design accounts for many factors that may affect the response to treatment; as a result, the treatment effect alone can be isolated.

Parameter — A quantity or constant whose value varies with the circumstances of its application.

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

Phenolphthalein alkalinity — A measure of the bicarbonate content.

Phosphorus — An element occurring in animal manure and chemical fertilizer that is essential to the growth and development of plants, but which, in excess, can cause water to become polluted and threaten aquatic animals.

Post-BMP implementation — The period of use and/or adherence to the BMP.

Pre-BMP implementation — The period prior to the use of a BMP.

Runoff — The portion of rainfall or snow melt that drains off the land into ditches and streams.

Sediment — Particles and/or clumps of particles of sand, clay, silt, and plant or animal matter carried in water.

Sedimentation — Deposition of sediment.

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

Subbasins — One of several basins that form a watershed.

Substrate sampling — Sampling of streambeds to determine the percent of fine particled material and the percent of gravel.

Subwatershed — A drainage area within the project watershed. It can be as small as a single field or as large as almost the whole project area.

Tailwater management — The practice of collecting runoff, "tailwater," from irrigated fields. Tailwater is reused to irrigate crops.

Targeting — The process of prioritizing pollutant sources for treatment with BMPs or a specific BMP to maximize the water quality benefit from the implemented BMPs.

Total alkalinity — A measure of the titratable bases, primarily carbonate, bicarbonate, and hydroxide.

Total Kjeldahl nitrogen (TKN) — An oxidative procedure that converts organic nitrogen forms to ammonia by digestion with an acid, catalyst, and heat.

Total Kjeldahl phosphorus (TKP) — An oxidative procedure that converts organic phosphorus forms to phosphate by digestion with an acid, catalyst, and heat.

Tracking — Documenting/recording the location and timing of BMP implementation.

Turbidity — A unit of measurement quantifying the degree to which light traveling through a water column is scattered by the suspended organic (including algae) and inorganic particles. The scattering of light increases with a greater suspended load. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU), but may also be measured in Jackson Turbidity Units (JTU).

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

Vadose zone — The part of the soil solum that is generally unsaturated.

Variable — A water quality constituent (for example, total phosphorus pollutant concentration) or other measured factors (such as stream flow, 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. Ridges of higher ground generally form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.

Appendix IV

Project Documents and Other Relevant Publications

This appendix contains publication references for the Section 319 National Monitoring Program projects. Project document lists appear in alphabetical order by state.

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Appendix V

Matrix for Section 319 National Monitoring Program Projects

PROJECT	BASIN SIZE	DESIGNATED BENEFICIAL USES	WATER QUALITY PROBLEM
Alabama: Lightwood Knot Creek	74 sq. miles	◆Recreation ◆Aquatic life support	◆Sediment ◆Nutrients ◆Bacteria
Arizona: Oak Creek Canyon	9 sq. miles	◆Recreation (primary contact) ◆Aquatic life support ◆Drinking water supply	◆Bacteria ◆Nutrients
California: Morro Bay Watershed	76 sq. miles	◆Endangered species habitat ◆Shellfish harvesting ◆Recreation (primary and secondary contact) ◆Esturine and fresh water habitat	◆Sediment ◆Nutrients
Connecticut: Jordan Cove Urban Watershed	less than 1 sq. mile	◆Shellfish harvesting	◆Sediment ◆Fecal coliform ◆Nutrients
Idaho: Eastern Snake River Plain	9,600 sq. miles (aquifer)	◆Drinking water supply (ground water)	◆Nitrates ◆Low-level pesticide concentrations
Illinois: Lake Pittsfield	11 sq. miles	◆Drinking water supply ◆Recreation (primary and secondary contact)	◆Sediment ◆Nutrients
Illinois: Waukegan River	12 sq. miles	◆Aquatic life support	◆Sediment ◆Loss of physical habitat
Iowa: Sny Magill Watershed	36 sq. miles	◆Aquatic life support ("put and take" recreational trout fishing)	◆Sediment ◆Nutrients ◆Animal wastes ◆Pesticides
Iowa: Walnut Creek	45 sq. miles	◆Aquatic life support	◆Sediment ◆Nutrients ◆Herbicides
Maryland: Warner Creek Watershed	1 sq. miles	◆Aquatic life support	◆Sediment ◆Nitrogen ◆Phosphorus
Michigan: Sycamore Creek Watershed	106 sq. miles	◆Aquatic life support ◆Recreation (primary contact)	◆Sediment ◆Dissolved Oxygen

SOURCE OF POLLUTANT	WATER QUALITY OBJECTIVES	WATER QUALITY MONITORING DESIGN
•Agricultural fields •Poultry operations	•Erosion control	•2 Paired sites — 2 control / 2 treatment
•Sediment •Septic systems	•Reduce fecal coliform by 50% •Reduce nutrient levels by 20% •Reduce automobile-related pollutants by 25% •Reduce BOD by 20%	•Upstream / downstream
•Cattle grazing •Roads •Streambank erosion and mass wasting	•Reduce sediment by 20-30%	•1 Paired site 1 control / 1 treatment •1 Single site •2 Upstream/downstream
•Construction •Urban runoff	•Retain sediment on site during construction •Reduce nitrogen by 65% •Reduce bacteria by 85% •Reduce phosphorus by 40%	•1 Paired site 1 control / 2 treatment
•Irrigated cropland	•Evaluate the effects of irrigation water management on nitrate-N ground water leaching •Evaluate the effects of crop rotation on nitrate-N ground water leaching •Decrease nitrate and pesticide concentrations	•2 Paired 5 acre plots 2 control / 2 treatment
•Cropland •Small livestock operations	•Reduce sediment loads into lake •Evaluate the effectiveness of sediment retention basins	•7 Single stations •3 Lake stations
•Streambank erosion	•Restore streambanks •Reduce or mitigate stormwater runoff	•Upstream / downstream
•Cropland •Livestock operations •Streambank erosion	•Reduce sediment by 50% •Reduce nitrogen, phosphorus, and pesticide by 25%	•Paired watershed 1 control / 1 treatment •Upstream/downstream on subbasins
•Cropland	•Reduce sediment, nitrogen, and phosphorus	•Paired watershed 1 control / 1 treatment
•Dairy operations	•Develop and validate a hydrologic and water quality model capable of predicting effects of BMP on WQ •Collect WQ data for use in model validation •Illustrate relationships between BMP and WQ	•Paired watershed 1 control / 1 treatment •Upstream/downstream on Warner Creek
•Streambanks •Urban areas •Cropland and cattle access	•Reduce impact of agricultural NPS pollutants on surface and ground water on Sycamore Creek •Reduce sediment in Sycamore Creek by 52% •Reduce peak flows •Improve instream aquatic habitat	•Paired watersheds 1 control / 2 treatment

PROJECT	SAMPLING SCHEME	PRIMARY WATER QUALITY PARAMETERS
Alabama: Lightwood Knot Creek	•Weekly April-August •DS, TSS, and explanatory variables monitored remainder of year	NH_3, NO_2, $NO_3 + NO_2$, OP, TP, Turbidity, TSS, FC, FS, TKN
Arizona: Oak Creek Canyon	•Weekly grab samples from May 15 - Sept.15	FC, NO_3, OP, TN, TP, NH_3, BOD
California: Morro Bay Watershed	•Storm events (30 min. intervals) •20 Weekly grab samples (start Nov.) •Macroinvertebrate and habitat monitoring	SS, Turbidity, NO_3, FC, Riparian Vegetation, Upland Rangeland Vegetation, Benthic Macroinvertebrate
Connecticut: Jordan Cove Urban Watershed	•Storm event (flow-weighted composite samples) •Grab samples (Bacteria & BOD) •Monthly composite samples	TSS, TP, TKN, NH_3, $NO_3 + NO_2$, FC
Idaho: Eastern Snake River Plain	•Monthly groundwater grab samples •Growing season soil water samples	NO_3, Organic Pesticides, DO, TKN
Illinois: Lake Pittsfield	•Storm events (automatic samplers) •Base flow sampled monthly •Lake grab samples monthly from April - October	OP, TP, NH_3, TKN, $NO_3 + NO_2$, TSS, VSS, SS, DP
Illinois: Waukegan River	•Seasonal biological parameters •Continuous flow	Fish Samples, Macroinveterbrates, Habitat, DO, Temperature, Flow
Iowa: Sny Magill Watershed	•Continuous stage, daily discharge and suspended sediment measurements •Weekly grab samples •Annual habitat assessment •Annual fisheries survey •Bi-monthly macroinvertebrates	FC, Habitat Assessment, Fisheries Survey, Benthic Macroinvertebrates, Sediment, TP, Nitrogen (N) Series, BOD, Herbicides
Iowa: Walnut Creek	•Water discharge and suspended sediment monitored daily at watershed outlets •Six surface water stations monthly (March, April, July, Sept.) and twice per month (May, June)	NO_3, OP, Turbidity, SS, Pesticides, NH_3, BOD, Macroinvertebrates, Fisheries
Maryland: Warner Creek Watershed	•Automated storm event - weekly from Feb.-June; bi-weekly remainder of year •Grab - weekly from Feb.-June; bi-weekly remainder of year	NH_3, TKN, $NO_3 + NO_2$, NO_3, OP, TKP, Sediment
Michigan: Sycamore Creek Watershed	•Storm events (1-2 hr. intervals) using automated samplers March - July •20 Evenly spaced weekly grab samples	Turbidity, TSS, TP, TKN, $NO_3 + NO_2$, OP, NH_3

BMP	MAJOR IMPLEMENTING INSTITUTIONS	PROJECT TIME FRAME
•Runoff and sediment control structures •Critical area planning •Cover and green manure crops •Pasture and hayland management	•Geological Survey of Alabama •USDA NRCS •USDA FSA •Covington County Extension	Jan. 1996- Dec. 1996 319 Project Approval 1996
•Enhance rest room facilities •Install showers •Enforce litter laws •Upgrade septic systems	•AZ Department of Environmental Quality •Northern Arizona University	1994-2001 319 Project Approval 1994
•Riparian cattle exclusion •Riparian pasture development •Rotational grazing of pasture •Floodplain restoration	•California Polytechnic State University •Central Coast Regional Water Quality Control Board •USDA NRCS	1993 - 2003 319 Project Approval 1993
•Phased grading •Seeding •Sediment detention basins and swales •Roof runoff dry wells •Gravel pack shoulders on access roads •Post-construction practices	•Aqua Solutions •USDA NRCS •Univ. of Connecticut, Dept. of Natural Resources •Connecticut Cooperative Extension Service •Boise State University	1996-2006 319 Project Approval 1996
•Decrease water use •Pesticide management strategies •Fertilizer evaluations and recommendations •Crop rotations	•Division of Environmental Quality •U. of Idaho Cooperative Extension Service •USDA NRCS	Oct. 1991 - Oct. 1997 319 Project Approval 1992
•Sediment retention basins •Conservation tillage •Integrated crop management •Livestock exclusion •Filter strips •Wildlife habitat management	•IL Environmental Protection Agency •IL State Water Survey •Pike Co. Soil and Water Conservation District	1994-1999 319 Project Approval 1994
•Runoff and sediment control structures	•IL Environmental Protection Agency •IL State Water Survey •IL Department of Conservation	1994-1999 319 Project Approval 1996
•Structural erosion control practices •Farmstead assessment •Water and sediment control structures •Animal waste management systems •Education and assistance	•IA DNR-Geologic Survey Bureau •IA State University Extension •USDA NRCS (319 Project is part of the Sny Magill Hydrologic Unit Area Project and North Cedar Creek Ag. Conservation. Program-WQ Special Project)	1991-unknown (Approximately 10 yrs. with funding) 319 Project Approval 1992
•Conversion of cropland to native tall grass prairie •Restore wetlands and riparian zones	•IA DNR-Geological Survey Bureau	Oct. 1994- Sept. 1998 319 Project Approval 1996
•Conversion of cropland to pasture •Installation of watering systems •Fencing to exclude livestock from streams •Manure slurry storage tanks	•MD Department of the Environment •U. of Maryland Agricultural Engineering	May 1993 - June 1997 319 Project Approval 1995
•Diversions •Cropland protective cover •Reduced tillage •No-till systems •Water and sediment control structures	•Ingham Co Soil Conservation District •Michigan Department of Natural Resources •Michigan State University Extension — Ingham County •USDA NRCS	1993 -1997 319 Project Approval 1993

PROJECT	BASIN SIZE	DESIGNATED BENEFICIAL USES	WATER QUALITY PROBLEM
Nebraska: Elm Creek Watershed	56 sq. miles	•Recreation •Aquatic life support (coldwater trout habitat)	•Sediment •Increased water temperatures •High peak flows
North Carolina: Long Creek Watershed	44 sq. miles	•Drinking water supply •Aquatic life support	•Sediment •Bacteria •Nutrients
Oklahoma: Peacheater Creek	25 sq. miles	•Recreation •Aquatic life support	•Nutrient enrichment •Loss of in-stream habitat •Loss of water clarity •Nuisance periphyton growth
Oregon: Upper Grande Ronde Basin	695 sq. miles	•Aquatic life support •Coldwater fish •Drinking water supply •Recreation (primary and secondary) •Wildlife habitat	•Water temperature •Loss of physical habitat •Loss of riparian vegetation
Pennsylvania: Pequea and Mill Creek Watersheds	3.2 sq. miles	•Aquatic life support •Wildlife habitat •Agriculture	•Nutrients •Bacteria •Organic enrichment
South Dakota: Bad River	5 sq. miles	•Aquatic life support •Recreation •Irrigation	•Sediment •Loss of channel capacity •Loss of water clarity
Vermont: Lake Champlain Basin Watersheds	12 sq. miles total	•Aquatic life support •Lake Champlain recreation and aesthetics (NPS pollutant loading)	•Nutrients (particularly phosphorus) •Bacteria •Organic matter
Washington: Totten and Eld Inlet Clean Water Projects	Totten=69 sq. miles Eld=36 sq. miles	•Shellfish harvesting •Recreation (primary and secondary) •Wildlife habitat	•Bacteria
Wisconsin: Otter Creek	Otter Creek = 11 sq. miles Meeme Creek = 16 sq. miles	•Aquatic life support •Recreation (secondary contact)	•Sediment •Phosphorus •Bacteria

SOURCE OF POLLUTANT	WATER QUALITY OBJECTIVES	*WATER QUALITY* MONITORING DESIGN
•Cropland •Rangeland •Streambank erosion •Irrigation return flows	•Implement appropriate and feasible NPS control measures for protection and enhancement of WQ •Reduce summer max. water temperature •Reduce instream sedimentation	•Upstream/downstream •Single downstream station
•Cropland •Dairy operations •Pastures •Streambank erosion •Urbanization	•Quantify the effects of NPS pollution controls on: -Bacteria, sediment, and nutrient loading to a stream from a local dairy farm -Sediment and nutrient loss from field with a long history of manure application -Sediment loads from the water supply watershed •Reduce sediment yield by 60%	•Paired watershed 1 control / 1 treatment •Single downstream station •Upstream/downstream
•Poultry houses •Dairies •Septic systems	•Restore recreational and aquatic life beneficial uses •Minimize eutrophication impacts	•Paired watershed 1 control / 1 treatment
•Grazing practices •Channel modifications	•Improve salmonid and aquatic macroinvertebrate communities •Quantitatively document a cause & effect relationship between improved habitat, lower water temperatures, & improved salmonid & macroinvertebrate communities	•Paired watershed 1 control / 1 treatment •Upstream/downstream •3 Single stations
•Dairy operations •Pastures	•Document the effectiveness of livestock exclusion fencing at reducing NPS pollution in a stream •Reduce annual total ammonia plus organic nitrogen and total phosphorus loads by 40%	•Paired watershed 1 control / 1 treatment
•Cropland •Rangeland •Grazing practices	•Document water quality improvements through riparian and rangeland management	•Two-paired watershed 2 control / 2 treatment
•Streambanks •Dairy operations •Livestock activity within stream and riparian areas •Cropland	•Quantitative assessment of the effectiveness of two livestock/grazing management practices •Document changes in nutrients, bacteria, and sediment concentrations and loads due to treatment •Evaluate response of stream biota to treatment	•Three-way paired watershed design 1 control / 2 treatment
•Livestock operations	•Reduce median 1992-93 fecal coliform values on: -Pierre Creek by 69% -Burns Creek by 63% -Schneider Creek by 50% -McLane Creek by 44%	•Paired watershed 1 control / 1 treatment •4 Single stations
•Cropland •Dairy operations •Streambank erosion	•Increase numbers of intolerant fish species •Improve recreational uses •Reduce loading to the Sheboygan River and Lake Michigan •Restore riparian vegetation	•Paired watershed 1 control / 1 treatment •Above and below •Single station

PROJECT	SAMPLING SCHEME	PRIMARY WATER QUALITY PARAMETERS
Nebraska: Elm Creek Watershed	•Weekly grab samples April - September •Seasonal biological, habitat data collection, and stream morphology	Qualitative and Quantitative Macroinvertebrate Sampling, Fish Collections, Creel Survey Substrate Samples, TSS, Morphology Characteristics, Water Temperature
North Carolina: Long Creek Watershed	•Weekly grab Dec.- May and monthly remainder of year •Stage activated storm event and weekly grab Dec. - May (year-round on trib.) •Annual biological survey	Percent Canopy and Aufwuchs, Invertebrate Taxa Richness, FC, FS, TSS, TS, DO, $NO_3 + NO_2$, TKN, TP, Temperature
Oklahoma: Peacheater Creek	•Weekly July-Jan. and monthly Feb.-June •During storm events •Biological monitoring sampling scheme varies with parameter	Periphyton Productivity, Fisheries Survey, Macro-invertebrate Survey, Habitat Assessment, Bank Erosion, Turbidity, DO, TKN, TP, $NO_3 + NO_2$, TSS
Oregon: Upper Grande Ronde Basin	•Early April-early Oct. Continuous water temperature •3 times during monitoring season for habitat/biological/water chemistry	Habitat, Macroinvertebrate, Fish, Water Temperature, pH
Pennsylvania: Pequea and Mill Creek Watersheds	•Grab samples every 10 days April - Nov. •Storm event composite •Monthly grab Dec. - March •Macroinvertebrate and habitat May and Sept.	SS, Total and Dissolved Ammonia plus Organic Nitrogen, Dissolved NH_3, Dissolved $NO_3 + NO_2$, Dissolved NO_3, Dissolved OP, Total and Dissolved P
South Dakota: Bad River	•During storm events •24-hour composite samples twice during first week of spring snowmelt and once per week until runoff ceases	TSS, Stream Discharge, Rainfall, Riparian Condition
Vermont: Lake Champlain Watersheds	•Automated continuous sampling stations •Weekly flow-proportional sampling •Twice weekly grab sampling •Macroinvertebrates once per year	FC, FS, E. Coli, Macroinvertebrates, Fish, TKN, TSS, TP, DO
Washington: Totten and Eld Inlet Clean Water Projects	•20 Weekly grab samples (Nov. to mid-April) •6 Storm events	FC
Wisconsin: Otter Creek	•Storm event •Grab samples (various timing) •Fisheries, macroinvertebrate and habitat monitoring yearly or every other year	Dissolved P, TKN, NH_3, Nitrogen Series, Turbidity, TSS, DO, FC, TP

BMP	MAJOR IMPLEMENTING INSTITUTIONS	PROJECT TIME FRAME
•Conventional BMP •WQ and runoff control structures •WQ land treatment •Conventional WQ management practices	•NE Department of Environmental Quality •USDA NRCS •Webster County Extension	April 1992 - 1996 (2 additional years contingent upon funding) 319 Project Approval 1992
•Land use requirements upstream of intake •Comprehensive nutrient management •Waste holding structures •Pasture management and livestock exclusion	•Gaston Co. Cooperative Extension •NC Cooperative Extension Service •NC Division of Water Quality •USDA NRCS	January 1993- Sept. 2001 319 Project Approval 1992
•Buffer zones and fencing along streams •Planned grazing systems •Animal waste mgt. planning & structures •Watering facilities •Critical area vegetation •Soil testing	•OK Conservation Commission •Cherokee & Sequoyah Cty. Conservation Dist. •USDA NRCS •Adair County Extension Service •Oklahoma State University	1995-2000 319 Project Approval 1995
•Streambank stabilization •Riparian revegetation	•OR Dept. of Fish and Wildlife •USDA NRCS •Local Soil & Water Conservation Districts (SWCDs) •Confederated Tribes of the Umatilla Indian Reservation (CTUIR)	Pending 319 Project Approval
•Streambank fencing on 100% of pasture land adjacent to the stream draining the treatment watershed	•PA Department of Environmental Protection-Bureau of Land and Water Conservation •USDA NRCS •USGS •PA State University Coop. Extension Service •Lancaster Conservation District	October 1993 - Sept. 1998 -2001 319 Project Approval 1993
•Cross-fencing •Riparian vegetation •Alternative feeding and watering sites	•SD Dept. of Environment and Natural Resources •USDA NRCS •Upper Bad River Task Force •East Pennington Conservation District	1996 - 2006 319 Project Approval 1996
•Livestock exclusion/stream bank protection •Intensive grazing management	•Franklin County Conservation District •U. of Vermont School of Natural Resources •USDA NRCS •VT Department of Environmental Conservation	Sept. 1993 - Sept. 1999 319 Project Approval 1993
•Repair failing on-site sewage systems •Implement farm plans on priority farm sites	•WA Department of Ecology •Thurston County Environmental Health Services •Thurston Conservation District •USDA NRCS	1993 - 2002 319 Project Approval 1995
•Shoreline and streambank stabilization •Barnyard runoff management and manure storage facilities •Grassed waterways •Reduced tillage •Nutrient and pesticide management	•Sheboygan Co. Land Conservation Committees •U. of Wisconsin Extension •USGS •WI Department of Natural Resources	Spring 1994- Spring 2001 319 Project Approval 1993